Executive Council

Sixty-ninth session

Geneva

10–17 May 2017

Abridged final report with resolutions and decisions

WEATHER CLIMATE WATER

WORLD
METEOROLOGICAL
ORGANIZATION

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This report contains the text as adopted by Plenary and has been issued without formal editing. Acronyms used in this report may be found in METEOTERM, the WMO terminology database, at http://public.wmo.int/en/resources/meteoterm.

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GENERAL SUMMARY OF THE WORK OF THE SESSION

1. The WMO President, Mr D. Grimes, opened the sixty-ninth session of the Council on Wednesday, 10 May 2017 at 9:30 a.m. in the WMO headquarters building in Geneva. The President welcomed the Council and other participants. In referring to the unprecedented concurrent vacancies of the three Vice-President positions of the Organization, the President expressed appreciation to the former Vice-Presidents for their contributions, and advised of the election by correspondence process, undertaken to fill the positions. The President highlighted the key thematic areas that would be covered during the session including in the areas of Strategic Planning, Governance and Budget, advancing on the Public-Private Engagement with the development of a draft Framework and the convening of a one-day Special Dialogue on Aviation services focusing on the implications and expectations for the provision of meteorological services beyond quality management and competencies. He further underscored recent and forthcoming developments and events related to WMO priorities including in the areas of water, climate and disaster risk reduction and noted the growing relevance of societal needs and priorities identified in WMO planning. The Secretary-General, Mr P. Taalas, welcomed the Council to Geneva and called members' attention on the most important challenges for the Organization, in particular the reform of the constituent bodies, the improvement of working procedures and practices to better serve its customers, and the relationship with the private sector. He underlined the growing impacts of climate change and natural disasters, noting the opportunities arising for WMO to contribute its expertise to address these issues and to support the objectives of the global sustainable development agenda.

2. The agenda is provided in Appendix 1.

3. The session adopted 23 resolutions (see Appendix 2) and 76 decisions (see Appendix 3).

4. The list of participants is provided in Appendix 4. Of the Council members, 15% were women, and in total women represented 23% of participants.

5. The Council agreed that the seventieth session would be held at the WMO headquarters from 20 to 29 June 2018. The session of the Financial Advisory Committee will be held on 18-19 June 2018.

6. The Council further tentatively scheduled the seventy-first session to be held at the WMO headquarters from 17 to 19 June 2019 following the Eighteenth Congress that will be held on 5–14 June 2019.

7. The sixty-ninth session of the Executive Council closed at 17:05 on 17 May 2017.

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APPENDIX 2. RESOLUTIONS ADOPTED BY THE SESSION

Resolution 1 (EC-69)

MANUAL ON THE WMO INTEGRATED GLOBAL OBSERVING SYSTEM (WMO-No. 1160), SECTION 2 AND SECTION 8

THE EXECUTIVE COUNCIL,

Noting:

(1) Articles 2 (a), 2 (c) and 8 (d) of the Convention of the World Meteorological Organization,

(2) Resolution 26 (Cg-17) – *Technical Regulations* (WMO-No. 49) – Manual on the WMO Integrated Global Observing System,

(3) Resolution 2 (EC-68) – Plan for the WMO Integrated Global Observing System pre-operational phase 2016–2019,

Having considered:

(1) Recommendation 1 (CBS-16) – *Manual on the WMO Integrated Global Observing System* (WMO-No. 1160), Section 2, Appendix 2.4 and attachment to Appendix 2.4 (WIGOS Metadata Standard),

(2) Recommendation 2 (CBS-16) – *Manual on the WMO Integrated Global Observing System* (WMO-No. 1160), Section 8,

Decides to adopt the updated Appendix 2.4 and the attachment to Appendix 2.4 as provided in the annex to the present resolution, and the updated Section 8 of the *Manual on the WMO Integrated Global Observing System* as also provided in the annex to the present resolution, with effect from 1 January 2018;

Decides also that the attachment to Appendix 2.4 will be extracted from the Manual and be processed separately as a stand-alone attachment in order to facilitate frequent updating of its technical content, and that the code tables from the current annex to the attachment to Appendix 2.4 be removed and included in the *Manual on Codes* (WMO-No. 306);

Authorizes the Secretary-General to make any subsequent purely editorial amendments;

Requests the Secretary-General:

(1) To publish the updated *Manual on the WMO Integrated Global Observing System* in all WMO official languages;

(2) To ensure the editorial consistency of the relevant documents.

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Note: The present resolution replaces Resolution 26 (Cg-17), which is no longer in force.

Annex to Resolution 1 (EC-69)

***MANUAL ON THE WMO INTEGRATED GLOBAL OBSERVING SYSTEM* (WMO-NO. 1160), SECTION 2 AND SECTION 8**

SECTION: Cover red

Manual on the WMO Integrated Global Observing System

Annex VIII to the WMO Technical Regulations

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Manual on the WMO Integrated Global Observing System

Annex VIII to the WMO Technical Regulations

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PUBLICATION REVISION TRACK RECORD

TABLE: Revision table

Date	*Part/chapter/ section*	*Purpose of amendment*	*Proposed by*	*Approved by*
	Section 2, Appendix 2.4	Further development of the WIGOS Metadata Standard and OSCAR/Surface	ICG-WIGOS (CBS-16)	
	Section 8	Modifications of the CryoNet station/site concept, of minimum requirements for stations/sites and of the procedure for testing stations/sites	EC-PHORS (CBS-16)	

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INTRODUCTION

General

1. This is the first edition of the *Manual on the WMO Integrated Global Observing System* (WMO-No. 1160), developed following the decision of the Sixteenth World Meteorological Congress to proceed with the implementation of that System (WIGOS). It was approved by the Seventeenth World Meteorological Congress.

2. The Manual was developed by the Executive Council through its Inter-Commission Coordination Group on WIGOS, specifically its Task Team on WIGOS Regulatory Material. It is the result of a collaborative approach involving all interested technical commissions under the leadership of the Commission for Basic Systems (CBS) and the Commission for Instruments and Methods of Observation (CIMO).

Purpose and scope

3. The Manual is designed:

(a) To specify the obligations of Members in the implementation and operation of WIGOS;

(b) To facilitate cooperation in observations between Members;

(c) To ensure adequate uniformity and standardization in the practices and procedures employed in achieving (a) and (b) above.

4. The Manual is Annex VIII to the *Technical Regulations* (WMO-No. 49) and should be read in conjunction with the four volumes and the set of annexes which together make up the *Technical Regulations*. In particular, the *Manual on the Global Observing System* (WMO-No. 544) will be for some time a companion to the present Manual, but it will eventually disappear as its content is progressively moved into the *Manual on the WMO Integrated Global Observing System*. Gradually, all technical regulations for all WMO component observing systems will be included under the identity of WIGOS.

5. Members will implement and operate their observing systems in accordance with decisions of Congress, the Executive Council, the technical commissions and regional associations. Where those decisions are technical and regulatory in nature, they will in due course be documented in the Technical Regulations.

6. In essence, the Manual specifies what is to be observed, and what practices and procedures are to be followed in order to meet the relevant observational requirements of Members. These requirements may arise directly at a national level or collectively through WMO Programmes at global or regional levels, and are expressed through the application areas of the Rolling Review of Requirements. A number of other Manuals and Guides provide more practices and procedures on the operation of observing systems including stations and

platforms, instruments and methods of observation, and on reporting and management of observations and observational metadata.

7. In the case of hydrological observations, there is not a widely implemented base of global exchange and global standard practices and procedures. *Technical Regulations* (WMO-No. 49), Volume III: Hydrology, provides Members with predominantly recommended practices and procedures. In order to help ensure the quality and comparability of observations within WIGOS, Members making their hydrological observations available through the WMO Hydrological Observing System (WHOS) are requested to comply with the provisions specified within the present Manual. For this reason, a number of provisions that are recommended practices and procedures for hydrology in *Technical Regulations*, Volume III, are listed as standard practices and procedures in the present Manual. It is recognized that it might not be easy for some of the WIGOS standard practices and procedures to be widely and quickly implemented by all Members for their hydrological observations. Nonetheless, Members are urged to make their best efforts to implement the WIGOS standard practices and procedures in the collection and exchange of hydrological observations and to make such observations available through WHOS.

Appendices

8. Appendices are used where a set of provisions on a single topic might, due to their detailed nature and length, otherwise interrupt the flow of the relevant section of the present Manual. Moreover, appendices are used to facilitate the ongoing review and update process by identifying subsections that fall under the responsibility of a particular group.

SECTION: Pr-Preliminary_pages

Chapter title in running head: GENERAL PROVISIONS

GENERAL PROVISIONS

1. The *Technical Regulations* (WMO-No. 49) of the World Meteorological Organization are presented in four volumes:

Volume I – General meteorological standards and recommended practices

Volume II – Meteorological service for international air navigation

Volume III – Hydrology

Volume IV – Quality management

Purpose of the Technical Regulations

2. The Technical Regulations are determined by the World Meteorological Congress in accordance with Article 8 (d) of the Convention.

3. These Regulations are designed:

(a) To facilitate cooperation in meteorology and hydrology among Members;

(b) To meet, in the most effective manner, specific needs in the various fields of application of meteorology and operational hydrology in the international sphere;

(c) To ensure adequate uniformity and standardization in the practices and procedures employed in achieving (a) and (b) above.

Types of Regulations

4. The Technical Regulations comprise *standard* practices and procedures and *recommended* practices and procedures.

5. The definitions of these two types of Regulations are as follows:

The *standard* practices and procedures:

(a) Shall be the practices and procedures that Members are required to follow or implement;

(b) Shall have the status of requirements in a technical resolution in respect of which Article 9 (b) of the Convention is applicable;

(c) Shall invariably be distinguished by the use of the term *shall* in the English text, and by suitable equivalent terms in the Arabic, Chinese, French, Russian and Spanish texts.

The *recommended* practices and procedures:

(a) Shall be the practices and procedures with which Members are urged to comply;

(b) Shall have the status of recommendations to Members, to which Article 9 (b) of the Convention shall not be applied;

(c) Shall be distinguished by the use of the term *should* in the English text (except where otherwise provided by decision of Congress) and by suitable equivalent terms in the Arabic, Chinese, French, Russian and Spanish texts.

6. In accordance with the above definitions, Members shall do their utmost to implement the *standard* practices and procedures. In accordance with Article 9 (b) of the Convention and in conformity with Regulation 128 of the General Regulations, Members shall formally notify the Secretary-General, in writing, of their intention to apply the *standard* practices and procedures of the Technical Regulations, except those for which they have lodged a specific deviation. Members shall also inform the Secretary-General, at least three months in advance, of any change in the degree of their implementation of a *standard* practice or procedure as previously notified and the effective date of the change.

7. Members are urged to comply with *recommended* practices and procedures, but it is not necessary to notify the Secretary-General of non-observance except with regard to practices and procedures contained in Volume II.

8. In order to clarify the status of the various Regulations, the *standard* practices and procedures are distinguished from the *recommended* practices and procedures by a difference in typographical practice, as indicated in the editorial note.

Status of annexes and appendices

9. The following annexes to the *Technical Regulations* (Volumes I to IV), also called Manuals, are published separately and contain regulatory material having the status of *standard* and/or *recommended* practices and procedures:

I *International Cloud Atlas* (WMO-No. 407), Volume I – Manual on the Observation of Clouds and Other Meteors, Part I; Part II: paragraphs II.1.1, II.1.4, II.1.5 and II.2.3; subparagraphs 1, 2, 3 and 4 of each paragraph from II.3.1 to II.3.10; paragraphs II.8.2 and II.8.4; Part III: paragraph III.1 and the definitions (in italics) of paragraph III.2;

II *Manual on Codes* (WMO-No. 306), Volume I;

III *Manual on the Global Telecommunication System* (WMO-No. 386);

IV *Manual on the Global Data-processing and Forecasting System* (WMO-No.485), Volume I;

V *Manual on the Global Observing System* (WMO-No. 544), Volume I;

VI *Manual on Marine Meteorological Services* (WMO-No. 558), Volume I;

VII *Manual on the WMO Information System* (WMO-No. 1060);

VIII *Manual on the WMO Integrated Global Observing System* (WMO-No. 1160).

These annexes (Manuals) are established by decision of Congress and are intended to facilitate the application of Technical Regulations to specific fields. Annexes may contain both *standard* and *recommended* practices and procedures.

10. Texts called appendices, appearing in the *Technical Regulations* or in an annex to the *Technical Regulations*, have the same status as the Regulations to which they refer.

Status of notes and attachments

11. Certain notes (preceded by the indication "Note") are included in the *Technical Regulations* for explanatory purposes; they may, for instance, refer to relevant WMO Guides and publications. These notes do not have the status of Technical Regulations.

12. The *Technical Regulations* may also include attachments, which usually contain detailed guidelines related to *standard* and *recommended* practices and procedures. Attachments, however, do not have regulatory status.

Updating of the *Technical Regulations* and their annexes (Manuals)

13. The Technical Regulations are updated, as necessary, in the light of developments in meteorology and hydrology and related techniques, and in the application of meteorology and operational hydrology. Certain principles previously agreed upon by Congress and applied in the selection of material for inclusion in the Technical Regulations are reproduced below. These principles provide guidance for constituent bodies, in particular technical commissions, when dealing with matters pertaining to the Technical Regulations:

(a) Technical commissions should not recommend that a Regulation be a *standard* practice unless it is supported by a strong majority;

(b) Technical Regulations should contain appropriate instructions to Members regarding implementation of the provision in question;

(c) No major changes should be made to the Technical Regulations without consulting the appropriate technical commissions;

(d) Any amendments to the Technical Regulations submitted by Members or by constituent bodies should be communicated to all Members at least three months before they are submitted to Congress.

14. Amendments to the *Technical Regulations* – as a rule – are approved by Congress.

15. If a recommendation for an amendment is made by a session of the appropriate technical commission and if the new regulation needs to be implemented before the next session of Congress, the Executive Council may, on behalf of the Organization, approve the amendment in accordance with Article 14 (c) of the Convention. Amendments to annexes to the *Technical Regulations* proposed by the appropriate technical commissions are normally approved by the Executive Council.

16. If a recommendation for an amendment is made by the appropriate technical commission and the implementation of the new regulation is urgent, the President of the Organization may, on behalf of the Executive Council, take action as provided by Regulation 9 (5) of the General Regulations.

Note: A fast-track procedure can be applied for additions to certain codes and associated code tables contained in Annex II (*Manual on Codes* (WMO-No. 306)). Application of the fast-track procedure is described in detail in Annex II.

17. After each session of Congress (every four years), a new edition of the *Technical Regulations*, including the amendments approved by Congress, is issued. With regard to the amendments between sessions of Congress, Volumes I, III and IV of the *Technical Regulations* are updated, as necessary, upon approval of changes thereto by the Executive Council. The *Technical Regulations* updated as a result of an approved amendment by the Executive Council are considered a new update of the current edition. The material in Volume II is prepared by the World Meteorological Organization and the International Civil Aviation Organization working in close cooperation, in accordance with the Working Arrangements agreed by these Organizations. In order to ensure consistency between Volume II and Annex 3 to the

Convention on International Civil Aviation – *Meteorological Service for International Air Navigation*, the issuance of amendments to Volume II is synchronized with the respective amendments to Annex 3 by the International Civil Aviation Organization.

Note: Editions are identified by the year of the respective session of Congress whereas updates are identified by the year of approval by the Executive Council, for example "Updated in 2012".

WMO Guides

18. In addition to the *Technical Regulations*, appropriate Guides are published by the Organization. They describe practices, procedures and specifications which Members are invited to follow or implement in establishing and conducting their arrangements for compliance with the Technical Regulations, and in otherwise developing meteorological and hydrological services in their respective countries. The Guides are updated, as necessary, in the light of scientific and technological developments in hydrometeorology, climatology and their applications. The technical commissions are responsible for the selection of material to be included in the Guides. These Guides and their subsequent amendments shall be considered by the Executive Council.

SECTION: Pr-Preliminary_pages

Chapter title in running head: DEFINITIONS

DEFINITIONS

Notes:

1. Other definitions related to observing systems may be found in the *Technical Regulations* (WMO-No. 49), Volume I and the *Manual on the Global Observing System* (WMO-No. 544), Volume I. Definitions are not duplicated between Manuals, hence the importance of consulting all publications.
2. Further definitions may be found in the *Manual on Codes* (WMO-No. 306), the *Manual on the Global Data-processing and Forecasting System* (WMO-No. 485), Volume I, the *Manual on the Global Telecommunication System* (WMO-No. 386) and other WMO publications.
3. Definitions, terminology, vocabulary and abbreviations used in relation to quality management are those of the International Organization for Standardization (ISO) 9000 family of standards for quality management systems, in particular those identified within *ISO 9000:2005, Quality management systems – Fundamentals and vocabulary*.

The following terms, when used in the present Manual, have the meanings given below.

Accuracy. The extent to which the results of the readings of an instrument approach the true value of the calculated or measured quantities, supposing that all possible corrections are applied.

Acoustic Doppler current profiler (ADCP). Hydroacoustic device to measure the velocity of water over a range of depths in a column using the Doppler effect, with the overall depth of water usually being measured simultaneously.

Acoustic velocity meter. System that uses the difference in travel time of acoustic (ultrasonic) pulses between transducers in a stream to determine the mean velocity on the signal path.

Adaptive maintenance. Modification of an instrument, software or other product, performed after installation to keep it usable in a changed or changing environment.

Bank. (1) Rising land bordering a river, usually to contain the stream within the wetted perimeter of the channel; (2) Margin of a channel on the left-hand (right-hand) side when facing downstream.

Cableway. Cable stretched above and across a stream, from which a current meter or other measuring or sampling device is suspended, and moved from one bank to the other, at predetermined depths below the water surface.

Calibration (rating) tank (Straight open tank). Tank containing still water through which a current meter is moved at a known velocity in order to calibrate the meter.

Catchment area. Area having a common outlet for its surface runoff.

Certification. The provision by an independent body of written assurance (a certificate) that the product, service or system in question meets specific requirements.

Compliance. Adherence to an internal code of conduct where employees follow the principles of one of the Quality Management Standards series (such as the ISO standards) or other internationally recognized practices and procedures. It could also be an external stamp of approval by an accreditation firm when customers or partners request documented proof of compliance.

Confidence level. Probability that the confidence interval includes the true value.

Control. Physical properties of a channel which determine the relationship between stage and discharge at a location in the channel.

Control structures. Artificial structures placed in a stream such as a low weir or flume to stabilize the stage-discharge relation, particularly in the low flow range, where such structures are calibrated by stage and discharge measurements taken in the field.

Co-sponsored observing system. An observing system from which some but not all observations are WMO observations.

Cross-section. Section perpendicular to the main direction of flow bounded by the free surface and wetted perimeter of the stream or channel.

Current meter. Instrument for measuring water velocity.

Current meter, propeller type. A current meter the rotor of which is a propeller rotating around an axis parallel to the flow.

Data archiving. Storage of data on a set of catalogued files which are held in some backup storage medium and not necessarily permanently online.

Data compatibility. The capacity for two systems to exchange data without having to be altered to do so and without any need for changes in data formats.

Data processing. Treatment of observational data until they are in a form ready to be used for a specific purpose.

Data quality objectives. Definition of the type, quality and quantity of primary data and derived parameters required to yield information that can be used to support decisions.

Discharge. Volume of water flowing through a river (or channel) cross-section per unit time.

Drainage basin. See **catchment area**

Elevation. Vertical distance of a point or level, on or affixed to the surface of the ground, measured from mean sea level.

Estuary. Broad portion of a stream near its outlet to a sea, lake or sabkha.

Flood. (1) Rise, usually brief, in the water level of a stream or water body to a peak from which the water level recedes at a slower rate; (2) Relatively high flow as measured by stage height or discharge.

Flood-proofing. Techniques for preventing flood damage in a flood-prone area.

Gauge boards (staff gauge). Graduated vertical scale, fixed to a staff or structure, on which the water level may be read.

Gauge datum. Vertical distance between the zero of a gauge and a certain datum level.

Gauging station. Location on a stream where measurements of water level and/or discharge are made systematically.

GAW Station Information System (GAWSIS). The official catalogue for monitoring sites, platforms or stations operating within the Global Atmosphere Watch (GAW) and related programmes, providing station metadata and serving as the clearing house for unique station identifiers. The GAW Station Information System represents the metadata source for OSCAR for GAW observations.

Hydrograph. Graph showing the variation in time of some hydrological data, such as stage, discharge, velocity and sediment load.

Hydrological forecast. Estimation of the magnitude and time of occurrence of future hydrological events for a specified period and for a specified locality.

Hydrological observation. Direct measurement or evaluation of one or more hydrological elements such as stage, discharge and water temperature.

Hydrological observing station. Place where hydrological observations or climatological observations for hydrological purposes are made.

Hydrological warning. Emergency information on an expected hydrological event that is considered to be dangerous.

Hydrometric station. Station gathering data on one or more parameters of water in rivers, lakes or reservoirs, such as stage, streamflow, sediment transport and deposition, water temperature and other physical or chemical properties of water, and characteristics of ice cover.

Intercomparison. A formalized process to assess the relative performance of two or more systems (observing, forecasting, etc.).

Moving-boat method. Method of measuring discharge which uses a boat to traverse the stream along the measuring section and continuously measure velocity, depth and distance travelled.

Quality. The degree to which a set of inherent characteristics fulfils requirements.

Quality assurance. That part of quality management focused on providing confidence that quality requirements will be fulfilled.

Quality control. That part of quality management focused on fulfilling quality requirements.

Quality management. The coordinated activities that direct and manage an organization with respect to quality.

Rating curve. Curve showing the relation between stage and discharge of a stream at a hydrometric station.

Recession. Period of decreasing discharge as indicated by the falling limb of a hydrograph starting from the peak.

Registration. Certification is very often referred to as registration in North America.

Reservoir. Body of water, either natural or man-made, used for storage, regulation and control of water resources.

River. Large stream that serves as the natural drainage for a basin.

Stage. See ***water level***.

Stage-discharge relation. Relationship between water level and discharge for a river cross-section, which may be expressed as a curve, a table or an equation.

Streamflow. General term for water flowing in a watercourse.

Uncertainty. Estimate of the range of values within which the true value of a variable lies.

Upstream. Direction from which a fluid is moving.

Verification. The process of establishing the truth, accuracy or validity of something.

Water level. Elevation of the free water surface of a water body relative to a datum level.

SECTION: Chapter First

Chapter title in running head: 1. INTRODUCTION TO WIGOS

1. INTRODUCTION TO WIGOS

1.1 PURPOSE AND SCOPE OF WIGOS

1.1.1 The WMO Integrated Global Observing System shall be a framework for all WMO observing systems and for WMO contributions to co-sponsored observing systems in support of all WMO Programmes and activities.

Note: The co-sponsored observing systems are the Global Climate Observing System (GCOS), the Global Ocean Observing System (GOOS) and the Global Terrestrial Observing System (GTOS), all joint undertakings of WMO and the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational, Scientific and Cultural Organization (UNESCO), the United Nations Environment Programme (UNEP) and the International Council for Science (ICSU).

1.1.2 The WMO Integrated Global Observing System shall facilitate the use by WMO Members of observations from systems that are owned, managed and operated by a diverse array of organizations and programmes.

1.1.3 The principal purpose of WIGOS shall be to meet the evolving requirements of Members for observations.

1.1.4 The interoperability (including data compatibility) of WIGOS component observing systems shall be achieved through their common utilization and application of internationally accepted standards and recommended practices and procedures. Data compatibility shall also be supported through the use of data representation standards.

1.2 WIGOS COMPONENT OBSERVING SYSTEMS

The component observing systems of WIGOS shall comprise the Global Observing System (GOS) of the World Weather Watch (WWW) Programme, the observing component of the Global Atmosphere Watch (GAW) Programme, the WMO Hydrological Observing System (WHOS) of the Hydrology and Water Resources Programme (HWRP) and the observing component of the Global Cryosphere Watch (GCW), including their surface-based and space-based elements.

Note: The above component systems include all WMO contributions to the co-sponsored systems, as well as to the Global Framework for Climate Services (GFCS) and the Global Earth Observation System of Systems (GEOSS).

1.2.1 The Global Observing System of the World Weather Watch

1.2.1.1 The Global Observing System shall be a coordinated system of observing networks, methods, techniques, facilities and arrangements for making observations on a worldwide scale and shall be one of the main components of the World Weather Watch.

1.2.1.2 The purpose of GOS shall be to provide the meteorological observations from all parts of the globe that are required by Member countries for operational and research purposes through all WMO and co-sponsored programmes.

1.2.1.3 The Global Observing System shall consist of: (a) a surface-based subsystem composed of regional basic and other networks of stations and platforms; and (b) a space-based subsystem composed of: (i) an Earth observation space segment; (ii) an associated ground system for data reception, dissemination and stewardship; and (iii) a user segment.

1.2.1.4 The Global Observing System shall comply with the provisions specified in sections 1, 2, 3, 4 and 5.

1.2.2 The Global Atmosphere Watch (observing component)

1.2.2.1 The Global Atmosphere Watch shall be a coordinated system of observing networks, methods, techniques, facilities and arrangements encompassing the many monitoring activities and scientific assessments devoted to the investigation of the chemical composition and related physical characteristics of the atmosphere.

Note: The GAW Programme has six focal areas: ozone, greenhouse gases, reactive gases, aerosols, ultraviolet (UV) radiation and total atmospheric deposition. The GAW stations in addition to measuring one or more of the parameters related to these areas may also measure ancillary variables such as radiation, radio nuclides and persistent organic pollutants.

1.2.2.2 The purpose of GAW shall be to provide data and other information on the chemical composition and related physical characteristics of the background, unpolluted atmosphere, as defined in section 6, from all parts of the globe, in order to reduce environmental risks to society and meet the requirements of environmental conventions, strengthen capabilities to predict the state of climate, weather and air quality, and contribute to scientific assessments in support of environmental policy.

1.2.2.3 The observing component of GAW shall consist of a surface-based system composed of networks for observation of specified variables, complemented by space-based observations.

1.2.2.4 The observing component of the GAW Programme shall be operated in accordance with the provisions specified in sections 1, 2, 3, 4 and 6.

1.2.3 The WMO Hydrological Observing System

1.2.3.1 The WMO Hydrological Observing System shall comprise hydrological observations, initially focusing on water level and discharge.

Note: The composition of WHOS is provided in *Technical Regulations* (WMO-No. 49), Volume III: Hydrology, Chapter D.1.2.

1.2.3.2 The WMO Hydrological Observing System shall expand to include other elements identified through the Rolling Review of Requirements (RRR) (described in section 2.2.4 and Appendix 2.3) at the national, regional and global levels.

1.2.3.3 The purpose of WHOS shall be to provide real-time stream data (both water level and discharge) from participating Members.

1.2.3.4 Members making their hydrological observations available through the WHOS shall comply with the provisions specified in sections 1, 2, 3, 4 and 7.

Note: The *Technical Regulations* (WMO-No. 49), Volume III: Hydrology, the *Guide to Hydrological Practices* (WMO-No. 168), the *Manual on Stream Gauging* (WMO-No. 1044) and the *Manual on Flood Forecasting and Warning* (WMO-No. 1072) provide the necessary information to operate hydrological stations to the prescribed standards.

1.2.4 The Global Cryosphere Watch (observing component)

1.2.4.1 The Global Cryosphere Watch shall be a coordinated system of observing networks, methods, techniques, facilities and arrangements encompassing monitoring and related scientific assessment activities devoted to the investigation of the cryosphere.

1.2.4.2 The purpose of the GCW shall be to provide data and other information on the cryosphere, from the local to the global scale, to improve understanding of its behaviour, interactions with other components of the climate system and impacts on society.

1.2.4.3 The GCW observing network and its standardized core network (CryoNet) shall build on existing observing programmes and promote the addition of standardized cryospheric observations to existing facilities.

1.2.4.4 The observing component of the GCW shall comply with the provisions specified in sections 1, 2, 3, 4 and 8.

1.3 GOVERNANCE AND MANAGEMENT

1.3.1 Implementation and operation of WIGOS

1.3.1.1 Members shall be responsible for all activities connected with the implementation and operation of WIGOS on the territory of their respective countries.

1.3.1.2 Members should, as far as possible, use national resources for the implementation and operation of WIGOS, but, where necessary and if so requested, assistance may be provided in part through:

(a) The WMO Voluntary Cooperation Programme (VCP);

(b) Other bilateral or multilateral arrangements/facilities including the United Nations Development Programme (UNDP), which should be used to the maximum extent possible.

1.3.1.3 Members should participate voluntarily in the implementation and operation of WIGOS outside the territories of individual countries (for example, outer space, oceans and the Antarctic), if they wish and are able to contribute by providing facilities and services, either individually or jointly.

1.3.2 WIGOS quality management

Notes:
1. Within the WMO Quality Management Framework (QMF), WIGOS provides the procedures and practices regarding to the quality of observations and observational metadata that should be adopted by Members in establishing their quality management system for the provision of meteorological, hydrological, climatological and other related environmental observations.

2. Section 2.6 contains detailed provisions for WIGOS quality management.

1.3.3 WIGOS high-level processes

Members should adopt a process-based approach to the management of WIGOS observing systems as described in Attachment 1.1.

SECTION: Chapter

Chapter title in running head: ATTACHMENT 1.1. WIGOS HIGH-LEVEL PROCES…

ATTACHMENT 1.1. WIGOS HIGH-LEVEL PROCESSES

Many of the WIGOS activities may be represented as a series of high-level processes.

The figure below **ELEMENT REF: 1 (Floating object)** provides a schematic description of the processes (horizontal bars), the collaborating entities (columns) and those primarily involved in each process (marked by solid circles). In reality, the processes have more complex interrelationships and sequences than shown by the arrows – the most extreme case being capacity development (including training) which is not shown as a step in the sequence since it provides important inputs to most of the other processes.

ELEMENT 1: Floating object (Automatic)

ELEMENT 2: Picture inline fix size

Element Image: 1160_Att_1_1_Fig_en.eps

END ELEMENT

Schematic representation of WIGOS high-level processes

END ELEMENT

These processes are carried out by Members through one of the following modes of collaboration:

- Data users in application areas: Members collaborate by selectively contributing application experts and information;

- WMO regional associations: Members collaborate by working together in a geographical grouping and by selectively contributing experts for regional teams;

- WMO technical commissions: Members collaborate by selectively contributing technical experts for global teams;

- As individual operators and managers of observing systems, Members directly undertake the relevant WIGOS process(es);

- WMO designated centres for performance monitoring (including lead centres and monitoring centres): individual Members or groups of Members operate a WMO centre designated for performance monitoring.

In the case of WIGOS processes being undertaken by the WMO Secretariat or other entities funded by WMO Programmes, the mode of collaboration is through the overall operation of WMO.

The following example illustrates the relation between the WIGOS high-level processes and the structure of the regulatory material. The standard and recommended practices and procedures relevant to each WIGOS process can be found in section 2, under the following sub-sections:

- Determination of user requirements: 2.1 and 2.2;

- Design, planning and evolution of WIGOS: 2.2;

- Development and documentation of standard and recommended practices and procedures for observing systems: 2.3;
- Implementation of an observing system by owners and operators: 2.3 and 2.4;
- Observing system operation and maintenance including fault management and audit: 2.4;
- Observation quality control: 2.4 and 2.6;
- Observations and observational metadata delivery: 2.4 and 2.5;
- Performance monitoring: 2.4 and 2.6;
- User feedback and review of requirements: 2.2 and 2.6;
- Capacity development (including training): 2.7.

SECTION: Chapter
Chapter title in running head: 2. COMMON ATTRIBUTES OF WIGOS COMPONENT…

2. COMMON ATTRIBUTES OF WIGOS COMPONENT SYSTEMS

2.1 REQUIREMENTS

2.1.1 Members shall take steps to collect, record, review, update and make available their user requirements for observation.

2.1.2 Members shall convey their user observational requirements, for each of the WMO application areas, to the RRR process described under section 2.2.4 and Appendix 2.3.

2.2 DESIGN, PLANNING AND EVOLUTION

2.2.1 General

2.2.1.1 The WMO Integrated Global Observing System shall be designed as a flexible and evolving system capable of continuous improvement.

Note: Factors that drive the evolution of WIGOS component observing systems include technological and scientific progress and cost-effectiveness; changes in the needs and requirements of WMO, WMO co-sponsored programmes and international partner organizations at national, regional and global levels; and changes in the capacity of Members to implement observing systems. It is important to identify the impact on all users before a change is made.

2.2.1.2 Members shall plan and operate their networks in a sustainable and reliable manner utilizing WIGOS standard and recommended practices and procedures, and tools.

Note: Sustainability over at least a ten-year period is recommended; however, this depends on paying sufficient attention to maintenance and operations following the establishment of the network.

2.2.2 Principles for observing network design and planning

2.2.2.1 Observing network design principles

2.2.2.1.1 Members should follow the principles specified in Appendix 2.1 when designing and developing their observing networks.

2.2.2.1.2 Members should conduct network design studies that address national, regional and global scale questions about the optimum affordable mix of components to best satisfy the requirements for observations.

2.2.2.2 Climate monitoring principles of the Global Climate Observing System

Members designing and operating observing systems for monitoring climate should adhere to the principles specified in Appendix 2.2.

Note: Fifty Essential Climate Variables have been identified for GCOS. These are required to support the work of the United Nations Framework Convention on Climate Change (UNFCCC) and the Intergovernmental Panel on Climate Change (IPCC). The Essential Climate Variables cover the atmospheric, oceanic and terrestrial domains, and all are technically and economically feasible for systematic observation. Further information about the Essential Climate Variables can be found in the *Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC* (2010 Update), GCOS-138 (also identified as WMO-TD/No. 1523).

2.2.3 Vision for WIGOS observing systems

Members shall take into account the Vision for the Global Observing System in 2025 when planning the evolution of their observing networks.

Notes:
1. The Vision for the Global Observing System in 2025 provides high-level goals to guide the evolution of the WMO Integrated Global Observing System in the coming decades. The Vision is updated on a multi-year time scale (typically decadal).

2. The Vision for the Global Observing System in 2025 is available at http://www.wmo.int/pages/prog/www/OSY/Publications/Vision-2025/Vision-for-GOS-in-2025_en.pdf.

2.2.4 The Rolling Review of Requirements

Members, both directly and through the participation of their experts in the activities of regional associations and technical commissions, shall contribute to the RRR process and assist the designated Points of Contact for each application area in performing their roles in the RRR.

Note: Appendix 2.3 provides further details on the RRR process.

2.2.5 Observation impact studies

2.2.5.1 Members, or groups of Members within regions, should conduct and/or participate in observation impact studies and related scientific evaluations to address WIGOS network design questions.

2.2.5.2 Members should provide expertise for synthesizing the results of impact studies and making recommendations on the best mix of observing systems to address the gaps identified by the RRR process.

Note: Impact studies involving Observing System Experiments, Observing System Simulation Experiments, Forecast Sensitivity to Observation studies and other assessment tools are used to assess the impact of the various observing systems on Numerical Weather Prediction model analyses and predictions, hence their value and relative priority for addition or retention for these application areas.

2.2.6 Evolution of WIGOS observing systems

2.2.6.1 Members should follow the plans published by WMO for the evolution of WIGOS component observing systems when planning and managing their WIGOS observing systems.

Notes:
1. The planning and coordination of the evolution of WIGOS observing systems is steered by the Executive Council and undertaken by Members individually and through regional associations, technical commissions and relevant steering bodies of WMO co-sponsored observing systems.

2. The current WMO plan for the evolution of WIGOS observing systems was published as the *Implementation Plan for the Evolution of Global Observing Systems* (EGOS-IP) (WIGOS Technical Report No. 2013-4). It contains guidelines and recommended actions to be undertaken by Members, technical commissions, regional associations, satellite operators and other relevant parties in order to stimulate cost-effective evolution of the WMO observing systems and address in an integrated way the requirements of WMO Programmes and co-sponsored programmes.

3. The WMO plan for the evolution of WIGOS observing systems is regularly updated and new versions are published on a multi-year time scale (typically decadal), taking into account the vision for the WIGOS observing systems, the advice of the technical commissions and regional associations concerned, relevant WMO co-sponsored observing systems and international experts in all application areas.

2.2.6.2 Members shall coordinate the activities of organizations within their country, including National Meteorological and Hydrological Services (NMHSs) and other agencies, in addressing relevant actions of the WMO plans for the evolution of WIGOS observing systems.

2.2.6.3 Where Member countries cover small areas and are geographically close or have already established multilateral working relationships, Members should consider a subregional or transboundary river basin approach, in addition to a national one, in WIGOS observing systems planning.

2.2.6.4 In this case, the Members concerned should work in close cooperation to prepare subregional or transboundary river basin reviews of requirements to be used as a basis for detailed planning at that scale.

2.2.7 Monitoring the evolution of WIGOS observing systems

Members should contribute to the monitoring of the evolution of WIGOS observing systems by providing their national progress reports on a yearly basis through nominated national focal points.

Note: The Commission for Basic Systems, in collaboration with other technical commissions, regional associations, and co-sponsored programmes, regularly reviews progress in the evolution of WIGOS observing systems and provides updated guidance to Members thereon.

2.3 INSTRUMENTATION AND METHODS OF OBSERVATION

2.3.1 General requirements

Note: Details are provided in the *Technical Regulations* (WMO-No. 49), Volume III: Hydrology, the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), *Weather Reporting* (WMO-No. 9), Volume D: Information for Shipping, and the *Guide to Hydrological Practices* (WMO-No. 168), Volume I: Hydrology – From Measurement to Hydrological Information.

2.3.1.1 Members should ensure that observations and observational metadata are traceable to the International System of Units (SI) standards, where these exist.

Note: Traceability to the International System of Units (SI) standards is an area where concerted effort is required to increase or improve compliance.

2.3.1.2 Members should employ properly calibrated instruments and sensors that provide observations satisfying at least measurement uncertainties that meet the specified requirements.

Notes:
1. Achievable measurement uncertainty is specified in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Chapter 1, 1.6.5.2, Annex 1.D.

2. A number of operational, financial, environmental and instrumental issues may cause the system to not always satisfy the specified requirements. Annex 1.D (see the column ”Achievable measurement uncertainty“) provides a list of the achievable and affordable measurement uncertainties which in some cases might not satisfy specified requirements.

2.3.1.3 Members should describe uncertainty of observations and observational metadata as specified in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Chapter 1, 1.6

Notes:
1. The corresponding text from the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Chapter 1, 1.6, will be included as an appendix in a future edition.

2. The definition of uncertainty in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Chapter 1, 1.6, is consistent with international standards approved by the International Committee for Weights and Measures (Comité international des poids et mesures (CIPM)).

2.3.1.4 Members should follow the definitions and specifications for the calculation of derived observations given in the WMO Technical Regulations.

Notes:
1. Further methods provided or referenced by the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8) and the *Guide to Hydrological Practices* (WMO-No. 168), Volume I: Hydrology – From Measurement to Hydrological Information, could also be considered.

2. Such derivations can take many forms, for example, statistical processing of average or smooth values, or multivariate algorithm to determine streamflow discharge.

3. The corresponding text from the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8) will be included as an appendix in a future edition of the present Manual.

2.4 OPERATIONS

2.4.1 General requirements

Note: Provision 2.4.1.1 of the *Technical Regulations* (WMO-No. 49), Volume I, Part I, applies.

2.4.1.1 WMO observing stations and platforms shall be uniquely identified by a WIGOS station identifier.

Note: The structure of WIGOS station identifiers is specified in Attachment 2.1.

2.4.1.2 Members shall issue WIGOS station identifiers for observing stations and platforms within their geographic area of responsibility that contribute to a WMO or co-sponsored programme and shall ensure that no WIGOS station identifier is issued to more than one station.

Note: Members may issue WIGOS station identifiers for observing stations and platforms within their geographic area of responsibility that do not contribute to a WMO or co-sponsored programme, provided that the operator has committed to providing and maintaining WIGOS metadata.

2.4.1.3 Before issuing a station identifier, Members should ensure that the operator of a station or platform has committed to providing and maintaining WIGOS metadata for that station or platform.

Notes:

1. In circumstances when a WIGOS identifier is required for a station or platform to support a WMO or co-sponsored programme and no Member is in a position to issue one (for example, in Antarctica), the Secretary-General may issue a WIGOS station identifier for that station or platform, provided that its operator has committed to:

   (a) Providing WIGOS metadata;

   (b) Conforming to relevant Technical Regulations.

2. In circumstances where a WIGOS identifier is required for a station or platform to support a WMO or co-sponsored programme and a Member is not able to issue one, the Secretary-General will work with the Member concerned to issue a WIGOS station identifier for that station or platform, provided that its operator has committed to:

   (a) Providing WIGOS metadata;

   (b) Conforming to relevant Technical Regulations.

2.4.1.4 Members shall make available to WMO the updated metadata each time a new station identifier is issued.

2.4.1.5 Members shall operate their observing systems with properly calibrated instruments and adequate observing and measuring techniques.

Notes:

1. Detailed guidance on observing practices of meteorological observing systems and instruments is given in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8).

2. Detailed guidance on observing practices of hydrological observing systems and instruments is given in the *Guide to Hydrological Practices* (WMO-No. 168), *the Manual on Flood Forecasting and Warning* (WMO-No. 1072) and the *Manual on Stream Gauging* (WMO-No. 1044).

3. Detailed guidance on observing practices of GAW observing systems and instruments is given in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8).

2.4.1.6 Members should address the requirements for uncertainty, timeliness, temporal resolution, spatial resolution and coverage which result from the RRR process specified in section 2.2.4 and in accordance with the details provided by other sections as appropriate.

2.4.1.7 Members shall ensure that proper safety procedures are specified, documented and utilized in all their operations.

Note: Safety practices and procedures are concerned with ensuring the welfare of staff while promoting overall efficiency and effectiveness of the NMHS and respond to national laws, regulations and requirements for occupational health and safety.

2.4.2 Observing practices

Members should ensure that their observing practices are adequate to comply with user observational requirements.

Note: Observing practices include station operation, data processing practices and procedures, applied calculation rules, documentation on calibration practices and associated metadata.

2.4.3 Quality control

2.4.3.1 Members shall ensure that observations provided through their WIGOS component observing systems are quality controlled.

2.4.3.2 Members shall implement real-time quality control prior to exchange of observations via the WMO Information System.

Notes:

1. Quality control of observations consists in examination of observations at stations and data centres to detect errors so that observations may be either corrected or flagged. A quality control system should include procedures for returning to the source of observations to verify them and to prevent recurrence of errors. Quality control is applied in real-time, but it also operates in non-real-time, as delayed quality control. The quality of observations depends on the quality control procedures applied during acquisition and processing of observations and during preparation of messages, in order to eliminate the main sources of errors and ensure the highest possible standard of accuracy for the optimum use of those observations by all possible users.

2. Quality control in real time also takes place in the Global Data-processing and Forecasting System, prior to the use of meteorological and climatological observations in data processing (i.e. objective analysis and forecasting).

3. Recommended minimum standards of quality control of meteorological and climatological observations at the level of the National Meteorological Centre are given in the *Manual on the Global Data-processing and Forecasting System* (WMO-No. 485), Volume I: Global Aspects, Appendix II-1, Table I. The *Guide on the Global Data-processing System* (WMO-No. 305) should be consulted for more detailed guidance.

4. Recommended practices and procedures for quality control of hydrological observations are given in the *Manual on Flood Forecasting and Warning* (WMO-No. 1072), Chapter 6, and in the *Guide to Hydrological Practices* (WMO-No. 168).

5. Recommended practices and procedures regarding the quality of observations for GAW requirements are formulated in Measurement Guidelines through Data Quality Objectives (see GAW reports at http://www.wmo.int/pages/prog/arep/gaw/gaw-reports.html).

2.4.3.3 Members not capable of implementing these standards should establish agreements with an appropriate Regional Meteorological Centre or World Meteorological Centre to perform the necessary quality control.

2.4.3.4 Members shall also perform quality control of observations on a non-real-time basis, prior to forwarding the observations for archiving.

2.4.3.5 Members should develop and implement adequate quality control processes.

Notes:

1. Quality control processes include (but are not necessarily limited to): (a) validation; (b) cleaning; and (c) monitoring.

2. Further guidance is available in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), the *Guide to Climatological Practices* (WMO-No. 100), the *Guide to Hydrological Practices* (WMO-No. 168), Volume I: Hydrology – From Measurement to Hydrological Information, and the *Guide to the Global Observing System* (WMO-No. 488).

2.4.4 Data and metadata reporting

2.4.4.1 Members shall report and make available observations in the standard formats specified by the *Manual on Codes* (WMO-No. 306).

2.4.4.2 In the case of GAW observations, Members shall report and make available observations in standard formats as advised by GAW data centres, in accordance with the provisions in chapter 6.

Note: Members are to report and make available up-to-date WIGOS metadata as specified in section 2.5.2.

2.4.5 Incident management

2.4.5.1 Members should implement incident management to detect, identify, record, analyse and respond to any incident, in order to restore normal operation of the observing system as quickly as possible, minimizing the negative impact and preventing recurrence.

2.4.5.2 Members shall implement procedures to detect, analyse and respond to system faults and human errors at the earliest stage possible.

2.4.5.3 Members should record and analyse incidents as appropriate.

2.4.6 Change management

2.4.6.1 Members should carefully plan and manage changes to ensure continuity and consistency of observations and record any modification related to the observing system.

Note: This requirement relates to any change in the observing system, including an observing station, observing programme, instruments, methods of observation, and so on.

2.4.6.2 In the event of significant changes in instruments or methods of observation used or the location in which observations are made, Members should ensure a sufficiently long period (to capture all expected climatic conditions) of overlap, with dual operation of old and new systems to identify biases, inconsistencies and inhomogeneities.

2.4.7 Maintenance

2.4.7.1 Members shall ensure that each observing system is rigorously maintained.

2.4.7.2 Members shall perform regular preventive maintenance of their observing systems including their instruments.

Note: Carefully organized preventive maintenance of all system components is recommended to minimize corrective action and to increase the operational reliability of an observing system.

2.4.7.3 Members shall determine the frequency and timing (schedule) of the preventive maintenance taking into account the type of observing system, environmental and climate conditions of the observing site and platform, and the instrumentation installed.

2.4.7.4 Members shall perform corrective maintenance in case of failure of an observing system component as soon as practically possible once the problem has been detected.

2.4.7.5 Members shall employ adaptive maintenance that satisfies the requirements for stability, continuity and consistency of observations through time.

Note: Detailed guidance on maintenance of observing systems and instruments is given in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), including technical papers on GAW measurements referenced in Part I, Chapter 16; the *Guide to Hydrological Practices* (WMO-No. 168) and the *Manual on Stream Gauging* (WMO-No. 1044).

2.4.8 Inspection

Members shall arrange periodic inspection of their observing systems.

Note: Such inspection could be undertaken directly or remotely, as necessary, to monitor the correct functioning of observing platforms and instruments.

2.4.9 Calibration procedures

2.4.9.1 Members shall ensure that measurement systems and instruments are calibrated regularly in accordance with adequate procedures for each type of system and instrument, as described in the relevant sections of the present Manual.

Notes:
1. Where international or national standards are not available, the basis for calibration is defined or supplied by the manufacturer or by the Scientific Advisory Groups for GAW observations.

2. Detailed guidance on calibration procedures is given in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), the *Guide to Hydrological Practices* (WMO-No. 168) and the *Manual on Stream Gauging* (WMO-No. 1044).

3. In the GAW Programme, World Calibration Centres perform the audit of the stations and require that every laboratory is traceable to the single network standard.

2.4.9.2 Members shall ensure that the measuring devices they use are:

(a) Calibrated or verified at specified intervals, or prior to use, against measurement standards traceable to international or national standards. Where no such standards exist, the basis used for calibration or verification shall be recorded;

(b) Adjusted or readjusted as necessary, but at the same time safeguarded from adjustments that would invalidate the measurements;

(c) Identified, enabling the calibration status to be determined;

(d) Protected from damage and deterioration during handling, maintenance and storage.

Note: Details regarding hydrological observations are given in *Technical Regulations* (WMO-No. 49), Volume III: Hydrology; guidance is available in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), the *Guide to Hydrological Practices* (WMO-No. 168) and the *Manual on Stream Gauging* (WMO-No. 1044).

2.4.9.3 When the equipment is found not to conform to requirements, the Member shall assess and record the validity of previous measuring results and take appropriate action on the equipment and the products affected.

2.4.9.4 Members shall record and maintain the results of calibration and verification.

2.5. OBSERVATIONAL METADATA

2.5.1 Purpose and scope

Notes:

1. Observational metadata are essential as they enable users of observations to assess their suitability for the intended application, and managers of observing systems to monitor and control their systems and networks. Members benefit from sharing observational metadata which describe quality of observations and provide information about stations and networks used to collect those observations.

2. Discovery metadata, defined in the *Manual on the WMO Information System* (WMO-No. 1060), are concerned with discovering and accessing information, including observations and their observational metadata. Requirements for discovery metadata are specified in the *Manual on the WMO Information System* and are not considered further here.

2.5.1.1 For all WIGOS observations they make available internationally, Members shall record and retain the observational metadata specified as mandatory in the WIGOS Metadata Standard defined in Appendix 2.4.

Notes:

1. The WIGOS Metadata Standard defines a common set of requirements for observational metadata. It includes a detailed list of mandatory, conditional and optional metadata.

2. "Not available", "unknown" or "not applicable" are valid values for many elements of the WIGOS Metadata Standard. These terms assist Members in achieving compliance with the standard, particularly while developing the capability to report actual values.

2.5.1.2 For all WIGOS observations they make available internationally, Members shall record and retain the observational metadata specified as conditional in the WIGOS Metadata Standard (Appendix 2.4) whenever the related condition is met.

2.5.1.3 For all WIGOS observations they make available internationally, Members should record and retain the observational metadata specified as optional in the WIGOS Metadata Standard (Appendix 2.4).

Notes:

1. Further requirements for observational metadata beyond the WIGOS Metadata Standard are stated in the following sections. In the case of GOS, as noted in chapter 5, the *Manual on the Global Observing System* (WMO-No. 544) contains further provisions for GOS metadata.

2. Further guidance on metadata and sound metadata practices, is provided in Guides and specific documentation associated with the individual observing system components.

2.5.2 Exchanging and archiving observational metadata

2.5.2.1 Members shall make available internationally, without restriction, those mandatory and conditional (whenever the condition is met) observational metadata that support observations made available internationally.

2.5.2.2 Members making observations available internationally shall retain and make available, without restriction, observational metadata for at least as long as they retain the observations described by the observational metadata.

2.5.2.3 Members making available internationally archived observations shall ensure that all WIGOS metadata describing the observations remain available, without restriction, for at least as long as the observations are retained.

2.5.2.4 Members making available internationally archived observations should ensure that any additional observational metadata describing the observations remain available, without restriction, for at least as long as the observations are retained.

2.5.3 Global compilation of observational metadata

2.5.3.1 Members shall make available to WMO for global compilation those components of the WIGOS metadata that are specified as mandatory or conditional (whenever the condition is met).

Note: Global compilations of WIGOS metadata are held in several databases. The database of the Observing Systems Capability Analysis and Review tool (OSCAR) of the WIGOS Information Resource (WIR) is the key source of information for WIGOS metadata. Other global compilations of specific components of WIGOS metadata include elements of the GAW Station Information System (GAWSIS), the database of the JCOMM In Situ Observations Programme Support Centre (JCOMMOPS) and others. Purpose and management of WIR and OSCAR are described in Attachment 2.2.

2.5.3.2 For all WIGOS component observing systems they operate, Members shall keep the relevant databases of WMO observational metadata up to date with the required WIGOS metadata.

2.5.3.3 Members shall routinely monitor the content of WIGOS metadata databases and provide feedback to WMO Secretariat on identified discrepancies, possible errors and required changes with respect to the WIGOS component observing systems they operate.

2.5.3.4 Members shall designate their national focal points responsible for making available metadata and monitoring content of WMO observational metadata databases, and inform the Secretariat accordingly.

2.5.3.5 Members delegating to a global or regional entity the responsibility of the national focal point for all or part of the observing networks they operate shall inform the Secretariat accordingly.

2.6 QUALITY MANAGEMENT

Notes:

1. Detailed guidance on how to develop and implement a quality management system (QMS) to ensure and enhance the quality of products and services of NMHSs is provided in the *Guide to the Implementation of a Quality Management System for National Meteorological and Hydrological Services* (WMO-No. 1100).
2. Definitions, terminology, vocabulary and abbreviations used in relation to quality management are those of the ISO 9000 family of standards for quality management systems, in particular *ISO 9000:2005, Quality Management Systems – Fundamentals and vocabulary*.
3. A QMS can be implemented only by the body that has the resources and the mandate to manage the observing system. According to the WMO QMF, Members are urged to follow the standard and recommended practices and procedures associated with implementation of a QMS. In practice, however, it is one or more organizations within the Member country that own and operate observing systems and provide observations and observational metadata, most notably the NMHSs. Therefore, implementation of the WMO QMF relies on the Member making arrangements for such organizations to implement a QMS.
4. In this section, the term “observations” includes also observational metadata.

2.6.1 Scope and purpose of WIGOS quality management

Note: The practices and procedures of WIGOS enable Members to comply with the WMO QMF in relation to the quality of observations.

2.6.2 WIGOS component of the WMO Quality Management Framework

2.6.2.1 Quality policy

2.6.2.1.1 In the establishment and maintenance of WIGOS observing systems, Members should ensure optimum affordable quality for all observations.

2.6.2.1.2 Members should, through a process of continual improvement, pursue effective and efficient management and governance of observing systems.

2.6.2.2 Application of the eight principles of quality management

Members should apply the eight principles of quality management to the implementation of WIGOS, as specified in Appendix 2.5.

2.6.3 WIGOS quality management processes

Note: The processes and roles of various entities are described in Attachment 1.1.

2.6.3.1 Determination and maintenance of user requirements

Note: The WMO RRR process for compiling observation user requirements is described in section 2.2.4 and Appendix 2.3.

2.6.3.2 Development and documentation of observing system standards and recommendations

Through involvement in the work of technical commissions, Members should participate in the development of observing system standard and recommended practices and procedures.

2.6.3.3 Training of personnel and capacity development

Members should ensure appropriate planning and implementation of training and capacity development activities.

2.6.3.4 Performance monitoring

Members should use and respond to the results, advice and reports of designated monitoring centres and any subsequent advice of expert groups.

2.6.3.5 Feedback, change management and improvement

2.6.3.5.1 Members should ensure that inconsistencies and other problems identified by WIGOS Lead and Monitoring Centres are rectified in a timely manner and that a process for their documentation and rectification is implemented and maintained.

2.6.3.5.2 Upon identification or notification of inconsistencies or other problems related to quality of observations, Members should analyse the problem detected and make the necessary improvements to operational practices and procedures so as to minimize the adverse impacts of those problems and prevent their recurrence.

2.6.3.5.3 Members should ensure that changes to operational practices and procedures are accordingly documented.

2.6.4 WIGOS aspects of development and implementation of the quality management system of Members

Note: This section specifies requirements for the integration of WIGOS practices and procedures into the QMS of Members. The requirements are based on the eight clauses of the ISO 9001 Standard. The *Guide to the Implementation of a Quality Management System for National Meteorological and Hydrological Services* (WMO-No. 1100) provides extensive explanatory notes about the eight clauses. The five subsections that follow correspond to the last five of those clauses, providing further details about the elements required in a QMS.

2.6.4.1 General requirements for the content of a quality management system

Members should identify their high-level processes and interactions that lead to the provision of observations.

Note: In addition to WIGOS specific provisions, there are many other general requirements for the content of a QMS that are not unique to WIGOS observations, hence are not repeated here.

2.6.4.2 Requirements related to management and planning

2.6.4.2.1 Members should clearly demonstrate and document their commitment to the integration of WIGOS quality management practices within their QMS.

2.6.4.2.2 Members should carefully identify and routinely review user requirements for observations prior to attempting to meet user needs.

2.6.4.2.3 Members should ensure that their published quality policy is consistent with the WIGOS quality policy.

2.6.4.2.4 Members should establish and indicate the objectives for the observations they intend to provide in the future so as to guide stakeholders, users and clients on the expected evolution of and changes to the observing systems they operate as a contribution to WIGOS.

Note: The objectives referred to in this provision constitute the WIGOS quality objectives.

2.6.4.2.5 Members should appoint a quality manager.

2.6.4.3 Requirements related to resource management

2.6.4.3.1 Members should determine and provide the resources needed to maintain and continuously improve the effectiveness and efficiency of their processes and procedures.

2.6.4.3.2 Members should define the competencies required for staff involved in the provision of observations.

2.6.4.3.3 Members should take steps to rectify any competency shortcomings identified for new or existing employees.

2.6.4.3.4 Members should implement policies and procedures to maintain the infrastructure required for the provision of observations.

2.6.4.4 Requirements related to the provision of observations

2.6.4.4.1 Members should undertake sound planning for the provision of observations.

Note: Such planning includes the following:

(a) Determination and continuous review of user and client requirements;

(b) Translation of user and client requirements into objectives and targets for observations and observing system design;

(c) Initial and ongoing allocation of adequate resources for all aspects of the design, implementation and maintenance processes of observing systems;

(d) Implementation of design processes and activities, including communication strategies and risk management, that will ensure and confirm the development and implementation of observing systems capable of meeting the design objectives and user and client requirements;

(e) Appropriate and ongoing documentation of planning processes and their results.

2.6.4.4.2 Members should identify the users of their observing systems and establish and document users' requirements for observations.

Note: The means for doing this include:

(a) The WMO RRR process, described in section 2.2.4 and Appendix 2.3;

(b) Other processes to establish user requirements within WMO Programmes through the activities of WMO technical commissions;

(c) Regional processes through the activities of WMO regional associations and other multilateral groupings of Members;

(d) National processes.

2.6.4.4.3 Members should have a clear description of the requirements that are agreed upon.

Note: It is important to note the difference between aspirational requirements and agreed requirements. The establishment of requirements provides essential information for the monitoring and measurement of conformance.

2.6.4.4.4 Members should identify and adhere to any statutory or regulatory requirements in relation to the provision of observations.

2.6.4.4.5 Members should design and develop, or otherwise implement, observing systems to satisfy the agreed user requirements.

2.6.4.4.6 Members should use a formal change management process to ensure that all changes are assessed, approved, implemented and reviewed in a controlled manner.

2.6.4.4.7 Members should conduct purchasing in a controlled manner.

Note: Observing systems are highly specialized and often require major expenditure. Staff responsible for purchasing orders or for providing information to suppliers must, therefore, ensure that the information and specifications provided are clear, unambiguous and based on the design objectives and system requirements to enable the delivery of the appropriate products and services. Purchasing in a controlled manner entails the following:

(a) Written specification of all performance requirements for equipment and/or services;

(b) Ensuring that purchasing is subject to a competitive process of more than one candidate for supply of equipment or services;

(c) Assessment of candidates for supply of equipment or services based on merit and suitability for purpose, which can be discerned from:

   (i) Written tendering or quotation of candidates;

   (ii) Experience or reliable anecdotal evidence of past performance;

   (iii) Recommendation of Member or recognized organization or agency;

(d) Documentation of the purchasing process and outcomes.

2.6.4.4.8 Members should include in their QMS the WIGOS provisions covering methods of observation, calibration and traceability, operational practices, maintenance and observational metadata.

2.6.4.4.9 Members should implement practices and procedures which ensure that observations remain accurate.

Note: Observations need to be checked as they must meet the agreed requirements. The methods include automated algorithms, manual inspection and oversight.

2.6.4.5 Requirements for monitoring, performance measurement, analysis and improvement

2.6.4.5.1 Members should use the agreed user requirements for observations (see 2.6.4.4) as a basis for defining and implementing appropriate measures of performance and success.

Note: It is important to gain a clear understanding of how satisfied users are with observations. This requires the monitoring of information on users' perception and on whether their expectations have been met. Surveys are commonly used for this purpose.

2.6.4.5.2 Members should implement activities to gain information on the satisfaction of users of observations.

2.6.4.5.3 Members should ensure that staff are made aware of the methods employed for determining users' perceptions and expectations, and that those methods are applied consistently.

2.6.4.5.4 Members should regularly conduct internal audits of WIGOS processes and procedures and analyse their results as part of the management processes of the observing system.

Note: A detailed explanation of the requirements of the internal audit is provided in the *Guide to the Implementation of a Quality Management System for National Meteorological and Hydrological Services* (WMO-No. 1100), chapter 4, section 4.3, clause 8, requirement 8.2.2.

2.6.4.5.5 Members should monitor the degree of adherence to the defined processes and requirements for producing observations.

Note: Ideally, performance monitoring will be conducted against specific key performance indicators and target levels of performance.

2.6.4.5.6 Members should monitor and measure the suitability and the quality of their observations as they are produced, in order to compare their characteristics with the agreed requirements.

Note: The means to do this include:

(a) The devising, implementation and routine analysis of manually or automatically generated key performance indicators and their associated targets;

(b) Manual inspection and oversight of observational data produced.

2.6.4.5.7 Members should record instances of non-conformity with requirements, and endeavour to rectify problems in a timely manner.

2.6.4.5.8 Members should maintain a documented corrective action procedure relevant to observations.

2.6.4.5.9 Members should specify and implement procedures that describe how non-conforming observations or observational metadata are identified, how they are dealt with, who is responsible for deciding what to do, what action should be taken and what records are to be kept.

Note: A detailed explanation of the requirements for corrective action is provided in the *Guide to the Implementation of a Quality Management System for National Meteorological and Hydrological Services* (WMO-No. 1100), Chapter 4, section 4.3, clause 8, requirements 8.2.3 and 8.2.4.

2.6.4.5.10 Members should analyse monitoring results to detect any performance-related changes, trends and deficiencies and use the results and analyses as input for continual improvement.

Note: Analysing trends and taking action prior to the occurrence of a case of non-conformity helps to prevent problems.

2.6.4.5.11 Members should maintain documented preventive action procedures relevant to observing systems and ensure that staff are aware of and, if necessary, trained in their routine application.

Note: Due consideration might be given to combining the preventive and the corrective action procedures for efficiency, and to simplify the process.

2.6.5 Compliance, certification and accreditation

Note: While WMO encourages the certification of Members' quality management systems by accredited agencies, unless otherwise required of a particular WIGOS component system or subsystem, there is no general regulated requirement for certification of QMS for WIGOS observing systems.

2.6.6 Documentation

2.6.6.1 Members should include the WIGOS quality policy (2.6.2.1) and objectives (2.6.4.2) in their QMS quality manual.

2.6.6.2 Members should include in their QMS documentation those documents that describe the procedures related to WIGOS, including, in particular, those relating to control of non-conforming observations, and corrective and preventive actions.

2.6.6.3 Members should include in their QMS documentation those documents that describe the procedures required to ensure the effective planning, operation and control of their WIGOS processes.

2.6.6.4 Members should include in their QMS documentation those records required by the ISO 9001 standard.

Note: More detailed information on documentation requirements is provided in the *Guide to the implementation of a Quality Management System for National Meteorological and Hydrological Services* (WMO-No. 1100), Chapter 4, section 4.3, clause 4, requirement 4.2.

2.7 CAPACITY DEVELOPMENT

2.7.1 General

2.7.1.1 Members should identify their needs for capacity development in all activity areas of WIGOS.

2.7.1.2 Members should develop plans to meet their capacity development needs.

Note: In addition to national resources allocated to NMHSs, support may be available from other domestic agencies, the WMO regional association concerned, other Members through bilateral or multilateral arrangements, and WMO Programmes (including appropriate technical commissions).

2.7.1.3 Members should establish bilateral and multilateral collaboration (within and beyond their Region) where necessary to address significant capacity development needs.

2.7.1.4 When planning capacity development activities, Members should take a holistic approach considering institutional, infrastructural, procedural and human resource requirements to support both current and continuing needs for installation, operation, maintenance, inspection and training. For this purpose, Members should prepare specific capacity development plans with measurable objectives to enable effective implementation, monitoring and assessment.

Note: Funds to meet these requirements should be planned well ahead, subject to national policies of Members, to assure long-term sustainable networks.

2.7.2 Training

2.7.2.1 Members shall provide adequate training for their staff or take other appropriate actions to ensure that all staff are suitably qualified and competent for the work assigned to them.

Note: This requirement is applied both to initial recruitment or introductory training and to continuing professional development.

2.7.2.2 Each Member should ensure that the qualifications, competencies, skills (and thus training) and numbers of their personnel or other contractors match the range of tasks to be performed.

2.7.2.3 Each Member should inform the staff of their role and how they contribute to the achievement of the quality objectives.

2.7.3 Infrastructural capacity development

Members should regularly review their infrastructure for collecting and making available observations and observational metadata and, as necessary, develop prioritized plans and priorities for capacity development.

SECTION: Chapter

Chapter title in running head: APPENDIX 2.1. OBSERVING NETWORK DESIGN …

APPENDIX 2.1. OBSERVING NETWORK DESIGN PRINCIPLES

1. Serving many application areas

Observing networks should be designed to meet the requirements of multiple application areas within WMO and WMO co-sponsored programmes.

2. Responding to user requirements

Observing networks should be designed to address stated user requirements, in terms of the geophysical variables to be observed and the space-time resolution, uncertainty, timeliness and stability needed.

3. Meeting national, regional and global requirements

Observing networks designed to meet national needs should also take into account the needs of WMO at the regional and global levels.

4. Designing appropriately spaced networks

Where high-level user requirements imply a need for spatial and temporal uniformity of observations, network design should also take account of other user requirements, such as the representativeness and usefulness of the observations.

5. Designing cost-effective networks

Observing networks should be designed to make the most cost-effective use of available resources. This will include the use of composite observing networks.

6. Achieving homogeneity in observational data

Observing networks should be designed so that the level of homogeneity of the delivered observational data meets the needs of the intended applications.

7. Designing through a tiered approach

Observing network design should use a tiered structure, through which information from reference observations of high quality can be transferred to other observations and used to improve their quality and utility.

8. Designing reliable and stable networks

Observing networks should be designed to be reliable and stable.

9. Making observational data available

Observing networks should be designed and should evolve in such a way as to ensure that the observations are made available to other WMO Members, at space-time resolutions and with a timeliness that meet the needs of regional and global applications.

10. Providing information so that the observations can be interpreted

Observing networks should be designed and operated in such a way that the details and history of instruments, their environments and operating conditions, their data processing procedures and other factors pertinent to the understanding and interpretation of the observational data (i.e. metadata) are documented and treated with the same care as the data themselves.

11. Achieving sustainable networks

Improvements in sustained availability of observations should be promoted through the design and funding of networks that are sustainable in the long-term including, where appropriate, through the transition of research systems to operational status.

12. Managing change

The design of new observing networks and changes to existing networks should ensure adequate consistency, quality and continuity of observations during the transition from the old system to the new.

SECTION: Chapter

Chapter title in running head: APPENDIX 2.2. CLIMATE MONITORING PRINCI…

APPENDIX 2.2. CLIMATE MONITORING PRINCIPLES OF THE GLOBAL CLIMATE OBSERVING SYSTEM

2.2.1 Effective monitoring systems for climate should adhere to the following principles:

(a) The impact of new systems or changes to existing ones should be assessed prior to implementation;

(b) A suitable period of overlap between new and old observing systems is required. This would be a period of dual operation, under the same climatic conditions, of the current and new observing systems, to identify and record any impact of the change;

(c) The details and history of local conditions, instruments, operating procedures, data processing algorithms and other factors pertinent to interpreting data (i.e. metadata) should be documented and treated with the same care as the data themselves;

(d) The quality and homogeneity of data should be regularly assessed as part of routine operations;

(e) Consideration of the need for environmental and climate-monitoring products and assessments, such as the Intergovernmental Panel on Climate Change (IPCC) assessments, should be integrated into national, regional and global observing priorities;

(f) Operation of historically uninterrupted stations and observing systems should be maintained;

(g) Data-poor regions, poorly observed parameters, regions sensitive to change, and key measurements with inadequate temporal resolution should be high-priority areas for additional observations;

(h) Long-term requirements, including appropriate sampling frequencies, should be specified to network designers, operators and instrument engineers at the outset of system design and implementation;

(i) A carefully planned conversion of research observing systems to long-term operations should be promoted;

(j) Data management systems that facilitate access, use and interpretation of data and products should be included as essential elements of climate monitoring systems.

Furthermore, operators of satellite systems for monitoring climate need to:

- Take steps to make radiance calibration, calibration-monitoring and satellite-to-satellite cross-calibration of the full operational constellation a part of the operational satellite system; and

- Take steps to sample the Earth system in such a way that climate-relevant (diurnal, seasonal, and long-term interannual) changes can be determined.

2.2.2 Satellite systems for climate monitoring should adhere to the following specific principles:

(a) Constant sampling within the diurnal cycle (minimizing the effects of orbital decay and orbit drift) should be maintained;

(b) A period of overlap for new and old satellite systems should be ensured that is long enough to determine inter-satellite biases and maintain the homogeneity and consistency of time-series observations;

(c) Continuity of satellite measurements (i.e. elimination of gaps in the long-term record) through appropriate launch and orbital strategies should be ensured;

(d) Rigorous pre-launch instrument characterization and calibration, including radiance confirmation against an international radiance scale provided by a national metrology institute, should be ensured;

(e) On-board calibration adequate for climate system observations should be ensured and associated instrument characteristics should be monitored;

(f) Operational provision of priority climate products should be sustained, and peer-reviewed new products should be introduced as appropriate;

(g) Data systems needed to facilitate user access to climate products, metadata and raw data, including key data for delayed-mode analysis, should be established and maintained;

(h) Use of functioning baseline instruments that meet the calibration and stability requirements stated above should be maintained for as long as possible, even when such instruments exist on decommissioned satellites;

(i) Complementary in situ baseline observations for satellite measurements should be maintained through appropriate activities and cooperation between space agencies and owners of in situ networks;

(j) Random errors and time-dependent biases in satellite observations and derived products should be identified.

SECTION: Chapter

Chapter title in running head: APPENDIX 2.3. THE WMO ROLLING REVIEW OF…

APPENDIX 2.3. THE WMO ROLLING REVIEW OF REQUIREMENTS

1. GENERAL

The Rolling Review of Requirements (RRR) compiles information on Members' evolving requirements for observations in the application areas that directly use observations; the extent to which current and planned WIGOS observing systems satisfy those requirements; guidance from experts in each application area on gaps and priorities, in order to tackle the deficiencies and opportunities in WMO observing systems; and plans for the future evolution of WIGOS observing systems.

The application areas are:

(a) Global numerical weather prediction (GNWP);

(b) High-resolution numerical weather prediction (HRNWP);

(c) Nowcasting and very short-range forecasting (NVSRF);

(d) Seasonal and interannual forecasting (SIAF);

(e) Aeronautical meteorology;

(f) Atmospheric chemistry;

(g) Ocean applications;

(h) Agricultural meteorology;

(i) Hydrology;

(j) Climate monitoring (as undertaken through the Global Climate Observing System (GCOS));

(k) Climate applications;

(l) Space weather.

Note: A detailed and up-to-date description of the RRR process is available on the WMO website at http://www.wmo.int/pages/prog/www/OSY/GOS-RRR.html.

Observational requirements for WMO polar activities and the Global Framework for Climate Services (GFCS) are also being considered.

An expert is identified for each application area to be the Point of Contact. This expert has a very important role as the conduit to the RRR for input to and feedback from the entire stakeholder community for that application area.

The nominated Points of Contact should coordinate with their application area community (technical commission and WMO Programme or co-sponsored programme, as appropriate) as needed in order to perform the following tasks:

(a) Investigate whether it is appropriate to represent the application area in several sub-applications;

(b) Submit the quantitative user observational requirements to the OSCAR/Requirements database (see http://www.wmo-sat.info/oscar/observingrequirements), review and keep up to date these requirements, and make changes as needed (the Points of Contact are provided with the required access rights);

(c) Produce, review and revise the Statement of Guidance for their application area;

(d) Review how cross-cutting activities (for example, those related to the cryosphere and climate services) are taken into account in the user requirement database and in the Statement of Guidance for the application area.

Note: The user requirements for observations, compiled through the RRR process, are stored and made available by the WIGOS Information Resource (WIR, which includes the OSCAR/Requirement database) as described in detail in Attachment 2.2.

The RRR process consists of four stages, as illustrated in the figure below**ELEMENT REF: 3 (Floating object)**:

1. A review of technology-free (that is, not constrained by any particular type of observing technology) user requirements for observations, within each of the WMO application areas (see section 2.1);

2. A review of the observing capabilities of existing and planned observing systems, both surface- and space-based;

3. A critical review, that is a comparison of requirements with the observing system capabilities;

4. A Statement of Guidance providing a gap analysis with recommendations on how to address the gaps for each application area.

ELEMENT 3: Floating object (Automatic)
ELEMENT 4: Picture inline
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END ELEMENT

Schematic representation of the steps included in the RRR process

END ELEMENT

2. REVIEW OF USER REQUIREMENTS FOR OBSERVATIONS

Notes:
1. This stage of the RRR is described briefly in section 2.1.

2. Regional associations examine and provide Points of Contact with additional details for the compiled user requirements, taking into account the particular requirements of the Region and transboundary river basin authorities.

3. REVIEW OF CURRENT AND PLANNED OBSERVING SYSTEM CAPABILITIES

Members shall take steps for collecting, reviewing, recording and making available information on current and planned capabilities of observing systems.

Note: Information on observing system capabilities is in the form of metadata and is to be made available for global compilation according to the provisions of section 2.5.

4. THE CRITICAL REVIEW

Note: This WMO Programme activity proceeds with assistance from the Points of Contact of the application areas. It compares the quantitative user observational requirements of each application area with the observing system capabilities.

5. STATEMENTS OF GUIDANCE

Notes:

1. The Statement of Guidance interprets the output of the critical review as a gap analysis and identifies priorities for action: the most feasible, beneficial and affordable initiatives to deal with the identified gaps or shortcomings in WMO observing systems for an application area. This draws on the subjective judgement and experience of the Points of Contact, the experts and other stakeholders they consult within their application area.

2. This stage of the RRR requires the Points of Contact to coordinate with their application area community and stakeholders, as needed, in order to produce, review and revise the Statement of Guidance for the application area.

SECTION: Chapter

Chapter title in running head: APPENDIX 2.4. THE WIGOS METADATA STANDA…

APPENDIX 2.4. THE WIGOS METADATA STANDARD

1. GENERAL

This appendix refers to the WIGOS Metadata Standard, which consists of the set of observational metadata elements to be made available internationally, for the effective interpretation by all observational data users of observations from all WIGOS component observing systems. In this way, metadata users can access important information about why, where and how an observation was made. Metadata also provide information on the processing of the raw data and data quality. Note that WIGOS metadata, which is required from specific components or subsystems, is detailed in sections 3–8.

The table below presents categories (or groups) of metadata, each containing one or more elements. Each element is classified (using the same terminology as ISO) as mandatory (M), conditional (C) or optional (O). In the table, the mandatory elements are shown in bold and the conditional elements in italics.

The definition of each metadata element, together with notes and examples, as well as the explanation of the conditions that apply to the conditional elements are specified in the WIGOS Metadata Standard, contained in the attachment to this appendix.

2. MEMBERS' OBLIGATIONS

Mandatory metadata elements shall always be made available. The content of the corresponding fields shall never be empty: either the metadata "value" or the reason for no-value, shall be made available.

Conditional metadata elements shall be made available when the specified condition or conditions are met, in which case the content of the corresponding fields shall never be empty: either the metadata "value" or the reason for no-value, shall be made available.

Optional metadata elements should be made available, as they provide useful information that can help to better understand an observation. These elements are likely to be important for a particular community, but less so for others.

3. ADOPTION THROUGH A PHASED APPROACH

Making available WIGOS metadata will generate substantial benefits for Members, but developing the capacity to make available these metadata requires a substantial effort on the part of (meta)data providers. To help Members comply with reporting obligations, guidance material will be developed and provided.

Moreover, reporting obligations will be enforced in phases, in order to allow Members sufficient time to develop the capacity to comply. Balancing the effort required to generate and make available individual elements and the need to have this information to make adequate use of observations, implementation will proceed in three phases as shown in the table below. Importantly, the elements required by the end of Phase I are either the mandatory elements contained in *Weather Reporting* (WMO-No. 9), Vol. A, or those of critical importance for the Observing Systems Capability Analysis and Review (OSCAR) tool of the WIGOS Information Resource (WIR), and are considered of benefit for all WMO application areas. Phase II adds elements recognized to be more challenging for Members, but the knowledge of which is still necessary for the adequate use of observations, in particular for assessing quality of observations. Phase III adds the remaining elements specified in this version of the standard.

Elements emerging as being important for specific application areas or observing programmes will be added to the standard as it evolves.

List of elements specified in the WIGOS Metadata Standard, and implementation phases for Members

TABLE: Table shaded header with lines

Category	*Phase I*	*Phase II*	*Phase III*
	2016	*2017–2018*	*2019–2020*
1. Observed variable	**1-01 Observed variable – measurand (M)**	1-05 Representativeness (O)	
	1-02 Measurement unit (C)		
	1-03 Temporal extent (M)		
	1-04 Spatial extent (M)		
2. Purpose of observation	**2-01 Application area(s) (M)**		
	2-02 Programmes/network affiliation (M)		
3. Station/	*3-01 Region of origin of*	**3-04 Station/platform**	**3-05 Station/platform**

platform	*data (C)*	**type (M)**	**model (M)**
	3-02 Territory of origin of data (C)	3-08 Data communication method (O)	
	3-03 Station/platform name (M)		
	3-06 Station/platform unique identifier (M)		
	3-07 Geospatial location (M)		
	3-09 Station operating status (M)		
4. Environment		4-04 Events at station/platform (O) 4-05 Site information (O)	*4-01 Surface cover (C)*
			4-02 Surface cover classification scheme (C)
			4-03 Topography or bathymetry (C)
			4-06 Surface roughness (O)
			4-07 Climate zone (O)
5. Instruments and methods of observation	**5-01 Source of observation (M)**	5-11 Maintenance party (O)	5-04 Instrument operating status (O)
	5-02 Measurement/observing method (M)	*5-12 Geospatial location (C)*	*5-06 Configuration of instrumentation (C)*
	5-03 Instrument specifications (~~M~~C)	*5-15 Exposure of instrument (C)*	*5-07 Instrument control schedule (C)*
	5-05 Vertical distance of sensor (C)		*5-08 Instrument control result (C)*
			5-09 Instrument model and serial number (C)
			5-10 Instrument routine maintenance (C)
			5-13 Maintenance activity (O)
			5-14 Status of observation (O)
6. Sampling	6-03 Sampling strategy (O)	**6-05 Spatial sampling resolution (M)**	6-01 Sampling procedures (O)
	6-07 Diurnal base time (C)		6-02 Sample treatment (O)
	6-08 Schedule of observation (M)		**6-04 Sampling time period (M)**

			6-06 Temporal sampling interval (M)
7. Data processing and reporting	**7-03 Temporal reporting period (M)**	7-02 Processing/analysis centre (O)	7-01 Data processing methods and algorithms (O)
	7-04 Spatial reporting interval (C)	7-06 Level of data (O)	7-05 Software/processor and version (O)
	7-11 Reference datum (C)	**7-09 Aggregation period (M)**	**7-07 Data format (M)**
		7-10 Reference time (M)	**7-08 Version of data format (M)**
			7-12 Numerical resolution (O)
			7-13 Latency (of reporting) (M)
8. Data Quality		*8-01 Uncertainty of measurement (C)*	
		8-02 Procedure used to estimate uncertainty (C)	
		8-03 Quality flag (M)	
		8-04 Quality flagging system (M)	
		8-05 Traceability (C)	
9. Ownership and Data Policy	**9-02 Data policy/use constraints (M)**	**9-01 Supervising organization (M)**	
10. Contact	**10-01 Contact (nominated focal point) (M)**		

SECTION: Chapter
Chapter title in running head: APPENDIX 2.4. THE WIGOS METADATA STANDA…

Attachment to Appendix 2.4. WIGOS Metadata Standard

I. PURPOSE AND SCOPE OF WIGOS METADATA

An important aspect of WIGOS (WMO Integrated Global Observing System) implementation is ensuring maximum usefulness of WIGOS observations. Observations without metadata are of very limited use: it is only when accompanied by adequate metadata (data describing the data) that the full potential of the observations can be utilized.

Two complementary types of metadata are required: discovery metadata and interpretation/ description or observational metadata. Discovery metadata facilitate data discovery, access and retrieval. They are WIS metadata and are specified and handled as part of WIS. Interpretation/description or observational metadata enable data values to be interpreted in context. They constitute WIGOS metadata and are the subject of this WIGOS standard for the interpretation metadata required for the effective utilization of observations from all WIGOS component observing systems by all users. The WMO Integrated Global Observing System metadata should describe the observed variable, the conditions under which it was observed, how it was measured, and how the data have been processed, in order to provide users with confidence that the data are appropriate for their application. The Global Climate Observing System(GCOS) Climate Monitoring Principle 2.2.1(c) (see Appendix 2.2) describes the relevance of metadata as follows: "The details and history of local conditions, instruments, operating procedures, data processing algorithms and other factors pertinent to interpreting data (i.e. metadata) should be documented and treated with the same care as the data themselves."

The WMO Integrated Global Observing System observations consist of an exceedingly wide range of data from manual observations to complex combinations of satellite hyper-spectral frequency bands, measured in situ or remotely, from single dimension to multiple dimensions, and those involving processing. A comprehensive metadata standard covering all types of observation is by nature complex to define. A user should be able to use the WIGOS metadata to identify the conditions under which the observation (or measurement) was made, and any aspects that may affect its use or understanding, that is to determine whether the observations are fit for the purpose.

II. WIGOS METADATA CATEGORIES

Ten categories of WIGOS metadata have been identified. These are listed in Table 1 below. They define the WIGOS metadata standard, each category consisting of one or more metadata elements. All of the categories listed are considered to be important for the documentation and interpretation of observations made, and even for their use in the distant future. Hence, the standard currently declares many elements that are clearly not needed for applications focusing on more immediate use of observations. For these applications, such as numerical weather prediction, aeronautical or other transport sector applications and advisories, profiles of the standard may be developed. The categories are in no particular order but reflect the need to specify the observed variable; to answer why, where and how the observation was made; how the raw data were processed; and what the quality of the observation is.

A schematic composition of all categories, containing the individual elements is shown in Figure 1. Note that some of these elements will most likely be implemented using several individual entities (for example, geospatial location will consist of a combination of elements, such as latitude, longitude, elevation or a set of polar coordinates, as well as a reference to the geo-positioning methods used). Chapter VII contains a set of tables detailing all the elements, including definition, notes and examples, obligations and implementation phase. Code tables enabling users to select from predefined vocabularies to facilitate the application of the WIGOS metadata standard and the exchange of metadata are presented in the *Manual on Codes* (WMO-No. 306).

Table 1: WIGOS metadata categories

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#	*Category*	*Description*
1	Observed variable	Specifies the basic characteristics of the observed variable and the resulting datasets.
2	Purpose of observation	Specifies the main application area(s) of the observation and the observing programme(s) and networks the observation is affiliated to.
3	Station/platform	Specifies the environmental ~~monitoring~~observing facility, including fixed station, moving equipment or remote sensing platform, at which the observation is made.
4	Environment	Describes the geographical environment within which the observation is made. It also provides an unstructured element for additional meta-information that is considered relevant for adequate use of the data and that is not captured anywhere else in this standard.
5	Instruments and methods of observation	Specifies the method of observation and describes characteristics of the instrument(s) used to make the observation. If multiple instruments are used to generate the observation, then this category should be repeated.
6	Sampling	Specifies how sampling and/or analysis are used to derive the reported observation or how a specimen is collected.
7	Data processing and reporting	Specifies how raw data are transferred into the observed variable and reported to the users.
8	Data quality	Specifies the data quality and traceability of the observation.
9	Ownership and data policy	Specifies who is responsible for the observation and owns it.
10	Contact	Specifies where information about the observation or dataset can be obtained.

For example, an observation/dataset may have the following metadata categories associated with it:

- One or several purpose(s) of observation;
- Data processing procedures associated with the instruments;
- Instruments which have been used to make the observation;
- A station/platform to which the instrument(s) belong(s);
- Ownership and data policy restriction;
- Contact.

An instrument output may contribute to observations of one or more variables. For example:

- A four wire humidity probe can produce temperature and humidity, as well as dew point;
- A sonic anemometer does report wind speed, wind direction and can report air temperature;
- A spectrometer can report absorption due to many different chemical species.

An instrument typically will be associated with the categories:

- Instruments and methods of observation;
- Sampling (e.g. 10 Hz samples of air temperature);
- Data processing and reporting (e.g. ceilometer reporting of 10 min statistics of cloud height following processing through sky condition algorithm).

An observed variable may be influenced or characterized by the environment, for example:

- Wind speed (observed variable) on top of a hill (environment);
- River yield (observed variable) characterized by the upstream catchment and land use.

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Chapter title in running head: APPENDIX 2.4. THE WIGOS METADATA STANDA…

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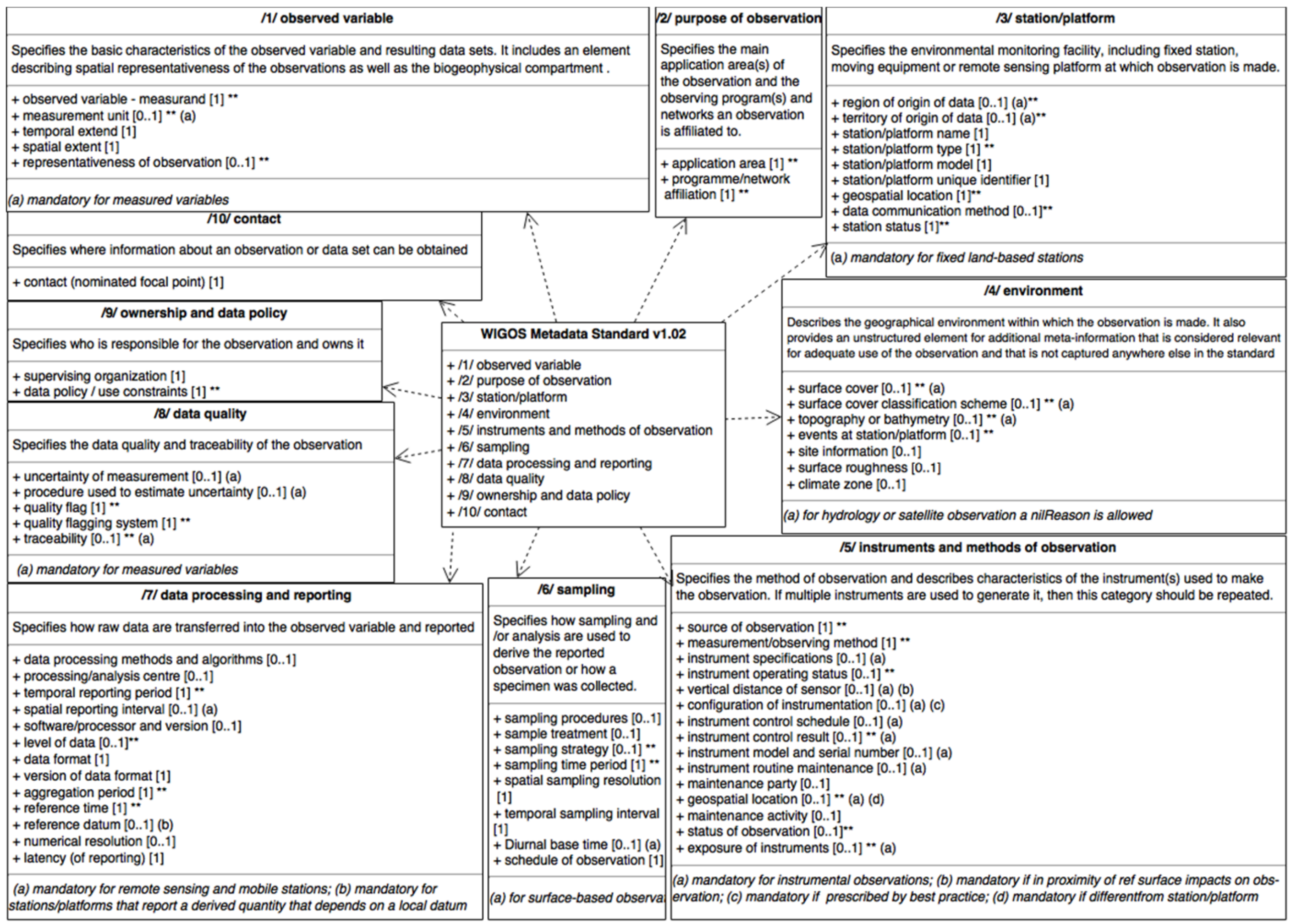

Figure 1. UML diagram specifying the WIGOS Metadata Standard (: code tables expected; [0..1*]: optional or conditional elements. Conditional elements become mandatory if a given condition is met. Conditions are referenced in parentheses. Optional elements may be declared mandatory as part of profiling the standard for specific application areas; [1..*]: mandatory elements. These elements must be reported, and if no value is available, a nilReason must be reported, which indicates that the metadata is “unknown”, or “not available”).**

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Table 2. Names and definition of elements

An asterisk (*) denotes the element is required for the ~~WIGOS~~WMO Rolling Review of Requirements (RRR) process. A hash sign (#) denotes that it is acceptable to record a "mandatory" element with a value of nilReason (that indicates that the metadata is either "unknown", or "not applicable", or "not available").

TABLE: Table shaded header with lines

Category	*Id*	*Name*	*Definition*	*MCO*	*Phase*
Observed variable	1-01	Observed variable – measurand	Variable intended to be measured or observed or derived, including the biogeophysical context	M*	1
	1-02	Measurement unit	Real scalar quantity, defined and adopted by convention, with which any other quantity of the same kind can be compared to express the ratio of the two quantities as a number [VIM3, 1.9]	C*	1
	1-03	Temporal extent	Time period covered by a series of observations inclusive of the specified date-time indications (measurement history)	M*	1
	1-04	Spatial extent	Typical georeferenced volume covered by the observations	M*	1
	1-05	Representativeness	Spatial extent of the region around the observation for which it is representative	O	2
Purpose of observation	2-01	Application area(s)	Context within, or intended application(s) for which the observation is primarily made or which has/have the most stringent requirements	M*	1
	2-02	Programme/Network affiliation	The global, regional or national Programmes/network(s) that the station/platform is associated with	M	1
Station/platform	3-01	Region of origin of data	WMO Region	C*	1

	3-02	Territory of origin of data	Country or territory name of the location of the observation	C*	1
	3-03	Station/platform name	Official name of the station/platform	M	1
	3-04	Station/platform type	A categorization of the type of ~~environmental monitoring~~observing facility at which an ~~observed variable is measured~~observation is made	M*	2
	3-05	Station/platform model	The model of the monitoring equipment used at the station/platform	M*#	3
	3-06	Station/platform unique identifier	A unique and persistent identifier for an ~~environmental monitoring~~observing facility (station/platform), which may be used as an external point of reference	M*	1
	3-07	Geospatial location	Position in space defining the location of the ~~environmental monitoring~~observing station/platform at the time of observation	M*	1
	3-08	Data communication method	Data communication method between the station/platform and some central facility	O	2
	3-09	Station operating Status	Declared reporting status of the station	M	1
Environment	4-01	Surface cover	The observed (bio)physical cover on the earth's surface in the vicinity of the observation	C	3
	4-02	Surface cover classification scheme	Name and reference or link to document describing the classification scheme	C	3
	4-03	Topography or bathymetry	The shape or configuration of a geographical feature, represented on a map by contour lines	C	3
	4-04	Events at station/platform	Description of human action or natural event at the station or at the vicinity that may influence the observation	O	2
	4-05	Site information	Non-formalized information about the location and its surroundings at which an observation is made and that may influence it	O	2
	4-06	Surface roughness	Terrain Classification in terms of effective surface roughness length	O	3

	4-07	Climate zone	The Köppen-Geiger climate classification scheme divides climates into five main groups (A, B, C, D, E), each having several types and subtypes	O	3
Instruments and methods of observation	5-01	Source of observation	The source of the dataset described by the metadata	M	1
	5-02	Measurement/observing method	The method of measurement/observation used	M#	1
	5-03	Instrument specifications	Intrinsic capability of the measurement/observing method to measure the designated element, including range, stability, precision, etc.	~~M~~C*#	1
	5-04	Instrument operating status	The status of an instrument with respect to its operation	O	3
	5-05	Vertical distance of sensor	Vertical distance of the sensor from a (specified) reference level such as local ground, or deck of a marine platform at the point where the sensor is located; or sea surface	C*	1
	5-06	Configuration of instrumentation	Description of any shielding or configuration/setup of the instrumentation or auxiliary equipment needed to make the observation or to reduce the impact of extraneous influences on the observation	C#	3
	5-07	Instrument control schedule	Description of schedule for calibrations or verification of instrument	C	3
	5-08	Instrument control result	The result of an instrument control check, including date, time, location, standard type and period of validity	C#	3
	5-09	Instrument model and serial number	Details of manufacturer, model number, serial number and firmware version if applicable	C#	3
	5-10	Instrument routine maintenance	A description of maintenance that is routinely performed on an instrument	C#	3
	5-11	Maintenance party	Identifier of the organization or individual who performed the maintenance activity	O	2
	5-12	Geospatial location	Geospatial location of instrument/sensor	C*	2

	5-13	Maintenance Activity	Description of maintenance performed on instrument	O	3
	5-14	Status of observation	Official status of observation	O	3
	5-15	Exposure of instruments	The degree to which an instrument is affected by external influences and reflects the value of the observed variable	C	2
Sampling	6-01	Sampling procedures	Procedures involved in obtaining a sample	O	3
	6-02	Sample treatment	Chemical or physical treatment of sample prior to analysis	O	3
	6-03	Sampling strategy	The strategy used to generate the observed variable	O*	1
	6-04	Sampling time period	The period of time over which a measurement is taken	M#	3
	6-05	Spatial sampling resolution	Spatial resolution refers to the size of the smallest observable object. The intrinsic resolution of an imaging system is determined primarily by the instantaneous field of view of the sensor, which is a measure of the ground area viewed by a single detector element in a given instance in time	M#	2
	6-06	Temporal sampling interval	Time period between the beginning of consecutive sampling periods	M	3
	6-07	Diurnal base time	Time to which diurnal statistics are referenced	~~M~~C	1
	6-08	Schedule of observation	Schedule of observation	M	1
Data processing and reporting	7-01	Data processing methods and algorithms	A description of the processing used to generate the observation and list of algorithms utilized to derive the resultant value	O	3
	7-02	Processing/analysis center	Center at which the observation is processed	O	2
	7-03	Temporal reporting period	Time period over which the observable variable is reported	M*	1

	7-04	Spatial reporting interval	Spatial interval at which the observed variable is reported	C*	1
	7-05	Software/processor and version	Name and version of the software or processor utilized to derive the element value	O	3
	7-06	Level of data	Level of data processing	O	2
	7-07	Data format	Description of the format in which the observed variable is being provided	M	3
	7-08	Version of data format	Version of the data format in which the observed variable is being provided	M	3
	7-09	Aggregation period	Time period over which individual samples/observations are aggregated	M	2
	7-10	Reference time	Time base to which date and time stamps refer	M	2
	7-11	Reference datum	Reference datum used to convert observed quantity to reported quantity	C	1
	7-12	Numerical resolution	Measure of the detail in which a numerical quantity is expressed	O	3
	7-13	Latency (of reporting)	The typical time between completion of the observation or collection of the datum and when the datum is reported	M	3
Data quality	8-01	Uncertainty of measurement	Non-negative parameter, associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the observation/measurand	C*#	2
	8-02	Procedure used to estimate uncertainty	A reference or link pointing to a document describing the procedures/algorithms used to derive the uncertainty statement	C*#	2
	8-03	Quality flag	An ordered list of qualifiers indicating the result of a quality control process applied to the observation	M#	2
	8-04	Quality flagging system	Reference to the system used to flag the quality of the observation	M#	2

	8-05	Traceability	Statement defining traceability to a standard, including sequence of measurement standards and calibrations that is used to relate a measurement result to a reference [VIM 3, 2.42]	C*#	2
Ownership and data policy	9-01	Supervising organization	Name of organization who owns the observation	M	2
	9-02	Data policy/use constraints	Details relating to the use and limitations surrounding data imposed by the supervising organization	M*	1
Contact	10-01	Contact (Nominated Focal Point)	Principal contact (Nominated Focal Point, FP) for resource	M	1

III. A NOTE ON SPACE AND TIME

It is important to understand that WIGOS metadata are intended to describe an individual observation or a dataset, i.e. one or several observations, including the where, when, how, and even why the observations were made. As a consequence, references to space and time are made in several places throughout the standard.

Figure 2 illustrates the concepts and terms used to describe the temporal aspects of an observation or dataset, including sampling strategy, analysis, data processing and reporting.

The concepts and terms used to describe spatial aspects (i.e., geospatial location) of observations are even more complex (cf. Figure 3). For example, for ground-based in-situ observations, the spatial extent of the observation coincides with the geospatial location of the sensor, which in most cases will be time-invariant and is normally close to the geospatial location of the station/platform where the observation was made. For a satellite-based lidar system, the situation is quite different. Depending on the granularity of metadata desired, the spatial extent of the individual observation may be an individual pixel in space, the straight line probed during an individual laser pulse, or perhaps an entire swath. In any case, the spatial extent of the observation will not coincide with the location of the sensor. The WIGOS metadata standard therefore needs to take into account such elements as:

1. The spatial extent of the observed variable (e.g. atmospheric column above a Dobson Spectrophotometer) (cf. 1-04);

ELEMENT REF: 7 (Floating object)2. The geospatial location of the station/platform (e.g. radar transmitter/receiver or aircraft position/route) (cf. 3-07);

3. The geospatial location of the instrument (e.g. the anemometer is adjacent to a runway) (cf. 5-05 Vertical Distance and 5-12 geospatial location);

4. The spatial representativeness of the observation (cf. 1-05).

ELEMENT REF: 9 (Floating object)All these are expressed in terms of geospatial location, specifying either a zero-dimensional geographic extent (a point), a one-dimensional geographic extent (a line, either straight or curved), a two-dimensional geographic extent (a plane or other surface), or a three-dimensional geographic extent (a volume).

A station/platform can be:

1. Collocated with the observed quantity as for in situ surface observing station (e.g. an Automatic Weather Station - AWS);

2. Collocated with the instrument but remote to the observed quantity (e.g. radar);

3. Remote from where the instrument may transmit data to the station (e.g. airport surface station where instruments are located across the airport, or a balloon atmosphere profiling station);

4. In motion and travelling through the observed medium (e.g. AMDAR - Aircraft Meteorological Data Relay - equipped aircraft);

5. In motion and remote to the observed medium (e.g. satellite platform).

An instrument can be:

1. Collocated with the observed variable (e.g. surface temperature sensor);

2. Remote to the observed variable (e.g. radar transmitter/receiver);

3. In motion but located in the observed medium (e.g. radiosonde);

4. In motion and remote from the observed quantity (e.g. satellite based radiometer);

5. Located within a standardized enclosure (e.g. a temperature sensor within a Stevenson screen).

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Figure 2. Graphical representation of temporal elements referenced in WIGOS Metadata categories

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Figure 3. Graphical representation of spatial elements referenced in WIGOS Metadata categories

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IV. REPORTING OBLIGATIONS FOR WIGOS METADATA

According with the International Organization for Standardization (ISO), the metadata elements are classified as either mandatory (M), conditional (C), or optional (O).

Mandatory metadata elements shall always be made available. The content of the corresponding fields shall never be empty, either the metadata "value" or the reason for no-value, shall be made available.

Most of the elements in this standard are considered **mandatory** in view of enabling adequate future use of observations by all WMO Application Areas. Metadata providers are expected to report mandatory metadata elements, and a formal validation of a metadata record will fail if mandatory elements are not reported. If Members cannot provide all the Mandatory elements the reason for that shall be reported as "not applicable" or "unknown" or "not available". The motivation for this is that knowledge of the reason why a mandatory metadata element is not available provides more information than not reporting a mandatory element at all. In the tables of chapter VII, these cases are indicated with $M^{\#}$.

Conditional metadata elements shall be made available when the specified condition or conditions are met, in which case the content of the corresponding fields shall never be empty, either the metadata "value" or the reason for no-value, shall be made available. For example, the element "Spatial reporting interval" is classified as conditional, because it only applies to remote sensing observations and mobile platforms. Therefore, the elements in this category should be considered mandatory for remote sensing and mobile observing systems but not so for e.g., surface land stations.

Optional metadata elements should also be made available. They provide useful information that can help to better understand an observation. In this version of the standard, very few elements are considered optional. Optional elements are likely to be important for a particular community, but less so for others.

V. TECHNICAL IMPLEMENTATION AND USE OF THE STANDARD

This document is a semantic standard that specifies the elements that exist and that can be recorded and reported. It does not specify how the information shall be encoded or exchanged. However, the following are likely scenarios and important aspects that may help the reader appreciate what lies ahead.

1. The most likely implementation will be in XML (Extensible Markup Language), in line with the specifications for WIS metadata and common interoperability standards. Regardless of the final implementation, the full metadata record describing a dataset can be envisioned as a tree with the categories as branches off the stem, and the individual elements as leaves on these branches. Some branches may occur more than once, e.g., a dataset may have been generated using more than one instrument at once, in which case two branches for 'instrument' may be required.

2. Not all of the elements specified in this document need to be updated at the same frequency. Some elements, such as position of a land-based station are more or less time-invariant, while others, such as a specific sensor, may change regularly every year. Still other elements, such as environment, may change gradually or rarely, but perhaps abruptly. Finally, elements restricting the application of an observation, e.g., to road condition forecasting, may have to be transmitted with every observation. The implementation of the WIGOS metadata needs to be able to deal with this.

3. Not all applications of observations require the full suite of metadata as specified in this standard at any given time. The amount of metadata that needs to be provided to be able to make adequate use of an observation, for example for the purpose of issuing a heavy precipitation warning, is much less than for the adequate use of even the same observation for a climatological analysis. On the other hand, the metadata needed for near-real-time applications may also need to be provided in near-real-time. This is important to realize, as it makes the task of providing WIGOS metadata much more tractable. The implementation of WIGOS metadata needs to be able to cope with vastly different update intervals, and incremental submission of additional metadata to allow the creation of 'complete' metadata records.

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Figure 4. Schematic of the relationship of WIS and WIGOS metadata and the scope of the ISO19115 standard (ISO, 2003). The WMO Core is a profile of ISO19115. WIGOS metadata exceed the scope of ISO19115 standard. A possible profile (subset) of WIGOS metadata elements for some specific near-real-time application is also shown.

END ELEMENT

4. Users will want to obtain and filter datasets according to certain criteria/properties as described within each WIGOS metadata record. This functionality requires either a central repository for WIGOS metadata or full interoperability of the archives collecting WIGOS metadata.

How, then can these requirements be met? In the case where observations are clearly only used for some near-real-time application and there is clearly no long-term use or re-analysis application to be expected, a profile of the WIGOS metadata standard may be specified that declares a specific subset of metadata elements as mandatory. This is depicted schematically in Figure 4.

Importantly, all WIGOS metadata elements (or group of elements) will have to be time-stamped with the time of validity and associated to a unique identifier for a dataset during transmission and for archiving. The specification of time stamps should also include a statement on the use of daylight savings time. Using this approach, increments of a 'full' WIGOS metadata record can be transmitted anytime changes occur and updates are deemed necessary. At the archive, the increments can be added to the existing metadata record for that dataset, establishing the full history of a particular observation with time.

VI. ADOPTION THROUGH A PHASED APPROACH

Making available WIGOS metadata will generate substantial benefits for Members, but developing the capacity to make available these metadata also requires a substantial effort on the part of (meta)data providers. To help Members comply with obligations, guidance material will be developed and provided.

Moreover, obligations will be enforced in phases in order to allow Members sufficient time to develop the capacity to comply. Balancing the effort required to generate and make available the metadata elements, and the need to have this information to make adequate use of observations, implementation will proceed through three phases as shown in Table 3. Importantly, elements required by the end of Phase I are either listed as mandatory elements in WMO-No. 9, Vol. A or are of critical importance for the Observing Systems Capability Analysis and Review (OSCAR) tool of the WIR (WIGOS Information Resource), and are considered of benefit for all application areas. Phase II adds elements recognized to be more challenging for Members, but the knowledge of which is still of rather immediate need for the adequate use of observations, in particular for assessing quality of observations. Phase III adds the remaining elements specified in this version of the standard.

Elements emerging as being important for specific application areas or observing programmes will be added to the standard as it evolves.

Table 3. List of elements specified in the WIGOS Metadata Standard, and implementation phases for Members

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Category	*Phase I*	*Phase II*	*Phase III*
	2016	*2017–2018*	*2019–2020*
1. Observed variable	**1-01 Observed variable – measurand (M)**	1-05 Representativeness (O)	
	1-02 Measurement unit (C)		
	1-03 Temporal extent (M)		
	1-04 Spatial extent (M)		
2. Purpose of observation	**2-01 Application area(s) (M)**		

	2-02 Programmes/network affiliation (M)		
3. Station/ platform	*3-01 Region of origin of data (C)*	**3-04 Station/platform type (M)**	**3-05 Station/platform model (M)**
	3-02 Territory of origin of data (C)	3-08 Data communication method (O)	
	3-03 Station/platform name (M)		
	3-06 Station/platform unique identifier (M)		
	3-07 Geospatial location (M)		
	3-09 Station operating status (M)		
4. Environment		4-04 Events at station/platform (O)	*4-01 Surface cover (C)*
		4-05 Site information (O)	*4-02 Surface cover classification scheme (C)*
			4-03 Topography or bathymetry (C)
			4-06 Surface roughness (O)
			4-07 Climate zone (O)
5. Instruments and methods of observation	**5-01 Source of observation (M)**	5-11 Maintenance party (O)	5-04 Instrument operating status (O)
	5-02 Measurement/observing method (M)	*5-12 Geospatial location (C)*	*5-06 Configuration of instrumentation (C)*
	5-03 Instrument specifications (C~~M~~)	*5-15 Exposure of instrument (C)*	*5-07 Instrument control schedule (C)*
	5-05 Vertical distance of sensor (C)		*5-08 Instrument control result (C)*
			5-09 Instrument model and serial number (C)
			5-10 Instrument routine maintenance (C)
			5-13 Maintenance activity

			(O)
			5-14 Status of observation (O)
6. Sampling	6-03 Sampling strategy (O)	**6-05 Spatial sampling resolution (M)**	6-01 Sampling procedures (O)
	6-07 Diurnal base time (~~M~~C)		6-02 Sample treatment (O)
	6-08 Schedule of observation (M)		**6-04 Sampling time period (M)**
			6-06 Temporal sampling interval (M)
7. Data processing and reporting	**7-03 Temporal reporting period (M)**	7-02 Processing/analysis centre (O)	7-01 Data processing methods and algorithms (O)
	7-04 Spatial reporting interval (C)	7-06 Level of data (O)	7-05 Software/processor and version (O)
	7-11 Reference datum (C)	**7-09 Aggregation period (M)**	**7-07 Data format (M)**
		7-10 Reference time (M)	**7-08 Version of data format (M)**
			7-12 Numerical resolution (O)
			7-13 Latency (of reporting) (M)
8. Data Quality		*8-01 Uncertainty of measurement (C)*	
		8-02 Procedure used to estimate uncertainty (C)	
		8-03 Quality flag (M)	
		8-04 Quality flagging system (M)	
		8-05 Traceability (C)	
9. Ownership and Data Policy	**9-02 Data policy/use constraints (M)**	**9-01 Supervising organization (M)**	
10. Contact	**10-01 Contact (nominated focal point) (M)**		

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VII. DETAILED SPECIFICATION OF WIGOS METADATA ELEMENTS

An asterisk (*) denotes the element is required for the WMO~~IGOS~~ Rolling Review of Requirements (RRR) process. A hash sign (#) denotes that it is acceptable to record a "mandatory" element with a value of nilReason (that indicates that the metadata is either "unknown", or "not applicable", or "not available"). M = Mandatory, C = Conditional, O = Optional.

CATEGORY 1: OBSERVED VARIABLE

Specifies the basic characteristics of the observed variable and the resulting datasets. It includes an element describing the spatial representativeness of the observation as well as the biogeophysical compartment the observation describe.

TABLE: Table shaded header with lines

Id	*Name*	*Definition*	*Note or example*	*Code Table*	*ItemMCO*
1-01	Observed variable (measurand)	Variable intended to be measured or observed or derived, including the biogeophysical context	*[ISO19156:2011] NOTE 1:* In conventional measurement theory the term "measurement" is used. However, a distinction between measurement and category-observation has been adopted in more recent work so the term "observation" is used for the general concept. "Measurement" may be reserved for cases where the result is a numeric quantity. *NOTE 2:* The biogeophysical context is expressed in terms of Domain, Subdomain/Matrix, and Layer, and variables are organized hierarchically using these dimensions. Relevant domains, matrices and layers include atmosphere, aerosol, lake, river, ocean, soil, cloud water, aerosol particulate phase, land surface, troposphere, upper troposphere/lower stratosphere, space, etc. *EXAMPLES:* In hydrology, this would typically be stage or discharge. Present weather; Air temperature near the surface; CO_2 mixing ratio in the atmosphere	1-01	M* (Phase 1)

Id	*Name*	*Definition*	*Note or example*	*Code Table*	*ItemMCO*
1-02	Measurement unit	Real scalar quantity, defined and adopted by convention, with which any other quantity of the same kind can be compared to express the ratio of the two quantities as a number [VIM 3, 1.9]	*[VIM 3, 1.9] NOTE 1:* Measurement units are designated by conventionally assigned names and symbols. *[VIM 3, 1.9] NOTE 2:* Measurement units of quantities of the same quantity dimension may be designated by the same name and symbol even when the quantities are not of the same kind. For example, joule per kelvin and J/K are respectively the name and symbol of both a measurement unit of heat capacity and a measurement unit of entropy, which are generally not considered to be quantities of the same kind. However, in some cases special measurement unit names are restricted to be used with quantities of a specific kind only. For example, the measurement unit 'second to the power minus one' (1/s) is called hertz (Hz) when used for frequencies and becquerel (Bq) when used for activities of radionuclides. *[VIM 3, 1.9] NOTE 3:* Measurement units of **quantities of dimension one** are numbers. In some cases these measurement units are given special names, e.g. radian, steradian, and decibel, or are expressed by quotients such as millimole per mole equal to 10^{-3} and microgram per kilogram equal to 10^{-9}. *[VIM 3, 1.9] NOTE 4:* For a given quantity, the short term "unit" is often combined with the quantity name, such as "mass unit" or "unit of mass". *EXAMPLE:* In hydrology, this would typically be m for stage or m^3/s for discharge.	1-02	C* (Phase 1)
1-03	Temporal extent	Time period covered by a series of observations inclusive of the specified date-time indications (measurement history)	*NOTE 1*: The Temporal Extent is defined through the begin and end dates of observations. *NOTE 2*: If the data are still being added to, omit the End date (but specify a Begin		M* (Phase 1)

Id	Name	Definition	Note or example	Code Table	ItemMCO
			date). *NOTE 3*: If there are gaps in the data collection (e.g. 1950-1955 then collection resumes 1960-present) then the first date recorded should be the earliest date and the last the most recent, ignoring the gap. *EXAMPLES:* Surface temperature at the station Säntis has been observed since 1 September 1882. The CO_2 record at Mauna Loa extends from 1958 to today. Continuous, 1-hourly aggregates are available from the World Data Centre for Greenhouse Gases for the period 1974-01-01 to 2011-12-31.		
1-04	Spatial extent	Typical spatial georeferenced volume covered by the observations	*NOTE 1*: The spatial extent of an observed quantity can be a zero-, one-, two-, or three-dimensional feature and will be expressed in terms of a series of geospatial locations describing a geometric shape. In the case of space-based observations the spatial coverage should be stated in terms of global (e.g. for LEO, characteristics like swathe width and repeat cycle), disk (GEO), vertical (soundings), etc. *NOTE 2*: A zero-dimensional geospatial location of an observation implies either an in-situ (point) observation or, by convention, a column-averaged quantity above the specified geospatial location in nadir. One-dimensional geospatial location of an observation implies a distribution/profile of a quantity along a trajectory (e.g., a straight line from the ground up with a given zenith angle). A two-dimensional geospatial location of an observation implies an area or hyper-surface (e.g., a radar image, or a satellite pixel of a property near the surface). A three-dimensional geospatial location of an observation implies a volume-averaged quantity (e.g., a radar pixel in 3D-space). *EXAMPLES:* (i) Air temperature at a surface observing site: Sydney Airport NSW: Lat. -33.9465 N; Lon. 151.1731 E, Alt: 6.0 m above msl; (ii) The projected area or volume of the cone around a particular weather	Free text, that could be complemented by one or more URLs	M* (Phase 1)

Id	Name	Definition	Note or example	Code Table	ItemMCO
			radar with a maximum range of 370 km (radar reflectivity) and 150 km (Doppler); to be expressed as a geometric shape; (iii) 3-dimensional grid of radar pixels; (iv) For ~~I~~infrared and visible imagery by meteorological satellite (sun-synchronous)~~: VIRR (FY-3: ~~Global ~~coverage twice/day (IR) or once/day (VIS)~~; (v) For nadir sounding: atmospheric column above ocean; (vi) NASA Aura satellite (705 km altitude) has a 16-day (233 orbit) repeat cycle; (vii) River discharge by gauge: size and geometric shape of a river Catchment.		
1-05	Representativeness	Spatial extent of the region around the observation for which it is representative	*NOTE*: The representativeness of an observation is the degree to which it describes the value of the variable needed for a specific purpose. Therefore, it is not a fixed quality of any observation, but results from joint appraisal of instrumentation, measurement interval and exposure against the requirements of some particular application (WMO-No. 8, 2008). Representativeness of an observed value describes the concept that the result of an observation made at a given geospatial location would be compatible with the result of other observations of the same quantity at other geospatial locations. In statistics, the term describes the notion that a sample of a population allows an adequate description of the whole population. Assessing representativeness can only be accomplished in the context of the question the data [or observations] are supposed to address. In the simplest terms, if the data [or observations] can answer the question, it is representative (Ramsey and Hewitt, 2005). The representativeness of an environmental observation depends on the spatio-temporal dynamics of the observed quantity (Henne et al., 2010). Representativeness of an observation can sometimes be specified quantitatively, in most cases qualitatively, based on experience or heuristic arguments.	1-05	O (Phase 2)

Condition:

{1-02} variables that are measured, rather than classified

CATEGORY 2: PURPOSE OF OBSERVATION

Specifies the main application area(s) of the observation and the observing programme(s) and networks the observation is affiliated to.

TABLE: Table shaded header with lines

Id	*Name*	*Definition*	*Note or example*	*Code Table*	*ItemMCO*
2-01	Application area(s)	Context within, or intended application(s) for which the observation is primarily made or which has/have the most stringent requirements	*NOTE:* Many observations serve more than one purpose, meeting the requirements of various applications areas. In such cases, the application area for which the station or platform was originally established should be listed first.	2-01	M* (Phase 1)
2-02	Program/Network affiliation	The global, regional or national program/network(s) that the station/platform is associated with	*EXAMPLES:* GUAN, AMDAR, GAW, RBSN, WHOS, etc. (full names to be referenced in code table)	2-02	M (Phase 1)

CATEGORY 3: STATION / PLATFORM

Specifies the ~~environmental monitoring~~observing facility, including fixed station, moving equipment or remote sensing platform at which the observation is made.

TABLE: Table shaded header with lines

Id	*Name*	*Definition*	*Note or example*	*Code Table*	*ItemMCO*
3-01	Region of origin of data	WMO Region	*NOTE:* WMO divides Member countries into six Regional Associations responsible for coordination of meteorological, hydrological and related activities within their respective Regions.	3-01	C* (Phase 1)

Id	*Name*	*Definition*	*Note or example*	*Code Table*	*ItemMCO*
3-02	Territory of origin of data	Country or territory name of the location of the observation	*NOTE*: Mandatory for fixed stations, optional for mobile stations *EXAMPLE*: Australia	3-02	C* (Phase 1)
3-03	Station/platform name	Official name of the station/platform	*EXAMPLES*: Mauna Loa, South Pole		M (Phase 1)
3-04	Station/platform type	A categorization of the type of ~~environmental monitoring~~observing facility at which an observation~~ed~~ ~~variable~~ is made~~asured~~	*NOTE*: Code table according to See [INSPIRE D2.8.III.7, 2013]	3-04	M* (Phase 2)
3-05	Station/platform model	The model of the monitoring equipment used at the station/platform	*EXAMPLES*: 'Landsat 8' is a platform/station model of 'satellite'; 'Almos Automatic Weather Station (AWS)' is a model of a 'land station'; 'Airbus A340-600' is a model of an 'aircraft'.		M*# (Phase 3)
3-06	Station/platform unique identifier	A unique and persistent identifier for an ~~environmental monitoring~~ observing facility (station/platform), which may be used as an external point of reference	*NOTE*: A globally unique identifier assigned by WMO for a station. Where a station has multiple identifiers, there must be a way of recording that they are synonyms. To be defined according to WMO guidelines. *EXAMPLE*: Ship: Call sign		M* (Phase 1)

Id	*Name*	*Definition*	*Note or example*	*Code Table*	*ItemMCO*
3-07	Geospatial location	Position in space defining the location of the environmental monitoring station/platform at the time of observation	*NOTE 1*: Required for fixed stations; for stations following pre-determined trajectory (e.g. satellites). *NOTE 2*: The elevation of a fixed terrestrial station is defined as the height above sea level of the ground on which the station stands ("Hha" in WMO Pub. 9 Vol A). *NOTE 3*: The geospatial location can be a zero-, one-, two-, or three-dimensional feature. *NOTE 4*: Geographical coordinates can be specified in decimal degrees. Latitudes are specified with reference to the equator, with positive sign for latitudes north of the equator, and negative sign for latitudes south of the equator. Longitudes are specified with reference to the Greenwich meridian, with positive sign for longitudes east of Greenwich, and negative sign for meridians west of Greenwich. Elevation is a signed number specified in some distance measure (e.g., meters) relative to a reference elevation, with positive sign in the direction away from the Earth centre. *NOTE 5*: The latitudinal and longitudinal positions of a station referred to in the World Geodetic System 1984 (WGS-84) Earth Geodetic Model 1996 (EGM96) must be recorded to a resolution of at least 0.001 decimal degrees (WMO-No. 8, 2008, Part I, Chapter 1, 1.3.3.2).	11-01 11-02	M* (Phase 1)
			NOTE 6: This element comprises 3 entities, the coordinates (Lat/Long/Alt), the "geopositioning method" (code table 11-01) which produced the coordinates, as well as the "geospatial reference system" (code table 11-02) used.	11-01 11-02	M* (Phase 1)

Id	Name	Definition	Note or example	Code Table	ItemMCO
			EXAMPLES: (i) The station Jungfraujoch is located at 46.54749°N 7.98509°E (3580.00 m a.m.s.l.). The reference system is WGS-84; (ii) Voluntary Observing Ship Route: WMO Regional Association 5, Sub Area 6 (R56); (iii) [geostationary satellite] Meteosat-8 (MSG-1) 3.6°E; (iv) [sun-synchronous satellite] NOAA-19 Height 870 km; Local Solar Time (LST) 13:39; (v) Weather Watch Radar: Warruwi NT -11.6485° N, 133.3800 E, Height 19.1 m amsl; (vi) River discharge gauge: Warrego River at Cunnamulla Weir 28.1000 S, 145.6833 E, Height: 180 m amsl.		
3-08	Data communication method	Data communication method between the station/platform and some central facility	*EXAMPLES*: Inmarsat-C, ARGOS, Cellular, Globalstar, GMS(DCP), Iridium, Orbcomm, VSat, landline telephone, mail	3-08	O (Phase 2)
3-09	Station operating status	Declared reporting status of the station	*NOTE:* Refer to the code table.	3-09	M (Phase 1)

Conditions:

{3-01, 3-02}: Mandatory for fixed land-based stations, optional for mobile stations

CATEGORY 4: ENVIRONMENT

Describes the geographical environment within which the observation is made. It also provides an unstructured element for additional meta-information that is considered relevant for adequate use of the observations and that is not captured anywhere else in the standard.

TABLE: Table shaded header with lines

Id	*Name*	*Definition*	*Note or example*	*Code table*	*ItemMCO*
4-01	Surface cover	The observed (bio)physical cover on the Earth's surface in the vicinity of the observation	*NOTE 1:* To be applied to 3 different geographic scales of the vicinity of the observation, namely horizontal radii of <100 m, of 100 m to 3 km, and of 3 km to 100 km. *NOTE 2:* Surface cover or land cover is distinct from land use despite the two terms often being used interchangeably. Land use is a description of how people utilize the land and socio-economic activity – urban and agricultural land uses are two of the most commonly known land use classes. At any one point or place, there may be multiple and alternate land uses, the specification of which may have a political dimension~~.(Wikipedia, 2013)~~ *NOTE 3:* There are various classification methods for 'land cover'. The MODIS product MCD12Q1 provides 5 different classifications on 500 m resolution grid (https://lpdaac.usgs.gov/dataset_discovery/modis/modis_products_table/mcd12q1). These include the IGBP, UMD, LAI/fPAR, NPP and PFT classifications. *NOTE 4:* An alternative approach is the Land Cover Classification System (LCCS) (Di Gregorio, 2005) adopted by the Food and Agriculture Organization of the United Nations. Translation of other systems to LCCS has been explored by Herold et al. (2009). Eight major land cover types are identified during the first, dichotomous classification phase. These are refined in a subsequent so-called Modular-Hierarchical Phase, in which ~~land~~surface cover classes are created by the combination of sets of pre-defined classifiers. These classifiers are tailored to each of the eight major ~~land~~surface cover types. This process can be supported by software (http://www.glcn.org/sof_7_en.jsp) or manually using a field log sheet	4-01	C (Phase 3)

Id	*Name*	*Definition*	*Note or example*	*Code table*	*ItemMCO*
			(http://commons.wikimedia.org/wiki/File:LCCS_field_protokoll.png).		
4-02	Surface cover classification scheme	Name and reference or link to document describing the classification scheme	IGBP, UMD, LAI/fPAR, NPP and PFT, LCCS (recommended implementation as a URI pointing to the code table)	4-02	C (Phase 3)
4-03	Topography or bathymetry	The shape or configuration of a geographical feature, represented on a map by contour lines	*NOTE 1*: Topography shall be formally expressed with the four elements 'local topography', 'relative elevation', 'topographic context', and 'altitude/depth'. *NOTE 2:* The term 'altitude' is used for elevations above mean sea level. The term 'depth' is used for elevations below mean sea level. *EXAMPLES (can be converted into entries of the code table):* "a ridge at low relative elevation within valleys of middle altitude" "a depression within plains of very low depth"	4-03	C (Phase 3)
4-04	Events at ~~station/platform~~ observing facility	Description of human action or natural event at the station or in the vicinity that may influence the observation	*NOTE 1:* This information may be frequently changing (for example ocean debris impacting buoys). *NOTE 2:* The start and end time/date of the event should be included	4-04 or free text or an URL	O (Phase 2)
4-05	Site information	Non-formalized information about the location and its surroundings at which an observation is made and that	*NOTE ~~1~~:* ~~This information may be frequently changing (for example ocean debris impacting buoys).~~	Free text and/or URL(s)	O (Phase 2)

Id	Name	Definition	Note or example	Code table	ItemMCO
		may influence it	~~*NOTE 2:*~~ In hydrology, description and dating of activities occurring in the basin that can affect the observed discharge, e.g., construction of a regulation structure upstream of the gauging location that significantly affects the hydrological regime, inter-basin diversion of water into or from the basin upstream of the gauging location, significant change in consumptive use, ~~land~~surface cover or land use. *EXAMPLES:* maps, plans, photographs, descriptions and other unique site information that is difficult to express in words or that cannot easily be quantified.		
4-06	Surface roughness	The Terrain classification in terms of aerodynamic roughness length	*NOTE:* The Terrain classification (Davenport and Wieringa) as mentioned in WMO-No. 8, 2008, Updated 2010, Annex to Chapter 5	4-06	O (Phase 3)
4-07	Climate zone	The Köppen climate classification of the region where the observing facility is located	The Köppen-Geiger climate classification scheme divides climates into five main groups (A, B, C, D, E), each having several types and subtypes.	4-07	O (Phase 3)

Conditions:

Either {4-01 and 4-02 and 4-03} or a nilReason=”not applicable” must be reported. For hydrology and satellite observations, specifying nilReason is appropriate.

CATEGORY 5: INSTRUMENTS AND METHODS OF OBSERVATION

Specifies the method of observation and describes characteristics of the instrument(s) used to make the observation. If multiple instruments are used to generate the observation, then this category should be repeated.

TABLE: Table shaded header with lines

Id	*Name*	*Definition*	*Note or example*	*Code Table*	*ItemMCO*
5-01	Source of observation	The source of the dataset described by the metadata	*NOTE:* Refer to the Code table	5-01	M (Phase 1)
5-02	Measurement/observing method	The method of measurement/ observation used	*EXAMPLES:* Temperature can be determined using different principles: liquid in glass; mechanical; electrical resistance; thermistor; thermocouple. Likewise, humidity is determined in AMDAR as a mass mixing ratio. Several chemical variables can be determined using infrared absorption spectroscopy. In hydrology, stage would be observed using a staff gauge, electric tape, pressure transducer, gas bubbler, or acoustics. Examples of satellite observation principles: Cross-nadir scanning IR sounder; MW imaging/sounding radiometer, conical scanning, etc. Visual observation of weather, cloud type, etc.	5-02	M# (Phase 1)
5-03	Instrument specifications	Intrinsic capability of the measurement/observing method to measure the designated element, including range, stability, precision, etc.	*NOTE 1*: The metadata record can be "not available". *NOTE 2*: Includes the Upper limit of operational range and the Lower limit of operational range. For space-based observations, the channels and their frequencies should be included.	An URL is acceptable in case of space-based observations	~~M~~C*# (Phase 1)

Id	Name	Definition	Note or example	Code Table	ItemMCO
			EXAMPLES: (i) Barometer measurement range 800–1100 hPa (i.e. unsuitable for some mountain ranges, Mt Everest ~300hPa); (ii) Maximum distance a human observer can observe given the topography.		
5-04	Instrument operating status	The status of an instrument with respect to its operation	*NOTE:* To be recorded by data providers for each individual observation.	5-04	O (Phase 3)
5-05	Vertical distance of sensor	Vertical distance of the sensor from a (specified) reference level such as local ground, or deck of a marine platform at the point where the sensor is located; or sea surface	*NOTE 1:* The reference surface (generally a surface which will strongly influence the observation) must be specified. *NOTE 2:* Away from center of earth, positive. Negative values indicate position below reference surface. *EXAMPLES:* (i) Air temperature: height of the temperature sensor is 1.50 m above ground surface (station level); (ii) Surface wind: 10.0 m above ground surface (station level); (iii) Soil temperature: 0.50 m below soil surface; (iv) Ship: Visual Obs Height: 22.0 m a.s.l.; (v) Weather Watch Radar: Warruwi AU 24.3 m above ground surface (see 7-07); (vi) Transmissometer 2.55 above runway surface;		C* (Phase 1)

Id	Name	Definition	Note or example	Code Table	ItemMCO
			(vii)Depth of buoy relative to lowest astronomical tide; (viii)Pressure sensor: vertical distance above mean sea level.~~;~~ ~~(ix) For satellites, e.g., geostationary orbit at 36000 km above geoid, or LEO at 800 km above geoid.~~		
5-06	Configuration of instrumentation	Description of any shielding or configuration/setup of the instrumentation or auxiliary equipment needed to make the observation or to reduce the impact of extraneous influences on the observation	*NOTE:* An URL could be provided in case of space-based observations. *EXAMPLES (for surface-based observations):* Shelter, temperature control, etc. Internal volume: [m^3] Aspirated: [Natural/forced/na] Aspiration rate: $m^3 s^{-1}$ Shielding from: [radiation/precipitation/ wind/etc.]		$C^{\#}$ (Phase 3)
5-07	Instrument control schedule	Description of schedule for calibrations or verification of instrument	*NOTE:* For space-based observations, it applies only to major changes; For very frequent changes on parameters, a specific link to external source should be provided. *EXAMPLE:* Every year on first week of February		C (Phase 3)
5-08	Instrument control result	The result of an instrument control check, including date, time, location, standard type and period of validity	*NOTE 1:* For the result of control check code table 5-08 is to be used.	5-08	$C^{\#}$ (Phase 3)

Id	*Name*	*Definition*	*Note or example*	*Code Table*	*ItemMCO*
			NOTE 2: record even if "not available" *NOTE 3:* Information should contain at least the following elements: Standard type: [International, Primary, Secondary, Reference, Working, Transfer, Travelling, collective] Standard name: [free text] Standard reference: [serial number or equivalent] Within verification limit [Y/N] *NOTE 4*: Can be implemented with a URI pointing to a document containing this information. *NOTE 5:* For space-based observations, it applies only to major changes; for very frequent changes on parameters, a specific link to external source should be provided. *EXAMPLE:* 20140207 15:30 UTC, travelling standard, <name>, <S/N>, field calibration, result: in calibration, validity: 4 years		
5-09	Instrument model and serial number	Details of manufacturer, model number, serial number and firmware version if applicable	*NOTE 1*: Record "not available" NOTE 2:		$C^{\#}$ (Phase 3)

Id	Name	Definition	Note or example	Code Table	ItemMCO
			Use the following formats: Instrument manufacturer: [free text] Instrument model: [free text] Instrument serial number: [free text] Firmware version: [free text] *EXAMPLE*: Vaisala PTB330B G2120006		
5-10	Instrument routine maintenance	A description of schedule maintenance that is performed on an instrument	*EXAMPLE*: Daily cleaning of a radiation sensor		C# (Phase 3)
5-11	Maintenance party	Identifier of the organization or individual who performed the maintenance activity			O (Phase 2)
5-12	Geospatial location	Geospatial location of instrument/sensor	*NOTE 1:* Geographic location of instrument such as airfield anemometer or transmissometer. *NOTE 2:* This element comprises 3 entities, the coordinates (Lat/Long/Alt), the "geopositioning method" (code table 11-01) which produced the coordinates, as well as the "geospatial reference system" (code table 11-02) used. *EXAMPLES:* (i) Melbourne Airport AU (East anemometer) –37.6602 N, 144.8443 E, 122.00	11-01 11-02	C* (Phase 2)

Id	*Name*	*Definition*	*Note or example*	*Code Table*	*ItemMCO*
			m amsl.; (ii) Relative position of wind sensor aboard ship; (iii) 30 km upstream of river mouth.		
5-13	Maintenance Activity	Description of maintenance performed on instrument	*NOTE:* A log of actual maintenance activity, both planned and corrective		O (Phase 3)
5-14	Status of observation	Official status of observation	*NOTE:* A binary flag	5-14	O (Phase 3)
5-15	Exposure of instruments	The degree to which an instrument is affected by external influences and reflects the value of the observed variable	NOTE: The exposure of an instrument results from joint appraisal of the environment, measurement interval and exposure against the requirements of some particular application. Expressed in terms of code table.	5-15	C (Phase 2)

Conditions:

{5-07, 5-08, 5-09, 5-10, 5-15} mandatory for instrumental observations

{5-05} mandatory for instrumental observations and if proximity of reference surface impacts on observation

{5-06} mandatory for instrumental observations and if prescribed by “best practice”.

{5-12} mandatory for instrumental observations and if different from station/platform

{5-05, 5-06, 5-10, 5-12, 5-15} A nil Reason = ”not applicable” is acceptable for space-based observations.

CATEGORY 6: SAMPLING

Specifies how sampling and/or analysis are used to derive the reported observation or how a specimen is collected.

TABLE: Table shaded header with lines

Id	*Name*	*Definition*	*Note or example*	*Code Table*	*ItemMCO*
6-01	Sampling procedures	Procedures involved in obtaining a sample	*EXAMPLES*: Temperature measurements are made using a XYZ thermometer and reported results are an average of 10 measurements made in a given hour. Aerosols may be sampled with an inlet with size-cutoff at 2.5 µm and be deposited on a teflon filter. Manual reading of a liquid-in-glass thermometer every three hours. As an exception, an observer may observe the state of the sky from home rather than at the station during night. Rain fall is accumulated during the whole week-end and distributed evenly over these 2 days.	An URL in case of space-based observations	O (Phase 3)
6-02	Sample treatment	Chemical or physical treatment of sample prior to analysis	*EXAMPLES*: Homogenization, milling, mixing, drying, sieving, heating, melting, freezing, evaporation.		O (Phase 3)
6-03	Sampling strategy	The strategy used to generate the observed variable	*EXAMPLES*: Continuous: global radiation, atmospheric pressure, or continuous ozone monitoring with a UV monitor; Discrete: gas chromatographic analysis of carbon monoxide, radar rainfall; Event: grab water samples, flask sampling of air, etc.	6-03 or an URL in case of space-based observations	O* (Phase 1)

Id	*Name*	*Definition*	*Note or example*	*Code Table*	*ItemMCO*
6-04	Sampling time period	The period of time over which a measurement is taken	*NOTE:* Includes the sampling time period, plus the meaning of time stamp (11–03). ~~*EXAMPLES:*~~ ~~surface winds sampled every 0.25 s (frequency 4 Hz) (WMO, 2008); surface winds measured once per hour; Barometric pressure measured once every 6 minutes; water column height measured every 15 seconds; water temperature measured once per hour (NOAA, 2009);~~ ~~For each example, Time stamp indicates "end of period".~~	11-03	$M^{\#}$ (Phase 3)
6-05	Spatial sampling resolution	Spatial resolution refers to the size of the smallest observable object. The intrinsic resolution of an imaging system is determined primarily by the instantaneous field of view of the sensor, which is a measure of the ground area viewed by a single detector element in a given instance in time.	*NOTE:* A representative value (L × L × L), where "L" is a length, is expected, according to the dimension (1-D, 2-D or 3-D), but free text is allowed for the characteristics to be explained. *EXAMPLES*: ~~AVHRR: 1.1 km IFOV s.s.p.~~ The sample is a point in space or a very small volume resembling a point, e.g., a temperature sampled by a thermocouple element: No size to be reported; The sample is a line, either straight (e.g., a line of sight of a DOAS instrument) or curved (e.g., the humidity sampled by an aircraft in flight). The 'length' of the line is to be reported; The sample is an area, either rectangular or of any other shape, e.g., ~~the pixel of a satellite or~~ the reach of a radar image. The 'length x length' of the area is to be reported; The sample is a volume, e.g. a water sample or a well-mixed volume of air sampled by flask. The 'length x length x length' of the volume is to be reported.		$M^{\#}$ (Phase 2)

Id	*Name*	*Definition*	*Note or example*	*Code Table*	*ItemMCO*
6-06	Temporal sampling interval	Time period between the beginning of consecutive sampling periods	*EXAMPLES:* Surface winds sampled every 0.25 s (frequency 4 Hz) (WMO, 2008); surface winds measured once per hour; Barometric pressure measured once every 6 minutes; water column height measured every 15 seconds; water temperature measured once per hour; For each example, Time stamp indicates "end of period".		M (Phase 3)
6-07	Diurnal base time	Time to which diurnal statistics are referenced	*EXAMPLES:* Rain fall observation is accumulated for 24 hours up until 0700z, the diurnal base time here is 0700z. Daily temperature maxima refer to the period 0600 local time, the diurnal base time here is 0600z.		~~M~~C (Phase 1)
6-08	Schedule of observation	Schedule of observation	*EXAMPLES:* AMDAR profiling observations are available from Zurich airport between 0600 and 1200 local time; Radio-sondes are collected at a particular station from January to August on weekdays at 0000z and 1200z.	Free text	M (Phase 1)

{6-05, 6-06, 6-07, 6-08} A nil Reason = "not applicable" is acceptable for space-based observations.

CATEGORY 7: DATA PROCESSING AND REPORTING

Specifies how raw data are transferred into the observed variables and reported to the users.

TABLE: Table shaded header with lines

Id	*Name*	*Definition*	*Note or example*	*Code table*	*ItemMCO*
7-01	Data processing methods and algorithms	A description of the processing used to generate the observation and list of algorithms utilized to derive the resultant value	*NOTE*: In hydrology, this would be the equation(s) defining the rating curve and any shifts or corrections applied to the data or the curve. *EXAMPLE:* Radiation correction and calculation of geo-potential height for upper-air soundings.	Free text or an URL	O (Phase 3)
7-02	Processing/analysis center	Center at which the observation is processed.	*EXAMPLES*: Chemical analysis, AMDAR processing center, National Hydrological Service office.		O (Phase 2)
7-03	Temporal reporting period	Time period over which the observed variable is reported	*NOTE:* Includes the temporal reporting interval, plus the meaning of time stamp. *EXAMPLES*: Hourly, daily, monthly, seasonal, event-based, 80 seconds interval during the day, etc. In each case, the meaning, "beginning, "middle", or "end" of period is indicated.	11-03	M* (Phase 1)
7-04	Spatial reporting interval	Spatial interval at which the observed variable is reported	*NOTE*: This is applicable only to remote sensing observations and mobile platforms in general. For most remote-sensing observations, this will be redundant with element 6-05~~6~~. *EXAMPLES:*		C* (Phase 1)

Id	*Name*	*Definition*	*Note or example*	*Code table*	*ItemMCO*
			(i) An observation from a satellite may be reported with a spatial resolution of 10 km x 20 km; (ii) An aircraft may sample every 1 km along its trajectory (cf. 6-05~~6~~), but may report at a spatial interval of 10 km.		
7-05	Software/processor and version	Name and version of the software or processor utilized to derive the element value	*EXAMPLES*: Avionics version, retrieval algorithm version; MCH Database Management System version 25/10/2013.		O (Phase 3)
7-06	Level of data	Level of data processing	*NOTE*: Pre- or post-processing.	7-06	O (Phase 2)
7-07	Data format[1]	Description of the format in which the observed variable is being provided.	*EXAMPLES*: ASCII, BUFR, NASA AMES, HDF, XML, AMDAR, comma-separated (CSV), tab-separated (.txt), MCH (for interchange)	7-07	M (Phase 3)
7-08	Version of data format[1]	Version of the data format in which the observed variable is being provided.	*EXAMPLES*: FM 12–XIV Ext. SYNOP; FM 42-XI Ext. AMDAR, FM 94-XIV BUFR Version 20.0.0, Radar: ODIM_H5		M (Phase 3)
7-09	Aggregation period	Time period over which individual samples/observations are aggregated	*NOTE:* Includes the aggregation interval, plus the meaning of time stamp. *EXAMPLES*: 5 minute mean, meaning of time stamp is “middle of period”; daily maximum, meaning of time stamp is “end of period”;	11-03	M (Phase 2)

Id	*Name*	*Definition*	*Note or example*	*Code table*	*ItemMCO*
			event based, meaning of time stamp is "beginning of period".		
7-10	Reference time	Time base to which date and time stamps refer	*NOTE:* The reference time must not be confused with the time zone (which is part of the representation of the time stamp), but indicates what the source of the time stamp is, i.e., to which reference time the time stamps of the observation are aligned. *EXAMPLES*: NIST time server NTP pool project	7-10	M (Phase 2)
7-11	Reference datum	Reference datum used to convert observed quantity to reported quantity	*NOTE 1:* Atmospheric pressure can be reported as (i) Field elevation Pressure (QFE), where the reference datum is the elevation corresponding to the official elevation of the aerodrome; (ii) Atmospheric pressure at nautical height (QNH), where the reference datum is mean sea level and the pressure altitude relationship of the ICAO standard atmosphere is used. Where observed atmospheric pressure cannot be reduced to mean sea level, a station should, by regional agreement, report either the geopotential of an agreed 'constant pressure level' or the pressure reduced to an agreed datum for the station. The level chosen for the station should be reported in this field. (Ref: WMO-No. 8 3.11.1). *NOTE 2:* Hydrology may report a gauge zero which is the gauge height of zero flow.		C (Phase 1)
7-12	Numerical resolution	Measure of the detail in which a numerical quantity is expressed	*NOTE 1*: The resolution of a numerical quantity is a measure of the detail in which the quantity is expressed. It can be expressed as the smallest possible difference between two numbers. It can also be expressed as the number of significant figures of a number, which are those digits that carry meaning contributing to its		O (Phase 3)

Id	*Name*	*Definition*	*Note or example*	*Code table*	*ItemMCO*
			resolution. *EXAMPLE*: If a measurement resolution to four decimal places (0.0001) is given as 12.23 then it might be understood that only two decimal places of resolution are available. Stating the result as 12.2300 makes clear that it is precise to four decimal places (in this case, six significant figures).		
			NOTE 2: The notion of measurement resolution is related but must not be confounded with the uncertainty of an observation. *EXAMPLES*: (i) An anemometer may measure wind speed with a measurement resolution of 0.1 ms^{-1} with a 1 Hz scan rate. Observations may be aggregated to 1-minute values and may be rounded and reported with a (reduced) measurement resolution of 1 ms^{-1}; (ii) A barometer may be capable of measuring atmospheric pressure with a readout resolution of 1 hPa and an uncertainty of 5 hPa (k=2). The data can be reported to the nearest hPa, however, the measurement resolution should be stated as "5 hPa" or "3 significant digits"; (iii) An ocean thermometer measures temperature to 0.0001 °C; (iv) Seawater salinity measured to 0.001 salinity units (derived from conductivity measurements with a resolution of 0.01 Sm^{-1}).		O (Phase 3)
7-13	Latency (of reporting)	The typical time between completion of the observation or collection of the datum and when the datum is reported	(i) For satellite data, the "observation" (e.g. a complete image) can take 20 minutes to generate. Hence the latency would be the time between the completion of the image collection, and when it is available. Typically this can be 2–3 minutes. Some satellite products such as SST can take about 10 minutes of processing until it is available; (ii) A radar volumetric scan can take 6–10 minutes (in Australia), so the latency		M (Phase 3)

Id	*Name*	*Definition*	*Note or example*	*Code table*	*ItemMCO*
			would be the time between the completion of the scan and when the data is locally available. In Australia, this varies between a few seconds to several minutes depending on delays in data communications; (iii) AWS data may have a latency of 1–20 seconds (or considerably more in some places) between the completion of the observation and arrival of the data at a central archive.		

1 Provided as part of the WIS metadata records

Conditions:

{7-04}: mandatory for remote sensing observations and mobile platforms in general

{7-11}: mandatory for stations/platforms that report a derived observation value that depends on a local datum

CATEGORY 8: DATA QUALITY

Specifies the data quality and traceability of the observation

TABLE: Table shaded header with lines

Id	*Name*	*Definition*	*Note or example*	*Code Table*	*ItemMCO*
8-01	Uncertainty of measurement	Non-negative parameter, associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the observation/ measurand	*NOTE 1:* In principle, an uncertainty statement needs to be reported for each observation, as it can change from observation to observation. If the uncertainty of observations remains virtually constant over time, it is sufficient to report the uncertainty at the beginning of the period and then again when substantial changes of the uncertainty occur. The actual uncertainty statements should be reported with the observations. *NOTE 2:*		C*# (Phase 2)

Id	*Name*	*Definition*	*Note or example*	*Code Table*	*ItemMCO*
			Complex observations such as gridded satellite imagery may contain large error covariance matrices that are not useful for the purpose of this standard. Such information must be kept with the data, and it is sufficient to report an aggregate (e.g., mean or median) uncertainty in the metadata. *NOTE 3:* Uncertainty may be expressed, for example, as a standard deviation (or a given multiple of it), or the half-width of an interval having a stated level of confidence. *NOTE 4:* Uncertainty of measurement comprises, in general, many components. Some of these components may be evaluated from the statistical distribution of the results of series of measurements and can be characterized by experimental standard deviations. The other components, which also can be characterized by standard deviations, are evaluated from assumed probability distributions based on experience or other information. *NOTE 5:* It is understood that the result of the measurement is the best estimate of the value of the measurand, and that all components of uncertainty, including those arising from systematic effects, such as components associated with corrections and reference standards, contribute to the dispersion. *NOTE 6:* For space-based observations, the implementation should be taken in a simple way. *EXAMPLE:* A thermometer reading may yield a value of 13.7 °C. A quality assessment of that observation may indicate that it has an expanded uncertainty of +/− 0.3 °C (k=2), where k=2 is a coverage factor corresponding approximately to a confidence interval of 95%.		

Id	*Name*	*Definition*	*Note or example*	*Code Table*	*ItemMCO*
8-02	Procedure used to estimate uncertainty	A reference or link pointing to a document describing the procedures/algorithms used to derive the uncertainty statement	*NOTE:* Uncertainty is a well-defined term, and guidance material exists to assist in the assessment of the uncertainty of observations and a formulation of adequate uncertainty statements. The authoritative source is the "Guide for the Expression of Uncertainty in Measurement" (JCGM 100:2008).		
8-03	Quality flag	An ordered list of qualifiers indicating the result of a quality control process applied to the observation	*NOTE 1:* BUFR code table series 0-33 contains data quality flags/definitions. *NOTE 2:* To be recorded by data providers for each individual observation.	8-03	M# (Phase 2)
8-04	Quality flagging system	Reference to the system used to flag the quality of the observation	*NOTE 1:* At present, there is no single, globally accepted flagging system. The purpose of this element is to make reference to the flagging system used. This reference should either be a URL to a document explaining the meaning of the quality flag, or a link to a code table where this information can be found. *NOTE 2*: The use of the BUFR quality codes listed above is recommended (WMO, 2013a)	8-04	
8-05	Traceability	Statement defining traceability to a standard, including sequence of measurement standards and calibrations that is used to relate a measurement result to a reference [VIM 3, 2.42]	*NOTE 1:* A metrological traceability chain is defined through a calibration hierarchy *[VIM 3, 2.42].* *NOTE 2:* A metrological traceability chain is used to establish metrological traceability of a measurement result *[VIM 3, 2.42].*	8-05	C*# (Phase 2)

Id	*Name*	*Definition*	*Note or example*	*Code Table*	*ItemMCO*
			NOTE 3: A comparison between two measurement standards may be viewed as a calibration if the comparison is used to check and, if necessary, correct the quantity value and measurement uncertainty attributed to one of the measurement standards *[VIM 3, 2.42]*. *NOTE 4:* For the statement on traceability, code table 8-05 is to be used. *NOTE 5:* For space-based observations, the implementation should be taken in a simple way.		

Conditions:

{8-01, 8-02 and 8-05} variables that are measured, rather than classified

CATEGORY 9: OWNERSHIP AND DATA POLICY

Specifies who is responsible for the observation and owns it.

TABLE: Table shaded header with lines

Id	*Name*	*Definition*	*Note or example*	*Code Table*	*ItemMCO*
9-01	Supervising organization	Name of organization who owns the observation	*EXAMPLES:* for satellite operators EUMETSAT, ESA, NOAA, NASA, CMA, RapidEye, ISRO		M (Phase 2)
9-02	Data policy/use constraints	Details relating to the use and limitations surrounding data imposed by the supervising organization	*NOTE:* Only one single use constraint with a value taken from WMO_DataLicenseCode is allowed to ensure unambiguity (WMO, 2013b, p. 51~~5~~)	9-02	M* (Phase 1)

CATEGORY 10: CONTACT

Specifies where information about an observation or dataset can be obtained.

TABLE: Table shaded header with lines

Id	*Name*	*Definition*	*Note or example*	*Code Table*	*ItemMCO*
10-01	Contact (Nominated Focal Point)	Principal contact (Nominated Focal Point, FP) for resource	*NOTE:* The FP would be able to provide data users with information regarding individual observing platforms and their observations. *EXAMPLES:* Programme or Network Manager, e.g. E-AMDAR Technical Coordinator (TC) has responsibility for data quality of several airlines' fleets, has information on aircraft type/software/known errors etc.		M (Phase 1)

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SECTION: Chapter

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APPENDIX 2.5. THE EIGHT PRINCIPLES OF QUALITY MANAGEMENT OF THE WMO QUALITY MANAGEMENT FRAMEWORK APPLIED TO WIGOS

1. User and client focus

Members should identify, document and understand the current and future needs of their users and clients for meteorological, climatological, hydrological, marine and related environmental observations.

Note: The means to achieve this includes participation in and application of the WMO Rolling Review of Requirements (RRR) (see section 2.2.4 and Appendix 2.3).

2. Leadership

Members should clearly define the goals and directions of their observing systems, and create an environment in which staff are encouraged to work towards those goals.

Note: The relevant WMO technical commissions provide technical guidance and leadership for the implementation of WIGOS. They provide information on WIGOS goals and directions, and stimulate the active involvement of technical experts from Member countries.

3. Involvement of experts

Experts from Member countries should be fully involved in the implementation of regulations pertaining to WIGOS quality management.

4. Process approach

Members should adopt a process-based approach to management of observing systems.

5. System approach to management

Members should identify, understand and manage WIGOS observing systems as sets of processes that may be operational, scientific or administrative, with the overall objective of producing the required observation outputs.

6. Continual improvement

Members should ensure that continual improvement is an integral and permanent component of WIGOS observing systems and is implemented through a range of processes and activities that include active participation in the WMO RRR; auditing of observing systems and sites; data quality monitoring and evaluation; and routine consultation with, and review of feedback from, WIGOS users and application areas, primarily through the WMO RRR.

Note: The outcome is the improvement of either the quality of observations or the efficiency of observing systems.

7. Factual approach to decision-making

Members should ensure that decisions, requirements and regulations associated with the design, development, implementation, operation, maintenance and evolution of WIGOS observing systems are based on scientifically, factually and analytically derived information.

Note: The above-mentioned information is available to Members through tools such as the WMO RRR, the WIGOS Information Resource (WIR), the Observing Systems Capability Analysis and Review (OSCAR) tool, and through WMO endorsed planning documents such as the *Implementation Plan for the Evolution of Global Observing Systems* (WIGOS Technical Report No. 2013-4). For further information see section 2.2.4, Appendix 2.1 and Attachment 2.2.

8. Mutually beneficial supplier relationships

Members should participate in, and share with each other and with suppliers, information and results of tests, trials and intercomparisons of instruments and systems, for the mutual benefit of both WIGOS and suppliers.

Note: Suppliers of instruments, systems and related products should be evaluated and selected on the basis of their ability to meet requirements and on the past performance of their products and services.

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ATTACHMENT 2.1. WIGOS STATION IDENTIFIERS

1. STRUCTURE OF WIGOS STATION IDENTIFIERS

Figure 1 shows the structure of the WIGOS station identifier. The description of each component is given in the table below.

TABLE: Table with lines

WIGOS identifier series	Issuer of identifier	Issue number	Local identifier

Figure 1. Structure of the WIGOS station identifier

Component parts of the WIGOS station identifier

TABLE: Table horizontal lines

Component	*Description*	*Initial range – series 0 (stations)*
WIGOS identifier series	This is used to distinguish between different systems for allocating identifiers. It allows future expansion of the system so that entities do not have to be issued with new identifiers if the structure of the WIGOS identifiers proves unable to meet future requirements. Different values of the WIGOS identifier series may correspond to different structures of the WIGOS identifier. Initial permitted range: 0-14.	0
Issuer of identifier	A number that is used to distinguish between identifiers issued by different organizations. It is allocated by WMO to ensure that only one organization can create a given WIGOS station identifier.	0-65534
Issue number	A number that an organization responsible for issuing an identifier may use to ensure global uniqueness of its identifiers. For example, allocating one issue number for hydrological stations and another for voluntary climate observing stations would enable the managers of the two networks to issue local identifiers independently without needing to check with each other that they were not duplicating identifiers.	0-65534
Local identifier	This is the individual identifier issued for each entity. An organization issuing identifiers must ensure that the combination of issue number and local identifier is unique; in that way global uniqueness is guaranteed.	16 characters

Notes:

1. The structure of WIGOS station identifiers has been designed to be general enough to identify other entities, such as individual instruments; however, this has not yet been implemented.

2. Although the table proposes initial ranges of permitted values of the components that make up a WIGOS identifier, future changes in requirements may result in these ranges being increased. Information technology systems must, therefore, be designed to process identifiers whose components are of arbitrary length. BUFR encodings will need to be prepared for WIGOS identifiers to allow efficient representation and these may use code lists to represent components of the identifier that are shared by many entities. Currently, station identifier = 0.

2. NOTATION FOR THE WIGOS IDENTIFIER

The convention for writing WIGOS identifiers (in the context of WIGOS) is:

<WIGOS identifier series>-<issuer of identifier>-<issue number>-<local identifier>

Here is an example of WIGOS identifier:

TABLE: Table with lines

WIGOS identifier series	Issuer of identifier	Issue number	Local dentifier
0	513	215	5678

which would be written as 0-513-215-5678.

3. REPRESENTING THE WIGOS IDENTIFIER IN CONTEXTS OUTSIDE WIGOS

The following convention should be used to represent the WIGOS identifier outside WIGOS or to show the relationship between the WIGOS identifier and an identifier that has been defined in a different context:

TABLE: Table with lines

int.wmo.wigos	WIGOS identifier	WIGOS supplementary identifier

Figure 2. Structure of an extended WIGOS identifier

Both the int.wmo.wigos and the WIGOS supplementary identifier elements are optional.

int.wmo.wigos

The first component of the extended WIGOS identifier (int.wmo.wigos) allows it to be recognized as a WIGOS identifier when used in contexts where it may be ambiguous as to what type of identifier is being used. This is optional and need not be represented in BUFR, because the entries for the WIGOS identifier provide this information;

WIGOS identifier

The second component (WIGOS identifier) is defined above. Within a WIGOS context it is the only component of the WIGOS identifier that is always required;

WIGOS supplementary identifier

The final component (WIGOS supplementary identifier) is optional and is used to associate identifiers issued using other systems with the WIGOS unique identifier. A single WIGOS identifier may be associated with many WIGOS supplementary identifiers (such as an observing site that is used for both synoptic and aviation reporting), and a WIGOS supplementary identifier may be associated with many WIGOS unique identifiers (such as a World Weather Watch drifting buoy identifier that has been issued to many drifting buoys). In BUFR, this would be indicated by a specific table entry (such as IIiii for World Weather Watch station identifier).

Note: If the above example of WIGOS identifier (0-513-215-5678) was also associated with an identifier (MYLOCATION) issued by another authority, a valid extended WIGOS identifier would be int.wmo.wigos-0-513-215-5678-MYLOCATION.

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ATTACHMENT 2.2. THE WIGOS INFORMATION RESOURCE

1. PURPOSE

The WIGOS Information Resource (WIR) is a tool designed to provide WIGOS stakeholders (observing network decision-makers, managers, supervisors, implementation coordination groups and observational data users) with all relevant information on the operational status and evolution of WIGOS and its observing components, and their capabilities to meet the user observational requirements of the WMO application areas; the operational requirements of WIGOS, including standard and recommended practices and procedures; and on best practices and procedures used in the WIGOS framework. The WIR serves a number of purposes and brings the following benefits to WMO Members:

(a) General information on WIGOS, its benefits to Members and the impact on Members of addressing WIGOS requirements;

(b) An overall description of the WIGOS component observing systems that are currently in place (list of observing networks, stations, their characteristics (metadata) including information on the observational products they deliver);

(c) Monitoring of the evolution of the observing systems and compare it with the plans in order to ascertain progress;

(d) An outline of existing national and regional plans for evolution of WIGOS component observing systems;

(e) Help for Members and those in charge of designing and implementing observing networks in understanding the requirements for the relevant observing systems, including standard and recommended practices and procedures and user observational requirements, in order for them to make appropriate decisions;

(f) Assistance for Members in identifying observational gaps through critical review and in conducting network design studies, in order for them to address those gaps;

(g) Help for Members in grasping the full potential of the current observing systems, including those operated by partner organizations, with regard to the WMO application areas, in order to enhance: (a) the scope and availability of observations made by specific observing stations; (b) collaboration; (c) data sharing; and (d) data exchange;

(h) Immediate access for data users to the list of WIGOS component observing systems and a basic set of observational metadata for each (specified by WMO Technical Regulations), with links to the appropriate national databases, where these exist, which contain more detailed information;

(i) Guidance for developing countries on observing network implementation, providing them with tools they can readily use to document their own observing systems (for example, by using the Observing Systems Capability Analysis and Review (OSCAR) tool of the WIR, they would not need to develop a national database);

(j) A mechanism for matching specific needs (capacity building, closing gaps, etc.) with resources (via knowledge sharing, donor contributions, etc.).

Notes:

1. The term observing station refers to any type of observing site, station or platform relevant to WIGOS, whether they are surface-based or space-based, on land, at sea, in a lake, river or in the air, fixed or mobile (including in the air), and making in-situ or remote observations.

2. Gaps are expressed in terms of required space and time resolution, observing cycle, timeliness and uncertainty for the WMO application areas.

2. THE OBSERVING SYSTEMS CAPABILITY ANALYSIS AND REVIEW TOOL

The Observing Systems Capability Analysis and Review tool of the WIR is a key source of information for WIGOS metadata. The surface- and space-based components of OSCAR are intended to record observing platform/station metadata, according to the WIGOS metadata standard described in the present Manual, and to retain a record of the current and historical WIGOS metadata.

3. MANAGEMENT OF THE OBSERVING SYSTEMS CAPABILITY ANALYSIS AND REVIEW

The management of OSCAR (for example, its functional specifications and their evolution) and its components is overseen by the WMO Secretariat in liaison with relevant expert groups and bodies, and in accordance with the WIGOS standards that have been agreed upon and recommended practices and procedures.

4. CONTENT MANAGEMENT OF THE OBSERVING SYSTEMS CAPABILITY ANALYSIS AND REVIEW

The WIGOS metadata are maintained under the authority of the Permanent Representatives with WMO.

The operator of OSCAR will collect feedback from Members on noted discrepancies, possible errors and required changes, so that the information content of OSCAR reflects the reality of the surface- and space-based capabilities of the observing platforms/stations they operate, including instrument and platform/station metadata.

The WMO Secretariat is responsible for coordinating management of the information content of OSCAR, with assistance from designated experts and focal points.

Current information can be found at http://www.wmo.int/oscar.

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3. ATTRIBUTES SPECIFIC TO THE SURFACE-BASED SUBSYSTEM OF WIGOS

3.1. REQUIREMENTS

Note: The user observational requirements of WMO application areas are expressed in a technology-free manner, hence they apply to all of WIGOS, not to any specific subsystem. The provisions of section 2.1 apply across all WIGOS subsystems.

3.2. DESIGN, PLANNING AND EVOLUTION

3.2.1 Composition of the surface-based subsystem of WIGOS

3.2.1.1 The WIGOS surface-based subsystem shall be composed of surface stations within the component networks (for example, GOS, GAW, WHOS, GCW).

3.2.1.2 Members should implement elements of the WIGOS surface-based subsystem under the coordination of regional associations when appropriate.

Note: Information regarding the current capabilities of the surface-based subsystem is to be available through the OSCAR tool at http://www.wmo.int/oscar.

3.3. INSTRUMENTATION AND METHODS OF OBSERVATION

3.3.1 General requirements

3.3.1.1 Members shall classify their surface meteorological and climatological observing stations on land.

Note: The *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Chapter 1, 1.1.2, Annex 1.B, provides guidelines on the classification of surface observing sites on land to indicate their representativeness for the measurement of different variables. The content of Annex 1.B will be included as an appendix in a future edition of the present Manual.

3.3.1.2 Members should locate each observing station at a site that permits instrument exposure against the requirements of the particular application and enables satisfactory non-instrumental observations.

Notes:

1. The *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Chapter 1, Annexes 1.B and 1.C provides further guidelines.

2. Requirements for GAW stations are formulated in section 6.

3.3.1.3 Members shall accurately ascertain and refer the position of a station to the World Geodetic System 1984 (WGS-84) and its Earth Geodetic Model 1996 (EGM96).

Notes:

1. Guidelines are provided in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Chapter 1, 1.3.3.2.
2. The WGS-84 is currently not in general use in hydrology. Its description will be included as an appendix in a future edition of the present Manual.

3.3.1.4 Members shall define the elevation of the station.

Note: The *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Chapter 1, 1.3.3.2(c), provides guidelines on defining the elevation of a station. This material will be included as an appendix in a future edition of the present Manual.

3.3.1.5 If a station is located at an aerodrome, Members shall specify the official elevation of the aerodrome in accordance with the *Technical Regulations* (WMO-No. 49), Volume II, Part II, Appendix 3, 4.7.2.

3.3.1.6 Members operating Regional Instrument Centres should follow the guidelines concerning capabilities and corresponding functions.

Note : The *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Annex 1.A, provides guidelines concerning capabilities and corresponding functions for Regional Instrument Centres. This material will be included as an appendix in a future edition of the present Manual.

3.3.1.7 Members operating Regional Marine Instrument Centres should follow the guidelines concerning capabilities and corresponding functions.

Note : The *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part II, Chapter 4, Annex 4.A, provides guidelines concerning capabilities and corresponding functions for operating Regional Marine Instrument Centres. This material will be included as an appendix in a future edition of the present Manual.

3.3.2 Requirements for sensors

3.3.2.1 Members shall avoid the use of mercury in their observing systems. Where mercury is still in use, Members shall obey the safety precautions provided.

Note: The *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Chapter 3, 3.2.7, provides safety precautions for the use of mercury. This material will be included as an appendix in a future edition of the present Manual.

3.3.2.2 For inflation of meteorological balloons, Members should prefer helium over hydrogen. If hydrogen is used, however, Members shall obey the safety precautions provided.

Note: The *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part II, Chapter 10, 10.6.1, provides safety precautions for the use of hydrogen. This material will be included as an appendix in a future edition of the present Manual.

3.3.2.3 Members shall calibrate all pyrheliometers, other than absolute pyrheliometers, by comparison, using the sun as the source, with a pyrheliometer that is traceable to the World Standard Group and has a likely uncertainty of calibration equal to or better than the pyrheliometer being calibrated.

Note: The *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Chapter 7, 7.2.1.4, provides detailed guidelines on calibration of pyrheliometers.

3.3.2.4 Members shall compare, calibrate and maintain barometers according to the guidelines.

Note: The *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Chapter 3, 3.10, provides guidelines on the comparison, calibration and maintenance of barometers. This material will be included as an appendix in a future edition of the present Manual.

3.4. OPERATIONS

3.4.1 General requirements

Members operating surface-based observing systems shall follow the provisions of section 2.4.1.

3.4.2 Observing practices

3.4.2.1 Members shall ensure that the exposure, when applicable, of instruments for the same type of observation at different stations is similar so that observations may be compatible.

3.4.2.2 Members shall determine a reference height for each surface observing station or system.

Note: A reference height is defined as follows:

(a) Elevation of the station: it is the datum level to which barometric pressure reports at the station refer; such current barometric values are termed "station pressure" and are understood to refer to the given level for the purpose of maintaining continuity in the pressure records;

(b) For stations not located on aerodromes: elevation (height above mean sea level) of the ground on which the raingauge stands or, if there is no raingauge, of the ground beneath the thermometer screen. If there is neither raingauge nor screen, it is the average level of terrain in the immediate vicinity of the station, expressed in metres rounded up to two decimals;

(c) For stations located on aerodromes it is an official altitude of the aerodrome.

3.4.3 Quality control

Members operating surface-based observing systems shall follow the provisions of section 2.4.3.

3.4.4 Data and metadata reporting

Members operating surface-based observing systems shall follow the provisions of section 2.4.4.

3.4.5 Incident management

Members operating surface-based observing systems shall follow the provisions of section 2.4.5.

3.4.6 Change management

Members should compare observations from new instruments over an extended interval before the old measurement system is taken out of service or when there has been a change of site. Where this procedure is impractical at all sites, Members should carry out comparisons at selected representative sites.

Notes:

1. This does not apply to all types of station; among the exceptions are hydrological stations.
2. Further details, including the required minimum intervals for such comparison, can be found in the *Guide to Climatological Practices* (WMO-No. 100).

3.4.7 Maintenance

Observing sites and instruments should be maintained regularly so that the quality of observations does not deteriorate significantly between station inspections.

Note: Detailed guidance on maintenance of observing sites, observing systems and instruments is given in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), the *Guide to Hydrological Practices* (WMO-No. 168) and the *Manual on Stream Gauging* (WMO-No. 1044).

3.4.8 Inspection and supervision

3.4.8.1 Members shall arrange for their surface observing sites, stations and systems to be inspected at sufficiently frequent intervals to ensure that a high standard of observations is maintained, that instruments and all their indicators are functioning correctly, and that the exposure, when applicable, of the instruments has not changed significantly.

Notes:

1. Detailed guidance on the inspection, including frequency, is given in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part III, Chapter 1.
2. Reference is made to the *Technical Regulations* (WMO-No. 49), Volume II, for provisions on the inspection of aeronautical meteorological stations including its frequency.

3.4.8.2 Members shall ensure that the inspection is performed by qualified and adequately trained staff.

3.4.8.3 When performing inspections, Members should ensure that:

(a) The siting, selection and installation, as well as exposure when applicable, of instruments are known, recorded and acceptable;

(b) Instruments have approved characteristics, are in good order and regularly checked against relevant standards;

(c) There is uniformity in the methods of observation and in the procedure for reduction of observations.

Note: Detailed guidance on inspection and supervision of observing systems and sites is given in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), which includes guidelines on GAW measurements (see Part I, chapter 16), the *Guide to Hydrological Practices* (WMO-No. 168) and the *Manual on Stream Gauging* (WMO-No. 1044).

3.4.9 Calibration procedures

Members operating surface-based observing systems shall follow the provisions of section 2.4.9.

3.5 OBSERVATIONAL METADATA

Note: Detailed guidance regarding the establishment, maintenance and update of metadata records is given in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Chapter 1, 1.3.4, and Part III, Chapter 1, 1.9; the *Guide to Climatological Practices* (WMO-No. 100), Chapter 3, 3.3.4; the *Guide to the Global Observing System* (WMO-No. 488), Appendix III.3, and the *Guide to Hydrological Practices* (WMO-No. 168), Volume I, Chapter 10.

Members operating surface-based observing systems shall follow the provisions of section 2.5.

Note: Further provisions specific to the WIGOS component observing systems appear in sections 5, 6, 7 and 8.

3.6. QUALITY MANAGEMENT

Members operating surface-based observing systems shall follow the provisions of section 2.6.

Note: Further provisions specific to the WIGOS space-based subsystem appear in section 4; those specific to the WIGOS component observing systems appear in sections 5, 6, 7 and 8.

3.7. CAPACITY DEVELOPMENT

Members operating surface-based observing systems shall follow the provisions of section 2.7.

Note: Further provisions specific to the WIGOS space-based subsystem appear in section 4; those specific to the WIGOS component observing systems appear in sections 5, 6, 7 and 8.

SECTION: Chapter

Chapter title in running head: 4. ATTRIBUTES SPECIFIC TO THE SPACE-BAS…

4. ATTRIBUTES SPECIFIC TO THE SPACE-BASED SUBSYSTEM OF WIGOS

4.1. REQUIREMENTS

4.1.1 General

Members shall strive to develop, implement and operate a space-based environmental observing system in support of WMO Programmes as described in Attachment 4.1.

Note: The space-based subsystem of WIGOS is established through dedicated satellites, remotely observing the characteristics of the atmosphere, the Earth and the oceans.

4.1.2 Observed variables

This subsystem shall provide quantitative data enabling, independently of or in conjunction with surface-based observations, the determination of variables including but not limited to:

(a) Three-dimension fields of atmospheric temperature and humidity;

(b) Temperature of sea and land surfaces;

(c) Wind fields (including ocean surface winds);

(d) Cloud properties (amount, type, top height, top temperature and water content);

(e) Radiation balance;

(f) Precipitation (liquid and frozen);

(g) Lightning;

(h) Ozone concentration (total column and vertical profile);

(i) Greenhouse gas concentration;

(j) Aerosol concentration and properties;

(k) Volcanic ash cloud occurrence and concentration;

(l) Vegetation type and status, and soil moisture;

(m) Flood and forest fire occurrence;

(n) Snow and ice properties;

(o) Ocean colour;

(p) Wave height, direction and spectra;

(q) Sea level and surface currents;

(r) Sea ice properties;

(s) Solar activity;

(t) Space environment (electric and magnetic field, energetic particle flux and electron density).

Note: Information regarding the current capabilities of the space-based subsystem is available through the OSCAR tool at: www.wmo.int/oscar.

4.1.3 Observing performance requirements

Satellite operators providing observational data to WIGOS shall strive to meet, to the extent possible, the uncertainty, timeliness, temporal and spatial resolution, and coverage requirements of WIGOS as defined in the WIR, based on the Rolling Review of Requirements described in section 2.

Notes:

1. In the present Manual, the term "satellite operators" refers to Members or a coordinated group of Members operating environmental satellites.
2. A coordinated group of Members operating environmental satellites acts jointly to operate one or more satellites through an international space agency such as the European Space Agency or the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT).
3. These requirements are recorded and maintained in the requirements database: http://www.wmo.int/oscar.

4.1.4 Global planning

Satellite operators shall cooperate to ensure that a constellation of satellite systems is planned and implemented to guarantee the continuous provision of space-based observations in support of WMO Programmes.

Note: Collaboration is pursued within the Coordination Group for Meteorological Satellites, which includes all Members operating space-based observation systems in support of WMO Programmes.

4.1.5 Continuity

Satellite operators working together under the auspices of the Coordination Group for Meteorological Satellites or otherwise, should ensure the continuity of operation and of the data dissemination and distribution services of the operational satellites within the subsystem, through appropriate contingency arrangements and relaunch plans.

4.1.6 Overlap

Satellite operators should ensure an adequate period of overlap of new and old satellite systems in order to determine inter-satellite instrumental biases and maintain the homogeneity and consistency of time series observations, unless reliable transfer standards are available.

4.1.7 Interoperability

4.1.7.1 Satellite operators shall achieve the greatest possible interoperability of their different systems.

4.1.7.2 Satellite operators shall make available sufficient technical details about the instruments, data processing, transmissions and dissemination schedules for Members to fully exploit the data.

4.2. DESIGN, PLANNING AND EVOLUTION

Note: The space-based subsystem is composed of:

(a) An Earth observation space segment;

(b) An associated ground segment for data reception, processing, dissemination and stewardship;

(c) A user segment.

4.2.1 Space segment architecture

Note: The overall architecture of the space segment is described in Attachment 4.1. It is defined and evolves in consultation with the Coordination Group for Meteorological Satellites.

It includes:

(a) A constellation of geostationary satellites;

(b) A core constellation of sun-synchronous satellites distributed over three separate orbital planes;

(c) Other operational satellites operated on either sun-synchronous orbits or other appropriate low Earth orbits;

(d) Research and development satellites on appropriate orbits.

4.2.2 Space programme life cycles

Satellite operators shall consider a trade-off between the need for a long series to pay off the development cost and the user learning curve, on one hand, and the need to develop a new generation in order to benefit from state-of-the-art technology, on the other hand.

Notes:

1. The development of an operational satellite programme is conducted in several phases including: definition of user requirements, feasibility assessment at system level, preliminary design, detailed design, development and testing of the subsystems, integration of all subsystems, system testing, launch campaign and on-orbit commissioning. The overall duration of these development phases is typically of the order of 10 to 15 years.
2. The exploitation phase for an operational programme including a series of recurring satellites is typically of the order of 15 years.

4.3. INSTRUMENTS AND METHODS OF OBSERVATION

Notes:

1. Space-based observation relies on a wide range of sensor types, for example, active or passive, operating in various spectral ranges, and with various scanning or pointing modes. Information on the principles of Earth observation from space, the different types of space-based instrument and the derivation of geophysical variables from space-based measurements can be found in the *Guide to Instruments and Methods of Observation* (WMO-No. 8), 2014 edition, Part III, chapter 5.
2. Detailed characteristics of current and planned systems of environmental satellites are available in the satellite module of the OSCAR tool, which is available on line (http://www.wmo.int/oscar/space). It also contains an indication of the main instruments that are relevant for each specific variable observable from space, with their potential performance for the respective variables.

4.3.1 Calibration and traceability

4.3.1.1 Satellite operators shall perform a detailed instrument characterization before launch.

Note: Members must strive to follow the pre-launch instrument characterization guidelines recommended by the Global Space-based Inter-calibration System.

4.3.1.2 After launch, satellite operators shall calibrate all instruments on a routine basis against reference instruments or calibration targets.

Notes:

1. Advantage should be taken of satellite collocation to perform on-orbit instrument intercomparison and calibration.
2. Calibration must be done in accordance with methodologies established and documented by the Global Space-based Inter-calibration System and the Committee on Earth Observation Satellites (CEOS) Working Group on Calibration and Validation.

4.3.1.3 Satellite operators shall ensure traceability to the International System of Units (SI) standards.

Note: The *Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC* (2010 Update), GCOS-138 (WMO/TD-No. 1523) calls for sustained measurement of key variables from space traceable to reference standards and recommends implementing and evaluating a satellite climate calibration mission.

4.3.1.4 To ensure traceability to the International System of Units (SI) standards, satellite operators shall define a range of ground-based reference targets for calibration purposes.

4.4. SPACE SEGMENT IMPLEMENTATION

4.4.1 Operational satellites on Geostationary Earth Orbit

4.4.1.1 Satellite operators should implement an operational constellation of satellites in geostationary orbit as described in Attachment 4.1.

4.4.1.2 Satellite operators shall ensure that the constellation of satellites in geostationary orbit provides full disc imagery at least every 15 minutes and achieves coverage of all longitudes, throughout a field of view between 60° S and 60° N.

Note: This implies the availability of at least six operational geostationary satellites if located at evenly distributed longitudes, with in-orbit redundancy.

4.4.1.3 Satellite operators should implement rapid-scan capabilities where feasible.

4.4.1.4 For the imagery mission in geostationary orbit, satellite operators should ensure an availability rate of rectified and calibrated data of at least 99% as a target.

4.4.1.5 To meet the essential requirement for continuity of data delivery, satellite operators shall strive to implement contingency plans, involving the use of in-orbit standby flight models and rapid call-up of replacement systems and launches.

4.4.2 Core operational constellation on sun-synchronous low Earth orbits

4.4.2.1 Operators of low Earth orbit (LEO) satellites should implement a core operational constellation of satellites in three regularly distributed sun-synchronous orbits as described in Attachment 4.1.

4.4.2.2 Operators of the core constellation of environmental LEO satellites on three sun-synchronous orbital planes, in early morning, mid-morning and afternoon orbit, shall strive to ensure a high level of robustness to permit the delivery of

imagery and sounding data from at least three polar orbiting planes, on not less than 99% of occasions.

Note: This implies provisions for a ground segment, instrument and satellite redundancy, and rapid call-up of replacement launches or in-orbit spares.

4.4.3 Other capabilities on low Earth orbits

Operators of environmental LEO satellites should implement capabilities in appropriate orbits as described in Attachment 4.1.

4.4.4 Research and development satellites

4.4.4.1 Operators of research and development satellites shall consider providing the following observing capabilities:

(a) Advanced observation of the parameters necessary to understand and model the water cycle, the carbon cycle, the energy budget and the chemical processes of the atmosphere;

(b) Pathfinders for future operational missions.

Note: For WMO, the main benefits of research and development satellite missions are:

(a) Support of scientific investigations of atmospheric, oceanic and other environment-related processes;

(b) Testing or demonstration of new or improved sensors and satellite systems in preparation for new generations of operational capabilities to meet WMO observational requirements.

4.4.4.2 Members shall strive to maximize the usefulness of observations from research and development satellites for operational applications. In particular, operators of research and development satellites shall make provisions, where possible, to enable near-real-time data availability to promote the early use of new types of observations for operational applications.

Notes:

1. Although neither long-term continuity of service nor a reliable replacement policy are assured, research and development satellites provide, in many cases, observations of great value for operational use.
2. Although they are not operational systems, research and development satellites have proven to support operational meteorology, oceanography, hydrology and climatology substantially.

4.5 GROUND SEGMENT IMPLEMENTATION

4.5.1 General

4.5.1.1 Satellite operators shall make observational data available to Members through the WMO Information System (WIS) in accordance with the provisions in the *Manual on the WMO Information System* **(WMO-No. 1060). Satellite operators shall inform Members of the means of obtaining these data through catalogue entries and shall provide sufficient metadata to enable meaningful use of the data.**

4.5.1.2 Satellite operators shall set up facilities for the reception of remote-sensing data (and Data Collection System data when relevant) from operational satellites, and for the processing of quality-controlled environmental observation information, with a view to further near-real-time distribution.

4.5.1.3 Satellite operators shall strive to ensure that data from polar-orbiting satellites are acquired on a global basis, without temporal gaps or blind orbits, and that data latency meets WMO timeliness requirements.

4.5.2 Data dissemination

4.5.2.1 Satellite operators shall ensure near-real-time dissemination of the appropriate data sets, as per the requirements of Members, either by direct broadcast via an appropriately designed ground segment, or by rebroadcast via telecommunication satellites.

4.5.2.2 In particular, operators of operational sun-synchronous satellites providing the core meteorological imagery and sounding mission should ensure inclusion of a direct broadcast capability as follows:

(a) Direct broadcast frequencies, modulations and formats should allow a particular user to acquire data from the satellite with a standardized antenna and signal processing hardware. To the extent possible, the frequency bands allocated to meteorological satellites should be used;

(b) Direct broadcast shall be provided through a high data rate stream, such as the High- resolution Picture Transmission (HRPT) or its subsequent evolution, to provide meteorological centres with all the data required for numerical weather prediction (NWP), nowcasting and other real-time applications;

(c) If possible, a low data rate stream should also be provided, such as the Low-rate Picture Transmission (LRPT), to convey an essential volume of data to users with lower connectivity or low-cost receiving stations.

4.5.2.3 Satellite operators shall consider implementing rebroadcast via telecommunication satellites to complement and supplement direct broadcast services and to facilitate access to integrated data streams, including data from different satellites, to non-satellite data and to geophysical data products.

4.5.2.4 Operators of operational geostationary meteorological satellites with rapid-scan capabilities shall strive to provide meteorological centres with data in near-real time as required for nowcasting, NWP and other real-time applications.

4.5.3 Data stewardship

4.5.3.1 Satellite operators shall provide a full description of all processing steps taken in the generation of satellite data products, including algorithms, characteristics and outcomes of validation activities.

4.5.3.2 Satellite operators shall preserve long-term raw data records and ancillary data required for their calibration and reprocessing as appropriate, with the necessary traceability information to achieve consistent Fundamental Climate Data Records.

4.5.3.3 Satellite operators shall maintain Level 1B satellite data archives including all relevant metadata pertaining to the location, orbit parameters and calibration procedures used.

4.5.3.4 Satellite operators shall ensure that their archiving system is capable of providing on-line access to the archive catalogue with a browsing facility, that it provides adequate description of data formats and will allow users to download data.

4.5.4 Data collection systems

4.5.4.1 Satellite operators with a capability to receive data and/or products from Data Collection Platforms (DCP) shall maintain technical and operational

coordination under the auspices of the Coordination Group for Meteorological Satellites (CGMS) in order to ensure compatibility.

4.5.4.2 Satellite operators shall maintain a number of “international” DCP channels, which should be identical on all geostationary satellites, to support the operation of mobile platforms moving across all individual geostationary footprints.

4.5.4.3 Satellite operators shall publish details of the technical characteristics and operational procedures of their data-collection missions, including the admission and certification procedures.

4.5.5 The user segment

4.5.5.1 Operators of research and development satellites shall implement capabilities enabling Members to access the data in one of the following ways: by downloading data from server(s) or by receiving data from a rebroadcasting service or a direct broadcast capability.

4.5.5.2 Members shall endeavour to install and maintain in their territory at least one system enabling access to digital data from both LEO and geostationary operational satellite constellations: either a receiver of rebroadcast service providing the required information in an integrated way, or a combination of dedicated direct readout stations.

4.5.5.3 Where appropriate, Members should strive to utilize fixed or moving DCP systems (for example, to cover data-sparse areas) to take advantage of the data-collection and relay capability of the environmental observation satellites.

4.6. OBSERVATIONAL METADATA

For each space-based system they operate, satellite operators shall record, retain and make available observational metadata in accordance with the provisions of section 2.5.

4.7. QUALITY MANAGEMENT

Satellite operators shall include appropriate quality indicators in the metadata for each dataset, in accordance with the provisions of section 2.5.

4.8. CAPACITY DEVELOPMENT

4.8.1 Centres of excellence

Satellite operators, and other Members having the capability to do so, shall provide support to the education and training of instructors in the use of satellite data and capabilities, at specialized Regional Training Centres or other training institutes designated as centres of excellence in satellite meteorology, in order to build up expertise and facilities at a number of regional growth points.

4.8.2 Training strategy

Satellite operators should focus their assistance, to the extent possible, on one or more of these centres of excellence within their service areas and contribute to the Virtual Laboratory for Education and Training in Satellite Meteorology.

Note: The aim of the education and training strategy implemented through the Virtual Laboratory is to systematically improve the use of satellite data for meteorology, operational hydrology, and climate applications, with a focus on meeting the needs of developing countries.

4.8.3 User preparation for new systems

4.8.3.1 In order to facilitate a smooth transition to new satellite capabilities, satellite operators should take steps to prepare users through training, guidance on necessary upgrades of receiving equipment and processing software, and the provision of information and tools to facilitate the development and testing of user applications.

4.8.3.2 In addition to working through the Virtual Laboratory, Members should, as appropriate, exploit partnerships with organizations providing education and training in environmental satellite applications, depending on their specific needs.

4.8.4 Collaboration between users and data providers

4.8.4.1 In order to achieve the most effective utilization of satellite data, Members should pursue close collaboration between users and data providers at a regional level.

4.8.4.2 Working with their regional association, Members should follow systematic steps to document the regional requirements for satellite data access and exchange.

SECTION: Chapter

Chapter title in running head: ATTACHMENT 4.1. CGMS BASELINE FOR THE O…

ATTACHMENT 4.1. CGMS BASELINE FOR THE OPERATIONAL CONTRIBUTION TO THE GOS

(Adopted at the thirty-ninth meeting of the Coordination Group for Meteorological Satellites (CGMS-39) on 6 October 2011)

FUTURE SATELLITE MISSIONS TO BE PERFORMED ON OPERATIONAL/ SUSTAINED BASIS

INTRODUCTION

In support of the programmes coordinated or co-sponsored by WMO for weather and climate, CGMS Members plan to maintain the operational capabilities and services described below, that constitute the "CGMS baseline for the operational contribution to the GOS".

While this particular document focuses on missions that are decided and managed in an operational or sustained framework, with a perspective of long-term follow-on, this in no way precludes the importance of other missions undertaken e.g. on a research or demonstration basis. First of all, because today's research and development are the foundation of tomorrow's operational missions. Furthermore, because many missions initiated in an R&D framework for a limited duration are eventually extended well beyond their design life time and provide longstanding support to both scientific and operational activities.

This baseline defines a constellation of geostationary satellites, a core meteorological mission on three sun-synchronous orbits, other missions in sun-synchronous orbits, missions in other Low Earth Orbits, and contains cross-cutting considerations on contingency planning, inter-calibration, data availability and dissemination.

I. CONSTELLATION IN GEOSTATIONARY ORBIT

At least six geostationary satellites shall be operated at evenly distributed locations with in orbit redundancy, and perform the following missions:

(a) Advanced visible and infrared imagery (at least 16 spectral channels, 2km resolution) over the full disc at least every 15 minutes;

(b) Infrared sounding (hyperspectral on some positions);

(c) Lightning detection;

(d) Data collection;

(e) Space environment monitoring.

On selected positions, the following missions shall be performed:

(f) Earth Radiation Budget monitoring;

(g) High spectral resolution UV sounding;

(h) Solar activity monitoring.

II. LEO SUN-SYNCHRONOUS MISSIONS

Operational sun-synchronous satellites shall be operated around three orbital planes in mid-morning (“am”, nominally 09:30 descending, 21:30 ascending ECT), afternoon (“pm”, nominally 13:30 ascending ECT) and early morning (nominally 05:30 descending, 17:30 ascending ECT) and, as a constellation, shall perform the following missions:

1) Core meteorological mission nominally on three orbital planes:

(i) Multispectral visible and infrared imagery;

(j) Infrared hyperspectral sounding (at least am and pm);

(k) Microwave sounding;

(l) Microwave imagery.

2) Other missions on sun-synchronous orbits:

(m) Wind scatterometry over sea surfaces (at least two orbital planes);

(n) Ocean surface topography by radar altimetry (at least on am and pm orbits, supplemented by a reference mission on a high-precision, inclined orbit);

(o) Radio-occultation sounding (at least am and pm, supplemented by a constellation in specific orbits);

(p) Broadband VIS/IR radiometer for Earth Radiation balance (at least am and pm);

(q) Total Solar Irradiance (at least one);

(r) Contribution to atmospheric composition observations (at least am and pm);

(s) Narrow-band Vis/NIR imagers (at least one sun-synchronous, am spacecraft) for ocean colour, vegetation and aerosol monitoring;

(t) High-resolution multi-spectral Vis/IR imagers (constellation of sun-synchronous satellites, preferably in am);

(u) IR dual-angle view imagery for high-accuracy SST (at least one am spacecraft);

(v) Particle detection and/or electron density (at least am and pm);

(w) Magnetic field (at least am and pm);

(x) Solar activity (at least two missions);

(y) Data collection.

III. OTHER LEO MISSIONS

The following missions shall be performed on an operational basis by Low Earth Orbit satellites on appropriate orbits:

(z) Ocean surface topography by radar altimetry (A reference mission on high-precision, inclined orbit, complementing two instruments on sun-synchronous am and pm orbit);

(aa) Radio-occultation sounding (dedicated constellation of sensors on appropriate orbits).

IV. CONTINGENCY PLANNING

The CGMS baseline is associated with contingency plans for geostationary and polar-orbiting satellite systems, which are detailed in the CGMS Global Contingency Plan[1].

[1] The Global Contingency Plan (http://www.wmo.int/pages/prog/sat/documents/CGMS_Contingency-Plan-2007.pdf) should be updated accordingly. It should indicate that in case of potential gaps on core sun-synchronous missions, absolute priority should be given to observation from mid-morning and early afternoon orbits, in order to maintain the continuity of these datasets.

V. INTER-CALIBRATION

Instruments should be inter-calibrated on a routine basis against reference instruments or calibration sites. The routine and operational inter-calibration and corrections shall be performed in accordance with standards as agreed by the Global Space-based Inter-calibration System (GSICS).

VI. DATA AVAILABILITY AND DISSEMINATION

VI.1. Data open availability with suitable timeliness

All operational environmental observation satellite systems should be designed to ensure the provision of data with suitable timeliness, as appropriate for their intended applications. Data should be preserved for the long term and documented with metadata allowing their interpretation and utilization. The satellite operators should establish dissemination contents and schedules that take into account the data requirements of users. Re-broadcast via telecommunication satellites should complement and supplement direct broadcast services, which allows cost-efficient access to integrated data streams including data from different satellites, non-satellite data and geophysical products. The dissemination systems should utilize all-weather resilient telecommunication means.

VI.2. Direct broadcast for core meteorological missions in LEO

The core meteorological satellite systems in LEO orbits, and other operational observation satellite systems when relevant, should ensure near real-time data dissemination of imagery, sounding, and other real-time data of interest to Members by direct broadcast. Direct broadcast frequencies, modulations, and formats for polar-orbiting satellites should allow a particular user to acquire data from either satellite by a single antenna and signal processing hardware. Direct Broadcast should use allocations in all-weather resilient frequency bands.

VII. NOTE

The present update of the CGMS baseline is adopted in the light of satellite mission plans as they are known in October 2011.

SECTION: Chapter
Chapter title in running head: 5. ATTRIBUTES SPECIFIC TO THE GLOBAL OB…

5. ATTRIBUTES SPECIFIC TO THE GLOBAL OBSERVING SYSTEM OF THE WORLD WEATHER WATCH

Notes:

1. The provisions of sections 1, 2, 3 and 4 are common to all WIGOS component observing systems including the GOS.
2. Provisions specific to the GOS are currently set out in the *Manual on the Global Observing System* (WMO-No. 544), Volume I.

SECTION: Chapter

Chapter title in running head: 6. ATTRIBUTES SPECIFIC TO THE OBSERVING…

6. ATTRIBUTES SPECIFIC TO THE OBSERVING COMPONENT OF THE GLOBAL ATMOSPHERE WATCH

Note: The provisions of sections 1, 2, 3 and 4 are common to all WIGOS component observing systems, including GAW. The provisions in this section are specific to GAW.

6.1. REQUIREMENTS

6.1.1 Members should perform the observations of atmospheric composition and related physical parameters using a combination of surface-based stations and platforms (fixed stations, mobile platforms and remote sensing) and space-based platforms.

6.1.2 Members should use the requirements from the RRR process, particularly in the area of atmospheric chemistry application, in developing their GAW stations.

Notes:

1 The user requirements are reviewed on a regular basis through the RRR process by the Scientific Advisory Groups (SAGs) for each variable, in consultation with the user community and with input from Members. The RRR process is described in section 2.2.4 and Appendix 2.1.

2. Scientific Advisory Groups exist for the six GAW focal areas and their terms of reference are defined by the Commission for Atmospheric Sciences.

6.1.3 Members should follow the Data Quality Objectives specified by the GAW Programme for the individual variables observed.

6.1.4 Members should establish and operate their GAW stations so that they satisfy the station requirements specified in Attachment 6.1.

6.1.5 Members operating GAW stations shall undertake long-term and uninterrupted operation with the stability and continuity of data collection required for the purposes outlined in 6.2.1.

6.2. DESIGN, PLANNING AND EVOLUTION

6.2.1 Members should design, plan and further develop their GAW observing network and stations to address user requirements, in particular those that concern key environmental issues and application areas, including but not limited to the following:

(a) Stratospheric ozone depletion and increase of UV radiation;

(b) Changes in the weather and climate due to human influence on atmospheric composition, particularly changes in greenhouse gases, ozone and reactive gases, and aerosols;

(c) Risk assessment of air pollution and UV on human health and the environment, and issues involving long-range transport of air pollution and its deposition.

6.2.2 Members should contribute observations through operating or supporting suitable platforms at GAW stations and/or through contributing networks.

6.2.3 When doing so, Members shall register their contribution in GAWSIS and submit their observations to the relevant GAW Data Centre.

6.2.4 Members operating a contributing network shall provide a description of the network, register the stations in GAWSIS and provide corresponding metadata.

6.2.5 Members should ensure that the frequency and spacing of the various observations is suited to the temporal and spatial requirements of the specific issues addressed in section 6.2.1.

6.3. INSTRUMENTATION AND METHODS OF OBSERVATION

6.3.1 General requirements of instruments

Members should use recommended types of instruments and methods of observation for variables observed at their stations, and follow further available guidance.

Notes:

1. Guidance is provided in the Standard Operating Procedures (SOPs) and measurement guidelines.
2. Instruments suitable for use at GAW sites are defined by the SAGs for each parameter, in terms of stability, precision and accuracy.
3. Standard Operating Procedures describe the standard approach to operate this kind of instrument.
4. The measurement guidelines describe the standard approach for this kind of measurement regardless of the instrument.

6.3.2 Calibration and traceability

6.3.2.1 Members shall perform calibrations and maintain traceability to the GAW primary standards, where available.

Notes:

1 The GAW primary standard is a single network standard, assigned by WMO for each individual variable. In the case of contributing networks, network observations are traceable to the network standard, which in turn is traceable to the GAW primary standard.

2. Details on calibrations are specified by the SOPs and measurement guidelines.

6.3.2.2 Members should utilize GAW central facilities to sustain the global compatibility of observations.

Note: The GAW central facilities include: Central Calibration Laboratories, World Calibration Centres, Regional Calibration Centres and Quality Assurance/Science Activity Centres.

6.4. OPERATIONS

6.4.1 Monitoring observing system implementation

6.4.1.1 Members shall monitor the operation of GAW stations for which they are responsible and ensure that they follow the relevant procedures for quality assurance and data submission. Members shall seek assistance from central facilities, SAGs and expert teams if operational problems cannot be solved locally.

Note: The procedures to be used in monitoring the operation of GAW are determined within the Commission for Atmospheric Sciences (CAS) in consultation with the participating Members.

6.4.1.2 Members should systematically monitor compliance with GAW regulations, in collaboration with relevant constituent bodies and the Secretariat, in order to identify critical cases of non-compliance (deficiencies) and undertake measures for their timely resolution.

6.4.2 Quality assurance

6.4.2.1 Members should follow specified quality assurance practices and procedures.

Note: Details are given in the GAW SOPs and measurement guidelines and in further documents provided by the SAGs and central facilities.

6.4.2.2 Members shall maintain detailed metadata records in accordance with procedures and practices specified in this Manual.

6.4.2.3 Members should participate in independent evaluations of quality of observations, including intercomparisons and system audits, as appropriate for the observed variables.

6.4.2.4 Members shall permit World Data Centres to perform an independent evaluation of the data quality of their observations.

6.4.3 Data and metadata representation and format

6.4.3.1 Members shall submit their observational data and associated metadata to the relevant GAW World Data Centres for the variables observed at the station within agreed time limits.

6.4.3.2 Members shall use the formats specified by the relevant World Data Centre when submitting their observational data and metadata.

6.5. OBSERVATIONAL METADATA

Note: The general provisions on observation metadata are specified in section 2.5.

6.5.1 Members shall provide metadata associated with instrumentation, site or platform, and calibration history as requested by the World Data Centre for each parameter and by GAWSIS.

6.5.2 Members shall provide such additional metadata as required by GAWSIS and any World Data Centre to which they contribute that are necessary to understand their observations.

6.6. QUALITY MANAGEMENT

Note: The general regulations on quality management are specified in section 2.6.

6.7. CAPACITY DEVELOPMENT

Note: General provisions for capacity development are provided in sections 2.7, 3.7 and 4.7.

6.7.1 Members not capable of implementing required standards should establish agreements with appropriate central facilities or establish partnership with more experienced stations in the form of stations twinning.

Note: In some regions of the world, and for some GAW variables, where there is a clear lack of capacity, Members may be requested to help support a station, or existing stations may be approached to become part of GAW. Such requests and invitations come after approval by the appropriate SAGs.

6.7.2 Members should use the GAW Training and Education Centre (GAWTEC) programme, as available, for capacity-building and staff training in measurement of the specific GAW variables.

SECTION: Chapter

Chapter title in running head: ATTACHMENT 6.1. REQUIREMENTS FOR THE GL…

ATTACHMENT 6.1. REQUIREMENTS FOR THE GLOBAL ATMOSPHERE WATCH STATIONS

1. GENERAL

Essential characteristics of the Global Atmosphere Watch (GAW) regional stations:

(a) The station location is chosen such that, for the variables measured, it is regionally representative and is normally free of the influence of significant local pollution sources;

(b) There are adequate power, air conditioning, communication and building facilities to sustain long-term observations with greater than 90% data capture (i.e. <10% missing data);

(c) The technical support provided is trained in the operation of the equipment;

(d) There is a commitment by the responsible agency to long-term observations of at least one of the GAW variables in the GAW focal areas (ozone, aerosols, greenhouse gases, reactive gases, UV radiation and precipitation chemistry);

(e) The GAW observations made are of known quality and linked to the GAW primary standard;

(f) The data and associated metadata are submitted to one of the GAW World Data Centres (WDCs), typically no later than one year after the observations are made. Changes in metadata, including instrumentation, traceability and observation procedures, are reported to the responsible WDC in a timely manner;

(g) If required, observations are submitted to a designated data distribution system in near-real-time;

(h) Standard meteorological in situ observations, necessary for the accurate determination and interpretation of the GAW variables, are of known quality;

(i) The station characteristics and observational programme are updated in the GAW Station Information System (GAWSIS) on a regular basis;

(j) A station logbook (a record of observations made and of activities that may affect observations) is maintained and used in the data validation process.

1.1 Additional essential characteristics of GAW global stations

In addition to the essential characteristics of regional stations, GAW global stations should fulfil the following requirements:

(a) Measurement of variables in at least three of the six GAW focal areas;

(b) A strong scientific supporting programme with appropriate data analysis and interpretation within the country and, if possible, the support of more than one agency;

(c) Provision of a facility at which intensive campaigns can augment the long-term routine GAW observations and where testing and development of new GAW methods can be undertaken.

2. GAW CONTRIBUTING NETWORKS

The GAW contributing networks provide observations from multiple stations. The stations comprising contributing networks should satisfy the criteria of either regional or global stations taking into account the contributing network regulations (within the contributing network, data submission requirements or standard used can differ from those required for regional and global stations). Where the network standards differ from those of WMO, they must have a confirmed traceability to the WMO standards, where these exist. Data submission regulations for the contributing networks must be at least as stringent as those required within GAW. A station designation as global or regional, if such designation already exists for individual stations, always takes precedence over the designation as contributing station. To be used in global assessments, data from the contributing stations must be submitted to the GAW World Data Centres.

SECTION: Chapter
Chapter title in running head: 7. ATTRIBUTES SPECIFIC TO THE WMO HYDRO…

7. ATTRIBUTES SPECIFIC TO THE WMO HYDROLOGICAL OBSERVING SYSTEM

Note: The provisions of sections 1, 2, 3 and 4 are common to all WIGOS component observing systems, including the WHOS. The provisions of this section are specific to the WHOS.

7.1 REQUIREMENTS

7.1.1 Members shall establish and operate a hydrological observing system according to their national requirements.

7.1.2 Members should also operate their hydrological observing systems to address the requirements of the RRR process, in particular for the hydrology application area.

Notes:

1. A hydrological observing system includes networks of hydrological observing stations, as defined in *Technical Regulations* (WMO-No. 49), Volume III: Hydrology, Chapter D.1.1, which should make observations of the elements described in Chapter D.1.2.
2. Information on hydrological data transmission can be found in the *Technical Regulations* (WMO-No. 49), Volume III: Hydrology, Chapter D.1.4, [D.1.4.]1.2, which states: "Transmission facilities should be organized for the international exchange of hydrological data, forecasts and warnings on the basis of bilateral or multilateral agreement." Further provisions for data transmission and international exchange through the WIS are given in the *Technical Regulations* (WMO-No. 49), Volume I, Part II, the *Manual on the WMO Information System* (WMO-No. 1060) and the *Manual on the Global Telecommunication System* (WMO-No. 386).

7.1.3 Members shall provide on a free and unrestricted basis those hydrological data and products which are necessary for the provision of services for the protection of life and property, and the well-being of all peoples.

7.1.4 Members should also provide, where available, additional hydrological data and products that are required by WMO Programmes and by Members as specified in paragraph 7.1.2.

7.1.5 At the global level, WHOS shall give Members access to near-real time hydrological observations from all Members.

Note: Currently, many Members are making such observations publicly available on the Internet.

7.1.6 Members should provide these sources of observations to the WHOS.

Note: Hydrological observations available through WHOS will initially comprise stage (water level) and discharge. This will likely expand over time to include other elements as identified in the Rolling Review of Requirements at the national, regional and global levels.

7.2 DESIGN, PLANNING AND EVOLUTION

Note: Design, planning and evolution is common to all WIGOS component observing systems.

Members should design and plan their observing network considering the review of the current and planned WHOS capabilities, undertaken as outlined in the RRR as described in section 2.2.4.

7.3 INSTRUMENTATION AND METHODS OF OBSERVATION

7.3.1 General requirements of instruments

7.3.1.1 Members should equip their stations with properly calibrated instruments and should arrange for these stations to follow adequate observational and measuring techniques to ensure that the measurements and observations of the various hydrological elements are accurate enough to address the needs of hydrology and other application areas.

Note: *Technical Regulations* (WMO-No. 49), Volume III: Hydrology, provides that Members should use instruments for measurement of stage (water level) in conformity with the specifications of its annex, section II: Water-level measuring devices.

7.3.1.2 Members should ensure that the uncertainty in the observation of the stage (water level) of rivers, estuaries, lakes and reservoirs does not exceed:

(a) In general, 10 mm at the 95% confidence level;

(b) Under difficult conditions, 20 mm at the 95% confidence level.

Note: Stage (water level) observations are used primarily as an index for computing streamflow discharge when a unique relation exists between stage (water level) and discharge.

7.3.2 Stage and discharge observations from hydrometric stations

Note: *Technical Regulations* (WMO-No. 49), Volume III: Hydrology, provides that Members should establish and operate hydrometric stations for measuring stage (water level), velocity and discharge in conformity with the specifications of its annex, section VI: Establishment and operation of a hydrometric station.

7.3.2.1 Members should ensure that the number of discharge measurements at a stream gauging station are adequate to define the rating curve for the station at all times.

Notes:

1. *Technical Regulations* (WMO-No. 49), Volume III: Hydrology, provides that Members should use the methods for determining the stage-discharge relation (rating curve) of a station as specified in its annex, section VII: Determination of the stage-discharge relation.
2. *Technical Regulations* (WMO-No. 49), Volume III: Hydrology, provides that Members should ensure, when undertaking moving-boat discharge measurements, that equipment and operational procedures are as specified in its annex, section XII: Discharge measurements by the moving-boat method.

7.3.2.2 Members should measure river discharges to an accuracy commensurate with flow and local conditions. Percentage uncertainty of the discharge measurement should not exceed:

(a) In general, 5% at the 95% confidence level;

(b) Under difficult conditions, 10% at the 95% confidence level.

Notes:

1. *Technical Regulations* (WMO-No. 49), Volume III: Hydrology, provides that Members should evaluate the uncertainty in discharge measurements in conformity with the specifications in its annex, section VIII: Estimation of uncertainty of discharge measurements.
2. Discharge measurements are taken to establish and verify the stability of a rating curve. Stage (water level) observations are converted to estimates of discharge using the rating curve on an ongoing basis.

7.3.3 Calibration procedures

Notes:

1. *Technical Regulations* (WMO-No. 49), Volume III: Hydrology, provides that Members should adhere to the specifications of facilities, equipment and procedure for the calibration of current meters as specified in its annex, section I: Calibration of current meters in straight open tanks.
2. *Technical Regulations* (WMO-No. 49), Volume III: Hydrology, provides that Members should ensure that operational requirements, construction, calibration and maintenance of rotating element current meters are as specified in its annex, section IV: Rotating element type current meters.

Members should recalibrate acoustic velocity meters on a routine basis to ensure stability of the calibration, using measurement standards traceable to international or national standards. Where no such standards exist, Members should record the basis used for calibration or verification.

Note: Additional information pertaining to the calibration of instruments can be found in the *Guide to Hydrological Practices* (WMO-No. 168), Volume I, and the *Manual on Stream Gauging* (WMO-No. 1044).

7.4 OPERATIONS

7.4.1 Observing practices

7.4.1.1 Members should collect and preserve their hydrological records.

7.4.1.2 Members should make the necessary arrangements to facilitate the retrieval and analysis of their hydrological observations by automatic data-processing equipment.

7.4.1.3 Where automatic registration is not available, Members should ensure that the observations of elements for hydrological purposes are made at regular intervals appropriate for the elements and their intended purposes.

7.4.1.4 Members should maintain in their archives an up-to-date inventory of their hydrological observations.

7.4.1.5 Members should generally ensure uniformity in time of observations within a catchment area.

7.4.1.6 Members should select the time units used in processing hydrological data for international exchange from the following:

(a) The Gregorian calendar year;

(b) The months of this calendar;

(c) The mean solar day, from midnight to midnight, according to the zonal time, when the data permit;

(d) Other periods by mutual agreement in the case of international drainage basins or drainage basins in the same type of region.

7.4.1.7 For hydrometric stations where data are internationally exchanged, Members should process the following characteristics for each year:

(a) Maximum instantaneous and minimum daily mean values of stages (water levels) and discharge;

(b) Mean daily stages (water levels) and/or mean daily discharges.

7.4.1.8 For rivers under flood conditions or where there are variable controls, Members should make special measurements at intervals frequent enough to define the hydrograph.

7.4.1.9 When sudden and dangerous increases in river levels occur, Members should make and report observations as soon as possible regardless of the usual time of observation, to meet the intended operational use.

7.4.1.10 Members should measure and store stage (water level) observations as instantaneous values rather than averaged values.

7.4.2 Quality control

7.4.2.1 Members should maintain detailed records for each station and for each parameter containing metadata related to the measurements, maintenance and calibration of equipment.

7.4.2.2 Members should perform periodic audits of their stations and collected data.

7.4.2.3 Members should ensure that recorded hydrological observations are converted to a form suitable for archiving and retrieval.

Note: Observations may be initially recorded using various media from paper to electronic digital form. As computer archiving has become a standard practice for most Members, it is advantageous to convert data to the required format early in the process.

7.4.2.4 Members should ensure that their data undergo, at various stages, a range of checks to determine their uncertainty and correctness.

7.4.2.5 With accelerating developments in technology, Members should ensure that data-processing and quality control systems are well-organized and that the relevant staff are trained to understand and use them.

Note: Data are collected and recorded in many ways, ranging from manual reading of simple gauges to a variety of automated data-collection, transmission and filing systems.

7.4.2.6 Members should consider the adoption of a quality management system, as described in section 2.6.

Note: Organizations usually employ an accredited certification agency to provide independent verification.

7.4.2.7 Members should undertake data processing and quality control as described in relevant publications.

Note: Such publications include the *Guide to Hydrological Practices* (WMO-No. 168), Volume I, Chapter 9, the *Manual on Flood Forecasting and Warning* (WMO-No. 1072), Chapter 6, and the *Manual on Stream Gauging* (WMO-No. 1044), Volume II, Chapter 6.

7.4.3 Observations and observational metadata reporting

7.4.3.1 Members should ensure, when providing hydrological information for international purposes, that open text or appropriate code forms are used as specified in bilateral or multilateral agreements.

7.4.3.2 Members should ensure that transmission facilities are organized for the international exchange of hydrological observations on the basis of bilateral or multilateral agreements.

7.4.3.3 In order to make data globally available for real-time exchange and discovery, access and retrieval, Members should report stage and discharge observations in compliance with WIS metadata standards.

Notes:

1. The WMO Information System may also be used for access to hydrological observations not required in real-time.
2. The regulations governing exchanges in international code forms are specified in the Manual on Codes (WMO-No. 306), Volume I.
3. Coded information exclusively for bilateral or multilateral exchange amongst Members may be in other forms by mutual agreement.

7.4.4 Incident management

Note: General provisions for incident management are provided in section 2.4.5.

7.4.5 Change management

Note: General provisions for change management are provided in section 2.4.6.

7.4.6 Maintenance

7.4.6.1 Members should determine the frequency and timing of visits to recording stations on the basis of the length of time that the station can be expected to function without maintenance and the uncertainty requirements of the data.

Notes:

1. There is a relation between the frequency of the visits and the resultant quality of the data collected. Too long a time between visits may result in frequent recorder malfunction and thus in loss of data, while frequent visits are both time consuming and costly.
2. Some data collection devices may suffer a drift in the relationship between the variable that is recorded and that which the recorded value represents. An example of this is a non-stable stage-discharge relationship.
3. Two visits per year are considered an absolute minimum; more frequent visits are recommended to decrease the potential loss of data and/or to avoid data being severely affected by problems such as silting, vandalism or seasonal vegetative growth.

7.4.6.2 Members should schedule periodic visits to the station to recalibrate the equipment or the measurement equations.

7.4.6.3 Members should periodically inspect stations using trained personnel to ensure the correct functioning of instruments.

7.4.6.4 Members should ensure that a formal written inspection is done routinely, preferably each year, to check overall performance of instruments and local observer, if applicable.

7.4.6.5 Members, when routinely inspecting sites, should:

(a) Measure gauge datum to check for and record any changes in levels;

(b) Check the stability of the rating curve and review the relationships between the gauges and permanent level reference points to verify that no movement of the gauges has taken place;

(c) Review the gauging frequency achieved and the rating changes identified;

(d) Undertake a number of maintenance activities as described in sections 7.4.6.8 and 7.4.6.9.

Note: It is vital, for the quality of data, that resources for gauging be allocated and prioritized using rigorous and timely analysis of the probability and frequency of rating changes.

7.4.6.6 Members should ensure that maintenance activities are conducted at data-collection sites at intervals sufficient to ensure that the quality of the data being recorded is adequate.

7.4.6.7 Members should ensure that such activities are conducted by the observer responsible for the sites, if there is one. Members should also ensure that maintenance activities are occasionally performed by an inspector.

7.4.6.8 Members should undertake the following maintenance activities at all collection sites:

(a) Service the instruments;

(b) Replace or upgrade instruments, as required;

(c) Retrieve or record observations;

(d) Perform the recommended checks on retrieved records;

(e) Carry out general checks of all equipment, for example, transmission lines;

(f) Check and maintain the site in accordance with the recommended specifications;

(g) Check and maintain access to the station;

(h) Record, in note form, all of the above activities;

(i) Comment on changes in land use or vegetation;

(j) Clear debris and overgrowth from all parts of the installation.

7.4.6.9 Members should undertake the following maintenance activities at discharge collection sites:

(a) Check the bank stability, as necessary;

(b) Check the level and condition of gauge boards, as necessary;

(c) Check and service the flow-measuring devices (cableways, etc.), as necessary;

(d) Check and repair control structures, as necessary;

(e) Regularly survey cross-sections and take photographs of major station changes after events or changes in vegetation or land-use;

(f) Record, in note form, all of the above activities and their results;

(g) Inspect the area around or upstream from the site, and record any significant land-use or other changes in related hydrological characteristics, such as ice.

Note: Further details are found in the *Manual on Stream Gauging* (WMO-No. 1044).

7.4.6.10 Members should have a well-trained technician or inspector visit stations immediately after every severe flood in order to check the stability of the river section and the gauges. If there is a local observer, Members should train this person to check for these problems and communicate them to the regional or local office.

7.4.6.11 Members should not programme flood gaugings as part of a routine inspection trip because of the unpredictable nature of floods.

7.4.6.12 Members should establish a flood action plan prior to the beginning of the storm or flood season and should specify priority sites and types of data required.

Note: If flood gaugings are required at a site, the preparations would ideally be made during the preceding dry or non-flood season so that all is ready for the annual flood season.

7.4.6.13 Members should consider undertaking the following additional measures if severe flooding is likely:

(a) Upgrade site access (helipad, if necessary);

(b Equip a temporary campsite with provisions;

(c) Store and check gauging equipment;

(d) Protect instrumentation, such as stage recorders, by taking flood-proofing measures.

7.4.6.14 Following the recession of floodwaters, Members should pay particular attention to ensuring the safety and security of the data-collection site and to restoring normal operation of on-site instrumentation.

Note: In some cases, redesign and reconstruction of the site may be required. Such work would ideally take into account information obtained as a result of the flood.

7.4.7 Calibration procedures

Note: Determination of a rating curve is described in section 7.3.2. Calibration procedures for current meters are described in section 7.3.3.

7.5 OBSERVATIONAL METADATA

Notes:

1. Provisions for describing observational metadata, for recording and retaining observational metadata, and for exchanging and archiving observational metadata are provided in section 2.5. These apply to all WIGOS component observing systems including the WHOS. Further provisions specific to WHOS are stated here.
2. The contents of observational metadata are detailed in Appendix 2.4, including WIGOS metadata and other metadata of specific relevance for WHOS.
3. Within an organization or country, a hydrological information system or a station registration file and a historical operation file (as indicated in the *Guide to Hydrological Practices*, WMO–No. 168) or similar repositories may be used as a convenient means to compile a set of metadata about a hydrological station and its observations.

7.5.1 In addition to the provisions in section 2.5, Members should record, retain and make available the WIGOS observational metadata and also the additional observational metadata specified in Appendix 2.4.

7.5.2 Members who use their own station identifiers for hydrological stations should maintain the means to match these with the WMO station identifiers, as specified in section 2.4, Attachment 2.1.

7.5.3 Members should collect and record additional detailed observational metadata identifying the purpose of the station in accordance with provisions in section 2.5.

Note: Further details are found in the *Guide to Hydrological Practices* (WMO-No. 168), Volume I, Chapter 10.

7.6 QUALITY MANAGEMENT

Notes:

1. Provisions for the implementation of quality management in WIGOS are provided in section 2.6. These apply to all WIGOS component observing systems including the WHOS.
2. The WMO Hydrology and Water Resources Programme has developed material on the implementation of the WMO Quality Management Framework in Hydrology and its adoption in national operations. Some Members have achieved compliance with the ISO 9001:2008 standard and examples have been documented to assist other Members.

7.7 CAPACITY DEVELOPMENT

Notes:

1. Provisions for the implementation of capacity development in WIGOS are provided in section 2.7.

2. Whatever the level of technical sophistication of a data-collection authority, the quality of its staff remains its most valuable resource.

7.7.1 Members should undertake careful recruitment, training and management to attain and maintain the appropriate personnel with the most appropriate skill sets.

7.7.2 Members should pursue a carefully structured training programme for all personnel engaged in field and office practices pertaining to data collection because they are in a strong position to influence the quality of the final data.

Note: Formal training ideally will aim at providing both a general course in first principles, plus training modules to teach in-house field and office procedures. All material has to be relevant and current.

7.7.3 Members should provide training classes, follow-up exercises and on-the-job training to field personnel, before they make streamflow and survey measurements using various technologies such as Acoustic Doppler Current Profiler (ADCP) and mechanical current meters.

7.7.4 Members should provide training classes, follow-up exercises, and on-the-job training on data-collection practices and processing of data to increase employee productivity and programme effectiveness.

7.7.5 Members should have appropriate technologies in place, such as hydrological information systems, to allow for streamflow data processing and facilitate the effective and efficient delivery of metadata, data and data products to users.

7.7.6 Members should have an adequate number of stations to meet priority needs and ensure sufficient resources to maintain and operate sites to attain required accuracies and reliability of data for their intended use.

SECTION: Chapter

Chapter title in running head: 8. ATTRIBUTES SPECIFIC TO THE OBSERVING…

8. ATTRIBUTES SPECIFIC TO THE OBSERVING COMPONENT OF THE GLOBAL CRYOSPHERIC WATCH

~~Note: The provisions of sections 1, 2, 3 and 4 are common to all WIGOS component observing systems including the GCW. The further provisions in this section are specific to the GCW.~~

~~8.1 Members should collaborate actively in, and give all possible support to, the development and implementation of the observing component of Global Cryosphere Watch.~~

~~Note: Implementation of GCW encompasses the use of surface- and space-based observations, observing standard and recommended practices and procedures, best practices for the measurement of essential cryospheric variables, and full assessment of error characteristics of in situ and satellite products. The initial focus of CryoNet, the surface-based standardized core observing network, is to promote the addition of cryospheric observations taken in accordance with GCW standard and recommended practices and procedures, guidelines and best practices, at existing sites rather than creating new ones. The development of GCW includes the development of a CryoNet guide.~~

~~8.2 Members should encourage partnerships between organizations to coordinate observing, capacity-building and training activities relevant to cryospheric observations, and to assist with the compilation and development of manuals on standard and recommended practices and procedures for cryospheric observation.~~

~~8.3 CryoNet shall be structured in two different categories of observational sites: Basic Sites and Integrated Sites with the following requirements:~~

~~(a) **Basic Sites shall monitor single or multiple components of the cryosphere (glaciers, ice shelves, ice sheets, snow, permafrost, sea ice, river/lake ice, and solid precipitation) and shall observe multiple variables of each component. They shall measure auxiliary meteorological variables, comply with GCW agreed practices, be currently active, have long-term financial commitment and make data freely available, whenever possible in (near) real time.** Basic Sites should be suitable for the assessment of long-term changes of the cryosphere as well as for the validation of satellite data and related models;~~

~~(b) **Integrated Sites shall promote, through worldwide scientific collaboration, progress in the scientific understanding of the processes that change the cryosphere. These sites shall integrate in-situ and space-based observations and create platforms of cryospheric observatories. In addition to the requirements for Basic Sites, CryoNet Integrated Sites shall monitor at least one of the other spheres (such as hydrosphere, biosphere and atmosphere), have a broader research focus, have supporting staff and training capability.** Integrated Sites are particularly important for the study of feedbacks and complex interactions between the atmosphere, cryosphere, biosphere and ocean;~~

~~(c) CryoNet sites contain one or more CryoNet stations:~~

- ~~**Primary stations shall be intended for long-term operation and shall have a four- (4) year initial commitment;**~~

- ~~**Baseline stations shall have long-term operational commitment and long-term (more than 10 years) records.**~~

~~**8.4 For inclusion of a GCW surface measurement site or station into CryoNet, Members and partners shall meet defined criteria. The minimum requirements are in Attachment 8.1.**~~

Note: The provisions of sections 1, 2, 3 and 4 are common to all WIGOS component observing systems including the GCW. The further provisions in this section are specific to the GCW.

8.1 Members should collaborate actively in, and give all possible support to, the development and implementation of the observing component of the Global Cryosphere Watch.

Note: Implementation of GCW encompasses the use of surface- and space-based observations, observing standard and recommended practices and procedures, best practices for the measurement of essential cryospheric variables, and full assessment of error characteristics of in situ and satellite products. The initial focus of CryoNet, the surface-based standardized core observing network, is to promote the addition of cryospheric observations taken in accordance with GCW standard and recommended practices and procedures, guidelines and best practices, at existing sites rather than creating new ones. The development of GCW includes the development of a CryoNet manual and guide.

8.2 Members should encourage partnerships between organizations to coordinate observing, capacity-building and training activities relevant to cryospheric observations, and to assist with the compilation and development of manuals on standard and recommended practices and procedures for cryospheric observation.

8.3 The GCW surface observing network shall comprise a core component, called CryoNet, and contributing stations that are not part of CryoNet.

8.4 The basic component of the CryoNet shall be the CryoNet station.

8.5 A CryoNet station shall measure one or more components of the cryosphere and one or more variables of each component.

Note: Cryosphere components are: sea ice, freshwater ice, ice sheets, glaciers, icebergs, ice caps, ice shelves, permafrost, seasonally frozen ground, snow, and solid precipitation.

8.6 A CryoNet station shall meet a minimum set of requirements, specified in Appendix 8.1.

8.7 A CryoNet Station shall be either a primary or a reference station.

8.8 A primary CryoNet station shall have a target (intent) of long-term operation and have at least a 4-year initial commitment.

8.9 A reference CryoNet station shall have a long-term operational commitment and long-term (more than 10 years) data records.

Note:

Any primary or reference CryoNet station may have one or more additional attributes:

1. A calibration/validation (Cal/Val) station is used for calibration and/or validation of satellite products and/or (earth system) models, or it has been used for such purposes in the past and it still provides the needed facilities.

2. A research station has a broader research focus related to the cryosphere.

8.10 A GCW station that is not part of CryoNet shall be the GCW Contributing station.

8.11 A GCW Contributing station shall measure at least one variable of at least one cryosphere component.

8.12 A GCW Contributing station shall be a station that provides useful measurements of the cryosphere but does not meet minimum requirements for a CryoNet station, or in some other way does not provide the quality and/or consistency of data required by CryoNet stations.

Notes:

1. For example, where data records may be short or with large gaps. These stations may be in remote, hard to access regions where cryospheric observations are scarce or in regions where they complement other cryospheric measurements. Mobile platforms such as ships, drifting stations and buoys may also be contributing stations.

2. Contributing stations may have the reference attribute.

3. A reference contributing station has a long-term operational commitment and/or long-term (more than 10 years) data records.

8.13 CryoNet shall consist of two different categories of observing sites, Basic Sites and Integrated Sites.

8.14 Basic sites shall monitor single or multiple components of the cryosphere (glaciers, ice shelves, ice sheets, snow, permafrost, sea ice, river/lake ice, and solid precipitation) and shall observe multiple variables of each component.

8.15 Integrated sites shall monitor at least two components of the cryosphere or at least one cryosphere component and one other component of the earth system. Integrated Sites shall promote, through worldwide scientific collaboration, progress in the scientific understanding of the processes that change the cryosphere.

Note: Integrated sites are particularly important for the study of feedbacks and complex interactions between these components.

8.16 Each CryoNet site shall encompass an area larger than a conventional observing station.

8.17 Each CryoNet site shall be comprised of two or more active GCW stations with varying capabilities that shall be operated as a coordinated unit. At least one station shall be a CryoNet station.

8.18 Each CryoNet site shall provide a information describing the research approach and the site management (e.g. cooperation between different partners).

8.19 Each CryoNet site shall meet requirements specified in Appendix 8.1.

Note:

1. A site may encompass several micro-climatological regions or extend over larger altitudinal gradients. Thus, further ancillary meteorological stations are part of a site. Different partners may operate the stations, but they are coordinated through one agency or institute.

2. Typically, sites have a broader research focus related to the cryosphere than stations. Whereas basic sites investigate the cryosphere only, integrated sites aim to provide a better understanding of the cryosphere and/or its linkages to other components of the Earth system, for example, the atmosphere, the hydrosphere, the biosphere, the oceans, soil, vegetation, etc.

8.20 A surface CryoNet station or CryoNet shall meet the minimum requirements specified in Appendix 8.1.

Note:

Contributing stations, which are part of the GCW surface network but not part of CryoNet, do not have the same requirements.

SECTION: Chapter

Chapter title in running head: ATTRIBUTES SPECIFIC TO THE OBSERVING CO…

ATTACHMENT 8.1. MINIMUM REQUIREMENTS FOR INCLUSION OF A GLOBAL CRYOSPHERE WATCH SURFACE MEASUREMENT SITE OR STATION IN CRYONET

~~1. The site location is chosen so that, for the cryospheric components measured, it is representative of the surrounding region.~~

~~2. User needs have been considered in the observation design process.~~

~~3. CryoNet sites have to be active and perform sustained observations in accordance with CryoNet best practices. There shall be a commitment to continue measurements for a minimum of four years.~~

~~4. Personnel are trained in the operation and maintenance of the site.~~

~~5. The responsible agencies are committed, within reasonable limits, to sustaining long-term observations of at least one cryosphere component, including auxiliary meteorological variables.~~

~~6. The relevant CryoNet observations are of documented quality. The measurements are made and quality controlled in accordance with CryoNet best practices.~~

~~7. Associated standard meteorological in-situ observations, when necessary for the accurate determination and interpretation of the Global Cryosphere Watch (GCW) variables, are of documented quality.~~

~~8. A logbook for observations and activities that may affect observations is maintained and used in the data validation process.~~

~~9. The data and metadata including changes in instrumentation, traceability, and observation procedures are submitted in a timely manner to a data centre that is interoperable with the GCW portal.~~

~~10. The station characteristics and observational programme information are kept up to date in the GCW station information database. Station metadata are also provided to the WIGOS Information Resource (WIR) and maintained regularly.~~

I. Minimum requirements for a CryoNet station

1. **Meeting Core CryoNet Measurement Requirements: The station shall measure at least one of the variables of one of the cryosphere components (i.e. snow, solid precipitation, lake and river ice, sea ice, glaciers, frozen ground and permafrost). The station location shall be chosen such that cryospheric measurements are representative of the surrounding region, and such representativeness shall be clearly described.**

2. Commitment of Operational Continuity: The station shall be active. The responsible agencies shall be committed, to the extent reasonable, to sustaining long-term observations of at least one cryosphere component. There shall be a commitment to continue measurements for a minimum of four (4) years.

3. Metadata Up to Date and Availability: The station metadata, including all metadata describing the station characteristics and observing programme, shall be kept up-to-date and available in the GCW Portal as the interface to the WIGOS Information Resource (WIR).

4. Compliance with Agreed Regulatory Practice: The station observational procedures, the instruments and method of observations, quality control practices, etc., shall follow GCW endorsed regulations, manuals, guides, and, to the extent possible, the recommended best practices.

5. Data and Ancillary Data Freely Available: Data shall be made freely available, and whenever possible in near real-time. In situ ancillary meteorological observations, as required by CryoNet practices shall also be available with documented quality.

6. Competency of Staff: Personnel shall be trained in the operation and maintenance of the station.

II. Requirements for GCW CryoNet site:

1. A site shall comprise at least one CryoNet station.

2. Integrated sites shall have technical supporting staff.

3. Integrated sites shall have training capability.

4. There shall be a long-term financial commitment.

5. Data shall be made freely available, and whenever possible, in (near) real-time.

SECTION: BC-Back_cover

Resolution 2 (EC-69)

INITIAL VERSION OF THE GUIDE TO THE WMO INTEGRATED GLOBAL OBSERVING SYSTEM

THE EXECUTIVE COUNCIL,

Noting:

(1) Resolution 2 (EC-68) – Plan for the WMO Integrated Global Observing System pre-operational phase 2016–2019,

(2) Decision 31 (EC-68) – Initial version of the Guide to the WMO Integrated Global Observing System to assist Members in the implementation of the relevant Technical Regulations,

Acknowledging with appreciation the further development and enhancement of this document with additional material developed in accordance with Decision 31 (EC-68) by the Intercommission Coordination Group on the WMO Integrated Global Observing System (WIGOS) and the Inter-programme Expert Team on Observing System Design and Evolution of the Commission for Basic Systems,

Having considered:

(1) Recommendation 3 (CBS-16) – Initial version of the Guide to the WMO Integrated Global Observing System,

(2) The need for recent progress achieved in the development of the surface-based observing systems component of the Observing System Capability Analysis and Review tool (OSCAR/Surface), including machine-to-machine interface, to be reflected in the Guide,

(3) The need for other recently developed guidance material to be incorporated in the initial version of the Guide, namely "Guidance on establishing a WMO Regional WIGOS Centre in pilot phase", "Guidance on the national WIGOS implementation" and "Guidance on WIGOS data partnerships",

(4) The draft initial version of the Guide proposed by the Intercommission Coordination Group on WIGOS (http://www.wmo.int/pages/prog/www/wigos/WGM.html),

Decides to adopt the initial version of the Guide to the WMO Integrated Global Observing System with effect from 1 July 2018;

Requests the Intercommission Coordination Group on WIGOS to finalize the initial version of the Guide with the additional guidance material;

Requests the Secretary-General:

(1) To publish the Guide to the WMO Integrated Global Observing System in all WMO official languages;

(2) To ensure the editorial consistency of the relevant documents;

Also requests the Secretary-General:

(1) To publish the specification of the binary universal form for the representation of meteorological data (BUFR) code table entries that support WIGOS station identifiers on the WMO website in advance of their formal approval through the fast-track procedure;

(2) To maintain *Weather Reporting* (WMO-No. 9) and the associated 5-digit WMO station identifiers until the Eighteenth World Meteorological Congress, when Members will have received training and will have had sufficient time to transition to the WIGOS station identifiers;

Requests the Intercommission Coordination Group on WIGOS to further develop and enhance the Guide with additional material as it becomes available in accordance with Resolution 2 (EC-68);

Invites Members:

(1) To use the Guide in their implementation of the relevant Technical Regulations;

(2) To provide feedback to the Secretary-General on how to improve subsequent versions of the Guide;

Requests Members to inform the Secretary-General of the intended date of transition to the WIGOS identifiers with sufficient lead time to enable operational changes by other Members to manage the impact of the change to the identifiers.

Resolution 3 (EC-69)

REVISED *MANUAL ON THE GLOBAL OBSERVING SYSTEM* (WMO-No. 544) AND *GUIDE TO THE GLOBAL OBSERVING SYSTEM* (WMO-No. 488)

THE EXECUTIVE COUNCIL,

Having considered Recommendation 4 (CBS-16) – Revised *Manual on the Global Observing System* (WMO-No. 544) and *Guide to the Global Observing System* (WMO-No. 488),

Decides:

(1) To amend the *Manual on the Global Observing System*, Volume 1 – Global Aspects, as detailed in Annex 1 to Recommendation 4 (CBS-16);

(2) To amend the *Guide to the Global Observing System* as detailed in Annex 2 to Recommendation 4 (CBS-16).

Resolution 4 (EC-69)

SATELLITE SKILLS AND KNOWLEDGE FOR OPERATIONAL METEOROLOGISTS

THE EXECUTIVE COUNCIL,

Noting:

(1) Recommendation 5 (CBS-16) – Satellite skills and knowledge for operational meteorologists,

(2) The request of the Sixteenth World Meteorological Congress to technical commissions to assign high priority to the development of job competency standards within their respective areas of responsibility,

Recognizing that the levels of skill and knowledge of operational meteorologists related to satellite data are not matching the needs of many Members,

Acknowledging that the guidance document presented in the annex to Recommendation 5 (CBS-16), Satellite Skills and Knowledge for Operational Meteorologists, developed within the WMO–Coordination Group for Meteorological Satellites Virtual Laboratory for Education and Training in Satellite Meteorology describes the underpinning skills supporting the WMO competency areas that relate to the use of satellite data by operational meteorologists,

Stresses that the guidance document should be used in conjunction with addressing the WMO qualification and competency definitions – for example, to assist trainers in developing appropriate learning objectives for satellite-related elements of their courses;

Decides to adopt the proposed Satellite Skills and Knowledge for Operational Meteorologists, as provided in the Annex to Recommendation 5 (CBS-16), as part of the Guide on Competency, under development by the WMO Education and Training Programme.

Resolution 5 (EC-69)

GUIDE TO AIRCRAFT-BASED OBSERVATIONS

THE EXECUTIVE COUNCIL,

Noting Recommendation 4 (CBS-16) – Revised *Manual on the Global Observing System* (WMO-No. 544) and *Guide to the Global Observing System* (WMO-No. 488),

Having considered Recommendation 6 (CBS-16) – New Guide to Aircraft-based Observations,

Decides to adopt the Guide to Aircraft-based Observations as formal guidance on regulations for Members in replacement of the *Aircraft Meteorological Data Relay (AMDAR) Reference Manual* (WMO-No. 958), as detailed in the annex to Recommendation 6 (CBS-16);

Requests the Secretary-General:

(1) To arrange for the publication of the new Guide to Aircraft-based Observations as a WMO Guide;

(2) To bring this resolution to the attention of Members;

(3) To mobilize resources for translation of the Guide into the official languages of WMO;

Invites Members to contribute to the translation of the Guide, noting that this Guide was not included in the list of publications to be published from the regular budget during the seventeenth financial period (Resolution 58 (Cg-17) – Publications for the seventeenth financial period).

Resolution 6 (EC-69)

ESTABLISHMENT AND DESIGNATION OF THE WMO GLOBAL DATA CENTRE FOR AIRCRAFT-BASED OBSERVATIONS

THE EXECUTIVE COUNCIL,

Having considered Recommendation 33 (CBS-16) - Establishment and designation of the WMO Global Data Centre for Aircraft-based Observations,

Noting:

(1) The growth over the past several decades and the expected continued growth in the future of the Aircraft Meteorological Data Relay observing system and in the volume of aircraft-based observations on the Global Telecommunication System,

(2) That these observations contribute to significant positive impact on meteorological, forecasting and other applications as a critical component of the Global Observing System, the WMO Integrated Global Observing System and World Weather Watch,

(3) The high quality of the data and its value to the climate record as a reliable and growing source of global upper-air temperature, wind and, increasingly, humidity meteorological information,

(4) The current lack of a formally recognized international repository for aircraft-based observations and the expected benefits to WMO Members, data users and contributing airline partners of having access to such a resource,

Recognizing:

(1) That the Commission for Basic Systems (CBS) has defined and endorsed the functional requirements and formal terms of reference of a WMO Global Data Centre for Aircraft-based Observations (GDC-ABO),

(2) That CBS has sought expressions of interest from, and made assessment of, potential candidates to undertake the role of the WMO GDC-ABO,

Considering:

(1) That the United States of America has formally offered in principle to the WMO Secretary-General to undertake the role of operation of the WMO GDC-ABO under its terms of reference, as a contribution to WMO activities, through its establishment within the Meteorological Assimilation Data Ingest System (MADIS) of the National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Prediction,

(2) That CBS has determined that MADIS will meet the functional requirements of GDC-ABO and has recommended to the Executive Council to accept the offer of the United States to host GDC-ABO under the management of the National Weather Service Aircraft-based Observations Program,

Decides to designate MADIS as the WMO GDC-ABO;

Requests the Secretary-General, in collaboration with CBS, to establish an agreement with the United States, designating and authorizing NOAA to operate the WMO GDC-ABO under the terms of reference defined by CBS, and to make every effort to ensure that such agreement comes into effect as soon as possible.

Resolution 7 (EC-69)

IMPLEMENTATION OF THE WMO INFORMATION SYSTEM

THE EXECUTIVE COUNCIL,

Noting:

(1) That the decisions, resolutions and recommendations of the Commission for Basic Systems (CBS) at its sixteenth session are contained in the *Abridged Final Report with Resolutions, Decisions and Recommendations of the Sixteenth Session of the Commission for Basic Systems* (WMO-No. 1183),

(2) Recommendation 14 (CBS-16) – Updates to the *Manual on the WMO Information System* (WMO-No. 1060), which proposes amendments to the list of WMO Information System (WIS) centres,

(3) Recommendation 15 (CBS-16) – Advice on metadata in the *Guide to the WMO Information System* (WMO-No. 1061), which introduces guidance on production of WIS discovery metadata,

(4) Recommendation 16 (CBS-16) – Information management practices, which introduces sections of the *Manual on the WMO Information System* and the *Guide to the WMO Information System* on information management practices,

(5) Recommendation 17 (CBS-16) – Guide to the Direct Broadcast Network, which recommends that the publication "Guidance on DBNet" should be designated as an attachment to the *Guide to the WMO Information System* describing the use of DBNet that is provided by satellite operators,

(6) Recommendation 18 (CBS-16) – Amendments to the *Manual on the Global Telecommunication System* (WMO-No. 386) and its attachments, which updates the World Weather Watch quantitative monitoring procedures for consistency with the WMO Integrated Global Observing System (WIGOS) station identifiers and the Regional Basic Observing Network, introduces information on the Regional Telecommunication Hubs (RTHs) into Volume I of the *Manual on the Global Telecommunication System*, updates practices and procedures for the Transmission Control Protocol/Internet Protocol (TCP/IP) on the Global Telecommunication System (GTS), and updates the *Guide to Information Technology Security* (WMO–No. 1115) and the *Guide to Virtual Private Networks (VPN) via the internet between GTS Centres* (WMO-No. 1116),

(7) The request from France to rename the Toulouse Data Collection or Production Centre that functions as a radar data centre,

(8) An agreement between Germany and Estonia for Global Information System Centre (GISC) Offenbach to act as the principal GISC for WIS centres in Estonia,

Observing the concerns expressed about the description of RTHs in the future structure of the Global Telecommunication System within the WMO information System in Annex 2 to Recommendation 18 (CBS-16),

Confirms that, following confirmation by CBS at its sixteenth session of technical compliance, the asterisk that denotes conditional designation in Table 2 of Appendix B to the *Manual on the WMO Information System* can be removed from those WIS Data Collection or Production Centres listed in Table 1 of the annex to Recommendation 14 (CBS-16);

Decides, in respect of the *Manual on the WMO Information System* and the *Guide to the WMO Information System*:

(1) To designate as WIS Data Collection or Production Centres those centres listed in Table 2 of the Annex to Recommendation 14 (CBS-16) and add them to Table 2 of Appendix B to the *Manual on the WMO Information System*;

(2) To update the country name for National Meteorological Centre (NMC) (Aruba) to NMC Aruba (Netherlands) in Table 3 of Appendix B to the *Manual on the WMO Information System*;

(3) To update the principal GISC for NMC Algeria and RTH/Regional Specialized Meteorological Centre (RSMC)-Geographical (Algiers) to be Toulouse, add Offenbach as principal GISC for Estonia and record this in Table 3 of Appendix B to the *Manual on the WMO Information System*;

(4) To editorially correct the name in French of "Centre de données océaniques (Toulouse)" in the French version of Table 2 of Appendix B of the *Manual on the WMO Information System* to "Centre des données radar OPERA";

(5) To amend the text of the *Manual on the WMO Information System* and the *Guide to the WMO Information System* in respect of the WMO Core Profile metadata as specified in the annex to Recommendation 15 (CBS-16);

(6) To add a new Part VI "Information Management" to the *Manual on the WMO Information System* and Part VI with the same title to the *Guide to the WMO Information System*, re-number the existing Part VI (Operational Guidance) of the *Guide to the WMO Information System* to Part VII, and introduce the text specified for Part VII in the annex to Recommendation 16 (CBS-16);

(7) To introduce the text "Note: guidance on information management best practices is provided in Part VI of the *Guide to the WMO Information System*" as Part VI of the *Manual on the WMO Information System* (WMO-No. 1060) pending development of provisions relating to information management;

(8) To publish the text in the Annex to Recommendation 17 (CBS-16) on the *Guide to the Direct Broadcast Network (DBNet)* with its own WMO publication number as an Attachment to the *Guide to the WMO Information System*, designate the text as Technical Specifications, and authorize amendment of the text using the fast-track (simple) procedure;

Also decides, in respect of the *Manual on the Global Telecommunications System* and its associated guidance documents:

(1) To update the requirements for World Weather Watch quantitative monitoring to reflect advances in technology and the introduction of WIGOS as specified in the amendments to the *Manual on the Global Telecommunications System* specified in Annex 1 to Recommendation 18 (CBS-16);

(2) To amend as specified in Annex 3 to Recommendation 18 (CBS-16) the recommended practices for the use of the TCP/IP protocol on GTS that are recorded in Attachment II-15 of the *Manual on the Global Telecommunications System*;

(3) To amend as specified in Annex 4 to Recommendation 18 (CBS-16) the *Guide to Information Technology Security* to reflect modern practices;

(4) To amend as specified in Annex 5 to Recommendation 18 (CBS-16) the *Guide to Virtual Private Networks (VPN) via the Internet between GTS Centres* to reflect modern practice;

Requests CBS to review further the proposed amendments to the *Manual on the Global Telecommunication System* Part 1 and Attachments I-2 and I-3 as specified in Annex 2 to Recommendation 18 (CBS-16) to reflect the current structure of GTS and to record information on the structure of GTS that is still required and that was previously recorded in Volume II of that Manual;

Authorizes the Secretary-General to make editorial changes to the amendments to the Manuals, Guides and supporting documentation approved in the present resolution.

Resolution 8 (EC-69)

STRATEGY AND GOVERNANCE FOR THE WMO INFORMATION SYSTEM

THE EXECUTIVE COUNCIL,

Noting:

(1) That decisions, resolutions and recommendations of the Commission for Basic Systems (CBS) at its sixteenth session are contained in the *Abridged Final Report with Resolutions, Decisions and Recommendations of the Sixteenth Session of the Commission for Basic Systems* (WMO-No. 1183),

(2) Recommendation 35 (CBS-16) – WMO Information System 2.0 strategy, which proposes a strategy for enhancing the ability of the WMO Information System (WIS) to meet the needs of WMO Members and Programmes,

(3) Recommendation 36 (CBS-16) – Intercommission Task Team on the WMO Information System, which endorses the escalation procedure for WIS issues and that proposes the task team be retained as a conduit for programme, technical commission and regional association involvement in the governance and operation of WIS and the development of WIS 2.0,

(4) Decision 25 (CBS-16) – WMO Information System security incident management process, which recognizes the potential impact of security incidents on the operation of WIS, proposes a procedure to assist Members in managing security incidents that potentially impact on the operation of WIS, and acknowledges that national policies on security may constrain the ability of Members to follow the procedure,

(5) Decision 26 (CBS-16) – System monitoring of the WMO Information System, which decides that the prototype monitoring dashboard developed by the Global Information System Centres should be made operational and that the monitoring should be developed further to encourage all types of WIS centres to participate in WIS monitoring,

Endorses the WIS 2.0 strategy in the Annex to Recommendation 35 (CBS-16);

Decides that the Intercommission Task Team on the WMO Information System should be retained with the terms of reference as given in the annex to the present resolution;

Requests CBS to further develop, implement and maintain a security incident response process that can be used by organizations participating in the operation of WIS to the extent permitted by national policies;

Authorizes the Secretary-General to make editorial amendments to the annex to the present resolution;

Urges Members to participate in the specification and operation of system monitoring of WIS.

Annex to Resolution 8 (EC-69)

TERMS OF REFERENCE FOR THE INTERCOMMISSION TASK TEAM ON THE WMO INFORMATION SYSTEM

Membership of the Intercommission Task Team on the WMO Information System (ITT-WIS) includes:

(a) Two co-chairpersons, one from CBS and the other a representative of a technical commission other than CBS;

(b) A representative for each technical commission not represented by the co-chairpersons;

(c) Chairperson of the CBS Open Programme Area Group on Information Systems and Services;

(d) A representative from a National Hydrological or Meteorological Service that is implementing the WMO Strategy for Service Delivery;

(e) A representative of those regional associations that do not have representation through one of the above roles.

The Intercommission Task Team on the WMO Information System (ITT-WIS) provides a channel for technical commission input into the operation and development of the WIS, in particular:

(a) Advise the president of CBS on the use of GlobalExchange and RegionalExchange flags in WIS in those cases that could not be resolved using normal operational coordination activities;

(b) Recommend to ICT-ISS solutions on issues unable to be resolved through the collaborative mechanisms established between WIS centres;

(c) Assist ICT-ISS in gathering the requirements of programmes, technical commissions and regional associations for what WIS would provide for them in the 2020s and beyond;

(d) Advise ICT-ISS on whether the guidance developed for WMO information management practices meets the requirements of all programmes, technical commissions and regional associations;

(e) Communicate to WMO Programmes and technical commissions on topics relating to WIS to support ICT-ISS outreach activities;

(f) Assist ICT-ISS in monitoring implementation of the WIS 2.0 strategy.

Resolution 9 (EC-69)

MODEL-DRIVEN CODE FORMS

THE EXECUTIVE COUNCIL,

Noting:

(1) That decisions, resolutions and recommendations of the Commission for Basic Systems (CBS) at its sixteenth session are contained in the *Abridged Final Report with Resolutions, Decisions and Recommendations of the Sixteenth Session of the Commission for Basic Systems* (WMO-No. 1183),

(2) Decision 8 (CBS-16) – Provisional operational implementation of data representation for WMO Integrated Global Observing System metadata, which defines a model-driven code form to allow Members to test its use for exchange of WMO Integrated Global Observing System (WIGOS) metadata in advance of introducing that code form into the *Manual on Codes* (WMO-No. 306),

(3) Recommendation 13 (CBS-16) – Provisional operational implementation of data representation for information in support of international air navigation, which recommends an amendment of the International Civil Aviation Organization meteorological information exchange model (IWXXM)-driven data representation that will allow Members to implement the requirement in Amendment 78 to Annex 3 of the Convention on International Civil Aviation for exchanging information in extensible mark-up language/geography mark-up language (XML/GML) as standard practice,

(4) Recommendation 11 (CBS-16) – Amendments to the METCE (modèle pour l'échange des informations sur le temps, le climat et l'eau) data representation, which proposes amendments to METCE and its supporting schemas that are required to support the WIGOS metadata data representation and the amendments to IWXXM described in Recommendation 13 (CBS-16),

(5) Recommendation 9 (CBS-16) – Amendment to the COLLECT-XML data representation, which facilitates the exchange of reports using the amendments of IWXXM introduced by Recommendation 13 (CBS-16),

(6) Recommendation 8 (CBS-16) — Recognition of TimeSeriesML for the representation of time series information, which introduces a model-driven XML representation of time series into the *Manual on Codes* and that was jointly developed by experts from CBS and the Open Geospatial Consortium,

Noting also:

(1) That early implementers of IWXXM 2.0 identified an inconsistency between the schemas for IWXXM 2.0 recommended by CBS at its sixteenth session and the implementation practices for the traditional alphanumeric code version of volcanic ash advisories,

(2) That CBS experts had issued a revised version of the XML/GML schemas for IWXXM as IWXXM 2.1 that makes IWXXM consistent with the traditional alphanumeric code volcanic ash advisories,

Endorses:

(1) Use of IWXXM 2.1 as defined by the schemas and unified modelling language at http://schemas.wmo.int/iwxxm/2.1, the code identifier FM 205-16 IWXXM-XML and amendment of the *Manual on Codes*, Volume I.3, Part D – Representations derived from data models, as specified in the text to Recommendation 13 (CBS-16) modified as described in the annex to the present resolution*;*

(2) Recommendation 11 (CBS-16) on the use of version 1.2 of METCE and its supporting schemas and amendment of the *Manual on Codes*, Volume I.3, Part D, as specified in the annex to that recommendation;

(3) Recommendation 9 (CBS-16) on the use of version 1.2 of COLLECT-XML and amendment of the *Manual on Codes,* Volume I.3, Part D, as specified in the annex to that recommendation;

(4) Recommendation 8 (CBS-16) on the use of TimeSeriesML and amendment of the *Manual on Code*s, Volume I.3, Part D, as specified in the annex to that recommendation;

Designates the entire Volume I.3, Part D of the *Manual on Codes* as Technical Specifications to which the fast track (simple) procedure for amendments may be applied;

Authorizes the Secretary-General to make editorial changes to the *Manual on Codes*, Volume I.3, Part D that are required to implement the endorsed items.

Annex to Resolution 9 (EC-69)

IWXXM 2.1

The amendments to WMO-No.306 *Manual on Codes* Volume I.3, Part D specified in the Annex to Recommendation 13 (CBS-16) should be modified as follows.

Change all instances of /iwxxm/2.0 to /iwxxm/2.1 (both upper case and lower case) *[This is version control information]*

In the sections numbered 205.19 and 205.20, and the tables labelled 205.19-1 205.20-1 after the CBS-16 changes have been applied, change all occurrences of “meteorological-position” to “SIGMET-position” and “meteorological position” to “SIGMET position”. *[This is to assist software developers]*

In the section numbered 205.22 and the table labelled 205.22-1 after the CBS-16 changes have been applied (and that should now be labelled as section 205.23), change all occurrences of “evolving meteorological” to “SIGMET evolving” and “evolving-meteorological” to “SIGMET-evolving” and “EvolvingMeteorological” to “SIGMETEvolving” [This is to assist software developers]

In the section numbered 205.28 and the table labelled 205.28-1 after the CBS-16 changes have been applied, change all occurrences of "evolving meteorological" to "evolving" and "evolving-meteorological" to "evolving" and "EvolvingMeteorological" to "Evolving" *[This is to assist software developers]*

Create new sections 205.22 and 205.27 with the following contents, renumbering the existing sections around them. *[These two sections address the issue identified by implementers]*

205.22 Requirements class: SIGMET evolving condition collection

205.22.1 This requirements class is used to define a collection of SIGMET phenomenon described by the requirements class SIGMET evolving condition, each representing a location where SIGMET observed or forecast conditions exist.

205.22.2 XML elements describing the characteristics of a SIGMET phenomenon shall conform to all requirements specified in Table 205.22-1.

205.22.3 XML elements describing the characteristics of a SIGMET phenomenon shall conform to all requirements of all relevant dependencies specified in Table 205.22-1.

Table 205.22-1. Requirements class xsd-SIGMET-evolving-condition-collection

Requirements class	
http://icao.int/iwxxm/2.1/req/xsd-SIGMET-evolving-condition-collection	
Target type	Data instance
Name	SIGMET evolving condition collection
Requirement	http://icao.int/iwxxm/2.1/req/xsd-SIGMET-evolving-condition-collection/valid The content model of this element shall have a value that matches the content model of iwxxm:SIGMETEvolvingConditionCollection
Requirement	http://icao.int/iwxxm/2.1/req/xsd-SIGMET-evolving-condition-collection/time-indicator The content model of this element shall have a value that matches the content model of iwxxm:SIGMETEvolvingConditionCollection/@TimeIndicator

205.27 Requirements class: AIRMET Evolving Condition Collection

205.27.1 This requirements class is used to define a collection of AIRMET phenomenon described by requirements class AIRMET Evolving Condition, each representing a location where AIRMET observed or forecast conditions exists.

205.27.2 XML elements describing the characteristics of a AIRMET phenomenon shall conform to all requirements specified in Table 205.27-1.

205.27.3 XML elements describing the characteristics of a AIRMET phenomenon shall conform to all requirements of all relevant dependencies specified in Table 205.27-1.

Table 205.27-1. Requirements class xsd-AIRMET-evolving-condition-collection

Requirements class	
http://icao.int/iwxxm/2.1/req/xsd-AIRMET-evolving-condition-collection	
Target type	Data instance
Name	AIRMET evolving condition collection
Requirement	http://icao.int/iwxxm/2.1/req/xsd-AIRMET-evolving-condition-collection/valid The content model of this element shall have a value that matches the content model of iwxxm:AIRMETEvolvingConditionCollection
Requirement	http://icao.int/iwxxm/2.1/req/xsd-AIRMET-evolving-condition-collection/time-indicator The content model of this element shall have a value that matches the content model of iwxxm:AIRMETEvolvingConditionCollection/@TimeIndicator

Resolution 10 (EC-69)

CODE TABLES SUPPORTING WMO INTEGRATED GLOBAL OBSERVING SYSTEM METADATA

THE EXECUTIVE COUNCIL,

Recalling that WMO Integrated Global Observing System (WIGOS) metadata are intended to record information about the conditions under which observations are made, that the WIGOS metadata standard is recorded in the *Manual on the WMO Integrated Global Observing System* (WMO-No. 1160) and that the Commission for Basic Systems (CBS) is developing a representation of WIGOS metadata in extensible mark-up language/geography mark-up language (XML/GML),

Noting:

(1) Recommendation 1 (CBS-16) – *Manual on the WMO Integrated Global Observing System* (WMO-No. 1160), section 2, Appendix 2.4. and attachment to Appendix 2.4. (the WIGOS metadata standard), which recommends that the code tables supporting the WIGOS metadata standard should be recorded in the *Manual on Codes* (WMO-No. 306) instead of in the *Manual on the WMO Integrated Global Observing System*,

(2) Recommendation 7 (CBS-16) – Amendments to code tables supporting WMO Integrated Global Observing System metadata, which recommends amendments to the contents tables supporting WIGOS metadata resulting from the work of the Intercommission Coordination Group on the WMO Integrated Global Observing System (ICG-WIGOS) Task Team on WIGOS Metadata,

(3) Decision 8 (CBS-16) – Provisional operational implementation of data representation for WMO Integrated Global Observing System metadata, which urges Members to use the WIGOS metadata data representation in XML and that underlines that representation relies on the code tables supporting the WIGOS metadata,

Noting also:

(1) That after the sixteenth session of CBS the ICG-WIGOS Task Team on WIGOS Metadata had further considered the tables supporting WIGOS metadata and concluded that entries in Table 1 on the topic of atmospheric composition were not mature enough to publish formally,

(2) That the experts in the CBS and ICG-WIGOS teams implementing the data representation in support of WIGOS metadata had identified that ongoing maintenance of the code tables would be simpler and more reliable if the code tables were placed in a simpler tree structure on http://codes.wmo.int than that recommended by CBS at its sixteenth session,

Decides to approve the WIGOS code tables specified in the annex to the present resolution for inclusion in the *Manual on Codes*, Volume I.3;

Authorizes the Secretary-General to amend as specified in the annex to the present resolution the *Manual on Codes* and the *Manual on the WMO Integrated Global Observing System*, to make consequent editorial adjustments as required and to arrange publication of the code tables on http://codes.wmo.int.

Annex to Resolution 10 (EC-69)

CODE TABLES SUPPORTING WMO INTEGRATED GLOBAL OBSERVING SYSTEM METADATA

Amend the Manual on WIGOS (WMO-No. 1160) as specified in the Annex to Recommendation 1 (CBS-16) [see Abridged Final Report with Resolutions, Decisions and Recommendations of the Sixteenth Session of the Commission for Basic Systems (WMO-No. 1183)]

Amend the Manual on Codes (WMO-No. 306) Volume I.3 and the tables at http://codes.wmo.int as specified in the Annex to Recommendation 7 (CBS-16), but make the following changes to the text.

(1) In the caption for Table 241-18, replace "WMDRS-XML" with "WMDR-XML".

(2) Replace all occurrences of the text "http://codes.wmo.int/common/wmds" with "http://codes.wmo.int/wmdr/"

(3) Omit from code table 1-01 the rows corresponding to observed variables relating to atmospheric chemistry:

(a) row 192 (>Atmosphere>Greenhouse Gas>CH4) to row 207 (>Atmosphere>Other Gas>HDO (as a chemical species));

(b) row 274 (>Atmosphere>Reactive Gas>BrO (bromine monoxide)) to row 291 (>Atmosphere>Reactive Gas>ROOH);

(c) row 332 (>Atmosphere>Greenhouse Gas>Halon>CBrClF2 (Halon 1211)) to row 351 (>Atmosphere>POPs>PAH>C18H12 (Benz(a)anthracene), in total precipitation);

(d) row 375 (>Atmosphere>POPs>POP>C12H8Cl6 (aldrin), in aerosol) to 385 (>Atmosphere>POPs>POP>C6H6Cl6 (1,2,3,4,5,6-hexachlorocyclohexane, gamma-lindane, gamma-HCH), in wet precipitation);

(e) row 390 (>Atmosphere>Reactive Gas>Nitrogen containing compounds>Ammonia (NH3)) to 398 (>Atmosphere>Reactive Gas>Nitrogen containing compounds>NOy);

(f) row 419 (>Atmosphere>Greenhouse Gas>PFCs>C2F6 (hexafluoroethane, PFC-116)) to row 421 (>Atmosphere>Greenhouse Gas>PFCs>CF4 (tetrafluoromethane, carbon tetrafluoride, perfluoromethane, PFC-14));

(g) row 428 (>Atmosphere>Reactive Gas>Sulfur containing compounds>COS (OCS, carbon oxide sulfide, carbonyl sulfide)) to row 430 (>Atmosphere>Reactive Gas>Sulfur containing compounds>SO2);

(h) row 434 (>Atmosphere>Reactive Gas>VOC>C2H2 (ethyne, acetylene)) to row 505 (>Atmosphere>Reactive Gas>VOC>t-C5H10 (trans-2-pentene));

(i) row 534 (>Atmosphere>Greenhouse Gas>HCFCs>C2H3Cl2F (1,1-dichloro-1-fluoroethane, HCFC-141b)) to row 548 (>Atmosphere>Total Atmospheric Deposition>Inorganic cations>Sodium (Na+));

(j) row 554 (>Atmosphere>Greenhouse Gas>HFCs>C2H2F4 (1,1,1,2-tetrafluoroethane, HFC-134a)) to row 562 >Atmosphere>Greenhouse Gas>HFCs>CHF3 (trifluoromethane, HFC-23);

(k) row 568 (>Atmosphere>Total Atmospheric Deposition>Inorganic nitrogen species>Ammonium (NH4+)) to row 570 (>Atmosphere>Total Atmospheric Deposition>Inorganic nitrogen species>Nitrite (NO2-));

(l) row 576 (>Atmosphere>Total Atmospheric Deposition>Organic acid>Acetate (CH3COO-)) to row 578 (>Atmosphere>Total Atmospheric Deposition>Organic acid>Propionate (C2H5COO-);

(m) row 589 (>Atmosphere>Greenhouse Gas>CFCs>C2Cl2F4 (1,2-dichlorotetrafluoroethane, CFC-114)) to row 595 (>Atmosphere>Greenhouse Gas>Halocarbons>CH3CCl3 (1,1,1-trichloroethane));

(n) row 597 (>Atmosphere>Total Atmospheric Deposition>Trace elements>Aluminum (Al)) to row 609 (>Atmosphere>Total Atmospheric Deposition>Trace elements>Zinc (Zn));

(o) row 614 (>Atmosphere>Aerosol>Composition>Inorganic anions>Chloride (Cl-), PM1) to row 626 (>Atmosphere>Aerosol>Composition>Inorganic carbonaceous>Total carbon (coarse), PM10);

(p) row 632 (>Atmosphere>Aerosol>Composition>Inorganic cations>Calcium (Ca++), PM10) to row 724 (>Atmosphere>Aerosol>Composition>Trace elements>Zinc (Zn), total aerosol).

(4) Modify code table 7-01 so that the WIGIS_CD column for formats in the Manual on Codes have the form “FM-number-name” where “number” is the FM number and “name” is the name of the code form.

Resolution 11 (EC-69)

DATA REPRESENTATIONS FOR HYDROLOGICAL INFORMATION

THE EXECUTIVE COUNCIL,

Noting that the Commission for Hydrology (CHy) had initiated the WMO Hydrological Observing System that would require the exchange of hydrological information between Members,

Noting also:

(1) That standardizing on a limited number of data representations offers potential savings of time and money for Members,

(2) That CHy had worked closely with the Open Geospatial Consortium (OGC) in developing a standard representation of time series of hydrological information known as WaterML2 Part 1 and a standard representation of streamflow information known as WaterML2 Part 2,

(3) That the *Manual on Codes* (WMO-No. 306), Volume I.3 records data representations derived from data models,

(4) That the *Manual on the WMO Information System* (WMO-No. 1060) requires Members to create WMO Information System (WIS) discovery metadata records to describe the information they wish to make available to other Members,

(5) The published edition of the *Guide to Hydrological Practices* (WMO-No. 168), Volume I predates WIS and the work of OGC on data representations for hydrology,

Noting further:

(1) That decisions, resolutions and recommendations of the Commission for Basic Systems at its sixteenth session are contained in the *Abridged Final Report with Resolutions, Decisions and Recommendations of the Sixteenth Session of the Commission for Basic Systems* (WMO-No. 1183),

(2) That decisions, resolutions and recommendations of CHy at its fifteenth session are contained in the *Abridged Final Report with Resolutions, Decisions and Recommendations of the Fifteenth Session of the Commission for Hydrology* (WMO-No. 1184),

(3) That Recommendation 1 (CHy-15) – Data representations for hydrological data, and Recommendation 12 (CBS-16) – Data representations for hydrological data, both recommend inclusion of WaterML2 Parts 1 and 2 into the *Manual on Codes*, Volume I.3 and the updating of the *Guide to Hydrological Practices*,

Decides:

(1) To amend the *Manual on Codes*, Volume I.3 to introduce WaterML2 Parts 1 and 2 as data representations that are suitable for the exchange of hydrological information, as specified in Annex 1 of the Annex to Recommendation 12 (CBS-16);

(2) To amend the *Guide to Hydrological Practices*, Volume I as specified in Annex 2 of the Annex to Recommendation 1 (CHy-15);

Requests the Secretary-General to amend the text of the *Manual on Codes*, Volume I.3 and the *Guide to Hydrological Practices* as specified in Recommendation 12 (CBS-16) and Recommendation 1 (CHy-15), and to make editorial changes as needed;

Requests WMO representatives to the Hydrology Domain Working Group of the OGC to work with that group to revise the non-normative (informative) material in the WaterML2 standards to address concerns of CHy.

Resolution 12 (EC-69)

ASSISTING COMPLIANCE WITH TECHNICAL REGULATIONS

THE EXECUTIVE COUNCIL,

Noting:

(1) That decisions, resolutions and recommendations of the Commission for Basic Systems (CBS) at its sixteenth session are contained in the *Abridged Final Report with Resolutions, Decisions and Recommendations of the Sixteenth Session of the Commission for Basic Systems* (WMO-No. 1183),

(2) Recommendation 25 (CBS-16) – Review of Technical Regulations managed by the Commission for Basic Systems, which identifies that the *Manual on Codes* (WMO-No. 306) contains both requirements on Members and technical details of how those requirements may be met,

(3) Decision 9 (CBS-16) – Terms of reference for national focal points supporting the work of the Open Programme Area Group on Information Systems and Services, which states the responsibilities and authorities of national focal points designated by Permanent Representatives in respect of the WMO Information System (WIS) in general, and in particular in relation to the operation of the fast-track (simple) procedure for amendments to technical specifications,

(4) Recommendation 15 (CBS-16) – Advice on metadata in the *Guide to the WMO Information System* (WMO-No. 1061), which identifies the WIS discovery metadata catalogue as a mechanism for Members to inform other Members about limitations on the use of information being shared,

Decides:

(1) That the *Manual on Codes*, Volumes I.2 and I.3 shall be designated as technical specifications to which the fast-track (simple) procedure for amendments may be applied;

(2) That provisions in Technical Regulations, other than the *Manual on Codes,* that specify obligations to exchange information shall be amended to state explicitly what information has to be exchanged, and which information representations in the *Manual on Codes* may be used to represent that information;

(3) That the status of the *Manual on Codes*, Volume I.1 shall remain unchanged until such time as the traditional alphanumeric codes are no longer supported for operational exchange by World Weather Watch, but that if any provision for information exchange that is expressed as an obligation in that volume should change, that provision should be transferred to the Technical Regulations from which the obligation is derived;

(4) That the mechanism used by a Member to “Make known to all Members ... those meteorological and related data and products which have conditions related to their re-export for commercial proposes outside of the receiving country or group of countries forming a single economic group” under Resolution 40 (Cg-XII) – WMO policy and practice for the exchange of meteorological and related data and products including guidelines on relationships in commercial meteorological activities, and the corresponding notifications under Resolutions 25 (Cg-XIII) – Exchange of hydrological data and

products, and 60 (Cg-17) – WMO policy for the international exchange of climate data and products to support the implementation of the Global Framework for Climate Services, is to assign the value "WMOAdditional" to the element known as "WMO_DataLicenseCode" in the WIS discovery metadata record in the WIS discovery metadata catalogue that describes the information, and that a letter from the Permanent Representative is no longer required;

Requests CBS to prepare amendments to the provisions in the *Manual on Codes*, Volumes I.2 and I.3 to remove provisions in those volumes that place obligations on Members to exchange information, so that the term "shall" in those volumes designates conformance to technical specifications that is required in order that systems using data representations can perform correctly;

Requests the Secretary-General to include annotations in the *Manual on Codes*, Volumes I.2 and I.3 required to designate them as technical specifications;

Requests Members to use the WIS discovery metadata catalogue to notify other Members of any conditions related to the use of information they provide.

Resolution 13 (EC-69)

AMENDMENT TO THE *TECHNICAL REGULATIONS* (WMO-No. 49), VOLUME I – GENERAL METEOROLOGICAL STANDARDS AND RECOMMENDED PRACTICES, PUBLIC WEATHER SERVICES PROVISIONS

THE EXECUTIVE COUNCIL,

Recalling:

(1) Resolution 5 (Cg-17) – Public Weather Services Programme, in which Congress requests regional associations to promote the implementation of the Competency Framework for Public Weather Services (PWS) forecasters and advisors in their respective regions,

(2) Decision 45 (EC-68) – Implementation of the Competency Framework for Public Weather Services, in which the Executive Council requests the Commission for Basic Systems (CBS), at its sixteenth session, to approve draft PWS provisions for *Technical Regulations* (WMO-No. 49), Volume I as a prerequisite for implementing the Competency Framework for Public Weather Services after approval by the Executive Council at its sixty-ninth session,

Having considered Recommendation 39 (CBS-16) – Implementation of the Competency Framework for Public Weather Services and development of public weather services provisions for *Technical Regulations* (WMO-No. 49), Volume I, in which CBS recommends PWS provisions for inclusion in the WMO Technical Regulations,

Decides to approve the CBS recommendation on the PWS provisions as given in the annex to the present resolution,

Requests the Secretary-General:

(1) To reflect this amendment in the updated *Technical Regulations*, Volume I;

(2) To facilitate training events for Members to assist them in the implementation of the PWS competencies in line with the WMO Strategy for Service Delivery and WMO Quality Management Systems, thus enhancing the satisfaction of their users through improvement of services and products of their National Meteorological and Hydrological Services.

Annex to Resolution 13 (EC-69)

PUBLIC WEATHER SERVICES PROVISION FOR INCLUSION IN *TECHNICAL REGULATIONS* (WMO-No. 49), VOLUME I

IV Meteorological, Hydrological and Climatological Services

5. PUBLIC WEATHER SERVICES

5.1 General

5.1.1 Members should provide public weather services to cover:

(a) Forecasts and related services in the areas of weather, climate and water to aid citizens in their day-to-day activities;

(b) Warnings of high impact weather and extremes of climate, and information to other government authorities as appropriate in pursuance of their mission to protect the lives, livelihoods and property of the citizens.

5.1.2 The purpose of public weather services provided by Members should be to support decision-making related to:

(a) Protection of life, livelihood and property;

(b) Welfare and well-being of the population;

(c) Social and economic development in response to the wide spectrum of requirements of the public and weather-sensitive user groups.

5.2 Public Weather Services Delivery

5.2.1 User Focus

Members should identify users and understand their needs for weather, climate, water and environmental-related information in their decision-making practices. Close coordination should be maintained with users and effective feedback mechanisms should be established.

5.2.2 Quality

Members should establish a properly organized quality management system comprising procedures, processes and resources necessary to provide for sustainable quality levels of public weathers services to be supplied to users.

Note: Quality management system in conformity with ISO 9000 standards are considered as a good practice.

5.2.3 Dissemination and communication of products

Members should ensure preparation and timely dissemination to relevant users, of public weather information including warning information concerning occurrence and evolution of severe weather phenomena. Such information should be fit for purpose for integration into decision-making processes and procedures related to protection of life and property and general welfare of the public.

5.2.4 Preparation of warnings

Warning information intended for decision-making related to protection of life, livelihood and property should be provided by bodies designated and mandated by government.

Members should provide warning information through the implementation of an early warning system.

Warning information should incorporate, to the extent possible, information about impacts of weather hazards on individuals and communities.

5.2.5 Socioeconomic benefits of meteorological and hydrological services
Members should perform socioeconomic benefit assessments to both measure and demonstrate the value of their services to the public and other users.

5.2.6 Public education and outreach
Members should engage in education, awareness and preparedness activities aimed at helping citizens make the best use of forecasts and warnings information, understand the potential threats of high impact weather and extremes of climate, and be aware of the appropriate mitigating actions.

5.3 Organization
Members should ensure that their NMHSs are properly equipped to provide essential public weather services and especially warnings of severe weather.

5.4 Competency
Members should ensure that the competency requirement of personnel engaged in the provision of public weather services is in accordance with the requirements indicated in Part V of the WMO *Technical Regulations*, Volume I (WMO-No. 49)(to be developed).

Resolution 14 (EC-69)

AMENDMENT TO THE *TECHNICAL REGULATIONS* (WMO-No. 49), VOLUME II – METEOROLOGICAL SERVICE FOR INTERNATIONAL AIR NAVIGATION

THE EXECUTIVE COUNCIL,

Noting that Amendment 77 to the International Standards and Recommended Practices, Meteorological Service for International Air Navigation (Annex 3 to the Convention on International Civil Aviation) was adopted by the Council of the International Civil Aviation Organization (ICAO) on 22 February 2016, with applicability dates of 10 November 2016 for Amendment 77-A and 5 November 2020 for Amendment 77-B,

Noting also the established procedures that shall ensure Annex 3 to the ICAO Convention and WMO *Technical Regulations* (WMO-No. 49), Volume II are aligned,

Approves the amendment to WMO *Technical Regulations*, Volume II, which ensures its necessary alignment with Amendment 77 to Annex 3 of the ICAO Convention;

Requests the Secretary-General to arrange for the publication of the amended *Technical Regulations*, Volume II;

Requests the Secretary-General, assisted by the president of the Commission for Aeronautical Meteorology, to review and, as necessary, publish updates to related WMO guidance material to ensure consistency with the amended *Technical Regulations*, Volume II.

Resolution 15 (EC-69)

INTERNATIONAL EXCHANGE OF SNOW DATA

THE EXECUTIVE COUNCIL,

Recalling:

(1) Resolution 60 (Cg-17) – WMO policy for the international exchange of climate data and products to support the implementation of the Global Framework for Climate Services,

(2) Decision 50 (EC-68) – Development of the Global Cryosphere Watch, urging Members to exchange in situ snow measurements in real time,

Noting the report of the seventh session of the Executive Council Panel of Experts on Polar and High-mountain Observations, Research and Services (EC-PHORS) (Ushuaia, Argentina, 21–24 March 2017),

Recognizing the positive impact of snow-depth data on the predictability in numerical weather prediction and hydrological forecasting,

Acknowledging:

(1) The need for real-time access to in situ snow measurements to support future polar and high-mountain Regional Climate Centres as a tool for providing the services proposed in the Global Framework for Climate Services,

(2) That the Global Cryosphere Watch is a significant component of the WMO Integrated Global Observing System and the WMO Information System (WIS), promoting interoperable and reference long-term observations, and near-real-time data and information exchange,

Having considered:

(1) Recommendation 41 (CBS-16) – International exchange of snow data, recommending to the Executive Council to approve an amendment to the *Manual on the Global Observing System* (WMO-No. 544), Volume I – Global Aspects, adding new provisions for reporting and exchange of snow cover and snow depth from all stations where snow is experienced,

(2) The recommendations of EC-PHORS at its seventh session regarding the further amendment of the text for inclusion in the *Manual on the Global Observing System*, Volume I from that of Recommendation 41 (CBS-16),

(3) The support for the wording recommended by EC-PHORS received from those Members who expressed concerns regarding the initial binding proposal presented by Recommendation 41 (CBS-16),

Decides to approve the amendment to the *Manual on the Global Observing System*, Volume I, by adding new provisions as follows:

(1) Members should report snow cover and snow depth four times a day, namely 00, 06, 12 and 18 UTC where snow is experienced and the capability to do so exists;

(2) Members shall report snow cover and snow depth at least once a day at stations where snow is experienced and the capability to do so exists, and indicate the timing of these observations;

(3) Members shall report values of zero snow depth (0 cm) from the above stations when snow is not present for the entire period during which snow can be expected and where the capability to do so exists. This period shall be defined for each location by the relevant Region;

(4) Snow cover should be reported in the state-of-ground field, where possible, and zero snow depth (absence of snow) should be reported in the quantitative-snow-depth field;

Requests Members to exchange in situ snow measurements in real time in BUFR through the Global Telecommunication System/WIS in accordance with the *Manual on the Global Observing System*, and contribute to the derivation of regional cryosphere products, for example, regional snow trackers;

Requests the Secretary-General to incorporate the approved amendment in the Manual and ensure adequate support for the execution of this Decision.

Resolution 16 (EC-69)

EXECUTIVE COUNCIL PANEL OF EXPERTS ON POLAR AND HIGH-MOUNTAIN OBSERVATIONS, RESEARCH AND SERVICES

THE EXECUTIVE COUNCIL,

Noting:

(1) Resolution 60 (Cg-XVI) – Global Cryosphere Watch,

(2) Resolution 22 (Cg-17) – Global Observing System,

(3) Resolution 23 (Cg-17) – Preoperational phase of the WMO Integrated Global Observing System,

(4) Resolution 40 (Cg-17) – WMO polar and high-mountain activities,

(5) Resolution 41 (Cg-17) – Antarctic Observing Network,

(6) Resolution 42 (Cg-17) – Amendments to the *Manual on the Global Observing System* (WMO-No. 544), Volume II, Regional Aspects – The Antarctic,

(7) Resolution 48 (Cg-17) – Global Integrated Polar Prediction System,

(8) Resolution 49 (Cg-17) – Year of Polar Prediction,

(9) Resolution 57 (Cg-17) – Participation of WMO in the International Polar Partnership Initiative,

(10) Resolution 59 (Cg-17) – Gender equality and empowerment of women,

(11) Resolution 3 (EC-67) – Executive Council Panel of Experts on Polar and High-mountain Observations, Research and Services,

(12) Decision 52 (EC-68) – Polar Regional Climate Centres,

(13) Decision 53 (EC-68) – Year of Polar Prediction,

(14) The report of the seventh session of Executive Council Panel of Experts on Polar and High-mountain Observations, Research and Services (EC-PHORS) (Ushuaia, Argentina, 21–24 March 2017),

(15) That EC-PHORS has expressed the willingness to strengthen its relationship with the Association of Polar Early Career Scientists (APECS) as a means to engaging the next generation of scientists in the work of the Panel,

Considering:

(1) That the polar regions, the "Third Pole", and other high mountain areas are extremely important in terms of their impacts on weather, climate and water, and the functioning of the Earth system,

(2) That the cryosphere, which encompasses approximately 100 countries, the Arctic Ocean and the Antarctic, is an integrative element within the climate system and provides one of the most useful indicators of climate change, yet it is arguably the most undersampled domain in the climate system,

(3) That the polar regions are experiencing an increase in human presence and activities, requiring new or enhanced services linked to weather, climate, water and related environmental matters,

(4) That there are concerns about amplification of climate change at higher latitudes, combined with an increasing interest in polar regions by many governments, which call for a better understanding of weather, climate, water and related environmental variability and change in order to improve our ability to make reliable quantitative predictions across the range of timescales,

(5) That there is increasing evidence that cryosphere-related feedbacks in the amplification of climate change cause impacts on weather, climate and water globally,

(6) That there remain key gaps in scientific understanding of processes and interactions in polar regions, including boundary layer behaviour, polar clouds and precipitation, sea ice/ocean dynamics, hydrology, permafrost and ice sheet dynamics, and the functioning of the Earth system,

(7) That there is a continuing need for:

(a) Weather, climate, hydrological and related environmental data from the polar regions, including enhancement and development of instruments and methods of observation suited to these areas,

(b) The full implementation of World Weather Watch and the Global Framework for Climate Services. For the full realization of the value of research, monitoring and prediction in the fields of hydrology, climate change, atmospheric composition and the ozone layer over the polar regions, observational networks in these regions need to be closely coordinated with the implementation of the WMO Integrated Global Observing System (WIGOS) and designed to improve in the most efficient way the capability of Members to provide a widening range of operational services and better serve research programme requirements,

(8) That there is an ongoing need to formalize WMO responsibilities for the Antarctic as a region not covered by any of the regional associations, and the establishment and maintenance of an Antarctic Observing Network (AntON) of surface and upper-air stations to meet the requirements of Members is among the most important obligations of Members under Article 2 of the WMO Convention,

(9) That the density of the current Antarctic observing network of surface and upper-air stations is much less than that needed to properly characterize Antarctic weather and climate,

(10) That cryospheric operational and research observing networks, including AntON, should be integrated within the framework of WIGOS and the WMO Information System (WIS) and enhanced to include cryosphere-related variables according to the Global Cryosphere Watch (GCW) Implementation Plan,

(11) That Seventeenth World Meteorological Congress decided to continue the decadal endeavour towards a Global Integrated Polar Prediction System (GIPPS), as an International Polar Year legacy to benefit the global community,

(12) That Seventeenth Congress decided to implement GCW during the next financial period as one of the major efforts of WMO with the goal that GCW should become operational,

(13) That high-mountain activities will be part of the development and implementation of GCW,

(14) That initiatives other than the International Polar Partnership Initiative (IPPI) already bring polar science together, such as the Arctic Monitoring and Assessment Programme under the Arctic Council; Sustaining Arctic Observing Networks; the Arctic Science Summit Week; and the Arctic Observing Summit in which WMO is engaged,

(15) That the Year of Polar Prediction (YOPP) is a good example of an international initiative which is bringing community together,

(16) That it is important to assess the socioeconomic benefits of WMO polar and high-mountain region activities,

Recognizing:

(1) That WMO has received a status of observer at the Arctic Council,

(2) That the Arctic Council at its Tenth Ministerial Meeting (Fairbanks, Alaska, United States, 11 May 2017) approved the "Agreement on enhancing international Arctic scientific co-operation" based on recommendations developed in the IPPI framework,

(3) That the polar science community represented at the seventh session of EC-PHORS did not consider that there was a strong need for an international mechanism such as the IPPI, and that the nominated chairpersons and organizations involved in IPPI are no longer active,

(4) That EC-PHORS at its seventh session recognized the need to improve the gender balance in EC-PHORS and GCW,

Decides:

(1) To establish the Executive Council Panel of Experts on Polar and High-mountain Observations, Research and Services;

(2) That the Panel shall be composed of members nominated by the Permanent Representatives of Members, including Parties to the Antarctic Treaty, and participants from other organizations that have active meteorological, hydrological, oceanographic or cryospheric programmes, in particular in the polar regions;

(3) That observers from other groups may be invited to attend meetings of the Panel;

(4) That the Panel, within its terms of reference, shall make recommendations to the Executive Council on AntON and applicable standard practices, especially updates of the relevant parts of the *Manual on the Global Observing System*, the *Manual on the Global*

Telecommunication System (WMO-No. 386) and the *Manual on the Global Data processing and Forecasting System* (WMO-No. 485), as well as other relevant Manuals and Guides, such as those on WIS, WIGOS and services to users in the polar regions;

(5) That the Panel shall continue advancing the following five key initiatives under the WMO polar and high-mountain regions priority activity: (a) AntON; (b) the polar Regional Climate Centres and polar Regional Outlook Forums; (c) GCW; (d) high-mountain region activities; and (e) GIPPS, including the Polar Prediction Project, and YOPP, and the World Climate Research Programme Polar Climate Predictability Initiative under the Climate and Cryosphere project;

(6) That the Panel shall compile and maintain information on the socioeconomic benefits and cost–benefit aspects of WMO polar and high-mountain region activities in particular by attracting expertise in this field, and engaging and aligning with existing mechanisms, such as the Societal and Economic Research and Applications subcommittee of the Polar Prediction Project;

(7) That the Panel explores mechanisms to actively engage young scientists in the delivery of results, including in collaboration with APECS;

(8) That the Panel will undertake:

For polar regions:

(a) To develop and promote an integrated approach to understanding the global impact of changes in polar regions so that the required services may be provided to users and governments may be advised on aspects of adaptation;

(b) To ensure that operational and research observing networks in polar regions (including AntON) are integrated within the framework of WIGOS and WIS and are enhanced to include cryosphere-related variables;

(c) To engage in a concerted effort to involve Members, technical commissions and regional associations, as well as relevant research and international organizations and bodies, in improving predictive capability in polar regions on timescales from hours to centuries;

(d) To coordinate WMO interests with other international organizations focused on polar science and observations, and to work collaboratively as appropriate;

(e) Where other initiatives are identified as aligned with the WMO goals, to engage and assess their validity and make recommendations to the Executive Council for further consideration;

(f) To oversee and guide the development and implementation of GCW in collaboration with technical commissions, regional associations and relevant WMO and international programmes, organizations, institutions and bodies;

(g) To oversee and guide the Polar Space Task Group, which provides coordination across space agencies to facilitate acquisition and distribution of fundamental satellite datasets, and to contribute to or support development of specific derived products for cryospheric scientific research and applications;

(h) To guide the development of GIPPS in collaboration with technical commissions, regional associations and relevant international programmes, organizations and bodies;

(i) To provide WMO participation in the implementation of the Arctic Council Agreement on enhancing international Arctic scientific cooperation;

(j) To facilitate the acquisition, exchange and archiving of observational data from polar regions in compliance with WIGOS requirements related to instruments, data exchange and the WMO Quality Management Framework to underpin the provision of services required for the polar regions;

(k) To provide a forum for discussion of relevant scientific issues and make recommendations on meteorological, hydrological, oceanographic and cryospheric research and operations related to the polar regions;

(l) To provide regular input on issues related to polar meteorology, hydrology, oceanography and the cryosphere to support the activities of relevant groups or bodies, such as the World Climate Programme, which includes the Global Climate Observing System (GCOS), the World Climate Research Programme and the World Climate Services Programme; Global Atmosphere Watch; the World Weather Research Programme; the Global Framework for Climate Services; and technical commissions, regional associations and programmes;

(m) To ensure close collaboration with and contribute to other international organizations, committees and programmes concerned, such as the Antarctic Treaty Consultative Meeting, the Arctic Council, the Scientific Committee on Antarctic Research, the International Arctic Science Committee, the International Association of Cryospheric Sciences and other relevant associations of the International Union of Geodesy and Geophysics, the Council of Managers of National Antarctic Programmes, the Forum of Arctic Research Operators, the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization (UNESCO), and the International Hydrological Programme of UNESCO;

For the Antarctic:

The Panel should cooperate, as appropriate, with other relevant international and regional entities:

(a) To promote the implementation of the resolutions of Congress and the Executive Council in the area from 60ºS to 90ºS;

(b) To coordinate programmes of surface and upper-air meteorological observations in the Antarctic, working with relevant international scientific organizations, and liaise with regional associations in relation to sub-Antarctic observations;

(c) To coordinate the design of AntON, comprising surface and upper-air stations, including the GCOS Surface Network, GCOS Upper-air Network, Global Atmosphere Watch and other relevant observing components;

(d) To coordinate standardization of observing, coding, data exchange and data management practices applied to the Antarctic;

(e) To propose recommendations to the Antarctic Treaty System;

For the Arctic:

(a) While appropriate functions are covered by the respective regional associations, the Panel may liaise with them in defining components of Arctic observing systems and services;

(b) To guide, in collaboration with the Commission for Hydrology, the further development of the Arctic Hydrological Cycle Observing System project;

For the high-mountain regions:

To contribute to the work of regional associations, technical commissions and programmes in defining appropriate components of hydrometeorological and cryospheric observing systems and services in high mountain regions;

Authorizes the Panel to establish subgroups and task teams as and when required, including in particular an Antarctic Task Team, a High-mountain Task Team, a Polar Space Task Group, a GCW Steering Group, and GCW teams;

Invites Members to take into account the importance of the gender balance policy with regard to nominating experts in EC-PHORS and GCW working structures;

Requests the Secretary-General:

(1) To maintain the membership of the Panel in accordance with the relevant General Regulations in consultation with the co-chairpersons and Members concerned;

(2) To formally invite the Arctic Council Arctic Monitoring and Assessment Programme, the International Arctic Science Committee and the Scientific Committee on Antarctic Research to participate in the Panel as members;

(3) To provide the necessary support to activities and sessions of the Panel, including the GCW working structure, and liaise with relevant international organizations, programmes and bodies.

———————

Note: This resolution replaces Resolution 3 (EC-67), which is no longer in force.

Resolution 17 (EC-69)

SEAMLESS DATA-PROCESSING AND FORECASTING SYSTEM

THE EXECUTIVE COUNCIL,

Recalling:

(1) Resolution 11 (Cg-17) – Towards a future enhanced integrated and seamless Data-processing and Forecasting System, which:

(a) Decides to initiate a process for the gradual establishment of an enhanced integrated and seamless WMO Data-processing and Forecasting System, in light of the conclusions of the first World Weather Open Science Conference (Montreal, Canada, August 2014),

(b) Requests the Executive Council to formulate the terms of reference for this process, and a description of the set of products the system should produce for consideration by Eighteenth World Meteorological Congress,

(2) Decision 55 (EC-68) – Implementation of the Seamless Data-processing and Forecasting System, which endorses the Vision for the Seamless Data-processing and Forecasting System (DPFS) and establishes a Steering Group on the Seamless Data-processing and Forecasting System, with the main task of developing and proposing the implementation plan for consideration by the Executive Council at its sixty-ninth session,

Noting:

(1) Relevant decisions, resolutions and recommendations of the Commission for Basic Systems (CBS) at its sixteenth session contained in the *Abridged Final Report with Resolutions, Decisions and Recommendations of the Sixteenth Session of the Commission for Basic Systems* (WMO-No. 1183),

(2) Decision 27 (CBS-16) – Implementation Plan of the future seamless Data-processing and Forecasting System,

(3) Recommendation 37 (CBS-16) – Resources for the implementation of the seamless Data-processing and Forecasting System,

(4) Recommendation 38 (CBS-16) – Steering Group on the Seamless Data-processing and Forecasting System – areas for consideration,

(5) Recommendation 43 (CBS-16) – Continuance of the work of the Executive Council Steering Group on the Seamless Data-processing and Forecasting System,

(6) That several developing countries are running numerical weather prediction models without data assimilation to improve model outputs,

Recognizing that although substantial progress has been made by the Steering Group on Seamless Data-processing and Forecasting in developing the concept for the seamless DPFS, there is a significant amount of work remaining to develop an implementation plan,

Requests that the upcoming Commission for Atmospheric Sciences (CAS) Science Summit (20–22 October) and seventeenth session of CAS (23–24 October) be used as a platform for interaction between CBS, CAS, representatives of other technical commissions and regional associations so as to define the scientific progress needed to realize the future seamless DPFS;

Requests the Secretary-General, in collaboration with technical commissions and Members, to consider organizing an Earth System Symposium, if financially feasible, to share the latest developments in data-processing, predictions and services in support of future seamless DPFS implementation;

Requests the presidents of CBS and CAS to report to the next Meeting of the Presidents of the Technical Commissions and Regional Associations on the progress made in defining the implementation plan;

Requests the CBS to facilitate capacity development in data assimilation for developing countries running numerical weather prediction models to improve the quality of their forecast products;

Requests technical commissions and regional associations to provide their full support to this initiative;

Calls upon advanced Global DPFS (GDPFS) Centres to assist with assessment of proof of concept of the seamless DPFS;

Identifies seamless DPFS as one of the strategic objectives for the next financial period 2020–2023 to be highlighted in the WMO Strategic Plan in view of its importance to future WMO services;

Agrees to define the role of GDPFS at national level, including research on how to define impacts, what information needs to be stored and how it is to be verified, how to calculate impact, how to store the information on impacts if it is retained, and how non-conventional information (such as exposure and vulnerability data) should be brought into GDPFS;

Agrees also that the work related to impact-based forecasting is reflected in the seamless DPFS solution;

Decides that the designation criteria of partner systems related to GDPFS should be included in the *Manual on the Global Data-processing and Forecasting System* (WMO-No. 485), or the inclusion of references and links to the relevant partner manuals;

Decides also that the Executive Council Steering Group on the Seamless Data-processing and Forecasting System will:

(1) Continue to coordinate collaboration between constituent bodies to create the documentation requested in Resolution 11 (Cg-17), namely:

  (a) A description of the set of products to be generated by the integrated and seamless DPFS;

  (b) A report on the integrated and seamless DPFS for consideration at the Eighteenth World Meteorological Congress;

(2) Be chaired jointly by the presidents of CBS and CAS;

Requests the Steering Group on the Seamless Data-processing and Forecasting System to develop a detailed implementation plan, in alignment with the existing ongoing development of the WMO Information System and the WMO Integrated Global Observing System through consultations with regional associations and technical commissions, for consideration by the Executive Council at its seventieth session;

Requests the Secretary-General to make the appropriate arrangements for the establishment of the Trust Fund for the Implementation of the Seamless Data-processing and Forecasting System.

Resolution 18 (EC-69)

REVISED *MANUAL ON THE GLOBAL DATA-PROCESSING AND FORECASTING SYSTEM* (WMO-No. 485)

THE EXECUTIVE COUNCIL,

Considering the *Manual on the Global Data-processing and Forecasting System* (WMO-No. 485),

Recalling Resolution 12 (Cg-17) – Report of the extraordinary session (2014) of the Commission for Basic Systems concerning the introduction of the new *Manual on the Global Data-processing and Forecasting System* (WMO-No. 485),

Noting:

(1) That decisions, resolutions and recommendations of the Commission for Basic Systems (CBS) at its sixteenth session are contained in the *Abridged Final Report with Resolutions, Decisions and Recommendations of the Sixteenth Session of the* Commission for Basic Systems (WMO-No. 1183),

(2) Decision 11 (CBS-16) – Designation of Global Data-processing and Forecasting System Centres against the new criteria/functions and their inclusion in the revised *Manual on the Global Data-processing and Forecasting System* (WMO-No. 485),

Having considered:

(1) Recommendation 19 (CBS-16) – Revised *Manual on the Global Data-processing and Forecasting System* (WMO-No. 485),

(2) Recommendation 20 (CBS-16) – Introduction of new types of centre into the revised *Manual on the Global Data-processing and Forecasting System* (WMO-No. 485),

(3) Recommendation 21 (CBS-16) – Mapping of existing Global Data-processing and Forecasting System Centres onto the corresponding designations described in the revised *Manual on the Global Data-processing and Forecasting System* (WMO-No. 485),

(4) Recommendation 22 (CBS-16) – Designation of new Global Data-processing and Forecasting System Centres against the existing criteria/functions and their inclusion in the revised *Manual on the Global Data-processing and Forecasting System* (WMO-No. 485),

(5) Recommendation 23 (CBS-16) – Proposed amendment to the WMO *Technical Regulations* (WMO-No. 49), Volume I on data-processing and forecasting aspects,

(6) Recommendation 24 (CBS-16) – Impact of the revised *Manual on the Global Data-processing and Forecasting System* (WMO-No. 485) on other WMO Manuals and Guides,

Noting also that the revised *Manual on the Global Data-processing and Forecasting System* includes functional requirements for Global Data-processing and Forecasting System (GDPFS) Centres,

Noting further that with the improved capability of some Members' National Meteorological and Hydrological Services and their enhanced capability in serving other Members, more and more Members are seeking designation as a Regional Specialized Meteorological Centre,

Recalling also the standard procedure for amending WMO Manuals that are the responsibility of CBS, as defined in the General Provisions,

Having examined the additional recommendation by the presidents of CBS and the Commission for Aeronautical Meteorology to amend the text related to volcanic contaminants and non-nuclear emergency response activities in the revised *Manual on the Global Data-processing and Forecasting System*, endorsed by CBS at its sixteenth session, to improve clarity of the guidance and to eliminate any ambiguity with respect to volcanic ash-related services provided to aviation under the International Civil Aviation Organization arrangements (see Annex 1 to the present resolution),

Having also examined the additional recommendation by the presidents of CBS and the Commission for Climatology for amending the text related to annual to decadal climate prediction in the revised *Manual on the Global Data-processing and Forecasting System*, endorsed by CBS at its sixteenth session (see Annex 2 to the present resolution), which is in line with the standard procedure for amending WMO Manuals. This would improve clarity of the services to be provided by the Lead Centre and the contributing centres for annual to decadal climate prediction,

Acknowledging the interest of some Members to have their centres designated as part of the Global Data-processing and Forecasting System and presented at the sixteenth session of CBS, as listed in the annex to Decision 11 (CBS-16),

Decides on each of the above recommendations as follows:

(1) Adopts the revised *Manual on the Global Data-processing and Forecasting System*, as provided in the annex to Recommendation 19 (CBS-16), with the amendment given in Annex 1 to the present resolution concerning volcanic contaminants, to take effect as per Resolution 12 (Cg-XII) and Regulation 127 of the General Regulations (2015 edition);

(2) Approves the introduction of new types of centres into the revised *Manual on the Global Data-processing and Forecasting System* in line with Resolution 12 (Cg-17), as provided in the annexes to Recommendation 20 (CBS-16), to take effect as per Resolution 12 (Cg-XII) and Regulation 127 of the General Regulations (2015 edition);

(3) Endorses Recommendation 21 (CBS-16) that proposes:

(a) That WMO Members currently hosting a World Meteorological Centre, a Regional Specialized Meteorological Centre (RSMC) with activity specialization and/or a Lead Centre that have confirmed the mapping of their centres onto the corresponding types of centre described in the revised *Manual on the Global Data-processing and Forecasting System*, complete the process to demonstrate compliance and retain their status according to the new designations;

(b) That the denomination of RSMC with geographical specialization be maintained until the Eighteenth World Meteorological Congress in 2019, and that the RSMCs with geographical specialization that have not confirmed the mapping of their centres retain that status until then;

(4) Approves Recommendation 22 (CBS-16) for the formal designation:

(a) For RSMC for Atmospheric Sand and Dust Storm Forecasts (ASDF):

(i) RSMC-ASDF Beijing (Regional Association (RA) II);

(b) For Regional Climate Centre (RCC):

(i) RCC Intergovernmental Authority on Development (IGAD) hosted by the IGAD Climate Prediction and Applications Centre (RA I);

(ii) RCC-Network Northern Africa (RA I);

(iii) RCC Pune (RA II);

(iv) RCC-Network Southern South America (RA III);

(v) RCC Caribbean hosted by the Caribbean Institute for Meteorology and Hydrology (RA IV);

(c) For global numerical long-range prediction (known as Global Producing Centre for Long-range Forecasts (GPCLRF)):

(i) GPCLRF Offenbach;

and their respective inclusion in Part III of the revised *Manual on the Global Data-processing and Forecasting System*;

(5) Adopts the proposed amendment to the WMO *Technical Regulations* (WMO-No. 49), Volume I, as provided in the annex to Recommendation 23 (CBS-16), which ensures the necessary alignment with the revised *Manual on the Global Data-processing and Forecasting System*;

(6) Adopts the proposed amendments to the *Manual on the Global Observing System* (WMO-No. 544), *Manual on Codes* (WMO-No. 306), *Manual on the WMO Integrated Global Observing System* (WMO-No. 1160), and *Manual on the WMO Information System* (WMO-No. 1060), as provided in Annexes 1–4 to Recommendation 24 (CBS-16);

Agrees that a new application for designation of an RSMC that has the potential to change regional operations of the existing RSMC(s) be fully coordinated with and supported by Member(s) hosting the RSMC(s), before its designation process is initiated;

Agrees also, however, that such coordination should not be regarded as a precondition for the application of a new RSMC and also not a part to the procedure for designation of an RSMC;

Authorizes the Secretary-General, in consultation with the president of CBS, to make any editorial amendments to the revised *Manual on the Global Data-processing and Forecasting System*;

Notes with appreciation the significant progress that has been made towards the completion of the designation process by interested Members, as defined in the revised *Manual on the Global Data-processing and Forecasting System*;

Endorses the formal designation of centres hosted by Members that have completed the designation process by the time of the sixty-ninth session of the Executive Council, as given in Annex 3 to the present resolution;

Requests the president of CBS to review the terminology related to long-range, seasonal and near-term climate prediction, ensuring their alignment with the definitions of meteorological forecasting ranges described in the *Manual on the Global Data-processing and Forecasting System*;

Requests CBS:

(1) To revise the *Guide on the Global Data-processing System* (WMO-No. 305) to ensure the necessary alignment with and provide further guidance to Members for the implementation of the revised *Manual on the Global Data-processing and Forecasting System*;

(2) To develop performance requirements for monitoring GDPFS Centres for inclusion in the *Manual on the Global Data-processing and Forecasting System* and the *Guide on the Global Data-processing System*;

Requests the Secretary-General and CBS to arrange for and maintain a rolling review of GDPFS Centres.

Annex 1 to Resolution 18 (EC-69)

PROPOSED AMENDMENT TO THE REVISED *MANUAL ON THE GLOBAL DATA-PROCESSING AND FORECASTING SYSTEM* (WMO-No. 485) CONCERNING VOLCANO WATCH SERVICES FOR INTERNATIONAL AIR NAVIGATION

~~VOLCANIC CONTAMINANTS~~VOLCANO WATCH SERVICES FOR INTERNATIONAL AIR NAVIGATION

2.2.2.X. ~~Volcanic contaminants~~Volcano watch services for international air navigation

Note~~s~~:

~~(1) For~~ Volcanic ash advisory centres which provide services in support of international air navigation~~,~~ are designated by the International Civil Aviation Organization (ICAO). This designation is consulted with WMO. Service provision arrangements in this respect and those for volcano observatories are described in WMO *Technical Regulations* (WMO-No. 49), Volume II, sections 3.5 and 3.6 ~~refer~~ respectively.

~~(2) For all other services, non-nuclear environmental emergency response refers.~~

NON-NUCLEAR ENVIRONMENTAL EMERGENCY RESPONSE

2.2.2.X. Non-nuclear environmental emergency response

2.2.2.X.1 Centres conducting non-nuclear emergency response shall:

(a) Prepare on request, from an authorized person[1], atmospheric transport and dispersion forecast or hindcast products relating to events in which hazardous non-nuclear contaminants have been released into the atmosphere. The criteria for activation of the regional support procedures and the Request Form are given in Appendices 6 and 10;

[...]

APPENDIX 6. ACTIVATION OF SUPPORT FOR NON-NUCLEAR ENVIRONMENTAL EMERGENCY RESPONSE

Environmental emergencies can be caused by a broad range of events with various temporal and spatial scales involving the release of hazardous substances into the environment. The scope of non-nuclear ERA includes: smoke from large fires, emissions from volcanic eruptions (excluding those service arrangements covered by 2.2.2.x – Volcano watch services for international air navigation), and large chemical releases. ~~Volcanic ash activities are not covered here, but are instead covered under activity 2.2.2.X.~~ Atmospheric sand and dust storm forecasts are covered under activity 2.2.2.5.

[…]

[1] The person authorized by the Permanent Representative of the WMO Member to request RSMC support; normally the NMHS operational contact point.

Annex 2 to Resolution 18 (EC-69)

PROPOSED AMENDMENT TO THE REVISED *MANUAL ON THE GLOBAL DATA-PROCESSING AND FORECASTING SYSTEM* (WMO-No. 485) CONCERNING ANNUAL TO DECADAL CLIMATE PREDICTION

Designation criteria for LC-ADCP *[amendment]*

2.2.2.X. Coordination of ~~near-term~~ annual to decadal climate prediction

2.2.2.X.1 Centres conducting coordination of ~~near-term climate~~annual to decadal climate prediction (known as Lead Centres for ~~near-term climate~~annual to decadal climate prediction (LC-~~NTC~~ADCP)) shall:

(a) Select a group of modelling centres to contribute to the LC-~~NTCP~~ ADCP (the "contributing centres") that meet the GPC-ADCP designation criteria and the approval by IPET-OPSLS; ~~with systems and outputs that meet published criteria set by the LC-NTCP and coordinate regular contributions of real-time predictions and related data. M~~manage changes in the membership of the group, as and when they occur, to maintain sufficient contributions;

(b) Maintain a list of the active contributing centres and the specification of their prediction systems;

[...]

Designation criteria for GPC-ADCP *[additional text]*

2.2.1.X.1 Centres conducting annual to decadal climate prediction (ADCP) (known as Global Producing Centres for Annual to Decadal Climate Prediction (GPCs-ADCP)) shall:

(a) Prepare, with at least annual frequency, global forecast fields of parameters relevant to annual to decadal climate prediction;

(b) Prepare verification statistics as defined in Appendix 13;

(c) Provide an agreed set of forecast and hindcast variables (as per Appendices 12 and 13) to the Lead Centre for Annual to Decadal Climate Prediction (LC-ADCP);

(d) Make available on a website up-to-date information on the characteristics of its global decadal prediction system.

Notes:

1. Non-designated centres with capacity to provide the minimum requirement may also contribute ADCP to the LC-ADCP;

2. Centres who wish to make available their products worldwide, may use the WIS as the a dissemination platform;

3. The bodies in charge of managing the information contained in the *Manual* related to coordination of annual to decadal climate prediction are specified in the Table below.

RESPONSIBILITY			
CHANGES TO ACTIVITY SPECIFICATION			
To be proposed by:	CBS-CCl/IPET-OPSLS		
To be approved by:	CBS	CCl	
To be decided by:	EC/Congress		
CENTRES DESIGNATION			
To be approved by:	CBS		
To be decided by:	EC/Congress		
COMPLIANCE			
To be monitored by:	CBS-CCl/IPET-OPSLS		
To be reported to:	CBS/ICT-DPFS	CBS	

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Annex 3 to Resolution 18 (EC-69)

LIST OF CENTRES HOSTED BY MEMBERS THAT HAVE COMPLETED THE DESIGNATION PROCESS AND THAT ARE ENDORSED BY THE EXECUTIVE COUNCIL AT ITS SIXTY-NINTH SESSION FOR FORMAL DESIGNATION AND INCLUSION INTO THE *MANUAL ON THE GLOBAL DATA-PROCESSING AND FORECASTING SYSTEM* (WMO-No. 485), PART III

World Meteorological Centres (WMCs)

WMC Beijing

WMC Exeter

WMC ECMWF

WMC Montreal

WMC Tokyo

Regional Specialized Meteorological Centres (RSMCs) for Limited-area Deterministic Weather Prediction

RSMC Khabarovsk

RSMC Moscow

RSMC Novosibirsk

RSMC Offenbach

RSMC Pretoria

RSMC Rome

Regional Specialized Meteorological Centres (RSMCs) for Limited-area Ensemble Numerical Prediction

RSMC Offenbach

RSMC Rome

Regional Specialized Meteorological Centres (RSMCs) for Nowcasting

RSMC Offenbach

RSMC Tokyo

Regional Specialized Meteorological Centres (RSMCs) for Volcano Watch Services for International Air Navigation

RSMC Tokyo

Lead Centre for Coordination of Annual to Decadal Climate Prediction (LC-ADCP)

LC-ADCP Exeter

Resolution 19 (EC-69)

WMO QUALITY POLICY STATEMENT

THE EXECUTIVE COUNCIL,

Recalling:

(1) Resolution 7 (Cg-17) – WMO Quality Management Framework,

(2) Decision 76 (EC-68) – WMO Quality Management Framework – Organization-wide approach,

Noting with satisfaction the follow-up actions for developing further the WMO Quality Management Framework as outlined in the annex to Decision 76 (EC-68),

Considering the need to update the WMO quality policy statement adopted with Resolution 32 (Cg-XV) – WMO Quality Management Framework, to reflect the evolving requirements and nature of the Framework,

Recognizing that the quality assurance, reliability and consistency of the information and services delivered to users become key success factors in view of the growing competition in the provision of meteorological, hydrological and climatological services,

Adopts the updated WMO quality policy statement as presented in the annex to the present resolution;

Requests the Secretary-General to inform Members through a circular letter of the adoption of the updated WMO quality policy statement to enable its application in the Members' Quality Management Frameworks;

Invites the presidents of regional associations and the presidents of technical commissions to promote the WMO quality policy statement as a guiding statement in their activities.

Annex to Resolution 19 (EC-69)

WMO QUALITY MANAGEMENT FRAMEWORK

POLICY STATEMENT

WMO, through its Programmes and activities, is dedicated to ensuring the highest possible quality of all meteorological, climatological, hydrological, marine and related environmental data, products and services, in particular, those supporting the protection of life and property, safety on land, at sea and in the air, sustainable economic development and protection of the environment.

To achieve this goal, WMO is committed to the adoption and implementation of an Organization-wide quality management approach, associated with meeting the WMO main objectives and strategic priorities.

The quality management approach provides WMO Members' National Meteorological and Hydrological Services (NMHSs) and other relevant stakeholders with a framework to assist in:

(a) Understanding their purpose and the context in which they operate both nationally and internationally;

(b) Planning and instigating their strategic direction;

(c) Identifying and providing the appropriate resources to achieve planned objectives;

(d) Achieving the consistent delivery of high quality products and services;

(e) Evaluating and reviewing organizational practices, procedures and processes to drive continual improvement.

This WMO Quality Policy is underpinned by relevant WMO regulatory and guidance material and sustained through compliance with national and international regulatory requirements and the practical application of the principles of quality management[1]:

(a) Customer focus;

(b) Leadership;

(c) Engagement of people;

(d) Process approach;

(e) Improvement;

(f) Evidence-based decision-making;

(g) Relationship management.

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[1] As specified by ISO 9001:2015 Quality management systems – Requirements, sub para 0.2.

Resolution 20 (EC-69)

AMENDMENT TO *TECHNICAL REGULATIONS* (WMO-No. 49), VOLUME I – GENERAL METEOROLOGICAL STANDARDS AND RECOMMENDED PRACTICES (QUALITY MANAGEMENT PROVISIONS)

THE EXECUTIVE COUNCIL,

Recalling:

(1) Resolution 7 (Cg-17) – WMO Quality Management Framework,

(2) Decision 76 (EC-68) – WMO Quality Management Framework – Organization-wide approach,

Noting with satisfaction the follow-up actions for developing further the WMO Quality Management Framework as outlined in the annex to Decision 76 (EC-68),

Considering the need to enhance the WMO regulatory and guidance material on quality management in line with existing requirements and strategic directions, such as the WMO Strategy for Service Delivery,

Endorses the proposed amendment to the WMO *Technical Regulations* (WMO-No. 49), Volume I – General Meteorological Standards and Recommended Practices, by introducing a new Chapter 7, Quality Management, as presented in the annex to the present resolution, to replace the current *Technical Regulations*, Volume IV – Quality Management;

Requests the Secretary-General to circulate the amendment to all Members for consultation and comments within 60 days;

Authorizes the President, upon completion of the consultation with Members, to approve the amendment on behalf of the Executive Council;

Requests further the Secretary-General:

(1) To publish the approved amendment with the next update of the *Technical Regulations*, Volume I – General Meteorological Standards and Recommended Practices;

(2) To continue providing support to regional and national capacity development actions aimed at enhancing the overall Quality Management Framework of WMO;

Invites the presidents of technical commissions to align relevant provisions of the Technical Regulations and related guidance material within their respective areas of responsibility and expeditiously prepare subsequent amendments as necessary;

Urges Members to consider timely implementation of the new provisions aimed at enhancing the quality management practices and procedures, taking into consideration relevant national requirements and normative frameworks.

Annex to Resolution 20 (EC-69)

PROPOSED AMENDMENT TO *TECHNICAL REGULATIONS* (WMO-No. 49), VOLUME I – GENERAL METEOROLOGICAL STANDARDS AND RECOMMENDED PRACTICES

DEFINITIONS

Note: include new text in the Definitions section of WMO Technical Regulations, Volume I, in alphabetical order

…

Certification of compliance. Certification is achieved through audit by an accredited external (third party), conformity assessment body.

Customer (in QMS context). Within WMO "clients" and "customers" are generally referred to as "users". However, the ISO family of Standards exclusively uses the term customers.

Organization. Person or group of people that has its own functions with responsibilities, authorities and relationships to achieve its objectives.

Products and services. For the purposes of the ISO 9000 family of Standards, any reference to products also includes services.

Quality. ISO defines quality as "the degree to which a set of inherent characteristics fulfils requirements".

Note: There are many definitions and interpretations of quality however, all have one element in common - the perception of the extent to which a product or service meets the customer's expectations. It should be noted that quality has no explicit meaning, unless it is related to a specific set of requirements.

Quality assurance (QA). Activities undertaken to instil confidence that quality requirements have been met. It involves the systematic monitoring and evaluation of the processes associated with the generation of a product or service.

Quality control (QC). Activities undertaken to ensure that quality requirements have been fulfilled prior to the dissemination of a product or the delivery of a service.

Quality management (QM). A process that focuses not only on the quality of the product but also on the means to achieve it and is centred on the following four activities: quality planning, quality control, quality assurance and quality improvement.

Quality management system (QMS). The organizational structure, procedures, processes and resources needed to ensure the delivery of an organization's products and services.

Validation (in QMS context). Validation in quality management terms focuses on the product or services provided post their delivery. That is, the provider validates that the product or service met the identified needs of the customer.

Verification (in QMS context). In general verification is considered by WMO Members as a post-delivery activity. However, in quality management terms a product is verified prior to delivery. That is, it meets all the specified requirements for that product or service in terms of content.

Note: The quality management system (QMS) terminology, vocabulary and definitions used within this Technical Regulation are those of the International Organization for Standardization (ISO) and, in particular, *ISO 9000:2015, Quality management systems – Fundamentals and vocabulary.* They are also from the *Guide to the Implementation of Quality Management Systems in the provision of meteorological, hydrological and climatological services within an ISO 9001:2015 Framework* (WMO–No. 1100 ed. 2017).

…

Note: include new Part 7 in WMO Technical Regulations, Volume I

PART VII. QUALITY MANAGEMENT

1. QUALITY MANAGEMENT

Note: Detailed guidance is provided in the *Guide to the Implementation of Quality Management Systems in the provision of meteorological, hydrological and climatological services within an ISO 9001:2015 Framework* (WMO–No. 1100 ed. 2017).

1.1General

1.1.1 Members should ensure that their organizations responsible for the provision of meteorological, hydrological, climatological or other environmental services establish and implement a properly organized quality management system (QMS), comprising procedures, processes and resources necessary to provide for the quality management of the information and services to be delivered to users.

Note: Additional requirements for quality management in the provision of meteorological services to international air navigation are given in WMO *Technical Regulations* (WMO-No. 49), Volume II, Meteorological service for international air navigation.

1.2 WMO international centres and facilities

1.2.1 Members undertaking to host global and/or regional centres and/or facilities on behalf of WMO Programmes should establish and implement a QMS which covers the entire scope of services for which the centre and/or facility has been designated.

1.3 Establishing a Quality Management System

1.3.1 The QMS established in accordance with 7.1.1 should:

(a) Demonstrate the commitment of the organization’s leadership to a quality management approach to the delivery of its products and services;

(b) Clearly identify the organization’s role within the environment (nationally and internationally), in which it operates;

(c) Establish a quality policy that:

  i. supports the organization’s strategic direction and objectives;

  ii. commits to meeting stakeholders needs; and

  iii. promotes continual improvement;

(d) Clearly articulate roles and responsibilities within the organization;

(e) Adopt a risk-based approach to their activities;

(f) Have plans and associated objectives and performance indicators;

(g) Be appropriately resourced to ensure the viability and long-term sustainability of the QMS;

(h) Ensure all staff are competent to undertake their roles and as appropriate, implement specific competence frameworks;

(i) Adhere to internationally recognized document control procedures and practices;

(j) Have a strong customer focus through effective communications and sound planning practices to meet the identified needs of customers;

(k) Establish verification and validation activities to ensure the outputs meet customer/user identified needs;

(l) Monitor, measure, analyse and evaluate the QMS through a rigorous audit schedule and regular reviews by management; and

(m) Promote a culture within the organization of continual improvement.

1.3.2 The QMS established in accordance with 7.1.1 should provide customers with assurance that the products and services provided, comply with the stated requirements in terms of geographical and spatial coverage, format and content, time and frequency of issuance and period of validity, as well as the accuracy of measurements, observations and forecasts.

Note: Such requirements are normally included in relevant service level agreements, contracts or other forms of establishing provider/customer relationship.

1.4Recognition of compliance of a Quality Management System

1.4.1 A QMS established in accordance with 7.1.1 should be in conformity with the current International Organization for Standardization *(ISO) 9001 Quality management systems – Requirements (ISO 9001)* Standard.

Note: The *ISO 9001 Quality management systems – Requirements* Standard provides an internationally recognized framework for a QMS.

1.4.2 Demonstration of compliance of the quality system applied should be by audit. All audits should be performed by qualified quality management auditors and appropriately documented and retained. If nonconformities are identified during audit, remedial action should be initiated to determine and correct the cause.

Note: Guidance on the methodology and procedures for internal and external audits to be conducted is provided in the *Guide to the Implementation of Quality Management Systems in the provision of meteorological, hydrological and climatological services within an ISO 9001:2015 Framework* (WMO–No. 1100 ed. 2017).

1.4.3 An ISO 9001 certificate of compliance issued by an appropriately accredited conformity assessment body, covering the information and services provided, should be considered as a sufficient demonstration of compliance of the established QMS.

Resolution 21 (EC-69)

2018-2019 BIENNIUM BUDGET

THE EXECUTIVE COUNCIL,

Noting:

(1) Financial Regulations – Articles 3, 4, 5, 6 and 7,

(2) Financial Rules 106.1, 106.2, 107.1 and 107.2,

(3) Resolution 70 (Cg-17) – Maximum expenditure for the seventeenth financial period (2016–2019),

(4) Resolution 9 (EC-67) – Budget for the 2016–2017 biennium,

(5) Decision 81 (EC-68) – Improved budget structure,

(6) Resolution 11 (EC-68) – Scale of assessment of contributions of Members for 2017–2019,

Noting also that the budget proposed by the Secretary-General was prepared in accordance with the above-mentioned regulatory framework,

Having considered the activities and the allocation of budgetary resources proposed by the Secretary-General,

Adopts the regular budget for the 2018–2019 biennium financed from the assessed contributions, as given in the annex to the present resolution;

Authorizes the Secretary-General:

(1) To reappropriate any unspent balance that may arise from the first biennial budget (2016–2017) to the corresponding Expected Results of the second biennial budget (2018–2019) in accordance with Financial Regulation 7.3;

(2) To make transfers between sections within the appropriation lines of the budget for the biennium, as necessary, to achieve the Expected Results in accordance with Financial Regulation 4.2;

(3) To use up to the amount of CHF 1.5 million in 2017 out of the reserve of CHF 3 million set aside from the 2016–2017 budget resources, and the remainder in 2018–2019, with a view to funding priority activities.

Annex to Resolution 21 (EC-69)

2018–2019 BIENNIUM BUDGET BY EXPECTED RESULTS (IN SWISS FRANCS)

Expected Result	Budget 2018-2019
1. Enhanced capabilities of Members to deliver and improve access to high-quality weather, climate, hydrological and related environmental predictions, information, warnings and services in response to users' needs and to enable their use in decision-making by relevant societal sectors	14,097,800
2. Enhanced capabilities of Members to reduce risks and potential impacts of hazards caused by weather, climate, water and related environmental elements	4,985,100
3. Enhanced capabilities of Members to produce better weather, climate, water and related environmental information, predictions and warnings to support, in particular, reduced disaster risk and climate impact and adaptation strategies	13,532,400
4. Enhanced capabilities of Members to access, develop, implement and use integrated and interoperable Earth- and space-based observation systems for weather, climate and hydrological observations, as well as related environmental and space weather observations, based on world standards set by WMO	20,779,100

5. Enhanced capabilities of Members to contribute to and draw benefits from the global research capability for weather, climate, water and related environmental science and technology development	11,232,500
6. Enhanced capabilities of Members' NMHSs, in particular, in developing and least developed countries and small island developing States, to fulfil their mandates	21,038,300
7. New and strengthened partnerships and cooperation activities to improve NMHSs' performance in delivering services and to demonstrate the value of WMO contributions within the United Nations system, relevant regional organizations, international conventions and national strategies	8,578,500
8. Ensured effective functioning of policy-making and constituent bodies and oversight of the Organization	35,418,900
Total	129,662,600

Resolution 22 (EC-69)

FINANCIAL STATEMENTS OF WMO FOR THE YEAR 2016

THE EXECUTIVE COUNCIL,

Noting Articles 14 and 15 of the Financial Regulations,

Having considered the Secretary-General's statement on the financial statements of the Organization for the year ending 31 December 2016, the report of the external auditor to the Executive Council, and recommendations of the WMO Audit Committee and the Financial Advisory Committee,

Gives formal approval to the audited financial statements for WMO for the year 2016;

Requests the Secretary-General to transmit the financial statements together with his report and the report of the external auditor thereon to all Members of WMO;

Notes with concern the long-term risks associated with year-on-year deficits and resulting decreases in the Organization's net assets;

Further requests the Secretary-General to develop options to modify the budget methodology to avoid future deficits deriving from unbudgeted non-cash expenditure.

Resolution 23 (EC-69)

REVIEW OF PREVIOUS RESOLUTIONS OF THE EXECUTIVE COUNCIL

THE EXECUTIVE COUNCIL,

Noting:

(1) Resolution 13 (EC-68) - Review of previous resolutions of the Executive Council,

(2) Article 14 (c) of the Convention regarding the functions of the Executive Council in considering and where necessary taking action on resolutions, in accordance with the procedures laid down in the Regulations,

(3) Regulation 156 (9) of the General Regulations (2015 edition), concerning the review of the Executive Council resolutions,

(4) Rule 27 of the Rules of Procedure of the Executive Council on the same subject,

Noting with appreciation the new format of the background information provided by the Secretariat that assists the Executive Council to monitor the implementation of resolutions,

Having examined its previous resolutions still in force,

Decides:

(1) To keep in force the following resolutions:

EC-IV	2
EC-XII	6
EC-XXXIV	13
EC-XXXV	21
EC-XXXVI	6
EC-XL	4
EC-XLIV	15
EC-XLV	13
EC-XLVIII	3, 4, 12
EC-LI	5
EC-LVI	9, 18
EC-LVII	5, 18
EC-LVIII	15
EC-LIX	16, 17, 19, 26, 27
EC-LX	4, 6, 18

EC-LXI	4, 8, 14
EC-LXII	15
EC-LXIII	8, 13
EC-64	2, 5, 8, 14, 15, 16, 17, 18, 20, 22, 23, 24*, 26
EC-65	3, 6, 11, 12
EC-66	2, 3, 4, 5, 7, 9, 10, 13, 18, 20, 22, 24
EC-67	1, 2, 4, 5, 6, 7, 9, 11, 12
EC-68	1, 2, 3, 5, 6, 7, 8, 9, 11, 12

(2) Not to keep in force the other resolutions adopted before the Executive Council's sixty-ninth session;

Agrees to monitor the implementation of resolutions of the Executive Council with a view to making recommendations for further action, as appropriate, at its seventieth session;

Requests the Secretary-General to publish the in-force resolutions, including those with corrigenda in a new issue of *Resolutions of Congress and the Executive Council* (WMO-No. 508) and to bring this publication to the attention of all concerned parties.

Note: This resolution replaces Resolution 13 (EC-68), which is no longer in force.

* Indicates that some resolutions mentioned in the given resolution are now not in force (see the annex to the present resolution).

Annex to Resolution 23 (EC-69)

FOOTNOTE TO THE FOLLOWING RESOLUTION

1. Resolution 24 (EC-64) - Guidelines on the planning and production of WMO publications

Resolution 20 (EC-LXII) not in force

APPENDIX 3. DECISIONS ADOPTED BY THE SESSION

Decision 1 (EC-69)

ORGANIZATION OF THE SESSION

THE EXECUTIVE COUNCIL,

Approves the provisional agenda as proposed by the President;

Adopts the establishment of committees as:

(1) Committee on the theme for World Meteorological Day 2019 (open):

Chairperson: A. E. Sakya;

(2) Selection Committee for the IMO Prize:

Chairperson: G. Adrian

Members: A. Kijazi, T. Sutherland and Liu Yaming;

(3) Selection Committee for the 2017 WMO Research Award for Young Scientists:

Chairperson: C. Saulo

Members: R. Philippe, A. Martis, M. Lopez;

(4) WMO Staff Pension Committee:

Members: T. Sutherland, G. Navarro, L. Bah

Alternate member: N. Kronig;

(5) Committee on the WMO Strategic Plan, Chairperson: R. Varley (open);

(6) Committee on the Public-private Engagement, Chairperson: C. Saulo (open);

(7) Drafting Groups on a number of documents;

(8) Rapporteur on Previous Resolutions of the Executive Council: F. Teshome;

Agrees the programme of work of the session:

(1) Working hours of the meetings: 9:30–12:30 and 14:30–17:30;

(2) Arrangement and allocation of agenda items for the session;

Notes General Regulation 112 for the approval of the minutes.

Decision 2 (EC-69)

CONSIDERATION OF THE REPORTS

THE EXECUTIVE COUNCIL,

Noted the reports of the President of WMO, presidents of regional associations and technical commissions and the Secretary-General, highlighting progress in the activities of the Organization, its constituent bodies and the Secretariat, since the last session of the Council;

Noted the decisions made by the President on behalf of the Council since its last session under General Regulation 9 (7) and Article 9.5 of the Staff Regulations;

Addressed reported gaps and challenges in the implementation of the Strategic Plan, notably in priority areas, in session decisions under the respective agenda items;

Considered recommendations of meetings of presidents of regional associations and technical commissions under the respective agenda items;

Emphasized the need to reflect in decisions and resolutions the general sense of the discussions;

Noted that the reports will be consolidated in a single volume following the session.

Decision 3 (EC-69)

WMO GLOBAL MULTI-HAZARD ALERT SYSTEM

THE EXECUTIVE COUNCIL,

Recalling:

(1) The WMO Convention (WMO-No. 15) which affirms "the vital importance of the mission of the National Meteorological, Hydrometeorological and Hydrological Services in observing and understanding weather and climate and in providing meteorological, hydrological and related services in support of relevant national needs which should include the following areas: (a) protection of life and property; (b) safeguarding the environment; (c) contributing to sustainable development; (d) promoting long-term observation and collection of meteorological, hydrological and climatological data, including related environmental data; (e) promotion of endogenous capacity-building; (f) meeting international commitments; (g) contributing to international cooperation"; and "Members need to work together to coordinate, standardize, improve and encourage efficiencies in the exchange of meteorological, climatological and hydrological and related information between them, in the aid of human activities and considering that meteorology is best coordinated at the international level and considering that there is a need for close cooperation with other international organizations",

(2) Resolution 10 (Cg-17) – Sendai Framework for Disaster Risk Reduction 2015–2030 and WMO Participation in the International Network for Multi-hazard Early Warning Systems (IN-MHEWS) calls for the necessity of enhancing multi-hazard early warning systems (MHEWS) and that the Member States of the United Nations called for strengthened regional and international cooperation to develop science-based methodologies and tools to support MHEWS,

(3) Paragraph 3.2.5 of the general summary (Cg-17) in which Congress highlighted global target (g) of the Sendai Framework for Disaster Risk Reduction (DRR) 2015–2030, which reads "substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to the people by2030",

(4) Resolution 9 (Cg-17)–Identifiers for Cataloguing Extreme Weather, Water and Climate Events in which Congress decided to develop identifiers for cataloguing weather, water and climate extreme events in cooperation with institutions having competences about possible impact of those weather events can provide an unambiguous reference for associated losses and damages and can promote consistency in the characterization of extreme events,

(5) Annex to paragraph 7.9.2 of the general summary (Cg-17) which states that NMHSs are the official authoritative source and in most countries, a single voice, on weather warnings in their respective countries, and, in many, they are also responsible for climate, hydrology, air quality, seismic and tsunami warnings and for space weather forecasts and warnings,

(6) Resolution 2 (Cg-17) - Implementation of WMO Strategy for Service Delivery; in which Congress considered that Members, through regional associations, technical commissions and various WMO activities, expressed a need for improved service delivery to the public, to the disaster community and to social and economic sectors,

(7) Decision 5 (EC-68) - Provision of Multi-Hazard Impact-Based Forecast and Risk-Based Warning Services to the Public; in which EC considered that there is a need to make every effort to assist Members to be more responsive to changing societal needs, thus fulfilling their role as the authoritative voice,

(8) The decision taken in paragraph 2.1.10 of the general summary (CBS-Ext.(2014)) – Open Programme Area Group on Public Weather Services (OPAG/PWS); in which the CBS strongly encouraged the engagement of Members in: (a) the "WMO Register of Alerting Authorities" initiative; and (b) adopting the Common Alerting Protocol (CAP) technology for communicating weather warnings and alerts, and in this connection to promote the WMO Alert Hub as performer of a service that is complementary to the international Register of Alerting Authorities to reinforce the principal of a single authoritative voice for alerting,

(9) Resolution 5 (Cg-17) – Public Weather Services Programme; requested the Secretary-General to liaise with the Member that hosts the SWIC website to carry out the enhancement necessary to enable the website to disseminate weather warnings that would be provided in CAP format by Members,

Recognizing that:

(1) Early warnings for weather, water and climate hazards have demonstrated to be very effective in reducing loss of life and property,

(2) Impacts related to hydrometeorological hazards affect an increasingly exposed and vulnerable population at the national, regional and global levels which necessitates that warning information from all countries should be made more easily available for decision makers with in the United Nations humanitarian agencies and economic sectors and the general public,

(3) There have been significant advancements in the accuracy, reliability and timeliness of observing, forecasting and warnings of severe weather phenomena,

(4) The global indicators to measure success of warnings (i.e. those for the global targets of the Sendai Framework) will require coordinated reporting from Members,

(5) The World Weather Information Services (WWIS) and Severe Weather Information Centre (SWIC) websites provide an example and Hong Kong, China is willing to enhance these websites to disseminate weather warnings provided in CAP format and other equivalent formats by Members,

(6) Regional, sub-regional and national platforms such as Meteoalarm of the European Meteorological Services Network (EUMETNET)and Meteoalert of the Federal Service for Hydrometeorology and Environmental Monitoring of the Russian Federation (Roshydromet), WMO Alert Hub, and, for example, Google Public Alerts serve as good examples that could be leveraged in the development of WMO GMAS,

(7) Members are the authoritative source for issuing disaster warning and alerting products in their respective countries,

Noting that:

(1) The UN Secretary General has recently called for enhanced information for the UN Operations and Crisis Centre (UNOCC) to support decision making,

(2) The UNOCC will require close coordination with WMO to facilitate and consolidate weather, climate and water information,

(3) A first GMAS concept was presented and well received at the meeting of the Presidents of Regional Associations and the Presidents of Technical Commissions (PRA/PTC, 9–11 January 2017, Geneva, Switzerland) and the 16th session of WMO RA II (12–16 February, Abu Dhabi, United Arab Emirates) and the 17th session of RA IV (27-31 March 2017, San José, Costa Rica),

(4) In addition to national early warning systems, further regional / sub regional multi-hazard alarm systems and partnerships are being set up by Members: (a) the South East Europe Multi-Hazard Advisory Systems project will shortly publish its Implementation Plan and is supported by the USAID and the World Bank, (b) the Pilot Project to Enhance the Capability of Meteorological Disaster Risk Reduction in RAII has been proposed and is being coordinated by the China Meteorological Administration (CMA)and the Hong Kong Observatory (HKO)based on the implementation of CAP, and (c) the experience of the HKO in hosting the WWIS and SWIC websites of WMO as per Resolution 5.2/10 (RA II-16),

Having been informed: that the WMO Secretary-General has established an Advisory Group on the WMO GMAS and the outcomes from its consultation meeting (13-15 March 2017, Geneva, Switzerland) contributed to the development of the first Concept Note of GMAS,

Endorses the GMAS vision in the Annex as an initial draft statement which will be further advanced through the guidance of the Executive Council Working Group on DRR (ECWG/DRR);

Requests the EC WG/DRR to:

(1) Further advance the GMAS concept and the development of a strategy that emphasizes the following components:

(a) Focuses on the benefits to and requirements of the users,

(b) Emphasizes that NMHSs are the official authoritative source and in most countries, a single voice, on weather warnings in respective cases,

(c) Considers the role of RSMCs in providing guidance to Members (e.g. tropical cyclones, and climate products),

(d) Considers both the meteorological and hydrological aspects,

(e) Accommodates public and private capacities and use cases,

(f) Takes into account other service providers such as GDACS,

(g) Utilizes the Common Alerting Protocol (CAP) or other industry standards to enable a robust mechanism for aggregating warnings from Members;

(2) Develop a project plan that to encompass to key deliverables:

(a) A detailed plan aimed at gathering the requirements,

(b) Development of a detailed proposal to be presented to EC 70, which leverages existing working mechanisms (for example, CBS Management Group Task Team on DRR, where available) in consultation with regional associations and technical commissions;

Urges Members, regional associations, technical commissions and technical programmes to participate and contribute to the development of WMO GMAS;

Requests the Secretary-General to:

(1) Support the EC WG/DRR to incorporate the work already conducted under the Advisory Group on the WMO GMAS into their own agenda;

(2) Mobilize the resources for the EC WG on DRR;

(3) Communicate this initiative to the Multi-Hazard Early Warning Conference (22-23 May 2017) and the 2017 Global Platform for DRR (22-26 May 2017) both in Cancún, Mexico, and receive feedback from stakeholders.

Annex to Decision 3 (EC-69)

WMO GLOBAL MULTI-HAZARD ALERT SYSTEM VISION

1. Introduction

1.1 Early warnings for weather, water and climate hazards have been demonstrated over the past decade to be very effective in reducing loss of life and property. These warnings, which come from the National Meteorological and Hydrological Services (NMHSs) of each country, provide the foundation on which early action to take precautions against hazards by the responsible authorities and public can be realized.

1.2 However, as the impacts related to these hazards affect an increasingly exposed and vulnerable population at the national, regional and global levels there is a need for warning information from all countries to be made more easily available and understandable for decision makers in the humanitarian agencies, economic sectors, the general public and travellers. It is proposed that a WMO Global Multi-Hazard Alert System (GMAS) be developed that would provide target users with authoritative hydrometeorological hazard warnings and related information.

2. Vision

To be recognized globally by decision makers as a resource of authoritative warnings and information related to high-impact weather, water, ocean and climate events

3. Rational

3.1 In 2015, governments, agencies, NHMSs representing their countries in WMO, WMO representatives and the wider disaster risk reduction community gathered together in Sendai, an area itself devastated by the Great Japan Earthquake, to discuss and formulate what has now become the ground breaking Sendai Framework for Disaster Risk Reduction.

3.2 In Sendai all agreed that we need to do more. We need to enhance our services, strengthen regional and global collaboration and develop science based methodologies to support Multi-Hazard Early Warning Systems.

3.3 Even prior to Sendai the demand for access to multi-hazard information was growing as decision makers including the likes of the UN, realized the power of assimilating environmental information into both their short-term response and longer-term decision making processes. Impacts related to hydrometeorological hazards continue to affect an increasingly exposed and vulnerable population at the national, regional and global levels which necessitates that warning information from all countries should be made more easily available for decision makers. However, into this arena we have seen a growing number of information providers, social media has become the norm and non-authoritative and irresponsible sources continue to proliferate which at times causes decision stagnation due to simple information overload.

3.4 This is an ever changing environment in which the NMHS in partnership with their national civil protection agencies have continued to deliver those vital multi-hazard services at times learning vital lessons along the way in respect of communicating to those at risk.

3.5 We now want to share this knowledge and our learnings with the global DRR community to ensure that we meet the needs of the users in the 21st century. We want to catalyse an energized conversation with all stakeholders across the wide spectrum which is DRR, we want to engage with those already providing multi-hazard information to develop services and systems that truly meet their needs.

3.6 NMHSs are the official authoritative source and in most countries, a single voice, on weather warnings in their respective countries, and, in many, they are also responsible for climate, hydrology, air quality, seismic and tsunami warnings and for space weather forecasts and warnings (Annex to paragraph 7.9.2 of the general summary (Cg-17)). We now want to build on this to ensure that the global community receives the multi-hazard information which they so desperately need.

3.7 WMO members are now committed to the delivery of a detailed outreach programme to truly understand those diverse requirements. Under the banner of the WMO GMAS members will work with all users to understand their requirements. We will learn from best practice elsewhere and we will ensure our own best practices (standardization, harmonization, interoperability) are applied to our discussions. We will ensure that national mandated authorities for issuing warnings remain at the heart of our discussions, but we will also ensure that where necessary our own complex hydrometeorological language is translated into information which can be 'actioned' by decision makers.

3.8 Ultimately we will ensure our services for the future provide high quality information with accountability and traceability to ensure we continue to enhance our service delivery in line with an ever changing world. Furthermore, the cooperation and utilization between neighbour countries will be improved for cross-border events.

3.9 In summary the GMAS initiative will reach across the traditional "Enhance Recover, Prevent, Prepare, Respond" Disaster Risk Management spectrum across all timescales through the utilization of authoritative multi-hazard information. It will thereby provide a solid foundation for those making critical decisions and thereby ultimately contribute to saving lives.

Decision 4 (EC-69)

IMPACT-BASED DECISION SUPPORT SERVICES

THE EXECUTIVE COUNCIL,

Recalling:

(1) Resolution 2 (Cg-17) - Implementation of the WMO Strategy for Service Delivery, in which Congress requested EC to support the further development of service delivery by Members in the area of impact-based forecast and warning services,

(2) Decision 30 (CBS-16) – Provision of multi-Hazard impact-based forecast and warning services, in which CBS decided that efforts needed to be enhanced for more rapid realization of impact-based forecast and warning services by NMHSs,

(3) Decision 9 (EC-68) – Severe Weather Forecasting Demonstration Project (SWFDP), that endorses the critical elements for consolidating the SWFDP into global sustainable operational services,

(4) Decision 58 (EC-68) – Operational implications and requirements for impact-based forecasting,

Acknowledging that:

(1) While much has been done by Members to build infrastructure and improve weather and climate modelling capabilities to enhance forecast products, largely through the GDPFS, developments in understanding the impacts of hazards have not always matched the improvement in such technical capabilities,

(2) The Severe Weather Forecasting Demonstration Project (SWFDP), through its cascading forecasting process and synergy with the Flash Flood Guidance System (FFGS) and the Coastal Inundation Forecasting Demonstration Project (CIFDP), is successfully strengthening capacity in NMHSs in developing and least developed countries; nevertheless, improved products offering from the GDPFS centres to SWFDP to facilitate impact-based forecasting need to be improved to enable every user to assess individual impacts,

Observing that graphical information and products being exchanged don't meet the evolving requirements for digital data, including probabilistic forecasts, to support impact-based forecasting and applications such as agriculture and hydrology, and to establish synergies with other initiatives, such as the Flash Flood Guidance System and the Coastal Inundation Forecasting Demonstration Project,

Noting that NMHSs need to develop skills and capacities to effectively collaborate with scientific organizations, national governmental agencies, local administrations, civil protection and emergency management authorities and other stakeholders for the collection of data including vulnerability and exposure data, and also noting the opportunities offered by various global initiatives such as the Group on Earth Observation (GEO) Human Planet Initiative that provides human settlement data and the GEO Data Access and Risk Management (GEO-DARMA) Initiative that provides comprehensive data access and risk management services that Members can use in developing impact-based services,

Noting further that WMO Regional Training Centres (RTCs) and Regional Specialized Meteorological Centres (RSMCs) can play an important role in training the staff of NMHSs in the new area of impact-based forecast and warning services in order to provide such skills to NMHSs more rapidly,

Decides:

(1) To further develop training materials on impact-based forecast and warning services in the curricula of WMO RTCs, taking into consideration the different regional and national cultural approaches and circumstances as well as training materials and guides prepared by the RSMCs and the Public Weather Services Programme;

(2) To develop a mechanism for the collection and processing of impact-related data and information for GDPFS centres to share digital data with SWFDP participants;

(3) To incorporate methods to assess likelihood and risk using numerical weather ensembles into the WMO Guidelines on Multi-Hazard Impact-based Forecast and Warning Services;

Requests:

(1) EC's Working Group on Education and Training to work with regional associations to elaborate curricula for WMO RTCs and RSMCs on impact-based forecasting and warning services;

(2) CBS to continue to give high priority to the implementation of SWFDP in sub-regions that have not as yet benefited from the demonstration phases;

Requests the Secretary-General:

(1) To facilitate resource mobilization to support training in impact-based forecast and warning services in RTCs and RSMCs as well for the WMO ongoing in-country training and pilot projects for NMHSs;

(2) To the extent that the resources are available, to support the processes for the development of impact-based decision support services.

Decision 5 (EC-69)

FLOOD FORECASTING

THE EXECUTIVE COUNCIL,

Recalls:

(1) Resolution 21 (Cg-XV) – Strategy for the Enhancement of Cooperation between National Meteorological and National Hydrological Services for Improved Flood Forecasting;

(2) Resolution 15 (Cg-XVI) – Establishment of an Advisory Group for the WMO Flood Forecasting Initiative;

(3) Decision 6 (EC-68) – Implementation of Common Alerting Protocol and, in particular, the request to the Commission for Hydrology to investigate the utility of new protocols, such as CAP, in public alerting for hydrological hazards;

(4) Decision 7 (EC-68) – Flood Forecasting Initiative that endorsed the Advisory Group for the WMO Flood Forecasting Initiative and its workplan for 2016-2019 to: (1) ensure that all major demonstration projects and their components include the requirements and reflect best practices for effective and sustainable flood forecasting; and (2) establish a team to develop assessment guidelines for End-to-End Early Warning Systems for flood forecasting and to assist Members in their assessment of flood forecasting capabilities;

Further recalls that the objective of the WMO Flood Forecasting Initiative is to "Improve the capacity of meteorological and hydrological services to jointly deliver timely and more accurate products and services required in flood forecasting and warning and in collaborating with disaster managers, active in flood emergency preparedness and response (…)";

Notes that the Commission for Hydrology (CHy), in its fifteenth session in December 2016, took decisions related to flood forecasting, such as:

(1) Adopting the Implementation Strategy for the End-to-End Early Warning Systems (E2E EWS) for flood forecasting, using the Community of Practice approach (Resolution 10 (CHy-15));

(2) Preparing guidelines on how to formulate numerical weather prediction information for use in flood forecasting, consistent with the Flood Forecasting Initiative Advisory Group Work Plan of 2016-2019 (Resolution 10 (CHy-15));

(3) Furthering efforts to advance use of climate sub-seasonal to seasonal to inter-annual forecasts, including RCOF outputs, for use in Seasonal Hydrological Prediction (Resolution 10 (CHy-15));

(4) Investigating the applicability of the Common Alerting Protocol for use in hydrology (Resolution 6 (CHy-15));

(5) Contributing to the future seamless data-processing and forecasting system by preparing a comprehensive structure for hydrology and procedures for the designation, mandatory functions and activities of new centres taking into account the principle that world and regional centres shall respect the primary roles and responsibilities of National Meteorological and Hydrological Services in the delivery of flood forecasting and warning services (Resolution 7 (CHy-15));

(6) Coordinating, with the president of the Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology, a joint assessment of the initial phase of the Coastal Inundation Forecasting Demonstration Project and, depending on its results, to consider the desirability of developing a governance structure and procedures that would transition the Project to a more sustainable platform for the strengthening of national multi-hazard early warning systems to address flooding in coastal areas (Resolution 6 (CHy-15));

Further notes that the CHy Advisory Working Group held its first session from 27 February to 3 March 2017 and developed detailed work programmes for its three generic themes (focus areas) including one on hydrological applications, products and services, which includes activities pertaining to flood forecasting;

Decides to endorse the above mentioned activities as they will improve the flood forecasting capabilities of WMO Members and thus contribute to establish a solid foundation for MHEWSs in the countries;

Requests the president of the Commission for Hydrology to coordinate with the president of CBS and other relevant technical commissions the necessary action to ensure that the future GDPFS is an operational system that has a direct interface to applications like FFGS;

Requests the Secretary General:

(1) To ensure that SWFDP and FFGS complement each other wherever possible;

(2) To support the establishment of a community of practice that supports the entire value chain from monitoring to forecasting;

(3) To take the necessary actions needed to catalyse the relations between NMSs and NHSs in the area of flood forecasting;

Requests Members to support regional FFGS operations and to ensure that the necessary data is provided and shared;

Invites Members and regional associations, in particular through their working groups related to hydrology and water resources management, to make all the necessary efforts to support the activities pertaining to advancing the implementation of CHy Advisory Working Group's workplans for 2016 to 2019.

Decision 6 (EC-69)

MONITORING EXTREME WEATHER AND CLIMATE EVENTS FROM SPACE

THE EXECUTIVE COUNCIL,

Noting:

(1) That the increase in the frequency of extreme weather and climate events and their impact on society is requiring the development and implementation of new tools for monitoring these phenomena using remote sensing techniques, and that for many countries an adequate human and technological capacity to provide a good level of services and the transfer of knowledge from countries with greater technological developments is essential,

(2) A workshop on Operational Space-based Weather and Climate Extremes Monitoring from 15 to 17 February 2017 in Geneva was attended by satellite operators, research and development space agencies, WMO Regional Climate Centres (RCCs) and National Meteorological and Hydrological Services (NMHSs) to stimulate enhanced utilization of space-based observation data and products for monitoring of weather and climate extremes over pentad (5-day), weekly and other periods of up to a month, in order to respond to current and future user requirements,

(3) That the workshop recognized that significant progress has been made in recent years in developing space-based observations in most geophysical fields, and that several high-resolution products were available on a quasi-real time basis, enabling enhanced utilization for monitoring weather and climate extremes from space,

Decides to support a demonstration project on space-based weather and climate extremes monitoring (SEMDP) in WMO Regions to the extent that resources are available;

Requests:

(1) The presidents of the Commission for Climatology (CCl) and the Commission for Basic Systems (CBS), with the support of the other TCs and RAs, to:

(a) Establish a demonstration project on space-based weather and climate extremes monitoring (SEMDP) and decide on priority WMO Region(s) starting in 2018 for a two year duration;

(b) Identify the deliverables of the demonstration project, concentrating on products at national and regional levels:

(i) Monitoring accumulated heavy precipitation and droughts;

(ii) Making best use of existing and newly developed satellite derived products and time series of measurements;

(iii) Making best use of products that combine satellite information with in situ and/or model reanalysis data;

(c) Assess the SEMDP products and other results, and recommend which should be transitioned from research to operations;

(2) The Secretary-General to provide the necessary assistance and mobilize resources for the establishment of a pilot SEMDP in WMO Regions.

Decision 7 (EC-69)

WMO SUPPORT TO IMPLEMENTATION OF THE PARIS AGREEMENT

THE EXECUTIVE COUNCIL,

Recalling:

(1) Resolution 9 (Cg-17) - Identifiers for cataloguing extreme weather, water and climate events,

(2) Resolution 23 (Cg-17) – Pre-operational phase of the WMO Integrated Global Observing System,

(3) Resolution 39 (Cg-17) - Global Climate Observing System,

(4) Resolution 46 (Cg-17) - Integrated Global Greenhouse Gas Information System,

(5) Resolution 63 (Cg-17) - Energy as an additional priority area of the Global Framework for Climate Services,

(6) Resolution 64 (Cg-17) - Development of a results-based framework for WMO support to the implementation of the Global Framework for Climate Services,

(7) Resolution 1 (EC-68) – WMO support to the Paris Agreement,

Further recalling:

(1) That the Paris Agreement entered into force on 4 November 2016, and that considerable technical work will be needed to support the implementation of the Paris Agreement,

(2) The twenty-second session of the United Nations Framework Convention on Climate Change (UNFCCC) Conference of the Parties (COP 22), in conjunction with the twelfth session of the Parties to the Kyoto Protocol and the first session of the Conference of the Parties serving as the Meeting of the Paris Agreement (CMA 1), was held in Marrakech, Morocco from 7 to 18 November 2016,

(3) The high level outcome of COP 22, called the “Marrakech Action Proclamation for Our Climate and Sustainable Development”,

(4) COP 22 Decision 19/CP.22 entitled "Implementation of the Global Observing System for Climate",

Noting the text of the Paris Agreement, in particular with respect to its provisions that relate to scientific knowledge on climate, including research, systematic observation of the climate system and early warning systems,

Observing that:

(1) The forty-fifth session of the Subsidiary Body for Scientific and Technical Advice (SBSTA-45) held at COP 22 in November 2016 welcomed the submissions from WMO on the Global Climate in 2011–2015 and the WMO Greenhouse Gas Bulletin;

(2) SBSTA-45 invited WMO to provide submissions on the state of the global climate on a regular basis, as appropriate, at subsequent sessions of SBSTA;

(3) The Integrated Global Greenhouse Gas Information System (IG^3IS) will provide information that may contribute to actions of nations, sub-national governments including cities, and the private sector to reduce GHG emissions through a measurement-and-modelling-based approach;

(4) The support of climate services to the energy, water, public health, transport and industry, agriculture and land use sectors contribute to a low-carbon and climate-resilient economy through the Global Framework for Climate Services (GFCS);

(5) Many Parties in their submissions have emphasized the need for scientific information on climate variability, trends and extremes and the use of climate information and services;

Having considered that:

(1) Enhanced observation of Essential Climate Variables (ECVs) may be important for the global stocktake, since the climate data records based on ECVs are used to close budgets of energy, carbon and water and to study changes in the growth rate of the atmospheric greenhouse gases (GHGs), or interaction between land and atmosphere, in a more integrated way,

(2) WMO annual Statements on the State of the Global Climate provide scientific evidence for tracking climate trends with climate indicators,

Decides:

(1) That appropriate measures should be taken to promote the value and relevance of scientific information and data for the global stocktake under the Paris Agreement through WMO submissions and reporting mechanisms to UNFCCC, noting that the inputs of the global stocktake are to be decided by Parties to the Paris Agreement;

(2) To assist NMHSs to engage at national level, as appropriate, to design and implement GCF proposals, coordinate with National Designated Authorities (NDAs), develop and implement NAPs, and generate relevant climate information and services, particularly through implementation of the GFCS and IG^3IS pilot projects;

Invites Members:

(1) To work at national level to fully engage NMHSs as critical actors in the cataloguing of extreme events, adaptation programmes, mitigation, and other areas that fall within the competency of their respective Services, and to contribute to the development of nationally determined contributions (NDCs), greenhouse gas monitoring systems and other observing systems;

(2) To engage in or, where necessary, establish institutional frameworks for climate services at national level that will serve as key coordination mechanisms to bring together stakeholders needed for the successful generation, tailoring, communication and use of climate services for enhanced decision-making;

(3) To actively participate in major UNFCCC meetings, such as COPs, SBSTA and SBI, including the participation of Directors of NMHSs as members of country delegations;

(4) To work towards the full implementation of the Global Climate Observing System (GCOS) implementation plan;

(5) To encourage active contributions by scientists, through peer-reviewed publications, to the Intergovernmental Panel on Climate Change Special Report on global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, expected to be published in September 2018;

Requests the Secretary-General:

(1) To include information on high-level climate policy issues at all relevant events for NMHS Directors, to enhance their access to information on the role of NMHSs in contributing to the high-level climate policy agenda and implementation of the Paris Agreement;

(2) To continue communicating to Members through Ministries of Foreign Affairs to encourage them to invite NMHSs to contribute, as applicable, to periodic updates on adaptation communications, referenced in Article 7, paragraphs 10 and 11, of the Paris Agreement, including concerning their support to NAPs, NDCs and their involvement in national COP delegations.

Decision 8 (EC-69)

RECOGNITION OF WMO LONG-TERM OBSERVING STATIONS

THE EXECUTIVE COUNCIL,

Recalling Decision 40 (EC-68) – WMO mechanism for the recognition of long-term observing stations,

Affirming that Members' collaboration on strengthening scientific knowledge on climate, including research and systematic observation of the climate system, informs climate services and supports decision-making,

Recognizing:

(1) That preserving long-term observing stations, including centennial stations, is a responsibility of governments for sustaining irreplaceable climate heritage to serve current and future generations' needs for long-term high quality climate records,

(2) That WMO, as the international body with a mandate for the standardization and sustaining meteorological observations, values these stations,

Noting with satisfaction:

(1) That a recognition mechanism for long-term observing stations has been successfully developed by WMO involving close collaboration between the Commission for Climatology (CCl), the Commission for Basic Systems (CBS), the Commission for Instruments and

Methods of Observations (CIMO), the Global Climate Observing System (GCOS), the WMO Secretariat, and Members,

(2) That 36 Members, representing all six regional associations, submitted 86 candidate stations in response to an initial invitation to nominate not more than three stations to be assessed as part of the first list of candidate WMO centennial stations,

Noting further the evaluation of the above list of candidate stations by an ad hoc advisory board with CCl, CBS, CIMO and GCOS representation,

Decides to endorse the proposal to recognize a first set of observing stations as WMO long-term observing stations as provided in the Annex;

Invites Members:

(1) To collaborate on this initiative and promote it at highest national governmental levels, as appropriate;

(2) To consider seconding experts to the WMO Secretariat to support the work necessary for implementing and sustaining the WMO recognition mechanism for long-term observing stations;

Requests the president of CCl, in consultation with CBS, CIMO and GCOS, through the advisory board for the recognition of long-term observing stations, to consider the value of recognizing centennial stations that produce homogeneous time series useful for climate applications but which may not fully comply with the current WMO siting standards;

Requests the Secretary-General:

(1) To facilitate provision of information on the value of long-term observing stations at high-level climate policy events and provide further guidance for NMHS Directors to communicate at governmental level on sustaining and preserving long-term observing stations;

(2) To further promote the WMO recognition mechanism for long-term observing stations and to issue another call for nomination of candidate stations in early 2018.

Annex to Decision 8 (EC-69)

WMO RECOGNITION OF LONG-TERM OBSERVING STATIONS

Summary of advisory board review

1. <u>List of stations recommended for recognition (60):</u>

RA	Country	Station name
I	South Africa	Cape Agulhas
		Cedara
		Roodebloem
II	China	Changchun
		Yingkou
		Hohot
	Hong Kong, China	Hong Kong Observatory
	Japan	Ishigakijma
	Kyrgyzstan	Naryn

		Baitik
	Republic of Korea	Seoul
		Busan
III	Chile	Quinta Normal
IV	United States of America	Blue Hill
		Mandan
		Olga
V	Australia	Hobart
		Mt Boninyong
		Yamba
	New Zealand	Hokitika
		Lincoln Broadfield
VI	Armenia	Gyumri
		Gavar
		Armavir
	Austria	Wien-Hohe Warte
		Kremsmünster
		Sonnblick
	Croatia	Gospic
		Hvar
	Cyprus	Lefkosia
		Polis Chrysochous
		Stavros Psokas
	Czechia	Opava
	Estonia	Vilsandi
	Finland	Parainen Utö
		Siikajoki Revonlahti
		Sodankylä
	France	Besancon
		Mont-Aigoual
		Paris-Montsouris
	Germany	Brocken
		Potsdam
		Hohenpeissenberg
	Greece	Asteroskopeio
	Ireland	Valentina Observatory
	Netherlands	De Bilt
	Romania	Drobeta Turnu Severin
		Calarasi
	Spain	Izana
		Tortosa Observatory
		Daroca
		Madrid Retiro
	Sweden	Stockholm
		Bjuröklubb
		Hoburg
	Switzerland	Col du Grand-St-Bernard
		Säntis
	United Kingdom of Great Britain and Northern Ireland	Rothamstedt
		Balmoral
		Eskdalemuir

2. Remaining candidate stations (26)

All other stations (26) to be re-evaluated for EC-70 in 2018 on the basis of more detailed information.

Decision 9 (EC-69)

STRENGTHENING WMO STATEMENT ON THE STATE OF THE GLOBAL CLIMATE

THE EXECUTIVE COUNCIL,

Recalling Decision 25 (EC-68) - Strengthening WMO climate monitoring and assessment,

Recognizing that the WMO Annual Statement on the State of the Global Climate constitutes the WMO authoritative global synthesis of best available analysis and scientific information, with indicators for tracking climate trends, extremes and their impacts, complementing the Intergovernmental Panel on Climate Change (IPCC) Assessment Reports which are issued every five to seven years,

Noting with satisfaction that:

(1) The release of the five-year climate statement on the state of the global climate in 2011-2015 and the provisional annual statement on the state of the global climate in 2016 at the UNFCCC COP 22 attracted an unprecedented coverage by the media, including most renowned international TV and radio channels, and on social media, which enhanced WMO visibility and filled an information gap within the United Nations system for regular reports on the state of the climate to complement the IPCC assessments,

(2) The forty-fifth session of the Subsidiary Body for Scientific and Technical Advice (SBSTA-45) held at COP 22 in November 2016 welcomed the submissions from WMO on the state of the global climate in 2011–2015 and the provisional annual statement on the state of the global climate in 2016 and invited WMO to provide submissions on the state of the global climate on a regular basis, as appropriate, at subsequent sessions of SBSTA,

Having considered that:

(1) A preliminary analysis of the value of the five-year climate statement on the state of the global climate in 2011-2015, based on a survey disseminated at RA II-16 shows an interest in providing multi-year climate statements (5 and/or 10 year based), albeit the survey also shows a modest number of Members (three out of 13) have actually used the publication,

(2) An expert meeting on WMO Statement on the State of the Global Climate, 20-21 February 2017, provided a pathway for improving the content and process of the WMO annual statement on the state of the global climate,

(3) WMO could also in the future issue special climate reports as the opportunity arises, based on a recommendation by the relevant constituent body,

Decides:

(1) To strengthen the WMO annual statement on the State of the Global Climate by adding, when feasible, information which requires multi-year analysis, such as carbon and sea level budgets and multi-year prolonged droughts, and to provide impacts information in partnership with other agencies;

(2) That WMO could issue multi-year climate reports, to address such issues as attribution of extreme events, which require a multi-year perspective, and that launching such reports can be proposed by the Secretary-General to the Executive Council;

Invites Members:

(1) To make use of the information provided in the annual statements on global climate for informing relevant policy- and decision-making at national and regional levels, noting in particular the influence of climate variability and change on economic and societal aspects;

(2) To further support NMHSs' capabilities which underpin robust climate assessment, including accelerating the recovery and digitization of old climate records, improving climate data management and leveraging remote sensed data and products for supporting NMHS climate monitoring activities to complement in-situ derived data and products;

Requests the Commission for Climatology (CCl) to work on improving the content of the annual statement and its publication process by providing guidance for Members' contributions and input to the statement;

Requests the Secretary-General:

(1) To continue WMO Secretariat support to the annual statement on the State of the Global Climate;

(2) To further promote WMO submissions of the annual Statement of the State of the Global Climate to SBSTA, contributing to the high-level climate policy agenda.

Decision 10 (EC-69)

CLIMATE SERVICES INFORMATION SYSTEM PRODUCTS TO SUPPORT UNITED NATIONS SYSTEM PLANNING AND WMO MEMBERS ON SEASONAL TO INTER-ANNUAL TIMESCALES

THE EXECUTIVE COUNCIL,

Recalling:

(1) Resolution 60 (Cg-17) – WMO policy for the international exchange of climate data and products to support the implementation of the Global Framework for Climate Services,

(2) Resolution 1 (EC-68) – WMO support to the Paris Agreement,

(3) Decision 28 (EC-68) – Operational implementation of a Global Seasonal Climate Update,

Noting with appreciation:

(1) That WMO has already attained a high level of visibility within the United Nations Framework Convention on Climate Change (UNFCCC) through, inter alia, annual and multi-year statements on the state of the global climate and the WMO El Niño/La Niña Update,

(2) That the Global Seasonal Climate Update (GSCU), developed through the concerted efforts of the Commission for Climatology Task Team on GSCU, is in the final stages of preparations for operational production,

Decides to strengthen the consolidated and effective provision and utilization of, on a regular basis, the WMO El Niño/La Niña Update, GSCU, and associated global monitoring products, to be made available as products of the Climate Services Information System (CSIS) to the relevant global, regional and national entities, including those of the United Nations system, for their reference and planning, as part of the implementation of the GFCS;

Requests the Commission for Climatology (CCl) and the Commission for Basic Systems (CBS) to lead the development and provision of relevant climate-related products and services, with inputs from other technical commissions, as well as the World Climate Research Programme and the Global Climate Observing System;

Requests the Secretary-General to strengthen WMO engagement in United Nations system planning for seasonal variability and extremes;

Urges Members to facilitate NMHS engagement to support United Nations system planning for El Niño and Southern Oscillation (ENSO) events and seasonal extremes.

Decision 11 (EC-69)

IMPLEMENTATION OF THE COUNTRY-FOCUSED RESULTS-BASED FRAMEWORK AND MECHANISM FOR WMO CONTRIBUTIONS TO THE GLOBAL FRAMEWORK FOR CLIMATE SERVICES

THE EXECUTIVE COUNCIL,

Recalling:

(1) Resolution 60 (Cg-17) – WMO policy for the international exchange of climate data and products to support the implementation of the Global Framework for Climate Services,

(2) Resolution 64 (Cg-17) – Development of a results-based framework for WMO support to the implementation of the Global Framework for Climate Services,

(3) Resolution 6 (EC-67) – A mechanism to advance WMO contributions to the Global Framework for Climate Services,

(4) Resolution 62 (Cg-17) – Relationship and interaction between the Intergovernmental Board on Climate Services and WMO constituent bodies,

(5) Decision 16 (EC-68) – Country-focused results-based framework and mechanism for WMO contributions to the Global Framework for Climate Services,

(6) Resolution 16 (Cg-17) – Report of the Commission for Climatology, approving the recommendation to establish National focal points of the Climate Services Information System,

Recognizing that climate services and the Global Framework for Climate Services (GFCS) constitute an essential contribution to the implementation of the 2030 Agenda for Sustainable Development, the Sendai Framework for Disaster Risk Reduction, Small Island Developing

States (SIDS) Accelerated Modalities of Action (SAMOA) Pathway and especially the United Nations Framework Convention on Climate Change, and Paris Agreement,

Welcoming the progress made by Members in the implementation of climate services,

Noting:

(1) The increased investment in climate change adaptation, climate resilience and climate services arising from the prominence of climate on the international development agenda,

(2) The need for more systematic tracking of the status of implementation of climate services and results achieved in order to avail of the necessary financial resources and technical assistance for support,

Noting further that an Extraordinary Meeting of Presidents of Regional Associations and Presidents of Technical Commissions, with participation by representatives of WMO and co-sponsored programmes, constituting the mechanism for WMO contributions to the GFCS, is planned for 18-19 May 2017, to engage WMO entities in the development and implementation of GFCS-related plans and to formalize commitments to the implementation of their respective contributions,

Noting with appreciation:

(1) The efforts of the chairpersons of the regional association working groups and task teams on climate and the GFCS to prepare inputs for the aforesaid meeting, by compiling and reviewing data on climate services implementation to promote better cohesion of country activities planning, implementation and monitoring,

(2) That these efforts are focused on identifying pragmatic, effective and efficient approaches to implementing GFCS activities, focusing on specific examples through which implementation needs can be identified,

Decides to strengthen implementation of the country-focused results-based framework and mechanism for WMO contributions to the GFCS, described in the annex to Decision 16 (EC-68), by:

(1) Increasing the availability of data needed to track implementation and facilitate the provision of support to Members;

(2) Increasing access to extrabudgetary resources for implementation and for the provision of cross-support for implementation among Members;

Invites Members:

(1) To regularly review and update the information they provide related to climate services implementation in the WMO Country Profile Database, other relevant surveys circulated by the WMO Secretariat, and in the monitoring and evaluation framework for the WMO Strategic Plan – the principle mechanisms for tracking country-level implementation of climate services and identifying areas of need for support;

(2) To actively seek extrabudgetary resources, where necessary, including through active collaboration with partner organization members of the GFCS Partners Advisory Committee, and engage in the design and implementation of major extrabudgetary programmes supported at country level by international partners to ensure that the funding and activities needed for climate services implementation – as well as for support to Members from WMO technical commissions and Programmes, including co-sponsored programmes, and from other WMO Members – is included in the budgets of these programmes;

(3) To identify a national Climate Services Information System (CSIS) focal point, whose terms of reference will be defined by the Commission for Climatology;

(4) To identify or, where necessary, promote the creation of national planning, coordination, information sharing and monitoring structures to support multi-stakeholder climate services implementation at country level;

(5) To inform the Secretary-General of their capacity to provide cross-support to other Members for the implementation of climate services or, conversely, of their interest in receiving such support;

Requests the Commission for Climatology to include facilitating the functioning of the mechanism for WMO contributions to the GFCS at country level, and the engagement of partner organizations seeing to support the implementation of climate services, in the terms of reference of national focal points for CSIS;

Requests the Secretary-General to:

(1) Regularly compile information provided by Members for the implementation of climate services and make it widely available to facilitate the function of the mechanism for WMO contributions to the GFCS and in particular to promote cross-support among Members;

(2) Align WMO extrabudgetary support for climate services implementation with the areas of support identified by Members through the Country Profile Database, their responses to surveys circulated by the WMO Secretariat, and climate services-related information provided by Members as part of the monitoring and evaluation framework of the WMO Strategic Plan;

(3) Make available to Members, on a regular basis, information on the status of extrabudgetary programmes prepared and implemented by international partners;

(4) Make available to international partners information from Members on the status of implementation of climate services and further support needs;

Requests the report on the status of implementation of the country-focused results-based framework and mechanism for WMO contributions to the GFCS, at the seventieth session of the Executive Council.

Decision 12 (EC-69)

RESPONSE TO PRIORITY NEEDS FOR GLOBAL FRAMEWORK FOR CLIMATE SERVICES IMPLEMENTATION

THE EXECUTIVE COUNCIL,

Recalling:

(1) Resolution 62 (Cg-17) – Relationship and interaction between the Intergovernmental Board on Climate Services and WMO constituent bodies,

(2) Decision 16 (EC-68) – Country-focused results-based framework and mechanism for WMO contributions to the Global Framework for Climate Services,

(3) Resolution 1 (Cg-Ext.(2012)) – Implementation of the Global Framework for Climate Services,

(4) Resolution 48 (Cg- XVI) – Implementation of the Global Framework for Climate Services,

Noting the role accorded to the Secretariat and the GFCS Office in the annex to Decision 16 (EC 68) with respect to resource mobilization,

Noting also:

(1) That the GFCS Intergovernmental Board on Climate Services, in its second session (IBCS-2, 2014), established a Task Team on the GFCS 2015-2018 Operational and Resource Plan (ORP-TT) through which the *Priority Needs for the Operationalization of the GFCS (2016-2018)* document was developed,

(2) That the *Priority Needs for the Operationalization of the GFCS (2016-2018)* has been informed by, and formulated through, discussions during joint meetings of the ORP-TT which included representatives of Member countries, members of the GFCS Partner Advisory Committee (PAC), as well as WMO technical commissions and Programmes,

(3) That the GFCS Intergovernmental Board on Climate Services Management Committee, in its fourth session (IBCS-MC 4) endorsed the *Priority Needs for the Operationalization of the GFCS (2016-2018)*,

(4) That the *Priority Needs for the Operationalization of the GFCS (2016-2018)* identifies priority activities for the implementation of the country-focused results-based framework for WMO contributions to the GFCS,

Recognizing:

(1) That implementation of the GFCS entails engagement with non-hydrometeorological stakeholders, both at country level and internationally,

(2) That the *Priority Needs for the Operationalization of the GFCS (2016-2018)* document is a valuable complement to the country-focused results-based framework and mechanism for WMO contributions to the GFCS contained in the annex to Decision 16 (EC-68), in that it outlines activities and budget requirements for implementing portions of the results-based framework at the same time it integrates WMO contributions into a wider set of contributions to GFCS implementation being pursued by GFCS partners,

(3) That the activities in the *Priority Needs for the Operationalization of the GFCS (2016-2018)*, which focus on planning, technical advisory and coordination services, are a valuable complement to, and support for, climate services-related investment projects and programmes being implemented at country level,

Decides:

(1) To endorse the *Priority Needs for the Operationalization of the GFCS (2016-2018)* to guide key implementation priorities in the context of the results-based framework for WMO contributions to the GFCS during the period 2016-2018;

(2) To incorporate future priority activities for supporting WMO contributions to the GFCS, implemented through the country-focused results-based framework, in updates to the *Priority Needs for the Operationalization of the GFCS* as appropriate;

Invites Members:

(1) To consider the Priority Needs for the Operationalization of the GFCS (2016-2018) in resource mobilization efforts;

(2) To inform the Secretary-General of successful implementation of activities contained in the Priority Needs for the Implementation of the GFCS for the period 2016-2018;

(3) To provide regular updates on activities and results achieved through projects undertaken in line with the Priority Needs for the Operationalization of the GFCS (2016-2018), through the mechanism for WMO contributions to the GFCS, and on climate services implementation in general, to the Secretary-General through the GFCS Office;

Invites the Chair of IBCS to communicate emerging priorities related to the implementation of the GFCS to the Executive Council on a regular basis;

Requests the Secretary-General:

(1) To facilitate implementation of the *Priority Needs for the Operationalization of the GFCS (2016-2018)*, through the mechanism for WMO contributions to the GFCS and through linking relevant WMO Programmes and activities with those of other GFCS partners;

(2) To raise awareness concerning the *Priority Needs for the Operationalization of the GFCS (2016-2018)* among the WMO community and partners;

(3) Regularly compile information provided by Members and make it widely available to promote cross-support among Members.

Decision 13 (EC-69)

WMO SUPPORT TO IMPLEMENTATION OF INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE ACTIVITIES.

THE EXECUTIVE COUNCIL,

Recalls:

(1) That the IPCC at its 44th Session (Bangkok, Thailand, 17-20 October 2016) approved the outline of the *Special Report on Global Warming of 1.5°C* to be delivered in September 2018 and the outline of the Methodology Report to refine the 2006 Guidelines for National Greenhouse Gas inventories to be finalized in early 2019;

(2) That the IPCC at its 45th Session (Guadalajara, Mexico, 28-31 March 2017) approved the outlines of the *Special Report on the Ocean and Cryosphere in a Changing Climate and the Special Report on Climate Change and Land: An IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems*, both to be finalized in September 2019;

(3) That the Scoping meeting for the Sixth Assessment Report (AR6) was held in Addis Ababa, Ethiopia, 1-5 May 2017;

Mindful of a continued urgent need to mobilize resources for the work of the IPCC so as to ensure the completion of activities and products planned for the Sixth Assessment Report (AR6) cycle and **appreciative** of the resource mobilization efforts by the Chair and the Secretary of IPCC encouraging IPCC Members to maintain and, if possible, increase their financial support for IPCC activities;

Considering:

(1) The key role that the IPCC plays in preparing and disseminating high quality assessments to inform national and international efforts on climate change-related issues,

(2) The importance of closer cooperation between the IPCC and the sponsoring organizations, WMO and the United Nations Environment Programme (UNEP), and the opportunities for the IPCC to participate where relevant in WMO-sponsored programmes and activities such as the Global Climate Observing System (GCOS) and the WMO's *Statement on the State of the Global Climate* as well as the opportunities for referencing IPCC findings where relevant,

(3) The need to encourage the scientific community to address information and research gaps identified during the structured expert dialogue, including scenarios that limit warming to below 1.5 °C relative to pre-industrial levels by 2100 and the range of impacts at the regional and local scales associated with those scenarios,

(4) The important role of and contributions from the WMO Members and their National Meteorological and Hydrological Services (NMHSs) towards the work of the IPCC and the substantial benefits that flow to NMHSs and the IPCC through the active involvement of scientists and experts from NMHSs, especially those from developing countries, in the activities of the IPCC,

(5) That a required level of financial resources in the IPCC Trust Fund is crucial to ensure satisfactory completion of activities and products planned for the Sixth Assessment Report (AR6) cycle,

Decides to foster WMO and Members' support to research and provision of information, and engagement in activities related to the IPCC Sixth Assessment Report including all Special Reports;

Urges Members:

(1) To actively participate in the activities of the IPCC, in particular through the contribution of scientists and experts from NMHSs, especially from developing countries;

(2) To maintain close collaboration of NMHSs with the IPCC national focal points (where the focal point is not an NMHS);

(3) To consider contributing to the IPCC Trust Fund and make in-kind contributions to the work of the IPCC, as appropriate;

Requests the Secretary-General:

(1) To alert governments as to the important role NMHSs play, and encourage their active participation, in providing data and scientific contributions to the work of the IPCC;

(2) To promote active participation of WMO technical, scientific and co-sponsored programmes in the planned activities of the IPCC AR6 Products.

Decision 14 (EC-69)

SUPPORT THE DEVELOPMENT OF ACTIONS BASED ON THE GLOBAL CLIMATE OBSERVING SYSTEM IMPLEMENTATION PLAN

THE EXECUTIVE COUNCIL,

Recalls Decision 21 (EC-68) — Address priorities and gaps identified in the GCOS Status Report 2015 and Decision 22 (EC-68) — Review of the GCOS Implementation Plan 2016;

Welcomes the new implementation plan, The Global Observing System for Climate: Implementation Needs (GCOS-200), hereinafter referred to as the implementation plan, approved by the GCOS Steering Committee at its 24th session (October 2016, Guayaquil, Ecuador);

Recognizes that Parties at the 22nd session of the UNFCCC Conference of the Parties noted in decision 19/CP.22 the important role of GCOS in meeting the need for climate observation and climate services under the Convention, welcomed the new implementation plan, submitted by the GCOS secretariat and prepared under the guidance of the GCOS Steering Committee; encouraged Parties to the Convention to work towards the full implementation of the plan and to consider what actions they can take to contribute towards its implementation; and invited United Nations agencies and international organizations to support its full implementation, as appropriate;

Recognizes that the sixteenth session of CBS (CBS-16) has decided to support Members in the implementation of the actions identified in the GCOS implementation plan and especially those identified as important components of the WMO Integrated Global Observing System, which are actions: (1) related to network needs, and which ensure that observations meet GCOS requirements and that resources for networks are made available; (2) that promote open data, metadata, discoverability and long term access, and actions that ensure the delivery of operational products; and (3) aimed at promoting future improvements to the climate observing system [Decision 23 (CBS-16)];

Notes that in accordance with the GCOS implementation plan the Secretariat has coordinated an action to identify a core set of climate change indicators to be used as a basis for reporting climate change to the public (Indicators of Climate Change, GCOS-206). There are in general two types of indicator, those describing the physical state and history of the climate system, and those looking at future impact, risk and adaptation designed to inform future policy decisions. Climate indicators should meet the following criteria: relevance, representativeness, traceability, timeliness. The number of historical indicators should be limited. The proposed indicators can be grouped as follows: temperature and energy; atmospheric composition; ocean; cryosphere; land use/vegetation change; extremes and human impacts;

Notes further the performance statistics and improvement plans as detailed in the reports on the GCOS surface network, GCOS upper-air network and GCOS Reference Upper-Air Network to regional association sessions [INF. 4.4 in Part II of the present report];

Recognizes that the fifteenth session of CHy noted that 24 actions in the new GCOS implementation plan are of particular interest to CHy. The Commission appreciated the substantive contributions towards the GCOS implementation plan by the Global Terrestrial Network – Hydrology through its federated global data centres including *Global Runoff Data Centre*, *Global Precipitation Climatology Centre*, *International Groundwater Resources Assessment Centre* and the International Data Centre on Hydrology of Lakes and Reservoirs. CHy-15 in its Resolution 3/1 decided to recommend that, in view of the complexity of the GCOS implementation plan, one or more Open Panel of Commission for Hydrology Experts members explore what actions might be needed to help GCOS make better use of CHy observing capabilities, particularly to WMO Hydrological Observing System, in its hydrology and water resources-related actions;

Recognizes further that ocean-related actions will need to be implemented by JCOMM, and that actions addressed to the satellite agencies will be brought to the attention of the Committee on Earth Observation Satellites and the Coordination Group for Meteorological Satellites;

Observes that some of relevant WMO constituent bodies are already engaged in the development of work plans addressing the actions in the implementation plan;

Endorses actions pertaining to WMO and observing systems coordinated by the Organization;

Urges technical commissions and regional associations to address relevant actions in their work plans;

Invites Members to contribute to the implementation of actions as discussed in the GCOS implementation plan;

Requests the Secretary-General:

(1) To provide guidance to Members and WMO constituent bodies on actions pertaining to the systems and networks coordinated by WMO to monitor and review progress in implementation;

(2) To continue promoting a single minimal set of indicators that describes climate changes and to further refining them;

(3) To facilitate identification of a suitable institution amongst Members to take over the coordination of the Global Terrestrial Network – Hydrology at the earliest, to ensure the continued provision of services provided by GTN-H.

Decision 15 (EC-69)

STRENGTHENING REGIONAL- AND GLOBAL-SCALE CLIMATE SERVICES INFORMATION SYSTEM OPERATIONS

THE EXECUTIVE COUNCIL,

Recalling:

(1) Resolution 17 (Cg-XVI, 2011) – Implementation of the Climate Services Information System,

(2) Resolution 60 (Cg-17, 2015) - WMO policy for the international exchange of climate data and products to support the implementation of the GFCS,

(3) Decision 27 (EC-68) - Exchange of Data and Products for the Implementation of the Climate Services Information System,

Noting with appreciation:

(1) The effort of the Implementation Coordination Team for Climate Services Information System (ICT-CSIS) of the Commission for Climatology (CCl) towards operationalization of the CSIS at global, regional and national levels,

(2) The report of the Developers Meeting on the GFCS-Relevant Climate Data, Products and Tools (6-8 December 2016, Geneva, Switzerland),

(3) The report of WMO International Workshop on Climate Services Information System Operations and Coordination (21-24 March 2017, Nanjing, China),

Acknowledging:

(1) The CSIS operations and coordination approaches in support of country-level CSIS implementation, and the associated action plans are among the important outcomes of the WMO International Workshop on CSIS Operations and Coordination,

(2) That the Global Producing Centres for Long-Range Forecasting (GPCLRF), Regional Climate Centres (RCC) and RCC-Networks, designated and in demonstration phase, provide climate products and services at the global and regional scales, as an important contribution to the CSIS operations at the national level,

Having considered the recommendations of the aforesaid meetings,

Decides to strengthen regional and global-scale CSIS operations and product access by ensuring structured provision, management and access to available GFCS-relevant data and products, in compliance with the WMO Integrated Global Observing System (WIGOS) and WMO Information System (WIS) regulations, the WIS 2.0 strategy, and in alignment with seamless Global Data-processing and Forecasting Systems (GDPFS) principles and arrangements, and review progress at the seventieth session of the Executive Council;

Requests the Commission for Climatology:

(1) To continue providing technical support for the implementation of the CSIS, particularly to facilitate global and regional inputs for national CSIS operations;

(2) To work closely with the Commission for Basic Systems (CBS) to ensure close alignment of CSIS operations with the relevant aspects of WIGOS, WIS and the GDPFS;

(3) To ensure potential synergies between climate, hydrological, marine and agricultural operations and practices, where feasible, liaising with the concerned technical commissions;

Requests the presidents of CCl and CBS, in consultation with presidents of other technical commissions, to provide guidance to the regional associations on how to implement the CSIS within their regions, building on lessons learned from all Regions;

Requests the regional associations to promote the implementation of the CSIS at regional level, and to provide guidance to NMHSs in optimally utilizing global and regional CSIS products to strengthen climate services at the national scale;

Urges Members to take up and effectively utilize climate products and services provided by the CSIS, including those provided by the Global Producing Centres of Long-Range Forecasts (GPCLRFs), Regional Climate Centres (RCCs) and Regional Climate Outlook Forums (RCOFs).

Decision 16 (EC-69)

DEPLOYMENT OF THE CLIMATE SERVICES TOOLKIT

THE EXECUTIVE COUNCIL,

Recalling:

(1) Decision 23 (EC-68) on Development of a Climate Services Toolkit, endorsing the actions initiated by CCl to advance the development of the Climate Services Toolkit (CST),

(2) Decision 27 (EC-68) on Exchange of Data and Products for the Implementation of the Climate Services Information System,

Noting with appreciation:

(1) The outcomes of the Developers Meeting on the GFCS-Relevant Climate Data, Products, and Tools (6-8 December 2016, Geneva, Switzerland) that facilitated the action plan towards the development of a CST prototype,

(2) That the CST prototype has been developed by CCl ICT-CSIS and made available for initial country-level trial and feedback, particularly focusing on the country participants at the WMO International Workshop on Climate Services Information System Operations and Coordination (21-24 March, 2017, Nanjing, China),

(3) The outcomes of the WMO International Workshop on Climate Services Information System Operations and Coordination that, inter alia, identified needs and actions to promote the short- and long-term evolution of the CST and approaches for its deployment and ultimate assimilation of the data and products generated into the operational CSIS,

Acknowledging:

(1) The CCl-led review of the GFCS relevant data and products to be provided by the Global and Regional Climate Centres,

(2) The ongoing efforts for the development and improvement of the CST towards its operationalization,

Decides to endorse the outline of a consolidated action plan provided in the annex to further develop and deploy the CST, through a phased approach consisting of a short-term action to provide an optimal organization of the available tools and data and facilitate easy access, and long-term action to customize the CST for country-specific needs;

Requests Members, particularly those hosting the developers’ home institutions, to secure their institutional commitment, and to contribute the required resources, in order to ensure sustainable operation and minimize risks affecting CST implementation;

Requests CCl to assist, through its ICT-CSIS, in deploying CST effectively to support CSIS operationalization, initially in selected countries in all regional associations, and subsequently upscale to all WMO Members;

Requests the Secretary-General to seek commitment and contribution of resources from WMO Members hosting developers’ home institutions to sustain the CST deployment and continuous improvement;

Urges Members hosting developers’ home institutions to facilitate the establishment of a CST Developers’ Network to ensure effective communication and coordination of their contributions, under the auspices of CCl ICT-CSIS and the WMO Secretariat, as well as to provide in-kind translation of the outline of the CST to facilitate the experts’ work.

Annex to Decision 16 (EC-69)

OUTLINE OF A CONSOLIDATED ACTION PLAN FOR THE DEVELOPMENT AND DEPLOYMENT OF THE CLIMATE SERVICES TOOLKIT

Based on the feedback received on the initial prototype of the Climate Services Toolkit (CST), the consolidated action plan for its further development and deployment will be based on a phased approach:

1. Short-term evolution (2017-2018):

(a) Undertake stakeholder review of the CST on the completeness and correctness, and also facilitate proposals for additional tools for inclusion in the CST;

(b) The organization of the information for the CST will be based on a hybrid solution combining the initial approach of grouping all the contents under guidance and products, with a domain-oriented structure consisting of data, monitoring, prediction and projection, along with sub-categories for each domain: tutorial, guidance, training, data, tools, help desk and forum, including related cross-references among the two information presentation approaches;

(c) Terminology and prerequisites for data and tool access and use to be included in the descriptions of each CST resource;

(d) Ensure access to high quality and homogeneous data sets;

(e) Data access to be allowed through one click (rather than directing to data holdings where CST users have to click their way through different information presentation logics) including data from national Climate Data Management Systems;

(f) Coordination to be pursued with the Capacity Development and User Platform Interface pillars of the GFCS regarding tutorials and CST service delivery section, respectively;

(g) Coordination to be pursued with the envisaged GFCS Help Desk for cross-pollination and consistency;

(h) Production and provision of a CD-ROM/DVD with a minimum set of CST tools and data for countries with limited Internet access capacities, upon country-specific requests;

(i) Identification of criteria for CST resources;

(j) Provision of a Technical Reference Catalogue;

(k) Outreach to promote CST, including peer-reviewed publications, fact sheets, and user workshops.

2. Long-term evolution (2019 and beyond):

(a) Assimilation of the data, tools and products into CSIS operations using the WMO Information System (WIS) to make them discoverable, and the Global Data-processing and Forecasting System (GDPFS) to assign the functions needed to the concerned participating entities;

(b) Explore ways to customize the data, products and tools to country needs;

(c) Allow access to specific data as opposed to reference to data providers;

(d) Identify permanent hosts for the various CST functions;

(e) Implement progressive learning for the use of CST resources in building climate services capabilities at global, regional, and national levels;

(f) Facilitate process for sharing advances in research and development amongst the international climate services community;

(g) Consider translation of CST resources into WMO languages;

(h) Coordinate with relevant international activities, such as the Copernicus Climate Change Service (C3S).

Decision 17 (EC-69)

NATIONAL IMPLEMENTATION OF THE CLIMATE SERVICES INFORMATION SYSTEM

THE EXECUTIVE COUNCIL,

Recalling:

(1) Resolution 64 (Cg-17) – Development of a Results-Based Framework for WMO support to the implementation of the Global Framework for Climate Services,

(2) Decision 16 (EC-68) – Country-Focused Results-Based Framework for WMO support to the implementation of the Global Framework for Climate Services,

(3) Decision 24 (EC-68) – National Climate Outlook Forums and National Climate Forums,

(4) Decision 27 (EC-68) — Exchange of Data and Products for the implementation of the Climate Services Information System,

Noting the report of WMO International Workshop on Climate Services Information System (CSIS) Operations and Coordination (21-24 March 2017, Nanjing, China),

Recognizing that the success of GFCS implementation critically depends on effectively meeting the needs of the national-level stakeholders, which in turn depends on the CSIS implementation at the national level,

Acknowledging the need to enhance the capacity of NMHSs in terms of human and technical resources, and institutional engagement, to enable them to provide actionable information for decision-making in climate-sensitive contexts through an effective and sustained CSIS operational mechanism at the national level,

Decides to endorse a special focus on national-level implementation of the CSIS covering the core functions of data, monitoring, prediction and projection, in close alignment with the Country-Focused Results-Based Framework for WMO Support to the Implementation of the GFCS;

Requests the Commission for Climatology:

(1) To provide, with support from the Commission for Basic Systems, technical guidance to Members for establishment and implementation of the CSIS with particular attention to national-level aspects and report back at the seventieth session of the Executive Council on the progress;

(2) To promote and facilitate the utilization of Climate Services Toolkit (CST) by Members;

Requests regional associations to enable their subsidiary bodies dealing with climate services to support consolidation of country action plans for CSIS, including through relevant linkages with the concerned Regional Climate Centres (RCCs);

Requests the Secretary-General to facilitate assistance to NMHSs in implementing the CSIS, including through technical guidance and assistance in developing action plans and undertaking resource mobilization;

Urges Members:

(1) To consolidate efforts for the implementation of CSIS at country level, focusing on national priorities and seeking resource mobilization for institutional, technical, financial and human capacities for climate services;

(2) To prepare tangible action plans, both short-term and long-term, for CSIS implementation at the national level, and explore project opportunities to avail of WMO technical guidance and support;

(3) To promote application of science-based climate information, and to raise awareness and facilitate interface with stakeholders and users through National Climate Outlook Forums/National Climate Forums.

Decision 18 (EC-69)

SUB-SEASONAL AND SEASONAL FORECASTING SYSTEMS

THE EXECUTIVE COUNCIL,

Recalling:

(1) Resolution 17 (Cg-XVI, 2011) – Implementation of the Climate Services Information System (CSIS), deciding, inter alia, that CSIS will promote consensus-based approaches to facilitate common understanding and user appreciation of uncertainties through, inter alia, Climate Outlook Forums,

(2) Resolution 1 (CCl-16) – Regional Climate Outlook Forums deciding to develop technical guidance for enhancing, strengthening and expanding the RCOF process,

Noting:

(1) That, since 1997, WMO has supported the routine generation of regional consensus-based seasonal climate outlooks in most regions of the world through the RCOF process as a principal mechanism,

(2) That RCOFs constitute an important mechanism identified under the Implementation Plan of the Global Framework for Climate Services (GFCS) straddling two of its pillars – the Climate Services Information System and the User Interface Platform,

(3) That, with two decades of successful and sustained operations, the RCOFs have been widely recognized to be important and regular platforms for the networking of global, regional and national climate information providers and user representatives, and spread around the world with 19 RCOFs currently in operation,

Acknowledging that RCOFs have demonstrated many benefits, including promoting broad awareness and acceptance of seasonal forecasts, improvements in Members' capacities to develop and interpret such forecasts, and the provision of useful information for decision-making,

Recognizing:

(1) That current use of dynamical forecasts in the process of developing seasonal climate outlooks at RCOFs is mainly subjective and depends on confirming or challenging the statistical results, and the blending of individual national forecasts into a spatially coherent regional outlook on the basis of expert assessment,

(2) The limitations of subjective consensus-based approaches for the usability of forecasts, particularly at the national level, as well as the challenges they pose for evaluation of forecast skill,

(3) That, at the same time, the expert assessment taking into account many aspects, such as current climate conditions, past statistical relationships as well as the characteristics and limitations of the models used, are also still required to formulate sub-seasonal to seasonal forecasts with better forecast skill,

(4) That the longstanding RCOF process involves seasonal outlook preparation through consensus building of expert assessment, and that it is not merely a mechanical blending of the various forecast inputs,

(5) The rapid advances in dynamical modelling for sub-seasonal and seasonal forecasting, operational availability of such forecasts with greater space-time resolutions, and the need to optimize their use in the operationalization of regional forecasting systems,

(6) That further progress on operational seasonal forecasting, and the routine development of associated tailored products for decision support, will entail more widespread adoption of objective seasonal forecasting schemes that readily facilitate the tailoring of forecast products to support specific end uses,

Decides to consider the adoption of objective sub-seasonal and seasonal forecasts as an overarching technical strategy, particularly at regional and national levels, promoted through RCOFs, by adopting suitable operational practices and capacity development efforts, to be facilitated by a global RCOF review;

Requests the Commission for Climatology:

(1) To develop Technical Guidance, in collaboration with the Commission for Basic Systems (CBS), on Operational Predictions from Sub-seasonal to Longer-time Scales;

(2) To support the development of operational practices of RCOFs based on objective sub-seasonal and seasonal forecasts;

(3) To provide information back to the seventieth session of the Executive Council on how best to advance objective use of data from Global Producing Centres of Long-Range Forecasts (GPCLRFs) in forecast preparation;

Urges:

(1) RCCs and other relevant organizations cooperating on RCOFs worldwide to actively contribute to the global RCOF review;

(2) GPCLRFs and other relevant entities to support timely and regular provision of objective sub-seasonal and seasonal forecast products, in suitable digital formats and other representations, to RCCs, RCOFs, and NMHSs;

Requests the Secretary-General to facilitate the availability of objective sub-seasonal and seasonal forecasts, and support the organization of the global RCOF review, including through assistance in resource mobilization.

Decision 19 (EC-69)

INTERNATIONAL DATA-RESCUE INITIATIVE

THE EXECUTIVE COUNCIL,

Recalling Decision 39 (EC-68) – Climate Data Management Systems and data rescue resource plan,

Reaffirming the importance of maintaining and managing high-quality, long-term climate data for climate applications and research,

Acknowledging the invaluable data hosted by Members and the availability of climate data management solutions for Members to host these data once digitized,

Recognizing the prominent role of NMHSs in preserving climate records and ensuring their permanent archival in optimal conditions for use in science and application at present and in the future,

Noting that other institutions such as universities, observatories, libraries and national archiving institutions have played, and continue to play, an important role in preserving old climate records, logs and books,

Noting further the leading role of WMO in coordinating Data Rescue by providing guidance on best practices, supporting in-country projects implementation and facilitating collaboration on Data Rescue worldwide,

Welcoming the entry in operation of the WMO International Data Rescue portal as a WMO single entry point for monitoring Data Rescue activities worldwide and providing online services including technical guidance and an interface to upload information on the status of Members' Data Rescue activities and needs,

Welcoming further the achievements of the CCl Expert Team on Climate Data Management System (ET-CDMS), including the release of CDMS specifications and the formulation of a vision for the development of an Open Source reference CDMS,

Appreciating the development of a resource plan by CCl, which maps the needs and costing for Climate Data Management Systems and Data Rescue activities over the next five years,

Decides to launch an international Data Rescue initiative, structured around the CCl resource plan as summarized in the Annex, with I-DARE as an integrated platform for monitoring progress of its implementation, to be funded from voluntary contributions;

Invites Members to collaborate enthusiastically, including through twinning, and to use the International Data Rescue portal (I-DARE) to streamline information on data rescue needs and decisions on data rescue priorities;

Requests the Secretary-General:

(1) To promote the I-DARE initiative and facilitate its implementation and related outreach activities in collaboration with NMHSs and other stakeholders and donors at global,

regional and national levels and to explore the possibility of establishing a trust fund for this initiative;

(2) To promote CDMS and DARE elements in GFCS projects and activities as appropriate;

(3) To coordinate closely this initiative with related international activities in order to ensure complementarity and synergy.

Annex to Decision 19 (EC-69)

SUMMARY OF CLIMATE DATA MANAGEMENT SYSTEM AND DATA RESCUE RESOURCE PLAN

The initial focus in this Plan is on undertaking or supporting climate data rescue and Climate Data Management System (CDMS) implementation over the next five years, in developing and least developed countries (D & LDCs) that have recently expressed needs for assistance in securing and managing their data. The CDMS concept discussed in this plan encompasses data on the past, present and future (forecasts and projections) state of Essential Climate Variables (ECVs) as defined by the Global Climate Observing System (GCOS).

Preliminary indicative costings per country over five years to implement these remedial actions have been developed, informed by actual and estimated costs for similar work carried out in the Regions. In addition, a number of engagement, collaboration, and capacity-building actions that complement the financial investment and lay the groundwork for longer-term sustainability are also described. The proposed approaches will build on existing technologies and approaches, of which many fine examples exist.

For CDMS, noting the emphasis on D & LDCs, it is proposed that the three current Open Source CDMSs, viz., ClimSoft, MCH and CliDE, be the primary basis of the deployment, as these are already widely deployed in many D & LDCs, and were purposefully designed and built with the special needs of D & LDCs in mind.

For data rescue, the proposal is to build on the needs and collaboration mechanisms identified by WMO data rescue activities including regional initiatives such as Indian Ocean Data Rescue (INDARE) and West African Climate Assessment and Data Rescue (WACA-DARE), global projects such as Atmospheric Circulation Reconstructions over the Earth (ACRE) and International Environmental Data Rescue Organization (IEDRO), and individual country-initiated projects such as the Australian Government-funded data rescue efforts in the Pacific. It is also proposed to strengthen, maintain and populate the existing I-DARE portal (www.idare-portal.org), which provides a global picture of data rescue needs, and to extend this to accommodate details of data rescue needs and projects in the hydrological and marine domains as well. For the sake of efficiency it will be important to collaborate with evolving development work in data rescue and data management (an example being the EU's Copernicus Climate Change Service initiative), as well as being mindful of the potential advantages offered by emerging digital technologies.

Based on costings for existing initiatives around CDMS deployment and data rescue in the Pacific, supplemented by information from similar initiatives in Africa, an indicative cost of approximately **CHF 350,000 per country** over five years is estimated. This sum is expected to cover CDMS implementation and training (including follow-up training), maintenance, bugfixes, and some development work, and to initiate data rescue activities including securing hard-copy records under accepted "good practice" archival conditions, as well as initiating and providing some funding for inventorying, digitization and imaging programs. An important caveat is that the actual needs and amount of work needed will vary substantially across the countries, depending on what has been achieved so far, identified needs, and the quantities of data needing to be rescued. It is important to re-emphasize, however, that successful implementation of the Plan is not just about financial support, but ensuring that the countries and their NMHSs are suitably engaged, and that the collaboration mechanisms and capacity development activities required are in place.

In addition to the in-country activities, estimated costings are also provided for maintaining the I-DARE portal as a means of coordinating data rescue activities globally, and extending it to marine and hydrological data; and to develop a prototype of OpenCDMS, seen as important to the long-term cost-effective maintenance of CDMS.

The overall cost of the in-country program (35 countries) plus I-DARE is estimated to be about CHF 12.25 million and that of OpenCDMS to be about CHF 4.25 million, with a total resource requirement of CHF16.5 Million over the five years. The cost will increase with the number of countries added.

Looking to the longer term beyond five years, the following complementary activities are proposed for enhanced sustainability:

1. Raise the in-country profile of NMHS data management;

2. Ongoing training and competency development;

3. Establish partnerships with NMHSs in neighbouring countries;

4. Form partnerships with Regional Centres of excellence;

5. Regional coordination activities;

6. A pool of relevant experts able to provide support as needed to CDMS and Data Rescue;

7. Encourage development of technologies and processes for crowd-sourced digitization and imaging;

8. Promote the creation and validation of high-quality homogeneous climatic data sets in the long term, particularly at regional and sub-regional levels;

9. Open Source CDMS development, leading to a convergence of technologies over time;

10. Ongoing collaboration with global initiatives;

11. Keep abreast of, and build upon, the outcomes of broader WMO cross-programme data and information management modernization approaches and infrastructure.

To support long-term sustainability, access to a reliable pool of funding (similar to the concept of the VCP) will be required, especially to support CDMS maintenance, administration, interventions when needed, and the maintenance of I-DARE. To ensure the continuity of such a fund, it is recommended that funding from several different sources be combined into an ongoing pool.

One of the measures proposed above is to invest in converging CDMS technologies around an Open Source system that is fully compliant with the *Climate Data Management Systems Specifications* (WMO-No. 1131), but is suitably designed to accommodate data from other environmental domains such as hydrology. This should be developed independently of, but in parallel with, the activities described in this paper over the next five years. The proposal would then be to support existing CDMSs in developing countries via other elements of the Plan, while gradually transitioning into implementing and supporting OpenCDMS (see the CCl vision statement below).

Finally, the costings and projections quoted here specify only the recommended requirements, not where the funding comes from. Such sources may, however, include public-private partnerships, international development agencies, and donations including through GFCS, I-DARE, etc.

CCl Vision Statement on CDMS

Currently, significant investment is needed to maintain a multitude of CDMSs worldwide to generate data for regional and global analyses. These CDMSs are not compliant with the new WMO-recommended *Climate Data Management Systems Specifications* (WMO-No. 1131). Significant investment will be required to conform to the requirements of WMO-No. 1131.

It will be very expensive and wasteful of resources to develop the same functionality in many CDMSs. There are several open source CDMSs used by WMO Members. There is considerable potential to address this situation by rationalizing these open source CDMSs. Therefore CCl proposes that: Open source CDMS should converge on ***one Reference Open Source CDMS***, namely Open-CDMS. Investment is required to make this happen.

Decision 20 (EC-69)

CLARIFICATION ON THE FUTURE OF PROVIA AND WMO PARTICIPATION IN THE UNITED NATIONS ENVIRONMENT PROGRAMME–PROVIA COUNTRY-LEVEL IMPACTS OF CLIMATE CHANGE PROJECT

THE EXECUTIVE COUNCIL,

Recalling:

(1) Resolution 6 (EC-65) - Restructuring of the World Climate Programme: Inclusion of the Global Programme on Climate Change Vulnerability, Impacts and Adaptation (PROVIA) as an additional component,

(2) Resolution 15 (Cg-17) - The World Climate Programme (WCP),

(3) Decision 29 (EC-68) - WMO support to the implementation of the Global Programme of Research on Climate Change Vulnerability, Impacts and Adaptation (PROVIA) and the Country-Level Impacts of Climate Change Project (CLICC) Project,

Recognizing:

(1) That emerging policies, such as the Paris Agreement, that will benefit from new scientific developments and lessons learned from the past programmes, provide a continuing rationale for WMO engagement in the UNEP-led PROVIA,

(2) That improved coordination of international research on the impacts of, and responses to, climate change will promote the provision of credible scientific information such as is being increasingly requested by decision-makers, and as is exemplified in the Working Group II report of the Intergovernmental Panel on Climate Change (IPCC),

Acknowledging that the Scientific Steering Committee of PROVIA met in 2016 and discussed the future of the programme and strengthened cooperation with WMO,

Noting that multidisciplinary partnership and collaboration will improve methodologies for conducting and communicating impact assessment in climate sensitive sectors and facilitate identifying key environmental thresholds,

Having considered that the CLICC project is a specific initiative under PROVIA, led by the United Nations Environment Programme (UNEP), to facilitate global understanding of country-level climate impacts to support action on climate change, by informing national mitigation and adaptation planning, and international dialogue,

Having examined the reports of the CLICC Pilot Phase project in six countries: China, Fiji, Ghana, the Russian Federation, the United Kingdom of Great Britain and Northern Ireland and Viet Nam during 2015-2016,

Observes:

(1) That the country reports employ extremely diverse impact assessment methodologies, whose initial finding are presented in many different ways, making it difficult to interpret and compare results;

(2) That there is an absence of common approaches, preferred timescales and rationale for the choice of sectors (water, health, agriculture and disaster risk reduction) analysed;

(3) That greater consistency in the assessment and communication of impacts and vulnerabilities at country level is both possible and necessary in order to maintain the level of scientific credibility required to support climate change policy formulation and implementation;

Decides to focus further WMO engagement in PROVIA on UNFCCC related activities, National Adaptation Plans (NAPs), IPCC assessment reports, and supporting implementation of the Paris Agreement;

Invites UNEP to clarify the scope of PROVIA, its current initiatives and governance arrangements, and to collaborate with WMO on a PROVIA workplan to strengthen scientific approaches and generate the knowledge needed to meet the evolving needs of UNFCCC stakeholders;

Invites Members to engage in regional and national workshops to assist in the preparation of NAPs and to offer venues for this purpose;

Requests the Secretary-General to seek clarification with respect to the above issues and PROVIA's future directions and to make recommendations with respect to WMO future engagement to the seventieth session of the Executive Council;

Further invites the Commission for Climatology to interact with the CLICC project in any future phases through provision of methodologies and impact-based monitoring tools, capabilities and networks.

Decision 21 (EC-69)

REGIONAL BASIC OBSERVING NETWORK

THE EXECUTIVE COUNCIL,

Noting:

(1) The *Manual on the Global Observing System* (WMO-No. 544), Volume I, Part III, Regulations 2.1.3.1-2.1.3.5, and the definitions of the Regional Basic Synoptic and Climatological Networks,

(2) Resolution 2 (EC-68) – Plan for the WMO Integrated Global Observing System pre-operational phase (2016-2019),

Recognizes:

(1) The need to integrate the Regional Basic Synoptic Network (RBSN) and the Regional Basic Climatological Network (RBCN) into the future Regional Basic Observing Network (RBON) and include additional observing stations/platforms into the RBON in order to reflect its multi-disciplinary nature in support of all WMO application areas,

(2) That the RBON will lead to improved services by delivering more and improved observations to stakeholders, and enable the full benefit of regional observing capabilities to be realized;

Having considered:

(1) Decision 21 (CBS-16) – Regional Basic Observing Network (RBON) concept,

(2) Decision 13 (RA II-16) – Pilot Regional Basic Observing Network in Regional Association II,

(3) That the stations/platforms currently comprising the RBSN and RBCN are the primary candidates for the RBON, and are expected to constitute the backbone of the RBON,

(4) The need to facilitate a transition from RBSN and RBCN to the future RBON through a pilot project,

(5) The need to engage the regional associations into committing new observing systems to meet the needs of WMO Applications,

(6) That the CBS is leading the ongoing development of the Concept incorporating feedback from all stakeholders,

(7) That the CBS is initiating the development of regulatory material describing the RBON and the obligations of the WMO Members in its implementation, to be included in the next edition of the *Manual on the WMO Integrated Global Observing System* (WMO-No. 1160) to be submitted to Cg-18 in 2019,

(8) The need to convert data from other parties from native to WMO standard format and the need to calibrate Automatic Weather Stations (AWS),

Decides to endorse the Regional Basic Observing Network (RBON) concept (hereafter referred to as "RBON Concept") as provided in the Annex;

Requests regional associations:

(1) To review the RBON Concept and provide their comments to the Secretary-General for consideration by the CBS in its review;

(2) To establish, on the model of RA II through Decision 4.3(1)/2 (RA II), pilot RBON in each WMO Region, comprised initially of the merging of all RBSN and RBCN stations of that Region;

Requests Members to actively participate in the further development of the RBON Concept, and propose inclusion of additional surface-based observing stations, such as weather radars, wind profiler systems, lightning detection systems, data buoys, voluntary observing ships and aircraft, in the Pilot RBON established by the regional association.

Annex to Decision 21 (EC-69)

THE REGIONAL BASIC OBSERVING NETWORK CONCEPT

1. Preamble

The Regional Basic Synoptic Network (RBSN) and Regional Basic Climatological Network (RBCN)[1] consist of surface stations and upper-air stations designated by the regional associations. They have proven to be highly effective and made valuable regional contributions to the activities of WMO and its Members. The observations from these stations, which are maintained by WMO Members, have been exchanged globally in real-time without restriction. Originally designed to support operational meteorology and climatology, these observations have produced significant benefits across a wide range of applications.

Additional and emerging requirements for observations across diverse application areas are driving the need to redefine the Regional Basic Synoptic and Climatological Networks. New and improved observational technologies provide the opportunity to reassess regional observational strategies. The WIGOS framework calls for a more integrated view of WMO observing systems to serve the needs of multiple application areas. The new Regional Basic Observing Network (RBON) will lead to improved services by delivering more and improved observations to stakeholders, and enable the full benefit of regional observing capabilities to be realized. As such, RBON will be a substantive and valuable subset of WIGOS.

Cg-17 decided that the development of WIGOS will continue during its pre-operational phase as one of the WMO strategic priorities in the period 2016-2019, with a focus on the regional and national implementation. As part of the regional WIGOS implementation, the RBON is being introduced to replace the existing RBSN and RBCN networks.

2. Draft concept of Regional Basic Observing Network (RBON)

RBON will be a subset of WIGOS, typically used in combination with space-based and remaining surface-based observing elements of WIGOS in any given application. By design, the RBON will be interoperable with many such remaining observing capabilities. RBON will help to

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[1] RBSN and RBCN are defined in the *Technical Regulations* (WMO-No. 49), Volume I, Definitions, and further elaborated in the *Manual on the Global Observing System* (WMO-No. 544), Part III

address many, but not all, of the requirements that Members have for WIGOS. Design, execution and management of a RBON will be made in the context of the broader WIGOS.

2.1 Definition of a RBON

2.1.1 In each WMO Region, and in Antarctica, the RBON consists of surface-based meteorological and related observing stations/platforms; it responds to the collective needs of its Members, allowing them to fulfil their mandates and responsibilities in the provision of products and services. The RBON is established and managed by the respective regional associations and the WMO Executive Council (in the case of Antarctica).

2.1.2 The RBON constitutes a selected subset of existing observing systems within WIGOS arising from the Region. The network capabilities will respond to user observational requirements at the national, regional and global levels, identified by the Rolling Review of Requirements (RRR) process[2].

2.1.3 The RBON will operate in support of not only weather forecasting and climate monitoring, but also aiming to address as many as possible of the following WMO application areas:

(a) Global numerical weather prediction (GNWP);

(b) High-resolution numerical weather prediction (HRNWP);

(c) Nowcasting and very short-range forecasting (NVSRF);

(d) Sub-seasonal to longer prediction;

(e) Aeronautical meteorology;

(f) Ocean applications;

(g) Agricultural meteorology;

(h) Climate monitoring (as undertaken through the Global Climate Observing System (GCOS));

(i) Climate applications;

(j) Atmospheric chemistry related application areas.

2.1.4 The RBON will comply with the Principles for observing network design and planning[3], paying particular attention to those aspects of the Principles as will be regulated in a new section on the RBON in the *Manual on WIGOS*.

2.2 The key attributes of the new RBON encompasses (not exclusive):

(a) Requirements for real-time and near-real-time data exchange at the global level;

(b) Requirements for regular updates of WIGOS metadata in the Observing Systems Capability Analysis and Review tool (OSCAR);

(c) Requirements for data exchange in defined WMO formats;

(d) Commitment to operate and maintain the station/platform in the RBON for a minimum of four (4) years;

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[2] see the *Manual on WIGOS* (WMO-No. 1160), section 2.2.4 and Appendix 2.3

[3] See the *Manual on WIGOS* (WMO-No. 1160), section 2.2.2 and Appendix 2.1

(e) Requirements for a higher frequency of data (hourly and sub-hourly data) and daily climate summaries;[4]

(f) Requirements for provision of required climate messages;

(g) Requirements for complying with the WIGOS quality management according to the *Manual on WIGOS*;

(h) Requirements for change management according to the *Manual on WIGOS*;

(i) Requirements for (regional) multilateral arrangements for inclusion of systems that cover more than one Region;

(j) Requirements to support as many as possible of the WMO application areas;

(k) Stations/platforms are not limited to those under the responsibility of the National Meteorological and Hydrological Services (NMHSs).

2.3 Process for the selection of stations/platforms into RBON

(a) The regional association (RA) will prioritize the WMO application areas relevant to its Region;

(b) The stations/platforms will be selected so that the RBON observations together with other sources of observations available regionally, including satellite observations, allow horizontal resolution requirements as recorded in OSCAR are met at least at the threshold level;

(c) The stations/platforms will be selected in such a way that at least the threshold, but preferably breakthrough, user observational requirements as recorded in OSCAR for vertical resolution (profile data), observing cycle, timeliness, uncertainty and stability are met;

(d) The selection will be done by the relevant regional group designated by the respective RA (e.g., a future possible Regional WIGOS Centre or other dedicated groups) with participation of experts, including users and data providers, from its Members, and well-coordinated with bodies (e.g. JCOMM) governing some of these observing systems;

(e) The proposal for RBON, including an action plan to deal with the identified gaps, will be submitted to the RA session for consideration and adoption through a resolution.

2.4 Criteria for the selection of stations/platforms into RBON

Only those stations/platforms that meet the following requirements can be selected:

(a) Stations/platforms will be capable of exchanging data in real-time or near-real-time on a global level;

(b) Stations/platforms will be capable of exchanging data in the WMO data representation formats (note: other parties may provide a conversion from local to WMO formats) with assistance from the NMHSs;

(c) Stations/platforms recorded in OSCAR will be considered;

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[4] Details on frequency of observations depending on the observing system and type of the observation will be specified in the technical regulations

(d) Stations/platforms will have a commitment to operate for a minimum of four (4) years;

(e) Stations/platforms will be capable of providing preferably hourly and sub-hourly data;

(f) Stations/platforms will comply with the Regional Quality Assessment;

(g) Change management procedures, including reporting, will be respected.

2.5 Monitoring of RBON

(a) RBON will be monitored against the requirements on a regular basis by one or more recognized global/regional centres, which will identify non-conforming stations/ platforms;

(b) Members will respond to any incident management finding within a defined and agreed time frame appropriate to regional capabilities and expectations.

2.6 Management of RBON

(a) The regional group will regularly analyse monitoring reports and assist those Members whose stations/platforms do not conform with the regional quality assessment;

(b) Members will inform the regional group on action taken to address long-term deficiencies vis-à-vis regional monitoring findings;

(c) Stations/platforms that, in the long-term, do not conform with the defined regional WIGOS quality standards will be proposed for removal from the RBON and the relevant Members consulted;

(d) In the intersessional period, minor changes in RBON can be authorized by the president of the RA based on the request of the corresponding Permanent Representative if supported by the relevant regional group;

(e) Identified gaps in the RBON observing capabilities will be documented and submitted to the RA session and an action plan will be proposed on how to fill the gaps.

2.7 Types of stations/platforms expected to be included in a RBON

According to the classification used in the OSCAR/Surface, the type of station/platform to be included in the RBON could be as follows:

(a) Land (fixed/mobile/on ice);

(b) Sea (fixed/mobile/on ice);

(c) Lake/River (fixed/mobile);

(d) Air (fixed/mobile).

For fixed stations/platforms, a commitment is made to observe at that location, whereas for mobile types the commitment is to assuring the observing programme as a whole to the extent declared.

2.8 Possible candidate stations for a RBON

The stations/platforms currently comprising the Regional Basic Synoptic Networks (RBSN) and the Regional Basic Climatological Networks (RBCN) are the primary candidates for the RBON, and are expected to constitute the backbone of the RBON. Those will be supplemented by other types of stations/platforms, such as weather radars, aircraft-based meteorological stations, wind profilers, lightning detection systems, voluntary observing ships and buoys. These stations/platforms need not necessarily be operated only by NMHSs.

More specifically:

(a) Automatic Weather Stations (AWS) are particularly significant as they provide a convergence of technology which is being used for weather forecasting and climatological requirements;

(b) Conversely, there is a divergence of technologies providing upper-air observations, so RBON will be a composite system of radiosondes, ground-based remote sensing, and the regional observations from aircraft based observing systems (e.g. AMDAR);

(c) Weather radar stations provide observations for which there are new requirements for international exchange, and hence will be an important element of RBON.

3. Further background and reference material for the Regional Basic Observing Network concept

The RBON is a subset of WIGOS stations selected essentially for global exchange, addressing the Vision for the Global Observing System in 2025 and responding to the Rolling Review of Requirements (RRR) and the Implementation Plan for the Evolution of Global Observing Systems (EGOS-IP)(the period up to 2025) (WIGOS Technical Report No. 2013-4) (as listed in the Annex).

The RBON complies with the Observing Network Design Principles as defined in the *Manual on WIGOS*. OSCAR is a key tool for: (i) recording user observational requirements agreed at the global and regional levels; and (ii) for collecting and recording RBON station metadata and their capabilities; hence particularly facilitating monitoring activities, gap analysis, and the planning for the evolution of RBON. Relevant reference material is provided below.

References:

1. Manual on the WMO Integrated Global Observing System (WMO-No. 1160)

2. Vision for the Global Observing System in 2025 (available at http://www.wmo.int/pages/prog/www/OSY/Publications/Vision-2025/Vision-for-GOS-in-2025_en.pdf)

3. WIGOS OND Principles Guidance (under development)

4. Guidance on the RRR process (Manual on WIGOS (WMO-No. 1160), Appendix 2.3; Guide to the Global Observing System (WMO-No. 448), Part II, Observational Data Requirements, 2.3.1)

5. Implementation Plan for the Evolution of Global Observing Systems (EGOS-IP) (WIGOS Technical Report No. 2013-4)

Decision 22 (EC-69)

VISION FOR THE WMO INTEGRATED GLOBAL OBSERVING SYSTEM IN 2040

THE EXECUTIVE COUNCIL,

Recalls Resolution 2 (EC-68) - Plan for the WMO Integrated Global Observing System Pre-Operational Phase 2016-2019;

Acknowledges the contributions made by many technical commission experts, representatives from regional associations and WMO partner organizations related to observation;

Having considered the way toward an integrated Vision for WIGOS in 2040 agreed by the Workshop on the Vision for WIGOS in 2040 (Geneva, Switzerland, 18-20 October 2016);

Having further considered Decision 24 (CBS-16) - Vision for the WMO Integrated Global Observing System in 2040;

Recommends that the Vision should address the following elements within its overall structure:

(1) Themes, needs, environment scan;

(2) Drivers, directions, dependencies;

(3) Trends and possibilities;

(4) Aspirations;

(5) Integration and complementarity of surface and space;

(6) Common elements;

(7) Specific space and surface elements;

Recommends further that the current draft Vision developed by a community of technical commission experts and representatives by the space agencies and user communities under the leadership of ICG-WIGOS [EC-69-inf05-1(1)-WIGOS-Decisions-VISION-2040_en, in Part II of the present report] be used as the basis for further consultation with Members, satellite operators, and user communities;

Decides that the Intercommission Coordination Group on the WMO Integrated Global Observation System (ICG-WIGOS) take ownership of the further development of the Vision, including the work necessary for the integration of the two drafts into one coherent Vision document, with a view to have it approved by the Eighteenth World Meteorological Congress in 2019.

Decision 23 (EC-69)

STANDARDIZATION OF OBSERVING SYSTEMS INSTALLED ON SHIPS

THE EXECUTIVE COUNCIL,

Having considered Recommendation 30 (CBS-16) - Standardization of Observing Systems Installed on Ships,

Noting that the Surface Marine Operational Service (E-SURFMAR) of the Economic Interest Group grouping of European National Meteorological Services (EUMETNET) has worked extensively to develop the new E-SURFMAR Shipboard Automatic Weather Station (AWS) system named EUCAWS (European Common AWS) with detailed design specifications and recommendations,

Noting further that:

(1) Tendering documents for shipboard AWS system were issued in mid-2012 and following detailed evaluation of the tenders, EUMETNET has decided to establish a framework agreement for manufacturers to fulfil,

(2) There are some other efforts for developing shipboard AWS systems,

Having considered the importance of standardizing marine meteorological observations installed on ships with the view to providing homogeneous observational data of known quality, and to facilitate the maintenance of instruments and data acquisition equipment by the port meteorological officers (PMOs),

Invites Members to collaborate in the European and others efforts, to facilitate standardization of AWS systems and their observations installed on ships as well as the maintenance of such systems by PMOs.

Decision 24 (EC-69)

NUMERICAL WEATHER PREDICTION IMPACT ASSESSMENT FOR OBSERVING SYSTEM DESIGN AND EVOLUTION

THE EXECUTIVE COUNCIL,

Having considered Recommendation 31 (CBS-16) – Impact Assessment for Observing System Design and Evolution,

Adopts Recommendation 31 (CBS-16);

Requests CBS to organize the Seventh WMO Workshop on the Impact of Various Observing Systems on NWP in the 2020 time frame;

Request Members:

(1) To continue the development and research of adjoint- and ensemble-based observation impact assessment tools, as a complement to traditional OSEs;

(2) To develop OSEs for the optimization of regional composite networks;

(3) To address the science questions listed in the Annex to Recommendation 31 (CBS-16), and have Numerical Weather Prediction Centres to undertake the required impact studies (e.g. OSEs, OSSEs) during the period 2017 to 2020;

(4) To volunteer hosting the Seventh WMO Workshop on the Impact of Various Observing Systems on NWP in 2020.

Decision 25 (EC-69)

STUDY TO BE UNDERTAKEN TO ANALYSE OPTIONS FOR OPTIMIZATION OF THE UPPER-AIR OBSERVATIONS PROGRAMME OF THE GLOBAL OBSERVING SYSTEM

THE EXECUTIVE COUNCIL,

Noting the report of the Sixth WMO Workshop on the Impact of Various Observing Systems on Numerical Weather Prediction (NWP) (Shanghai, China, 10–13 May 2016),

Having considered:

(1) Recommendation 32 (CBS-16) – Study to be Undertaken to Analyse Options for Optimization of the Upper-Air Observations Programme of the Global Observing System (GOS),

(2) The recommendations of the Implementation–Coordination Team on Integrated Observing Systems and of the Sixth WMO Workshop on the Impact of Various Observing Systems on NWP,

Recognizing Action G10 of the EGOS-IP, which calls for Members to "Investigate possibility to optimize the radiosonde network in order to make the upper-air conventional observation coverage more uniform taking into account all the user requirements in terms of space and time distribution; and make relevant recommendations to the CBS for updating Technical Regulations accordingly",

Further recognizing that:

(1) Radiosonde data is continually shown by model adjoint studies to be located in the top five (out of approximately 40) data systems in providing value to numerical predictions,

(2) Radiosonde data is the only observing system to provide independent measures of temperature, moisture, and wind at the same place and same time with detailed vertical resolution,

(3) These types of data become increasingly important in adequately representing the atmosphere in extreme events,

(4) The data helps to eliminate bias in other observing systems used in data assimilation that initializes numerical prediction systems,

and therefore great care should be applied in the assessment and optimization of the global radiosonde network,

Acknowledging the growth over the past several decades and the expected continued growth in the future of the Aircraft Meteorological Data Relay (AMDAR) observing system and the volume of aircraft-based observations on the Global Telecommunications System,

Having examined the plan provided in the Annex to Recommendation 32 (CBS-16) for the project aimed at assessing evidence of the impact of a potential change to the radiosonde network configuration based on complementary optimization with the AMDAR observing system (hereafter referred to as "Radiosonde Optimization Study Plan"),

Endorses the Radiosonde Optimization Study Plan as provided in the Annex to Recommendation 32 (CBS-16);

Acknowledging the CBS initiative to undertake coordination and implementation of that Plan,

Agrees that the Radiosonde Optimization Study Plan should be implemented with extrabudgetary contributions from Members;

Invites Members to support the execution of the Radiosonde Optimization Study Plan.

Decision 26 (EC-69)

RESPONSIBILITY FOR OVERSIGHT OF INFORMATION ABOUT SPACE WEATHER AND WEATHER RADAR OBSERVING CAPABILITIES HELD IN THE OBSERVING SYSTEMS CAPABILITY ANALYSIS AND REVIEW TOOL

THE EXECUTIVE COUNCIL,

Noting:

(1) Decision 35 (EC-68) – Inter-Programme Expert Team on Operational Weather Radars,

(2) Decision 33 (EC-68) - Four-year plan for activities related to space weather,

(3) Decision 16 (CBS-16) – Responsibilities for the oversight and review of OSCAR,

Having considered Recommendation 44 (CBS-16) - Responsibility for oversight of information about space weather and weather radar observing capabilities held in OSCAR,

Decides that:

(1) The Inter-Programme Expert Team on Operational Weather Radars should have the following added to its terms of reference: "oversee the development and review of the Observing Systems Capability Analysis and Review tool (OSCAR) by integrating and improving the Weather Radar Database (WRD) so that it meets the needs of WIGOS for information operational weather radar observing system capabilities";

(2) The Inter-Programme Team on Space Weather Information, Systems and Services (IPT-SWeISS) should have the following added to its terms of reference: "oversee the development and review of OSCAR so that it meets the needs of the WMO Integrated Global Observing System (WIGOS) for information concerning user space weather observing system capabilities";

Urges Members to register their weather radar information (metadata) in the WRD which will be made interoperable with OSCAR through machine to machine interface.

Decision 27 (EC-69)

DEVELOPING THE WMO INTEGRATED GLOBAL OBSERVING SYSTEM STANDARDIZATION OF OBSERVATIONS REFERENCE TOOL

THE EXECUTIVE COUNCIL,

Recalls Resolution 2 (EC-68) - Plan for the WMO Integrated Global Observing System pre-operational phase 2016-2019;

Having considered the recommendation of Cg-17 on the further development of "Standardization of Observations" Reference Tool (SORT) being critical for WIGOS,

Observes that SORT, being a tool to electronically navigate complex regulatory and guidance material with multiple cross references, would address an overall need for the Organization, rather than a need being specific to just WIGOS;

Agrees that the development of SORT should be part of a WMO larger document effort to facilitate navigating its regulatory and guidance material;

Agrees further that resources required for its development and subsequent operation should be guaranteed;

Requests the Secretary-General to make the development of SORT an Organization-wide activity rather than something unique to WIGOS;

Urges Members to contribute to the WIGOS Trust Fund, or in terms of secondments, in order to support further development and subsequent sustainable operation and maintenance of SORT.

Decision 28 (EC-69)

TROPICAL PACIFIC OBSERVING SYSTEM 2020

THE EXECUTIVE COUNCIL,

Noting that the Seventeenth World Meteorological Congress urged Members to enhance through partnership their contributions in support of the implementation and operations of the tropical moored buoy arrays, in particular in the Tropical Pacific Ocean, where data availability has dropped substantially in the last two years,

Noting further the first report on the Tropical Pacific Observing System 2020 project (TPOS 2020), which defines TPOS 2020 as is an international, limited-term effort to enhance and redesign the Observing System in the Tropical Pacific Ocean, and identifies the sponsors of TPOS 2020, which include individual institutions and agencies who are providers and users of ocean information in the Pacific Ocean region, as well as relevant intergovernmental bodies such as the Global Ocean Observing System (GOOS), the Global Climate Observing System (GCOS), and the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM),

Recognizing that while TPOS is motivated by challenges sustaining the Tropical Moored Buoy Arras (TMA), and that the project addresses observing system requirements as a whole, and the optimum multiplatform mix to meet these requirements, both satellite and in situ,

Recognizing further that:

(1) The main driver of the project is an identified significant risk to El Niño–Southern Oscillation (ENSO) predictions and associated services due to the deterioration of the TMA in the Pacific in 2012-2014,

(2) The TPOS network aims to mitigate this risk as well as to accelerate advances in the understanding and prediction of tropical Pacific variability and its profound consequences to multiple sectors, ranging across agriculture, marine ecosystems, human health and disaster preparedness, around the globe,

(3) In response to other science drivers, especially climate, TPOS 2020 will continue key observational records, intensify monitoring of key upper ocean/surface atmosphere parameters and phenomena, include ocean biogeochemistry and expand to both the eastern and western boundary regions,

Acknowledging that the first report on the Tropical Pacific Observing System 2020 project includes recommendations for the sustained backbone observing system, and identification of pilots and process studies to further refine the future design and targeting forecast model systematic errors, and that key actions include:

(1) Addressing degraded sampling in the West Pacific,

(2) Staged reconfiguration of the tropical Pacific moored buoy array,

(3) A step-by-step increase in Argo (beginning in the western Pacific),

(4) Retargeted flux measurements (and a series of assessments and sensitivity experiments to better inform future recommendations),

(5) That tropical Pacific surface winds and wind stress remain a significant issue,

Decides that TPOS 2020 is now recognized as a WIGOS Pre Operational Regional Pilot, and that its implementation and transition back into the global sustained observing system is coordinated by the TPOS 2020/JCOMM Transition and Implementation Task Team;

Requests Intercommission Coordination Group on WIGOS and JCOMM to facilitate implementation of this Decision;

Requests Members to actively engage, collaborate and contribute resources towards implementing the recommendations of the first report on the Tropical Pacific Observing System 2020 project;

Invites JCOMM to consider working with GOOS to ensure that similar activities can be undertaken in other ocean basins based on the example of TPOS 2020.

Decision 29 (EC-69)

EDUCATION AND OUTREACH STRATEGY FOR BUOY VANDALISM

THE EXECUTIVE COUNCIL,

Recalling the Decision 49 (EC-68) - Technical assessment of the Marine Meteorology and Oceanography Programme,

Noting the IOC of UNESCO Decision EC-XLIX/3.4, Part III – Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems, requesting IOC and WMO, working through the Data Buoy Cooperation Panel (DBCP) and the IOC Working Group on Tsunami and Other Hazards Related to Sea-level Warning and Mitigation Systems, to develop a regionally relevant education and outreach strategy (for discussion in 2017), that could be jointly implemented by IOC and WMO and their Member States, the Food and Agriculture Organization of the United Nations (FAO), the fisheries sector and other relevant organizations in order to substantially reduce damage through vandalism or interference with ocean data buoys,

Noting the draft Outreach Strategy to Reduce Damage to Ocean Data Buoys from Vandalism or Interference as developed by the Data Buoy Cooperation Panel (DBCP) as per Decision 49 (EC-68),

Having considered that the proposed draft strategy is expected to help mitigating data buoy vandalism with goals to:

(1) Develop regionally and nationally relevant education materials,

(2) Enhance national, regional, and international coordination and cooperation to protect data buoys,

(3) Identify key stakeholder groups and enhance education and outreach efforts to those stakeholders,

(4) Implement education and awareness to build compliance and support enforcement,

Acknowledging that the draft strategy is still under review by the IOC of UNESCO Working Group on Tsunami and Other Hazards Related to Sea-level Warning and Mitigation Systems, the Food and Agriculture Organization of the United Nations (FAO), and other relevant organizations with the goal to be finalized and endorsed at the fifth session of JCOMM in 2017,

Requests:

(1) JCOMM, through the DBCP, to continue to seek input from relevant international organizations and work to finalize the strategy by October 2017 for submission to EC-70 for final approval;

(2) Members to actively engage, support and collaborate in the efforts of the DBCP and its Working Group on Data Buoy Vandalism to collect existing education and outreach materials related to national or regional mitigation of data buoy vandalism efforts;

Urges Members to take action to prevent and mitigate the effects of vandalism for other types of observing platforms such as AWS.

Decision 30 (EC-69)

GUIDANCE ON ESTABLISHING REGIONAL WMO INTEGRATED GLOBAL OBSERVING SYSTEM CENTRES IN PILOT PHASE

THE EXECUTIVE COUNCIL,

Recalls Resolution 2 (EC-68) - Plan for the WMO Integrated Global Observing System (WIGOS) pre-operational phase 2016-2019, and Decision 30 (EC-68) - Regional WMO Integrated Global Observing System Centres;

Having examined the Guidance developed by the Intercommission Coordination Group on WIGOS on establishing a WMO Regional WIGOS Centre in pilot phase,

Decides to endorse the Guidance on establishing a WMO Regional WIGOS Centre in pilot phase (thereafter referred to as “RWC guidance”) as provided in the Annex to this Decision as technical guidance to regional associations for establishing such a RWC and its implementation arrangements;

Requests regional associations to support the establishment of RWC(s) in their Region;

Urges Members:

(1) To familiarize themselves with the RWC guidance;

(2) To actively participate in the implementation of RWCs in their Region, in collaboration with other RWCs where applicable;

Requests the Secretary-General to provide the necessary assistance and Secretariat support for the establishment of RWCs in the WMO Regions;

Authorizes presidents of regional associations to approve the pilot RWC(s) with applications from Members;

Invites the regional partner organizations to participate in establishing RWC(s) in the Region.

Annex to Decision 30 (EC-69)

ESTABLISHING REGIONAL WMO INTEGRATED GLOBAL OBSERVING SYSTEM CENTRES IN PILOT PHASE

WORLD METEOROLOGICAL ORGANIZATION

WMO INTEGRATED GLOBAL OBSERVING SYSTEM (WIGOS)

ESTABLISHING A REGIONAL WIGOS CENTRE

IN PILOT MODE

DURING THE WIGOS PRE-OPERATIONAL PHASE 2016-2019

(Technical Guidance)

EXECUTIVE SUMMARY

According to the decision of the Seventeenth World Meteorological Congress (Cg-17, 2015), the concept development and initial establishment of Regional WIGOS Centres (RWCs) is one of five priority areas for the WIGOS pre-operational phase 2016-2019. The RWCs will play a critical role in advancing the implementation of WIGOS within their Region (or subregion) and will be providing regional coordination and technical support to Members.

RWCs will be working closely with data providers to facilitate primarily: (i) regional WIGOS metadata management (OSCAR/Surface); and (ii) regional WIGOS performance monitoring and incident management (WIGOS Data Quality Monitoring System).

This document provides: (i) the justification of the Project; (ii) its alignment with WMO strategic priorities and Member's priorities; (iii) compliance with WMO regulations and rules; (iv) description of the Project; and (v) its implementation arrangements.

CONTENT

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1. INTRODUCTION

This document describes how to establish a Regional WIGOS Centre in Pilot mode to support and coordinate the WIGOS implementation activities in a given WMO Region or subregion.

2. RATIONALE

Congress-17 decided that WIGOS, supported by WIS, is one of the WMO strategic priorities for 2016-2019. Subsequently, the concept development and initial establishment of Regional WIGOS Centres (RWCs) was identified as one of five priority areas for the WIGOS pre-operational phase 2016-2019.

EC-68 recognized the critical role that Regional WIGOS Centres (RWCs) will play in advancing the implementation of WIGOS at the regional level by providing regional coordination, technical guidance, assistance and advice to Members and regional associations in accordance with *Technical Regulations* (WMO-No. 49), Volume I – General Standards and Recommended Practices, and its Annex VIII, *Manual on the WMO Integrated Global Observing System* (WMO-No. 1160).

The WMO Regions differ in terms of WIGOS readiness, economic strength, cultural and linguistic characteristics, and these differences need to be taken into account in establishing and operating their respective RWCs.

EC-68 endorsed the "Concept Note on establishment of WMO Regional WIGOS Centres" (thereafter referred to as "RWC Concept", and included as Annex 1 to this document) as general guidance to regional associations outlining the basic principles and providing a clear specification of mandatory and optional functions.

3. PROJECT DESCRIPTION

3.1 Objectives

Expected results of establishing a RWC in pilot phase include an assessment of the feasibility of subsequently establishing a fully operational RWC, and, based on the final project evaluation, a set of recommendations on key aspects of such a centre, including institutional set-up, concept of operations and strategy for long-term sustainability.

3.2 Terms of Reference

The Terms of Reference (to include the main WIGOS functionalities offered by the Centre) must be defined; as a minimum, they must include the mandatory functions as specified in the RWC Concept (see Annex 1); however, depending on available resources and the willingness of the Member with primary responsibility for the RWC, one or more optional functions may be considered, e.g. assistance with regional and national observing network management, calibration support, education and training.

3.3 Infrastructure

3.3.1 Basic infrastructure

In order to ensure a rapid start-up for the Centre, it would be desirable for the host country to make available to the Centre, either permanently or on a temporary basis, adequate, secure, fully-equipped, and easily accessible premises. These premises must be supplied with water and electricity and be equipped with a reliable telecommunications system.

3.3.2 Technical infrastructure

The Centre must have adequate IT facilities and infrastructure (work stations, high speed Internet access, data processing and storage capabilities) needed for RWC mandatory functions.

4. RESOURCING

There is no funding for RWC operations in the regular WMO budget. The responsibility for funding the establishment and operations of an RWC thus rests with the Member(s) involved. Suitable resources for establishment and sustained operations of the Centre must be identified. The amount and nature of resources required will depend on the intended functionalities of the Centre.

In order to ensure the long-term sustainability of the RWC, the Pilot phase should include the development of a long-term funding strategy based on effective resource mobilization where appropriate.

4.1 Human resources

The necessary human resources (management staff, scientific staff, technical staff and administrative staff) should be specified in terms of competencies and number of staff (expressed in full-time equivalents) allocated to the RWC development and operations. The staff may be permanent NMHS employees or may be temporarily hired project staff. Where appropriate, some of the responsibilities of the RWC may be fulfilled through secondment of staff from other WMO Members in the Region.

4.2 Funding resources

The responsibility for funding the RWC operations rests with the Member(s) involved, and it is expected that efficiencies facilitated by the RWC in designing, procuring and operating the observing systems will offset most of these costs. Nonetheless, there will be less well-resourced Members that will have difficulties in identifying the required resources at the national level. In these cases the RWC partner(s) will have to develop effective resource mobilization strategies with a view to deriving maximum benefit from the various multilateral funding mechanisms, and regional development institutions, etc. The WMO Secretariat is prepared to support all stages of such resource mobilization efforts.

5. IMPLEMENTATION STAGES

To be designated as a WMO RWC, after the launch period (start-up phase), there must be a successful pilot phase, after which the Centre may enter an operational phase.

5.1 Start-up phase

The RWC candidate will contact the president of the respective WMO Regional Association (P/RA) in writing through, and with the endorsement of, the Permanent Representative(s) of the Member(s) with WMO in which the RWC candidate is situated, expressing its intent to be designated as a WMO RWC in Pilot Mode. The Application template for a RWC candidate is reproduced in Annex 2.

P/RA, in close collaboration with the management group and related expert group of the RA, Intercommission Coordination Group on WIGOS (ICG-WIGOS), and the WIGOS Project Office in the WMO Secretariat, will consider the proposal. The candidate(s) will follow recommendations and guidance for further elaboration of the proposal.

During this phase, which may last several months, the framework for Pilot phase operations is created, the infrastructure and human resources are made available, the functionalities assigned to the Centre are specified and clarified, partners are mobilized and consortia of technical, scientific and financial partners, if needed, are developed.

5.2 Pilot phase

The aims of this phase are: (i) to begin helping a group of Members within the domain[1] of the RWC to benefit from WIGOS; and (ii) to prepare the solid basis for a transition to a subsequent Operational phase, depending on final assessment. The functionality and services provided during this phase are evaluated on a regular basis by the RWC Project Manager[2], with methods readjusted as necessary.

In the beginning of the Pilot phase, the RWC Project Manager will ensure that the required preparatory work is conducted and implementation arrangements are put in place according to the Project document.

At the end of the Pilot phase, the RWC Project Manager will prepare and submit a Project Final Report to P/RA, evaluating the performance of the Project, sustainability of results and documenting the experience. For this purpose, the RWC Project Manager will:

(a) Assess the Centre performance in terms of achievements as compared to the targets, as well as their sustainability; the assistance and benefits received by Members of the (sub)Region should be documented;

(b) Assess the Project financial management including allocation of funds (final status as compared to the initial budget);

(c) Draw lessons from the overall project management experience including stakeholders engagement, monitoring and reporting system to feed into subsequent implementation project;

(d) Describe the measures put in place to ensure continuity of the Centre in operational mode, as appropriate.

Upon successful completion of the Pilot phase and based on the respective positive assessment of the management group of the RA, P/RA will contact the Secretary-General of WMO with a request for formal designation of the candidate as WMO RWC, providing documentation on the assessment of the capability to meet requirements of the designation criteria.

[1] Geographical/economical/linguistic region for which the RWC functionalities are offered
[2] RWC Project Manager is the expert proposed by the RWC candidate

6. RISK ASSESSMENT / MANAGEMENT

The main risks, how they might affect the RWC operations and WIGOS as a whole, and possible mitigation measures should be considered. The level of risk should be assessed (low, medium, high) for each type of risk. Typical risk factors include:

(a) Political/institutional risks, such as low political commitment to the Project, interest from stakeholders, change in government, etc.;

(b) Financial/resources risks, e.g. inadequacy of the financial management system, availability of project resources;

(c) Human resources/capacity risks, e.g. skills and/or expertize availability; adequacy between existing and required experience and specialized skills.

The Risk Management Plan will be developed for each implementation activity/sub project, including risk mitigation.

7. GOVERNANCE, MANAGEMENT AND EXECUTION

The Project management (i.e. RWC Project Manager, Project Executive) should work closely with the P/RA, management group and relevant WIGOS working body of the RA, WMO Secretariat (OBS Department), and other WMO related entities.

8. MONITORING AND EVALUATION

The RWC Project Manager has the routine responsibility for management, coordination, monitoring and evaluating the Project, and for reporting to Executive Management of the organization under which the RWC is framed.

He is also responsible for updating the procedures and practices if and when needed. The monitoring and evaluation process should demonstrate the progress achieved as well as identify risks, encountered problems and difficulties, and the need for adjustment of the Project accordingly.

Annexes: 2

ANNEX 1

Annex to Decision 30 (EC-68)

CONCEPT NOTE ON ESTABLISHMENT OF WMO REGIONAL WIGOS CENTRES

(See Executive Council, Sixty-eighth session, Geneva, 15–24 June 2016, Abridged final report with resolutions and decisions (WMO-No. 1168))

ANNEX 2

APPLICATION TEMPLATE FOR A RWC CANDIDATE

An agency or organization that wishes to be considered for WMO designation as a RWC will make this known to the president of the respective WMO Regional Association in writing through, and with the endorsement of, the Permanent Representative with WMO of the country in which the candidate RWC is situated.

The written communication should comprise a ***letter of intent*** that clearly states the candidate's willingness and ability to provide RWC functionalities with an ***annex*** providing the following information (applies also to individual members of a virtual RWC which will collectively fulfil the RWC functions):

1. Name of the country, WMO Regional Association, name of the organization and full address;
2. Affiliation (sponsors, stakeholders, partnering agencies, etc.) at the global, regional and national levels;
3. Mandate of the Centre relevant to WIGOS activities (mandatory and optional functions) ;
4. Liaison with relevant existing WMO Centres, particularly regional centres;
5. Website relevant to the Centre with WIGOS relevant activities;
6. Current operational activities relevant to the RWC application (structured along the mandatory and optional RWC functions);
7. Staff deployment/human resources relevant to RWC-related activities (management, scientific, technical and administrative categories);
8. Description of current facilities, the necessary basics, physical infrastructure and communication systems relevant to RWC mandatory and optional functions;
9. Funding strategy to ensure the long-term sustainability of the RWC;
10. Geographical/economical/linguistic region for which the RWC functionalities are offered;
11. Type of RWC (a single multifunctional RWC or as a virtual/distributed RWC (RWC-network) provided by a group of Members);
12. Proposed RWC Project Manager (name, position, contacts; CV);
13. Stakeholders engaged in the current and planned RWC operations;
14. Relevant National Focal point(s);
15. Project proposal:
    - Prepared by (name, position);
    - Approved by (name, position);
    - Project Executive (name, position);
    - RWC Terms of Reference;
    - Implementation period;
    - Project budget;
    - Funding sources;
    - List of activities, deliverables, outcomes, milestones, resources required and associated risks;
    - Additional documentation demonstrating the experience and the capacity of the candidate organization to fulfil the described functions;
16. Additional information as appropriate.

References:

1. Seventeenth World Meteorological Congress: Abridged final report with resolutions (WMO-No. 1157; http://library.wmo.int/)

2. Executive Council - Sixty-eighth session: Abridged final report with resolutions (Resolution 2 and Decision 30; WMO-No. 1168; http://library.wmo.int/)

3. Project Management Guidelines and Handbook: Part I – Project Management Guidelines, Part II – Project Management Handbook (http://library.wmo.int/pmb_ged/2016_wmo_project-management-guidelines-handbook_en.pdf)

Decision 31 (EC-69)

INDICATORS FOR MONITORING PROGRESS IN THE WMO INTEGRATED GLOBAL OBSERVING SYSTEM NATIONAL IMPLEMENTATION

THE EXECUTIVE COUNCIL,

Recalls Resolution 2 (EC-68) - Plan for the WMO Integrated Global Observing System pre-operational phase 2016-2019;

Recognizes the need for a regular assessment of the progress achieved in the national implementation of the WIGOS by Members;

Acknowledges the guidance material assisting Members with the implementation of the WIGOS technical regulations, such as "Guidance on the National WIGOS Implementation" [EC-69-inf05-1(3)-WIGOS- Decisions-GUIDANCE-NATIONAL-IMPLEMENTATION_en, in Part II of the present report] and "Guidance on WIGOS Data Partnerships" [EC-69-inf05-1(4)-WIGOS-Decisions-GUIDANCE-DATA-PARTNERSHIPS_en, in Part II of the present report], developed by the Intercommission Coordination Group on WIGOS;

Having considered the Indicators of monitoring the progress of the WIGOS national implementation as provided in the Annex,

Decides to endorse these Indicators as an initial version of the Key Readiness Indicators to assist Members with a regular assessment of the progress achieved in the national WIGOS implementation;

Requests the Intercommission Coordination Group on WIGOS to further develop this monitoring tool to be used by Members;

Requests the Secretary-General to assist Members with a regular assessment of the progress achieved in the national implementation of the WIGOS;

Urges the Members to collaborate with the Secretary-General in this assessment.

Annex to Decision 31 (EC-69)

INDICATORS FOR MONITORING PROGRESS IN THE WMO INTEGRATED GLOBAL OBSERVING SYSTEM NATIONAL IMPLEMENTATION

1. National WIGOS governance mechanism: in place (I=1/0); [1)]
2. National WIGOS partnership agreements for integration and open-sharing of observations from NMHSs and non-NMHSs sources: in place (I=1/0); [1)]
3. OSCAR/Surface and the WIGOS Metadata Standard: OSCAR/Surface being populated and updated with WIGOS metadata for which observations are exchanged internationally (I=1/0) with the following sub-indicators:

   3.1: Number of reporting stations updated by Member in OSCAR/Surface ≥1. [2)]

   3.2: Number of reporting stations included in OSCAR/Surface with all Metadata Standard mandatory elements ≥1. [2)]

   3.3: Number of staff trained in OSCAR/Surface ≥1. [1)]
4. WIGOS Station Identifiers: implemented (I=1/0) with the following sub-indicator

   4.1: Number of stations reporting in WIS with the WIGOS ID > 0. [3)]
5. WIGOS Data Quality Monitoring System (WDQMS): national process for acting on quality problem information received from the WDQMS in place (I=1/0); [1)]

   Sub-indicator 5: % of reporting stations making available observations at frequency and timeliness as specified in OSCAR/Surface ≥ 70. [4)]
6. National WIGOS focal point: nomination completed (I=1/0); [1)]
7. National OSCAR/Surface focal point: nomination completed (I=1/0); [1)]
8. National WDQMS focal point nomination completed (I=1/0); [1)]
9. National WIGOS Implementation Plan adopted/approved (I=1/0); [1)]

Notes:

1) Information provided by Members via the WMO Country Profile Database (CPDB)
2) Indicators generated by the OSCAR/Surface
3) Indicators generated by the WIS.
4) Indicators generated by the WDQMS.

For all of the above indicators it is proposed to have the three following target dates for the assessment of the Members WIGOS readiness: January 2018, January 2019, and January 2020.

Decision 32 (EC-69)

WAY FORWARD FOR TRANSITIONING THE WMO INTEGRATED GLOBAL OBSERVING SYSTEM FROM THE CURRENT PROJECT STRUCTURE INTO THE WMO PROGRAMMATIC STRUCTURE

THE EXECUTIVE COUNCIL,

Recalls Decision 82 (EC-68) - Preparation of WMO Strategic and Operating Plans 2020-2023;

Recalls further Resolution 2 (EC-68) - Plan for the WMO Integrated Global Observing System pre-operational phase 2016-2019;

Recognizes that WIGOS, as an operational system supporting all WMO Programmes and activities, will assist in improving the integrated operations of Members and in building productive partnerships to sustain and improve their ability to provide weather, climate, water and other relevant environmental services;

Recognizes that the unique nature of WIGOS as a cross-cutting infrastructure element supporting all WMO Programmes and activities will require well-developed collaboration and coordination mechanism between regional and technical working structures;

Recognizes further the need to start planning for the future of WIGOS after the current project phase, which is scheduled to end in 2019;

Requests the Intercommission Coordination Group on WIGOS to develop a proposal for WIGOS in the WMO programmatic structure, taking into account the proposed changes to the WMO governance structure being developed by the EC Working Group on Strategic and Operational Planning (EC-SOP);

Requests the Secretary-General to coordinate collaboration with partners responsible for co-sponsored and non-WMO observing systems in the development of the proposal in order to address their requirements;

Invites partners responsible for co-sponsored and non-WMO observing systems to collaborate with the Intercommission Coordination Group on WIGOS in the development of this proposal.

Decision 33 (EC-69)

RADIO FREQUENCIES FOR METEOROLOGICAL AND RELATED ENVIRONMENTAL ACTIVITIES

THE EXECUTIVE COUNCIL,

Recalls:

(1) Resolution 29 (Cg-17) - Radio frequencies for meteorological and related environmental activities;

(2) Decision 36 (EC-68) - Preserving the radio-frequency spectrum for meteorological and related environmental activities at the World Radiocommunication Conference 2019 (WRC-19);

(3) Decision 22 (CBS-16) - Preserving the radio-frequency spectrum for meteorological and related environmental activities at the World Radiocommunication Conference 2019;

Recognizes:

(1) That the International Telecommunication Union (ITU) Study Group on Science Services (Study Group 7) and the CBS Steering Group on Radio Frequency Coordination (SG-RFC) had updated the content of the joint WMO/ITU Handbook on the "Use of Radio Spectrum for Meteorology: Weather, Water and Climate Monitoring and Prediction";

(2) That the ITU SG 7 has approved the changes to the 2008 version as available online at http://wis.wmo.int/file=2994;

(3) That CBS has prepared a preliminary WMO Position Paper on WRC-19 Agenda as available online at http://wis.wmo.int/file=3379;

Decides to publish a 2017 update to the handbook on "Use of Radio Spectrum for Meteorology: Weather, Water and Climate Monitoring and Prediction";

Requests the Secretary-General:

(1) To continue to support the work of CBS and SG-RFC as requested in Decision 22 (CBS-16);

(2) To coordinate with ITU in publishing the updated handbook on use of radio spectrum for meteorology;

Authorizes the Secretary-General to make editorial changes to the handbook on use of radio spectrum for meteorology for the purposes of distribution and publication;

Urges Members:

(1) To ensure participation of representatives from NMHSs in national radio frequency coordination activities including presenting the Preliminary WMO position on WRC-19 agenda at national and regional frequency management and coordination forums;

(2) To encourage the participation of experts from the NMHSs and national radiofrequency regulators in the planned WMO/ITU Seminar proposed to be conducted at ITU Geneva on 23-24 October 2017, just prior to working parties of Study Group 7.

Decision 34 (EC-69)

TRANSLATION OF THE *INTERNATIONAL CLOUD ATLAS* (WMO-No. 407)

THE EXECUTIVE COUNCIL,

Recalling Decision 34 (EC-68) – Approval of the new editions of the *International Cloud Atlas* (WMO-No. 407),

Noting that the new edition of the *International Cloud Atlas – Manual on the observation of clouds and other meteors* (WMO-No-407) was released in the form of a website (www.wmocloudatlas.org) on the occasion of the World Meteorological Day 2017 whose theme was "Understanding Clouds",

Noting also with satisfaction the very large interest shown by Members and the media to this year's World Meteorological Day and the International Cloud Atlas,

Noting further:

(1) That several inquiries on the availability of the Atlas in other WMO languages were received,

(2) That the update of the Atlas was carried out with a very limited budget,

Invites Members to support this effort through voluntary contributions to the CIMO Trust Fund;

Requests the Secretary-General to arrange for translation of the Atlas into official WMO languages using voluntary contributions from Members in support of this effort.

Decision 35 (EC-69)

UPDATE OF THE *GUIDE TO METEOROLOGICAL INSTRUMENTS AND METHODS OF OBSERVATION* (WMO-No. 8)

THE EXECUTIVE COUNCIL,

Recalling that the Agreement on Working Arrangements between the World Meteorological Organization and the International Organization for Standardization (ISO) enables the development and publication of common WMO/ISO standards,

Noting:

(1) WMO and ISO cooperated on the development of the common WMO/ISO standard on Ground-based remote sensing of wind by heterodyne pulsed Doppler lidar,

(2) All WMO Members had been invited to review and provide feedback on the draft text of the standard,

(3) That the CIMO president approved the proposed text for inclusion in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8) as he had indicated he would be doing in case no objection to the text were received from Members by conclusion of the mandatory review period,

Requests the Secretary-General to publish the updated Guide in all WMO languages;

Authorizes the Secretary-General to make editorial amendments.

Decision 36 (EC-69)

DISCONTINUATION OF THE CONCEPT OF REGIONAL STANDARD BAROMETERS

THE EXECUTIVE COUNCIL,

Recalling:

(1) Recommendation 15 (CIMO-I) – International Comparison of Barometers, that established the concept of Regional Standard Barometers (RSBs) and their comparison within the Region to support WMO Members in ensuring the traceability of pressure measurements,

(2) Recommendation 19 (CIMO-IX) – Establishment of Regional Instrument Centres (RICs), that established the concept of RICs to assist WMO Members to calibrate or compare their national meteorological standard instruments,

(3) That WMO signed the International Committee for Weights and Measures (CIPM) Mutual Recognition Arrangement (MRA); the framework through which National Metrology Institutes demonstrate the international equivalence of their measurement standards and the calibration and measurement certificates they issue,

Noting that current practices indicate, the traceability of atmospheric pressure measurements to the International System of Units (SI) should be ensured through accredited RICs, or other laboratories that are either accredited or designated by National Metrology Institutes,

Noting also the view of CIMO that maintaining the RSB concept, in addition to the RIC concept, creates a duplication of work and is uneconomical and inappropriate,

Noting further that all WMO Members hosting RSBs had been contacted and all responses supported the above-mentioned concept of traceability assurance for atmospheric pressure measurements and the discontinuation of the RSB concept,

Agrees to discontinue the concept of Regional Standard Barometer;

Requests the Commission for Instruments and Methods of Observations to:

(1) Update the Guide to Meteorological Instruments and Methods of Observations and other relevant WMO guidance and regulatory documents ensuring their consistency;

(2) Submit amended documents to relevant constituent bodies, as appropriate.

Decision 37 (EC-69)

SATCOM USER FORUM

THE EXECUTIVE COUNCIL,

Recalling Resolution 31 (Cg-17) and Recommendation 9 (CBS-Ext.(2014)) to establish a Satcom users' forum,

Recognizing that:

(1) Congress considered the potential benefits of coordinating the efforts of users of satellite communications systems, and judged that these justified the estimated cost of CHF 10,000 a year to the Secretariat to coordinate the Satcom Forum proposed in Recommendation 9 (CBS-Ext.(2014)),

(2) The progress in developing and moving the Satcom Forum forward has been a joint effort of both WMO and the Intergovernmental Oceanographic Commission of UNESCO (IOC-UNESCO),

Acknowledging that:

(1) A formal session of the WMO-IOC International Forum of Users of Satellite Data Telecommunication Systems (Satcom2016) was held at IFEMA – Feria de Madrid, in Spain from 27-29 September 2016, hosted by Spain,

(2) The report of Satcom2016 is available online at http://wis.wmo.int/file=3130. It highlights the potential benefit of the Satcom Forum to the Commission for Hydrology and Commission for Agrometeorology in addition to the Commission for Basic Systems (CBS) and the Joint Commission for Ocean and Marine Meteorology (JCOMM). The report includes a strategy for moving the Satcom Forum forward for WMO, IOC-UNESCO and other organizations that could benefit from the Satcom Forum,

Decides to endorse the elected Satcom Forum Executive Committee (hereafter referred to as "ForumEC") as provided in the Annex to this decision;

Requests the Secretary-General to facilitate the necessary arrangements to support the Satcom Forum in undertaking the activities agreed at Satcom2016;

Requests the Commission for Basic Systems, with support from JCOMM, to monitor the progress of the Satcom Forum activities and encourage the participation of the other technical commissions and the regional associations;

Urges Members to participate in the Satcom Forum and to make use of satellite communications services, in particular the development and uptake of those costing models and services that support early warning alerting systems.

Annex to Decision 37 (EC-69)

SATCOM FORUM EXECUTIVE COMMITTEE

Elected Satcom Forum Executive Committee following Satcom2016

Name	Role on Forum EC	Organization or Country
Michael Prior-Jones	Chairperson	United Kingdom of Great Britain and Northern Ireland
Johan Stander	Vice-chairperson	South Africa
Bryan Hodge	Member representative	Australia
David Meldrum	User community representative	United Kingdom
Sean Burns	Meteorological Satellites	CGMS
Yann Bernard	Operator representative	CLS/ARGOS
Mariuxi Chavez	Operator representative	ORBCOMM
Allan Place	Operator representative	JouBeh Technologies
Wolfgang Marxer	Manufacturer representative	SEBA Hydrometerologie
Andy Sybrandy	Manufacturer representative	Pacific Gyre
Eric Locklear	Subprogram - Joint Tariff Agreement	Joint Tariff Agreement (JTA)
<position vacant>	IOC Secretariat	IOC-UNESCO
Remy Giraud	Liaison to WMO CBS	CBS/ET-CTS
David Thomas	WMO Secretariat	WMO
Etienne Charpentier	WMO Secretariat	WMO

Decision 38 (EC-69)

IMPLEMENTATION OF TABLE-DRIVEN CODE FORMS

THE EXECUTIVE COUNCIL,

Noting:

(1) That the decisions, resolutions and recommendations of the sixteenth session of the Commission for Basic Systems (CBS-16) are contained in the *Abridged final report with resolutions, decisions and recommendations of the sixteenth session of the Commission for Basic Systems* (WMO-No. 1183),

(2) Decision 5 (CBS-16) — Reporting observations in BUFR that urged Members to exchange World Weather Watch reports in Table Driven Code Forms (TDCF) and to ensure that such reports are compliant with the B/C regulations,

(3) Decision 6 (CBS-16) — Experimental implementation of FM 92 GRIB (edition 3) that urged Members to test a new edition of GRIB that is designed to extend the types of information that can be exchanged using GRIB,

(4) Decision 7 (CBS-16) — Removal of FM 92-XI Ext GRIB from the *Manual on Codes* (WMO-No. 306) that concluded that there was no longer an operational requirement for FM-92-XI Ext GRIB and decided that its definition should be removed from Volume I.2 of the *Manual on Codes*, but that the definition should remain permanently available to support interpretation of archived information,

(5) Recommendation 10 (CBS-16) — Ceasing maintenance of Traditional Alphanumeric Code Forms that sought endorsement of the principle that the only developments of Traditional Alphanumeric Code Forms should be those in support those of amendments to Annex 3 of the Convention on International Civil Aviation Meteorological Service for International Air Navigation,

Confirms that:

(1) FM 92-XI GRIB should be removed from Volume I.2 of the *Manual on Codes* (WMO-No. 306);

(2) No further development of the traditional alphanumeric codes should take place, with the exception of amendments to traditional alphanumeric codes that support implementation of amendments to Annex 3 of the Convention on International Civil Aviation Meteorological Service for International Air Navigation;

(3) WMO should encourage ICAO to use modern alternatives to traditional alphanumeric codes to meet new requirements to exchange of meteorological information in line with the move to ICAO System Wide Information Management;

Decides that:

(1) The technical commission responsible for maintenance of the *Manual on Codes* (WMO-No. 306) is authorized to remove from that manual code forms when they are no longer required for routine exchange of information;

(2) Specifications of code forms removed from the *Manual on Codes* should be permanently made available to Members so information archived in those forms may be interpreted correctly.

Decision 39 (EC-69)

DEVELOPMENT OF A GENERAL SERVICE DELIVERY GUIDE BASED ON EXISTING GUIDES DEVELOPED BY WMO PROGRAMMES AND TECHNICAL COMMISSIONS

THE EXECUTIVE COUNCIL,

Mindful that delivery of meteorological, climatological and hydrological services is essential to saving lives and livelihoods, improvement of the quality of life and enhancement of national economies and support of NMHSs by governments;

Recalling:

(1) Decision 42 (EC-68) – Implementation of WMO Strategy for Service Delivery, in which EC requested technical commissions to mainstream service delivery into their work plans and guidance materials,

(2) Decision 29 (CBS-16) – Further implementation of the WMO Strategy for Service Delivery, that defines the work plan for holistic WMO-wide harmonized approach to Service Delivery implementation, following the request of EC-68,

Noting that the WMO Strategy for Service Delivery, which was developed through the coordination of the CBS OPAG/PWS, targets promoting high-quality service delivery across all areas of WMO responsibility, and not just in Public Weather Services, and that a holistic WMO-wide approach to Service Delivery must be achieved through cooperation and collaboration,

Noting further that the WMO *Guide to Public Weather Services Practices* (WMO-No. 834) is currently being revised and updated, and that this revision will take full account of the WMO Strategy for Service Delivery,

Recognizing that there is a need to address requirements related to service delivery identified by all relevant WMO Programmes in order to provide guidance and support to Members on issues related to service delivery,

Decides that a General Service Delivery Guide based on the work underway to update the "Guide to Public Weather Services Practices" and other existing guidelines developed by WMO Programmes and technical commissions whose mandate includes service delivery should be developed, in order to provide holistic service delivery guidance to Members in major application areas covering weather, climate, water, agriculture, health, marine and other areas;

Requests CBS to collaborate with other technical commissions including CAgM, CCl, CAeM, JCOMM and CHy, to draft the General Service Delivery Guide for endorsement by Cg-18;

Invites Members to support the development of the general service delivery guide;

Requests the regional associations and technical commissions to continue to include the implementation of the WMO Strategy for Service Delivery in their work plans;

Request the Secretary-General to:

(1) Coordinate a WMO-wide approach to service delivery;

(2) Allocate resources within available budget for the development of a general service delivery guide.

Decision 40 (EC-69)

CONCEPT PAPER FOR THE DEVELOPMENT OF COMMON INTERFACES FOR SERVICE DELIVERY

THE EXECUTIVE COUNCIL,

Recalling Decision 42 (EC-68) – Implementation of WMO Strategy for Service Delivery, in which EC endorsed big data sourcing and application for service delivery as one of the critical areas of focus in implementing the WMO Strategy for Service Delivery,

Recalling Decision 5 (EC-68) – Provision of multi-hazard impact-based forecast and risk-based warning service to the public, in which EC urged Members, with the support of the Secretariat, to accelerate adoption of multi-hazard impact-based forecast and warning services, which will contribute to their efforts in disaster reduction and mitigation,

Acknowledging that a common interface for service delivery which would be a one-stop-shop for service-related data products from different sources, would help NMHSs attain the objective of meeting their need to keep pace with new and evolving demands of users for real-time and intuitive access to weather and climate information using modern state-of-the-art communication means,

Noting the potential to leverage the existing global platforms to contribute to the development of common interfaces for an integrated seamless service delivery, **Recognizing** that service delivery initiatives are implemented by the different technical programmes of WMO using varying approaches and systems which need sufficient interaction, in order to avoid difficulties in accessing services and risk of duplication of effort,

Recognizing that such common interfaces would provide NMHSs with much more visibility and would support attribution of NMHSs as the providers of such services and hence strengthen the authoritative voice of NMHSs as well as enhance the number of their users and clients,

Decides to task CBS, in coordination with other TCs, to set up a mechanism for the development of a concept paper on common interfaces for service delivery driven by data from NMHSs and emerging sources to enable users to seamlessly access weather and climate information in a way that would ensure attribution to NMHSs as providers of services;

Requests CBS to present the concept paper at EC-70 for consideration for approval following which an implementation plan will be developed;

Requests TCs to appoint service delivery and technical experts who would create the common interfaces in order to ensure that both science and information technology perspectives are addressed in the concept paper;

Requests Members to embrace opportunities offered by new and emerging technologies and data sources, to enable their NMHSs to provide consistent and authoritative weather information and services to users through the modern communication paradigm;

Requests the Secretary-General to:

(1) Support the development of the concept paper on the common interfaces for service delivery;

(2) Support Members' efforts to adopt modern technologies such as weather mobile phone applications, the Common Alerting Protocol (CAP) and social media that would improve the range, quality and delivery of services.

Decision 41 (EC-69)

GUIDELINES FOR THE DEVELOPMENT OF AN INTEGRATED OPERATIONAL PLATFORM TO MEET URBAN SERVICE DELIVERY NEEDS

THE EXECUTIVE COUNCIL,

Mindful that half of the world's population currently lives in urban areas, and that by 2050 this number is projected to rise by 70 per cent,

Recalling:

(1) Decision 15 (EC-68) – Implementation of WMO Cross-cutting Urban Focus, in which EC adopted the outline of the 2016-2019 implementation framework for the cross-cutting urban focus, which included the establishment of a cross-programme Working Group on Integrated Urban Weather, Environmental and Climate Services, under the Executive Council, that would serve within the defined lifetime of four years,

(2) Decision 42 (EC-68) – Implementation of WMO Strategy for Service Delivery, in which EC endorsed the critical areas of focus in implementing the WMO Strategy for Service Delivery which included urban areas,

(3) Resolution 68 (Cg-17) – Establishing a WMO Cross-cutting Urban Focus, in which Congress decided that urban activities should be a specific cross-cutting element within WMO,

Noting with concern that urban areas are vulnerable to weather extremes including heatwaves, heavy rain and associated flooding and inundation, severe convective weather, droughts, storm surge for urban coastal areas, air pollution and impacts brought about by climate change and variability,

Noting further that Cg-17 had requested WMO to focus on the development of climate, weather and environmental services as an important component of the holistic implementation of the WMO Strategy on Service Delivery, in order for megacities and large urban complexes to be resilient in withstanding environmental hazards, factor weather and climate to city planning, infrastructure design, transportation, power supply, water supply, food safety, disaster risk reduction, climate change adaptation and mitigation, and the health of citizens,

Recognizing that the urban services should be people-centred, with targeted improvements in communication and client relations through a robust multi-channel system of dissemination and communication of information to all partners and the public,

Recognizing further that some NMHSs have developed integrated operational platforms for service delivery to provide people-centred services in urban areas,

Recalling that Cg-17 had requested EC to provide guidance on the development of a service delivery strategy to address urban needs and to coordinate the work of technical commissions on urban issues in a seamless and holistic manner, and that EC-68 has further adopted the outline of the 2016-2019 implementation framework for the cross-cutting urban focus, as the baseline for the WMO-wide implementation of Resolution 68 (Cg-17),

Decides to expedite the work on a Guide for Urban Integrated Hydrometeorological/Climate/Environment Services, using the expertise of the WMO GAW Urban Research Meteorology and Environment (GURME) that would steer the transition from research to operations, to be approved by Cg-18,;

Requests that CBS with CAS, in consultation with other Technical Commissions, develop guidelines based on Members' best practices for an integrated operational platform, to support urban service delivery needs;

Invites Members to take advantage of resources and opportunities offered by the urban environment to develop innovative state-of-the-art monitoring, data processing, and dissemination systems focused on the provision of weather, climate and hydrological services for improved decision–making for the "safety and well-being of the people" and the "better city, better life" concept;

Requests TCs to appoint urban service delivery and technical experts who would develop the guidelines in order to ensure that research findings are integrated into operations;

Requests regional associations and technical commissions to support the development of the guidelines;

Requests the Secretary-General to facilitate the work of CBS and CAS on the development of the above guidelines.

Decision 42 (EC-69)

FUTURE OF AERONAUTICAL METEOROLOGICAL SERVICES

THE EXECUTIVE COUNCIL,

Recalling Resolution 66 (Cg-17) concerning WMO support to evolving aeronautical meteorological services, where future developments at a global, regional and national level should be fully aligned with the International Civil Aviation Organization (ICAO) Global Air Navigation Plan (GANP) and its aviation system block upgrades (ASBU) methodology,

Recalling further Decision 43 (EC-68) concerning an action plan for meteorological services for aviation which, inter alia, requested the development of a draft long-term plan for the WMO Aeronautical Meteorology Programme (LTP-AeMP) aligned with the ICAO GANP and ASBU methodology,

Noting the development of the draft LTP-AeMP,

Further noting the findings of the 2016/17 CAeM global survey on aeronautical meteorological service provision,

Having held an EC-69 Special Dialogue on the Future of Aeronautical Meteorological Services involving stakeholders from the meteorological and aviation communities, including the participation of public and private sector representatives, with the outcomes of the Special Dialogue summarized in the Annex to this Decision,

Considering the key issues to be addressed in enhancing the provision of meteorological service for international air navigation,

Welcomes the open dialogue with the aviation stakeholders and their recognition of the continuing and ever growing importance of the provision of high quality, consistent, fit-for-purpose, meteorological information and services to the safety, efficiency and regularity of the aviation operations;

Acknowledges the significant challenges and opportunities related to the growth of the air transport industry and the rapidly changing service requirements, institutional arrangements, technological developments, and related environment and climate change issues which will lead to respective major changes in the ways the meteorological information and services will be provided to users, as outlined in the ICAO GANP and ASBU;

Acknowledges further the importance of applying fair and transparent cost recovery for aeronautical meteorological service provision to help sustain basic meteorological infrastructure and ensure high quality services;

Recognizes the pressing cost-effectiveness requirements, coupled with the need to sustain high-performing meteorological services for aviation, compliant with the requirements for quality management, competency and qualification of personnel, and other ICAO and WMO requirements;

Decides that the outcomes of the Special Dialogue as outlined in the Annex should be reflected on the activities of the Aeronautical Meteorology Programme (AeMP) of the WMO;

Agrees that the underpinning basic infrastructure, data and information provision, and the aviation-related science and research developments shall be considered as vital contributions of WMO Members to the air transport industry which need to be sustained and enhanced in the planning of the future systems and services;

Requests the president of CAeM:

(1) To consider the outcomes of the Special Dialogue in preparing the agenda for the sixteenth Session of the CAeM (July 2018) as well as to continue regular dialogue and consultation with relevant aviation stakeholders; and

(2) In collaboration with presidents of regional associations, to develop a methodology and conduct a sensitivity analysis of various scenarios of future meteorological service delivery for aviation, including the degree of engagement of private sector providers, to assess possible impacts both on the NMHSs as aeronautical meteorological service providers and on the resulting service quality levels, where such analytical information is to inform WMO planning of aviation-related activities in the future;

Requests the presidents of regional associations, in coordination with the president of CAeM, to organize appropriate regional awareness events to highlight the issues discussed at the EC-69 Special Dialogue and downscale them to the regional and Members' level in order to raise their awareness and preparedness for the foreseen changes in the provision of meteorological services to aviation;

Urges Members to analyse the outcomes of the Special Dialogue, including through the conducting of a SWOT (strengths, weaknesses, opportunities, threat) analysis of their NMHSs, and to consider developing their own plans taking into account national stakeholder requirements for aeronautical meteorological service provision, global and regional plans and trends;

Requests the Secretary-General, in coordination with the presidents of regional associations and the president of CAeM, to support future GANP and ASBU awareness and planning activities in the regions.

Annex to Decision 42 (EC-69)

SUMMARY OF THE SPECIAL DIALOGUE ON THE FUTURE OF AERONAUTICAL METEOROLOGICAL SERVICES

Introduction

The Executive Council recognized the importance of this timely dialogue on the evolving requirements for the provision of meteorological services to international air navigation given existing and foreseen changes within the aviation sector over the next 10 to 15 years and the perceived impacts of change on aeronautical meteorological service provision.

With a view to stimulating strategic thinking and to assist the Executive Council chart a path for WMO Members that provide meteorological services to aviation, the dialogue highlighted both the challenges and the opportunities that lie ahead. Consideration was also given of the existing and new service delivery models intended to ensure sustainable aeronautical meteorological service provision to the required levels of performance, quality and cost effectiveness.

A keynote address was given by Mr C.M. Shun, President of the CAeM, Director of Hong Kong Observatory and Permanent Representative of Hong Kong, China with WMO, followed by presentations given by Mr Yong Wang, Chief of Airport Operations and Infrastructure, International Civil Aviation Organization (ICAO); Mr Magdy Reda, Manager of ATC Charges, International Air Transport Association (IATA); Captain Mark Hoey, General Manager of Operations, Cathay Pacific Airways; Mr Dennis Hart, Head of System Wide Information Management, EUROCONTROL; Mr Robert Rutledge, Lead Operations, Space Weather Prediction Centre, NOAA National Weather Service, United States of America; Dr Agnes Kijazi, Director General of the Tanzania Meteorological Agency and Permanent Representative of the United Republic of Tanzania with WMO; Ms Mary Glackin, Senior Vice-President, Science and Forecasting Operations, The Weather Company; and Ms Maria Lundblad, Senior Advisor, Aviation Services, Swedish Meteorological and Hydrological Institute.

In addition, the Executive Council valued an interactive panel discussion, moderated by the President of WMO, Mr David Grimes, with Members which expanded consideration of the key topics with a view to building awareness and understanding.

Summary of keynote address and presentations

The Executive Council noted that air transport plays a major role in driving sustainable social and economic development and that, today, it carries more than 3 billion passengers – a figure which is expected to double by the end of the next decade. The Executive Council recalled that the Global Air Navigation Plan (GANP) of the International Civil Aviation Organization (ICAO) provides a rolling, 15-year strategic methodology for air transport upgrade progress, including a description of expected enhancements in the aeronautical meteorology domain which, together with other domains, are considered necessary or desirable to achieve tangible air navigation capacity and efficiency performance improvements while sustaining aviation’s number one priority: safety.

The Executive Council observed some of the key findings to emerge from a recent global survey on aeronautical meteorological service provision conducted by the Commission for Aeronautical Meteorology (CAeM), for which there had been a highly commendable 92 percent response rate amongst Members. The survey highlighted, inter alia, that while NMHSs of WMO Members were still heavily involved in aeronautical meteorological service provision – at local, national, regional and/or global levels – a number of other parties were now typically involved, including air navigation service providers and commercial meteorological service providers. The Executive Council observed also that while there had been great progress in the implementation, by Members, of key initiatives including quality management systems for aeronautical meteorological service provision and competency assessment of aeronautical meteorological personnel, gaps still remained in some regions.

Recognizing the prevailing drivers for change: the foreseen growth of air traffic, the need to maintain aviation safety whilst also increasing air navigation capacity and efficiency, reduction of the impacts of aviation on the environment, and noting the trend of increasing regionalization and globalization in response to user's needs for globally harmonized and seamless services, the Executive Council recognized the need for the meteorological community to respond to the associated paradigm shift in modes of service delivery. These would include the development of new business models, utilization of the latest information technologies and scientific research, harnessing new and innovative methods of service delivery and being able to leverage a higher level of regional and international cooperation to bridge existing gaps. In this connection, the Executive Council acknowledged that WMO and ICAO should further strengthen their cooperation and collaboration in aeronautical meteorology matters – as emphasized at the recent bilateral meeting between the Secretary-General of WMO and the Secretary General of ICAO – to thereby enable Members/States to better fulfil their mandates.

The Executive Council recognized that aeronautical users, including but not limited to the airlines represented by the International Air Transport Association (IATA), require more transparency and a simplification of aeronautical meteorological charges, and that this could be achieved through improved engagement between, not least, the aeronautical meteorological service provider and user communities, facilitated through WMO, ICAO and IATA. It was also recognized that, on occasion, the costs recovered from aviation do not always make their way back to the service provider(s), often due to the arrangements within a Member/State, with consequent ramifications on the ability of the service provider(s) to deliver and further develop their services.

The Executive Council noted the growing need for more aircraft based meteorological data and appreciated the support of IATA in helping to expand the AMDAR programme and the effective sharing of aircraft meteorological data available from both public and private sectors with the meteorological community.

In respect of aviation safety, the Executive Council was informed that hazardous meteorological conditions continue to be a significant factor in aviation incidents and accidents at airports and in the air. When considering flight safety as well as the efficiency, economy and environmental protection factors, aeronautical meteorology understandably continues to be a priority area of interest to, not least, the airlines and air traffic management (ATM).

The Executive Council noted the rapid advancement in the methods of disseminating meteorological information to the flight deck, including increased use of computer tablets, which was also now influencing how users were undertaking flight crew training in meteorology. It was noted, for example, that the pilots are now harnessing the power of new technologies and that, as a consequence, the traditional means of obtaining pre-flight briefing materials and in-flight updates were likely to become outdated sooner rather than later. It was further noted that meteorological information was at the heart of ATM and that emerging operational concepts in support of trajectory-based operations would be heavily reliant on the availability of relevant ATM information (including meteorological information) at the right time, in the right place and in the right format. Meteorological information with increased granularity covering the wide range of weather scales down to the nowcasting scale (< 20 min) was envisaged for the future.

The Executive Council acknowledged that, through the implementation of the system-wide information management (SWIM) that will underpin the future ATM system, issues may arise concerning the physical management of the information (including meteorological information) which will require appropriate governance arrangements to be developed, including data management policies for both the providers and consumers of the information within SWIM. The need for interoperability of the WMO Information System (WIS) with SWIM was noted.

In the context of service delivery models, the Executive Council considered a variety of current models – at a global, regional, sub-regional/multi-national and national level – that may serve as guidance and inspiration for the future. The Executive Council recognized that all models, regardless of their geographic coverage, shared a common characteristic: their intent to provide an efficient and effective, globally harmonized and seamless meteorological service for international air navigation typically building on collaborative partnerships and a spirit of cooperation unconstrained by national borders.

In considering multi-national coordination and collaboration in aeronautical meteorological service provision, the Executive Council appreciated that challenges often have to be overcome, including national legislative barriers. However, it was noted that overcoming the challenges often leverages new opportunities, through the building of mutual trust, honesty and engagement amongst the parties involved.

On a related matter, the Executive Council recognized the importance of public-private engagement, noting a need to ensure harmonization between the activities of the public and private sectors to improve aeronautical meteorological service provision and, ultimately, to achieve "win-win" outcomes for all concerned. It was highlighted that while establishing such partnerships can be challenging, the returns on the investment can be huge, leading to a mutual understanding of the missions, strengths and constraints of the parties involved. Such engagement helps to develop a common view of the service demands, science and technology challenges and opportunities, as well as helping to define goals and manage expectations. The importance of sustaining dialogue in public-private engagement was strongly underscored.

Summary of panel discussion

1. Need for dialogue and partnership with the stakeholders

It was emphasized that the dialogue and partnership with stakeholders was of the utmost importance to aeronautical meteorological service provision, given that aviation users are advanced users with challenging targets. It was also well understood that private sector service providers will continue to have a growing and complementary role which could make the PPE (public-private engagement) in aviation a model for other service delivery areas.

As a strongly user focused service area, aeronautical meteorology benefits from a clear and detailed definition of users' requirements. The ICAO Meteorology Panel (METP) has the main role in this regard in coordination with relevant user's representatives and bodies, including WMO and IATA.

The ongoing and foreseen changes in the global ATM system and related changes in MET service provision are happening in a very dynamic, rapidly changing environment; thus, the continued dialogue between the different communities – users and providers, at all levels (national, regional and global) – has been identified as a crucial factor to ensure the required levels of flexibility, agility and adaptability. The Executive Council was reminded that the MET developments discussed here, were a part of similar intensive discussions and coordination among other stakeholders of the aviation industry. With this complexity, the formulation of the user requirements for MET information and services was not an easy task.

2. Understanding the GANP and ASBU requirements and their impacts on MET

Understanding the GANP and ASBU requirements for the integration of the meteorological information into the ATM decision-making processes in support of trajectory-based operation (TBO) was understood to be crucial. Entering into an increasingly automated decision-making environment will require respective automation of the MET information generation and sharing, and will require a close dialogue with users.

In response to the concerns relating to the potential impacts on the role of the service providers in the smaller or least developed countries, it was affirmed that in a future regionalized or globalized framework of services, the local providers would still have a role to play, especially in the provision of essential information and services, e.g., for the airports and terminal areas of their airports. Sharing of information from the underpinning meteorological infrastructure will also need to be maintained, particularly for nationally, regionally or globally assembled and processed information, in due consideration of the relevant data policy frameworks.

It was further clarified that not all ASBU modules contained in the GANP need to be applied to all countries around the globe. Each region and State would have to make an analysis of the operational requirements and define what capacities need to be built, bearing in mind the technological advancement. A crucial factor in this regard was the engagement and cooperation, at national level, between the relevant MET and aviation stakeholders.

Recognizing that the ASBU modules were aimed at structured and scheduled performance improvements, the inhomogeneous distribution of air traffic density would inevitably result in different needs for implementation of ASBU components, i.e., "one size does not fit all". The definition of "What is good enough" will increasingly need to be used to define the minimum levels of service quality in due consideration of flight safety and cost-effectiveness requirements.

3. Growth of private sector

It was considered that the growth of the private sector in information and service provision would need relevant legislative and oversight measures to ensure quality, consistency and accountability. Thus, the role of the MET Authority designated by the government should be maintained as well as clear rules for designation of service providers. It was felt that the roles of the MET authority and MET service provider should be better defined.

With regard to the need to regulate the participation of the private sector in service delivery, it was clarified that this is a matter of fact even today. Private sector players are required to ensure that they comply with the requirements from ICAO and WMO on the training and competence of their personnel in the same manner as the public sector. Improved governance of aeronautical meteorological services to ensure that a minimum service quality level is consistently maintained across the public and private sectors may be required in the future. Recognizing that there were national variations in the engagement of the private sector, it was also clear that airlines require globally consistent and harmonized levels of service. Both sectors therefore should work towards optimum solutions in this regard and WMO should try to facilitate this work. From the airlines perspective, the main call was for service provision models that will guarantee agreed levels of quality and global consistency (through appropriate governance mechanisms) as well as efficiency (optimum cost/quality), with data and information acquired from recognized and approved trustworthy sources.

In discussing the relationship between the public and private sector, it was noted that it could take the form of complementary partnership, provider-customer relation, or competition. All these were available in today's service delivery models, moreover, such relationships were present within each of the sectors (e.g., there were possible cases of competition between the NMHSs).

4. Changing service delivery models – regionalization and globalization

With regard to concerns expressed by some Members of the envisaged further regionalization and globalization of MET service provision, it was made clear that such developments were a part of the overall consolidation of air navigation services, as a measure to eliminate the current fragmentation of the airspace with related significant unnecessary cost for the aviation users (estimated at 2 billion euros/year in the EUROCONTROL airspace alone). With the understanding that these changes are inevitable, some Executive Council members sought assurance that the decisions concerning the establishment of future regional centres and facilities should be well coordinated and justified to allow for respective forward looking national planning.

It was recognized that the regionalization and globalization were concepts necessary to support the requirements of the global ATM community. The discussion about how far are the realization of such concepts and what would be the implications for the current providers was still ongoing, most prominently with ICAO. The two-year amendment cycle of the Standards and Recommended Practices of ICAO Annex 3 / WMO-No. 49, Technical Regulations, Volume II, was noted and thus the issue of establishment of regional centres will be a subject of further deliberation in the next amendment due for 2020. It was also noted that the realization of future regional systems, e.g., the potential Regional Hazardous Weather Advisory Centres (RHWAC), would require a rebalancing of the roles of current service providers including NMHSs.

5. Changing technology and Information Management

The integration of MET information into the ICAO system-wide information management (SWIM) environment was considered as a main priority for Members in the next couple of years. In this connection, the implementation of the ICAO Meteorological Information Exchange Model (IWXXM) was due for completion by 2020 as the first step of the integration. WMO and ICAO should coordinate to ensure the interoperability of their information management concepts and systems and also in facilitating the implementation through coordinated capacity development actions.

It was acknowledged that there were aspects of SWIM that needed further consideration. For example, the authorized MET providers will use the available interfaces to insert the required information, but there will be many other players also supplying information. In a highly-automated, data-rich digital environment, one side effect is that NMHSs may lose contact with the end-users, e.g. pilots, relative to the situation today. Similarly, with quality a global concern, feedback from the users may be lost. As a consequence, mechanisms to ensure that effective interfaces and interactions between provider and consumer can be sustained will need to be sought.

6. How the less developed Members (LDCs and SIDS) will cope with the change

The implementation of the MET elements of the GANP and ASBU was seen as a massive effort by Members in the years to come. This would necessitate an intense capacity development programme and increased level of awareness on the implications and impact of these changes in particular for the LDCs and SIDS. These countries were concerned about the strong pressure to improve the services in view of their scarce resources. The Executive Council therefore emphasized the importance of fair cost recovery schemes in order to sustain the basic and underpinning meteorological infrastructure. It was further explained that GANP and ASBU implementation was to be localized in accordance with the level of aviation operations and the needs of each sub-region or State. To facilitate such regional and national impact assessment and planning, WMO was requested to extend these types of awareness building discussions to the regional level. This was related to the proclaimed "no country left behind" approach and the need to assist the developing countries to cope with the forthcoming changes, which had also been highlighted in the joint statement on the occasion of the recent meeting between the Secretary General of ICAO and the Secretary-General of WMO.

7. Need for research and development

The primary importance of intensive research and development to underpin the foreseen performance improvements in the GANP and ASBU was emphasized. Various demonstration projects (e.g. the Aviation Research Demonstration Project (AvRDP)) and experimental services currently conducted in the WMO framework, but also similar developments in the private sector, have raised expectations of what can be 'pulled through' from the global research community. WMO is planning a large-scale scientific event on aeronautical meteorology in November 2017 as a collaboration between the CAS, CAeM and CBS. Executive Council members felt that the meteorological community has a lot more information that could potentially be used for enhanced service provision, noting however, there were resource constraints on what could be 'pulled through'.

The modern digital stream of information and services poses new challenges that need to be subject to research, for instance "the seductive element" of the easily accessible forecast products through web-based applications and other such tools and the user's perception of their accuracy (i.e. weather forecast being perceived as faultless). The trend is towards more and more automated generation of forecasts. There are aspects of the decision making based on such data that need to be studied from social science perspectives.

There was also a need to build new approaches different to the classical notion of "best forecast", such as the quality of the utilization of impact- and risk-based forecast . Thus, instead of only trying to improve the accuracy of the forecast, the translation of the meteorological forecast elements, qualified with uncertainty and confidence information, into operational impacts, and the communication of such information to users, should also be addressed to improve their decision-making. Thus, the question is how to make the 'best decision', rather than simply to supply the 'best forecast'.

8. What can WMO and ICAO do to facilitate the process

WMO has a clear role to play in providing guidance and raising awareness for the different scenarios and use cases, including the engagement of NMHSs with users at national level. Regional awareness events, such as the planned African Conference on Meteorology for Aviation (ACMA), would help the regional and national discussions.

A recent joint circular letter signed by the Secretary-General of WMO and the Secretary General of ICAO strongly encouraged the enhancement of the dialogue and coordination between the national authorities. It also expressed the commitment of ICAO and WMO to jointly plan and support capacity development actions for the LDCs, LLDCs and SIDS.

Closing remarks

In his concluding remarks, **Mr CM Shun, President of CAeM**, strongly encouraged all NMHSs to do their SWOT analysis vis-a-vis the outlined challenges and paradigm changes in the air navigation service provision of which meteorology is a key enabler. The meteorological services for aviation need to modernize and develop in alignment with the GANP and ASBU developments. The trustworthiness and fitness for purpose of these services should be ensured. The recognition that there will be increasing competition was crucial for success. The competition will accelerate innovation which will in turn drive service enhancements to meet the evolving performance requirements of users. Members' concerns on the challenges are valid and need to be addressed by measures for establishing level playing field conditions to ensure fair and equitable competition, including the sharing of existing and new aeronautical meteorological data, e.g. aircraft data, while respecting IP rights. The "no country left behind" principle should result in concrete capacity development actions. A major undertaking for all will be to ensure the sustainability of the NMHSs and the basic infrastructure provided by all Members collectively to underpin the services provided to aviation; more appropriate cost-recovery mechanisms may be needed in this regard. Mr Shun strongly supported that similar dialogues and awareness events should be facilitated at the regional level, and envisaged that aeronautical meteorological services would remain a focus in the future strategic planning of WMO. Finally he called for all to embrace change because only by doing so could we turn challenges into opportunities.

Mr Petteri Taalas, WMO Secretary-General expressed his satisfaction of the dialogue as an "eye-opening" exchange between the MET community and the other players of the aviation industry. He stressed that the world was changing and the Members' NMHS needed to change accordingly. To achieve this, they should understand better the needs of customers. Another major driver is the technology advancement that provides new opportunities for enhancing en-route services which will help airlines to avoid hazardous weather. The changing business models and the private sector growing share poses serious questions about future funding of NMHSs if aviation customer is lost, including the development of improved services. All of this necessitate an impact assessment to be made, in particular for the developing countries some of which rely heavily on the aviation customer. The question many were facing was about the price for safety combined with the pressure for cost reduction. Mr Taalas strongly encouraged meteorological services to keep the dialogue with end users; he also called for WMO, ICAO and IATA to use their mechanisms and power to address the issues and challenges in a collaborative manner.

Mr David Grimes, President of WMO referred to the new paradigm and the need for a new approach. He recommended the use of a sensitivity analysis of different possible scenarios, including extreme cases, such as the NMHS not anymore engaged as aeronautical meteorological service provider (AMSP). Such analysis should be two-fold – not only on effects on the NMHS, but also on potential impacts on the users and the aviation industry. In his view, the impacts on aviation will be highly negative because of the loss of the significant science and technology infrastructure built and maintained by the Members. Thus, when we reflect on the next steps – what are the risks – we need to think on both sides because there is a strong co-dependence. Historically, many NMHSs have been established mostly for the need of air navigation; massive science, research and infrastructure development have also been funded to support aviation safety and efficiency. In the current pressure for cost effectiveness, it should be remembered that when the users state they need "good enough service", it does not mean "the cheapest service". The big question now is how to provide an enterprise solution to meet the needs and expectations of the aviation users. The sensitivity analysis will inform how WMO should plan its aeronautical meteorology activities in this regard.

Mr Grimes stressed further that the new digital world brings new players, processes and systems. This necessarily leads us to embrace new cooperation and partnerships. Different solutions could be foreseen – both centralization and de-centralization of services. The important consideration is how to raise the collective capacity by working together. An important prerequisite for such collaboration will be better definition of roles and responsibilities because of the complexity of the stakeholder's landscape. WMO, as a standard-making organization, has an important role to play in cooperation with its partner agencies.

Decision 43 (EC-69)

ESTABLISHMENT OF A SOIL MOISTURE DEMONSTRATION PROJECT

THE EXECUTIVE COUNCIL,

Recalling Resolution 2 (CAgM-16) - Priorities (2014–2018) of the Commission for Agricultural Meteorology,

Noting the recommendations of the CAgM Task Team on Soil Moisture Measurements,

Noting the work of the International Soil Moisture Network (ISMN) at the Technical University of Vienna,

Noting further that soil moisture measurement is a GCOS Essential Climate Variable (ECV),

Recognizing the need to validate satellite estimates of soil moisture with in situ soil moisture measurements,

Recognizing that recent WMO extrabudgetary funding has extended in situ soil moisture measurements in South Africa and will soon begin in West Africa and the Pacific Islands,

Decides to establish the Soil Moisture Demonstration Project under the coordination of CAgM and that extrabudgetary funding would be used to further develop field activities;

Requests the Secretary-General to support the development of a concept note and draft implementation plan under the leadership of CAgM for consideration by EC-70.

Annex to Decision 43 (EC-69)

RECOMMENDATIONS FROM THE COMMISSION FOR AGRICULTURAL METEOROLOGY TASK TEAM ON SOIL MOISTURE MEASUREMENTS

The following are the main recommendations of the CAgM Task Team on Soil Moisture Measurements that met in September 2016 in conjunction with the 3rd Satellite Soil Moisture Validation and Application Workshop held in New York, United States of America.

Main Recommendations

1. Make intercomparisons of different soil moisture sensors in different climates.

2. Liaise with the satellite soil moisture community on in situ soil moisture measurements.

3. Develop project proposals to add more additional soil moisture sensors in developing countries as with recent project in South Africa and in future in West Africa and the Pacific Islands.

4. Refine the following draft components of the demonstration project:

(a) **Component A: Stakeholder engagement workshops.** In order to engage stakeholders, promote buy-in and commitment, and motivate action. A key aim of developing results is to ensure that ownership goes to as many stakeholders as possible.

(b) **Component B: Analysis of soil moisture networks.**

(i) **Task 1**: Review the current meteorological stations that are maintained, used and disseminated.

(ii) **Task 2**: Analyse the placement and standardization of probes/sensors, and surface homogeneity of current soil moisture stations.

(iii) **Task 3**: Survey the archive of historical ground measurements that are available to be utilized, quality-controlled, and accessible.

(iv) **Task 4**: Investigate available remotely sensed data and algorithms for soil moisture estimation from space, and assess the performance.

(v) **Task 5:** Determine the proper technical approaches for integration of remote sensing measurements and ground soil moisture networks, and requirements for improvement of soil moisture networks.

(c) **Component C: Improve networks, computing capacity, and databases.**

(i) **Task 1**: Expand ground-based observation networks, including AWS, farmer rain gauges and soil moisture data, for enhanced agricultural weather monitoring, analysis and early warning.

(ii) **Task 2**: Implement the capability to retrieve soil moisture data with satellite remote sensing measurements, calibrate and validate remotely-sensed soil moisture data through integration of remote sensing observations and ground soil moisture data network.

(iii) **Task 3**: Establish a database to integrate ground soil moisture data, remotely sensed soil moisture data, weather and climate data, as well as agricultural crop statistics and crop phenology information when available.

(iv) **Task 4**: Develop applications server for establishment of sustainable decision support system. In this regard, some of the top challenges for agriculture are: climate extremes; improved agricultural practices; agricultural development; and, markets and consumption.

Decision 44 (EC-69)

ENHANCING NATIONAL AND REGIONAL DROUGHT-MONITORING SYSTEMS

THE EXECUTIVE COUNCIL,

Recalling:

(1) Resolution 5 (CHy-14) - Establishment of an Integrated Drought Management Programme,

(2) Resolution 10 (CHy-15) - Work Programme and Structure of the Commission for Hydrology, which includes developing guidelines for assessing hydrological drought severity and impacts for water resources management which could be achieved through the establishment of a Community of Practice on Droughts,

(3) Resolution 1 (CAgM-16) - Integrated Drought Management Programme (IDMP),

Noting:

(1) The need to move from a reactive to proactive approach to drought management, based on risk management principles as stated in the Final Declaration of the High-Level Meeting on National Drought Policy (HMNDP),

(2) The IDMP *Handbook of Drought Indicators and Indices* (WMO-No. 1173),

Noting also the outcomes of the several international drought workshops on the development of an international drought information system which aims to promote regional drought monitoring products,

Recognizing:

(1) That drought monitoring and early warning systems involve technical expertise from CAgM, CHy, CCl, CBS and CAS along with coordination from the regional associations,

(2) That IDMP is co-sponsored by WMO and the Global Water Partnership (GWP),

(3) That over 30 international, regional and national partner organizations participate in IDMP activities, including the Food and Agriculture Organization of the United Nations (FAO), United Nations Convention to Combat Desertification (UNCCD), United Nations Convention of Biological Diversity (CBD) and Group on Earth Observations (GEO),

Decides to strengthen intercommission cooperation on regional and national drought monitoring and early warning systems;

Requests the president of CAgM to take the lead in coordinating issues on drought monitoring and early warning systems with CHy, CCl, CBS, CAS and the regional associations;

Invites Members:

(1) To inform the WMO Secretariat on the status of their national or regional drought monitoring and early warning systems;

(2) To promote, and further assist the WMO Secretariat and partner institutions in further developing, the Global Drought Information System (GDIS);

Requests the Secretary-General to support Members in further developing national and regional drought monitoring systems.

Decision 45 (EC-69)

DEVELOPMENT AND IMPLEMENTATION OF THE GLOBAL CRYOSPHERE WATCH

THE EXECUTIVE COUNCIL,

Recalling:

(1) Resolution 40 (Cg-17) - WMO polar and high mountain activities, deciding that operational and research observing networks including the observing component of the Global Cryosphere Watch (GCW) and other activities in polar and high-mountain regions, should be integrated within the framework of WMO Integrated Global Observing Systems (WIGOS) and of the WMO Information System (WIS),

(2) Resolution 43 (Cg-17) - Global Cryosphere Watch, deciding to mainstream and implement GCW in WMO Programmes as a cross-cutting activity, undertaken during the seventeenth financial period as one of the major efforts of the Organization with the goal that GCW should become operational,

(3) Decision 50 (EC-68) - Development of the Global Cryosphere Watch, defining the GCW surface observing network that includes CryoNet and contributing stations,

(4) Decision 51 (EC-68) - High-mountain activities, agreeing that the Executive Council Panel of Panel of Experts on Polar and High Mountain Observations, Research and Services (EC-PHORS) should facilitate the development of high-elevation cryosphere observational sites for inclusion into CryoNet,

(5) Recommendation 40 (CBS-16) – Development of the Global Cryosphere Watch, requesting Members to contribute to the further development of CryoNet through partnerships among national research institutes, universities, academia, and to nominate focal points,

Noting the report of the seventh session of EC-PHORS, (Ushuaia, Argentina, 21-24 March 2017),

Recognizing:

(1) That the cryosphere provides one of the most useful indicators of climate change, yet, it is arguably the most under-sampled domain,

(2) That changes in the cryosphere have direct impact on the sustainability of communities, on their water resources, increasing the risk of natural disasters,

Acknowledging that the GCW is one of the four components of WIGOS and WIS, promoting interoperability and near real-time data and information exchange,

Having considered:

(1) Recommendation 40 (CBS-16), requesting that Members contribute to the CryoNet network, and that regional associations consider relevant CryoNet stations for the Regional Basic Observing Networks (RBON),

(2) The recommendations of the seventh session of EC-PHORS, held from 21 to 24 March 2017, regarding the implementation of the GCW surface observing network, in particular the list of CryoNet Sites and Stations to establish,

(3) Recommendations 1, 3, 4, 14 and 15 of CBS-16 regarding the updated Manual on and Guide to WIGOS, on the amendment of the Manual on and Guide to the Global Observing System, and on the Manual on and for the Guide to WIS,

Decides to approve the list of stations in the Annex to the present Decision as part of the GCW surface observing network, as CryoNet stations and Contributing Stations, respectively;

Requests:

(1) Members responsible for these stations to record them in the Observing System Capability Analysis and Review Tool (OSCAR)/Surface, to associate them with the GCW surface observing network, and to assist the organizations responsible through their OSCAR Focal Points;

(2) Members to continue contributing to the development and implementation of the GCW surface observing network, by proposing additional CryoNet stations in polar and high mountain regions, to provide better coverage for all cryosphere components (e.g. snow, solid precipitation, glaciers, ice, permafrost, sea ice, river/lake ice);

(3) Members to support their national organizations contributing to GCW with the implementation of WIGOS and WIS requirements for data and metadata exchange in [near] real-time, and to facilitate their engagement with National Focal Points for WIGOS, the Global Telecommunication System (GTS) on WIS Matters, for Codes and Data Representation Matters, for WIS Discovery Matters;

(4) Members to identify at least one GCW Focal Point, in particular those not having nominated focal points yet;

(5) Members to explore possibilities to collaborate with research communities in promoting polar and high mountain region activities, including contribution to GCW;

Invites technical commissions and regional associations to consult with GCW in defining the requirements for observations in polar and high mountain regions, and for the preparation of GCW Best Practices Guide and Manual;

Requests the Secretary-General to ensure adequate support within the allocated budget for the execution of this Decision.

Annex to Decision 45 (EC-69)

LIST OF STATIONS FOR INCLUSION IN THE GLOBAL CRYOSPHERE WATCH SURFACE OBSERVING NETWORK

1.1 CryoNet Stations

	Station name	Country of the operating organization	Country/region where the site is operational
1	Base Belgrano II	Argentina	Antarctica
2	Base Esperanza	Argentina	Antarctica
3	Base Jubany (Carlini)	Argentina	Antarctica
4	Base Marambio	Argentina	Antarctica
5	Base Orcadas	Argentina	Antarctica

	Station name	Country of the operating organization	Country/region where the site is operational
6	Base San Martin	Argentina	Antarctica
7	Davis main AFIN station	Australia	Antarctica
8	AWS Pasterze	Austria	Austria
9	AWS-Kleinfleisskees	Austria	Austria
10	Goldbergkees	Austria	
11	Jamtalferner	Austria	Austria
12	Kleinfleisskees	Austria	Austria
13	Pasterze	Austria	Austria
14	Sonnblick Observatory	Austria	Austria
15	Bjelasnica	Bosnia and Herzegovina	Bosnia and Herzegovina
16	Ivan Sedlo	Bosnia and Herzegovina	Bosnia and Herzegovina
17	Eureka (MSC)	Canada	Canada
18	Kluane Lake Research Station (KLRS)	Canada	Yukon Territory, Canada
19	Valle Nevado	Chile	Chile
20	Jimunai station	China	China
21	laohugou station	China	China
22	Miaoergou Ice Cap Station	China	China
23	Muz Taw glacier station	China	China
24	Qilian	China	China
25	Suli station	China	China
26	Tanggula	China	China
27	Urumqi Glacier No.1 station	China	China
28	Xidatan	China	China
29	A.P. Olsen Ice Cap	Denmark	Greenland
30	PROMICE KAN_L	Denmark	Greenland
31	PROMICE KAN_M	Denmark	Greenland
32	PROMICE KAN_U	Denmark	Greenland
33	PROMICE KPC_L	Denmark	Greenland
34	PROMICE KPC_U	Denmark	Greenland
35	PROMICE NUK_L	Denmark	Greenland
36	PROMICE QAS_L	Denmark	Greenland
37	PROMICE QAS_U	Denmark	Greenland
38	PROMICE SCO_L	Denmark	Greenland
39	PROMICE SCO_U	Denmark	Greenland
40	PROMICE TAS_A	Denmark	Greenland
41	PROMICE TAS_L	Denmark	Greenland
42	PROMICE THU_L	Denmark	Greenland
43	PROMICE THU_U	Denmark	Greenland
44	PROMICE UPE_L	Denmark	Greenland
45	PROMICE UPE_U	Denmark	Greenland

	Station name	Country of the operating organization	Country/region where the site is operational
46	Antisana 15 alfa	Ecuador	Ecuador
47	Pallas-Kenttarova	Finland	Finland
48	Sodankyla Intensive Observation Area (IOA)	Finland	Finland
49	Sodankyla Sounding Station	Finland	Finland
50	Adelie Land	France	Antarctica
51	Argentiere Glacier	France	France
52	Col de Porte	France	France
53	Lac Blanc	France	France
54	Saint-Sorlin Glacier	France	France
55	Dome C Concordia air / snow observatory	France / Italy	Antarctic plateau
56	Zongo Glacier	France and the Plurinational State of Bolivia	Plurinational State of Bolivia
57	Hofsjökull Ice Cap	Iceland	Iceland
58	Hveravellir	Iceland	Iceland
59	AWS1 FORNI	Italy	Italy
60	Dome-C Surface-Snow-Meteo	Italy	Antarctica
61	SIGMA-A	Japan	Greenland
62	SIGMA-B	Japan	Greenland
63	Mera	Nepal/France	Nepal
64	Dammay, Bagrot AWS (Chira glacier)	Pakistan	Pakistan
65	Khama Bagrot AWS(Hinarchi Glacier)	Pakistan	Pakistan
66	Ice Base Cape Baranova	Russian Federation	Russian Federation
67	Tiksi	Russian Federation	Russian Federation
68	Formigal-Sarrios	Spain	Spain
69	Juan Carlos I	Spain	Antarctica
70	Davos SLF (SLF)	Switzerland	Switzerland
71	Davos SwissMetNet AWS (DAV)	Switzerland	Switzerland
72	Fluela permafrost station (FLU)	Switzerland	Switzerland
73	IMIS Parsenn 2 automatic station (PAR2)	Switzerland	Switzerland
74	Stillberg station (STILL)	Switzerland	Switzerland
75	Weissfluhjoch Versuchsfeld (WFJV)	Switzerland	Switzerland
76	Barrow Baseline Observatory	United States of America	United States
77	Quelccaya Ice Cap	United States	Peru

1.2 GCW Contributing Stations

	Site name	Country of the operating organization	Country / region where operational
1	ARA Suboficial Castillo	Argentina	Antarctica, Southern Ocean
2	ARA Puerto Deseado	Argentina	Antarctica, Southern Ocean
3	ARA Canal de Beagle	Argentina	Antarctica, Southern Ocean
4	ARA Almirante Irizar	Argentina	Antarctica, Southern Ocean
5	Vuriloches	Argentina	Argentina
6	Morenas Coloradas Rockglacier	Argentina	Argentina
7	Wintergasse	Austria	Austria
8	Kolm Saigurn	Austria	Austria
9	AWS Fraganter Scharte	Austria	Austria
10	Wurtenkees	Austria	Austria
11	Mocho-Choshuenco Volcano	Chile	Chile
12	Middle Station	China	China
13	Terminus Station	China	China
14	Fuyun station	China	China
15	Kanas station	China	China
16	Qingbingtan 72 Glacier station	China	China
17	PROMICE TAS_U	Denmark	Greenland
18	Zackenberg Research Station	Denmark	Greenland
19	Traub Glacier (Quito)	Ecuador	Antarctica
20	Sodankyla Lake Orajarvi	Finland	Finland
21	Sodankyla Peatland	Finland	Finland
22	Mer de Glace Glacier	France	France
23	Gebroulaz Glacier	France	France
24	Dome C GLACIOCLIM SAMBA stakes network north	France	Antarctic plateau
25	Dome C GLACIOCLIM SAMBA stakes network south	France	Antarctic plateau
26	La Muzelle	France	France
27	Col	France	France
28	Rabben Station in Ny-Alesund	Japan	Svalbard
29	Goriz	Spain	Spain
30	Bachimana	Spain	Spain
31	LLauset	Spain	Spain
32	Angel Orus	Spain	Spain
33	Renclusa	Spain	Spain
34	Matta Frauenkirch observer station (5MA)	Switzerland	Switzerland
35	Klosters Kraftwerk observer station (5KK)	Switzerland	Switzerland

	Site name	Country of the operating organization	Country / region where operational
36	Klosters RhB observer station (5KR)	Switzerland	Switzerland
37	Scaletta Glacier (SCAL)	Switzerland	Switzerland
38	Silvretta Glacier (SILV)	Switzerland	Switzerland
39	NIME station Dischma (DMA)	Switzerland	Switzerland
40	NIME station Monstein (MST)	Switzerland	Switzerland
41	Verstancla Glacier (VERST)	Switzerland	Switzerland
42	Bueschalp observer station (5DB)	Switzerland	Switzerland
43	Weissfluhjoch SwissMetNet AWS (WFJ)	Switzerland	Switzerland

Decision 46 (EC-69)

DEVELOPMENT AND IMPLEMENTATION OF THE ARCTIC POLAR REGIONAL CLIMATE CENTRE NETWORK AND OF POLAR REGIONAL CLIMATE OUTLOOK FORUMS

THE EXECUTIVE COUNCIL,

Recalling:

(1) Resolution 40 (Cg-17) - WMO polar and high mountain activities,

(2) Decision 52 (EC-68) – Polar Regional Climate Centres, endorsing the Arctic Polar Climate Centre (PRCC) Network as a joint initiative between RAs II, IV, and VI, and the follow-up in the development of an implementation plan,

(3) Decision 50 (EC-68) regarding the development of regional snow trackers as a quick look at the current state of the cryosphere relative to the mean state over the last two to three decades, to support PRCCs,

Noting:

(1) Decision 11 (RA II-16) – Implementation and coordination of Regional Climate Centre operations in RA II,

(2) Decision 11 (RA IV-17) – Implementation and coordination of Regional Climate Centre operations in Regional Association IV,

(3) Decision 22 (RA IV-17) – Development and implementation of the Arctic Polar Climate Centre Network and of the Polar Climate Outlook Forums in Regional Association IV,

(4) The report of the Regional Consultation on Climate Services for the Third Pole and other High Mountain Regions (Jaipur, India, 9-11 March 2016),

(5) The report of Arctic Polar Regional Climate Centres (PRCC) network implementation planning meeting, (Geneva, Switzerland, 7-9 November 2016),

(6) The report of the seventh session of the Executive Council Panel of Experts on Polar and High Mountain Observations, Research, and Services (EC-PHORS-7) (Ushuaia, Argentina, 21-24 March, 2017),

Acknowledges the growing need for reliable and timely information on the status of, and threats to the Arctic environment, in support of decisions of governments on mitigating the impact of climate change and sustaining the economic development, in particular in the remote areas of the Arctic;

Having considered:

(1) The recommendations of the Arctic PRCC-Network implementation planning meeting (Geneva, Switzerland, 7-9 November 2016) regarding the development of the draft Implementation Plan for the Arctic PRCC-Network with three geographically delineated nodes having sub-regional domains of responsibility: (i) North American Node led by Canada (with Canada and the United States of America as members of consortium); (ii) Northern Europe and Greenland Node led by Norway (with Denmark, Finland, Iceland, Norway, Sweden and possibly other interested European countries as members of consortium); and (iii) Eurasian Node led by the Russian Federation, and on the organization of the first Polar Regional Climate Outlook Forum (PCOF), in conjunction with the research and user communities,

(2) That each of the Arctic PRCC-Network nodes will also undertake a significant cross-node mandatory function for the entire pan-Arctic domain,

(3) That discussions have progressed well in Norway as well as the wider Nordic forum of the Nordic NMSs (NORDMET), and that Norway is prepared to coordinate the Arctic PRCC-Network for the first three-year period including the demonstration phase,

(4) The initiative taken by Canada to coordinate and host the inaugural session of Arctic PCOF,

(5) The recommendations of the seventh session of the EC Panel of Experts on PHORS regarding the draft implementation for an Arctic Polar RCC-Network,

(6) The recommendations of the Regional Consultation on Climate Services for the Third Pole Region (Jaipur, India, 9–11 March 2016) on establishing an RCC-Network and a Regional Climate Outlook Forum (RCOF) focused on the special needs of the Third Pole Region,

Recognizes:

(1) That an integrated and focused approach is needed to providing the required climate services to users and advice to governments to enable better management of climate risks faced by the polar and high mountain regions;

(2) The substantial progress made towards the implementation of the Arctic PRCC-Network under the guidance of EC-PHORS;

(3) The contribution of the Global Cryosphere Watch (GCW), which is developing integrated cryospheric products such as snow trackers;

(4) That there are a few issues that remain to be clarified in the draft PRCC Implementation Plan such as mechanisms and governance for validating Arctic PRCC-Network Nodes, whether Sea Ice and Marine Forecast should be part of the highly recommended functions, and additional issues raised by the Nordic National Meteorological Services (NORDMET);

Agrees that the mechanisms for the evaluation of the Arctic PRCC-Network Nodes ought to be developed in two phases: (i) a proof of concept phase between now and the third quarter of

2018; and (ii) a demonstration phase by the coalition of the concerned Members (time frame to be defined at a later stage based on the results of the first phase) with the overarching aim to seek formal WMO designation;

Endorses:

(1) The structure for the Arctic PRCC-Network as proposed by the Arctic PRCC-Network implementation planning meeting (7-9 November 2016) and detailed in the draft Implementation Plan of the Arctic PRCC-Network;

(2) The organization of Polar Climate Outlook Forums;

Requests EC-PHORS:

(1) To clarify the remaining issues in consultation with the concerned Members with the view to reach consensus, and within three months to finalize the draft PRCC Implementation Plan accordingly;

(2) To develop and propose, in consultation with appropriate partners, a roadmap to implement the Antarctic and Third Pole PRCCs (Networks) learning from the lessons of developing the Arctic PRCC-Network, and to report to EC-70 in this regard with a proposal;

(3) To provide an update on these development to the fortieth session of the Antarctic Treaty Consultative Meeting;

Requests EC-PHORS to define and agree on the governance for the Arctic PRCC-Network and Nodes in consultation with the concerned Members;

Authorizes the President to approve establishment of Arctic PRCC-Network Nodes on behalf of the Executive Council, following exchange of letters between the Secretary-General and the concerned Members committing to their identified roles and responsibilities, and the evaluation of their level of compliance with regard to the agreed functions of the Arctic PRCC-Network Nodes;

Requests:

(1) Members to contribute to the functions of the Arctic PRCC-Network as defined in the PRCC Implementation Plan, and to consider contributing to similar functions for the foreseen Antarctic PRCC and Third Pole RCC (or Networks);

(2) Regional Associations II, IV and VI to support the development, implementation and operations of the Arctic PRCC-Network and of Polar Climate Outlook Forums according to the PRCC Implementation Plan once approved, and in close collaboration between themselves;

(3) EC-PHORS to facilitate initiating the establishment and development and operations of the Arctic PRCC Network including the demonstration phase and improve satellite data contributions not only by meteorological satellites but also by other remote sensing techniques;

(4) The technical commissions, and in particular the Commission for Climatology and the Commission for Basic Systems, to assist during the demonstration phase with regard to assessing whether the requirements of the Arctic PRCCs Network are met by the candidate Arctic PRCC Nodes;

(5) The President to consult with EC-PHORS and the concerned Members and approve the draft PRCC Implementation Plan on behalf of the Executive Council;

(6) The Secretary-General to facilitate the coordination and provide the necessary Secretariat support for implementing the Arctic PRCC-Network as stipulated in this Decision, including though support for resource mobilization efforts.

Decision 47 (EC-69)

ANTARCTIC OBSERVING NETWORK

THE EXECUTIVE COUNCIL,

Recalling:

(1) Resolution 41 (Cg-17) - Antarctic Observing Network, on the approval of stations and observational programmes that constitute the Antarctic Observing Network,

(2) The *WMO Technical Regulations* (WMO-No. 49), Volume I, Part II, 1.3.1.1.2,

(3) The WMO Strategic Plan 2016–2019,

(4) The *Manual on the Global Observing System* (WMO-No. 544), Volume I, Global Aspects, Part III, sections 2.1.3 and 2.1.4, and Volume II, Regional Aspects – The Antarctic,

Noting the report of the seventh session of the Executive Council Panel of Experts on Polar and High Mountain Observations, Research, and Services (EC-PHORS-7) (Ushuaia, Argentina, 21-24 March 2017), regarding the Antarctic Observing Network,

Having considered the recommendations of EC-PHORS-7, regarding the Antarctic Observing Network and collaborations with the Scientific Committee on Antarctic Research (SCAR) concerning enhancement of observing systems in Antarctica,

Decides to approve the inclusion of the stations listed in the Annex to the present Decision, in the existing Antarctic Observing Network (AntON);

Requests Members:

(1) To consider their AntON observing stations for inclusion into the GCW Observing Network;

(2) To consider increasing: (a) deployment and maintenance for the long-term of high quality in situ observing platforms and/or Automated Weather Stations at strategic locations in Antarctica (e.g., coastal); (b) the release of weather balloons from ships during voyages to Antarctica; and (c) deployment of surface drifters near Antarctica;

(3) To comply with the standard times of observation, the coding procedures and the data-collection standards, as stated in the *Technical Regulations*, Volume I and the *Manual on the Global Observing System*, the *Manual on Codes* (WMO-No. 306), the *Manual on the Global Telecommunication System* (WMO-No. 386) and the *Manual on the Global Data-processing and Forecasting System* (WMO-No. 485), providing the data in real-time as far as practicable;

(4) To update the observational metadata for all the stations, to make available appropriate discovery metadata and to provide them with all observational datasets through the WMO Information System;

Requests the Secretary-General to ensure adequate support within the allocated budged for the execution of this Decision.

Annex to Decision 47 (EC-69)

PROPOSED LIST OF ADDITIONAL STATIONS IN THE ANTARCTIC OBSERVING NETWORK

This list shows the stations proposed in 2017 for inclusion in the Antarctic Observing Network (AntON). These stations complement the network established through Resolution 41 (Cg-17).

It shows whether the stations currently contribute synoptic (S), climate (C) or upper-air (U) synoptic observations that are to be sent to the Global Telecommunication System (GTS), and whether they are GCOS Surface Network (GSN), GCOS Upper-Air Network (GUAN) or Global Atmosphere Watch (GAW) stations. Key stations are those that are Global Climate Observing System (GCOS) stations or are over 200 km distant from a GCOS station. Station numbers beginning AA are sent on the GTS in SYNOP MOBIL code form. All operational AntON stations are expected to produce CLIMAT messages, provided that they have suitable data.

Antarctic stations									
WMO No.	***Station***	***Operator***	***Type***	***S/C***	***U***	***Key***	***GSN***	***GUAN***	***GAW***
89011	Soerasen								
89057	Filchner								
89776	Bharati								

Decision 48 (EC-69)

POLAR AND HIGH-MOUNTAIN REGIONS PRIORITY ACTIVITY

THE EXECUTIVE COUNCIL,

Recalling:

(1) Resolution 2 (Cg-17) – Implementation of the WMO Strategy for Service Delivery,

(2) Decision 42 (EC-68) – Implementation of the WMO Strategy for Service Delivery,

(3) Resolution 40 (Cg-17) - WMO Polar and High Mountain Activities,

(4) Resolution 49, (Cg-17) – Year of Polar Prediction – which decided to support a period of intensive observing, numerical modelling simulations, verification, user-engagement and education activities through the Polar Prediction Project (PPP) Year of Polar Prediction (YOPP),

(5) Decision 53 (EC-68) – Year of Polar Prediction, which endorsed the roadmap to the Year of Polar Prediction as provided in the report of the Year of Polar Prediction Summit,

Noting:

(1) The report of the sixth session of the Executive Council Panel of Experts on Polar and High Mountains Observations, Research and Services (Reykjavik, Iceland, 8–11 September 2015),

(2) The final report of the seventh session of the Executive Council Panel of Experts on Polar and High Mountain Observations, Research, and Services, (EC PHORS-7), 21-24 March, 2017,

(3) Resolution 1 (CHy-15), which requested the Commission for Hydrology (CHy) Advisory Working Group (AWG) to explore with the GCW Project Office possible joint activities and collaboration regarding high-latitude and high-altitude services, with a focus on observations and availability of data,

(4) The Terms of Reference of EC-PHORS, whereby EC-PHORS is tasked to contribute to the work of regional associations, technical commissions and programmes in defining appropriate components of hydrometeorological and cryospheric observing systems and services in high-mountain regions,

(5) Recommendation 2 (CHy-15) - CHy's contribution to the formulation of the WMO Strategic Plan 2020-2023, recommending to the Executive Council that water issues be given a higher visibility in the Strategic Plan 2020-2023, by elevating them to the level of a strategic priority, while recognizing their cross cutting relevance,

Considering:

(1) That the services provided by WMO contribute to enhancing the safety of personnel in the Antarctic, and these could be sustained through the sharing of best practices with respect to Antarctic weather service delivery,

(2) The importance of understanding changes of the cryosphere in high mountain regions, and of enhancing predictability of changes at various time scales, for addressing the potential impact on the availability of water resources and food security,

(3) The need to clarify the scope and definition of “high mountain regions” in the framework of WMO Polar and High Mountain Regions Priority Activity,

(4) The need to facilitate implementation of collection of data from observing platforms in high mountain regions of developing countries,

(5) That the core period of the YOPP, entailing intensive observation and modelling campaigns in both the Arctic and the Antarctic is scheduled from mid-2017 to mid-2019, and that funds available to hold key activities, such as the meetings of the steering committee, are shortly coming to an end,

(6) That it is critical to assure appropriate funding of the EC-PHORS and PPP (including YOPP) activities,

Recognizing that the Green Climate Fund offers a good opportunity to support the WMO polar and high mountain regions priority activity,

Acknowledging that the WMO Strategy for Service Delivery should guide the implementation of WMO Programmes and the desire to contribute fully to the realization of the WMO key Strategic Thrust in Service Delivery across the areas of weather, climate and water,

Recalling that the sixth meeting of EC PHORS decided that the Antarctic Task Team should explore approaches to develop an integrated service delivery model for Antarctic weather services, including a possible coordinating role of WMO, and how to engage with the Antarctic Treaty Consultative Meeting (ATCM) during this process,

Concurs with the proposal of EC-PHORS to organize a Third Pole Science Summit in the 2018 time frame, focusing on water resources issues;

Encourages Least Developed Countries (LDCs) to engage with the International Forum of Users of Satellite Data Telecommunication Systems (Satcom) in order to have requirements for Satcom on their high mountain regions better considered by satellite operators and equipment manufacturers;

Decides:

(1) To renew its efforts through EC-PHORS to coordinate the products and services provided to Antarctic operators by NMHSs, build interoperability into existing systems and, where feasible, provide integrated products and services to improve service delivery capabilities of Members to meet end-user needs in the Antarctic;

(2) That high mountain regions shall be defined as *"mountain areas where seasonal or perennial cryosphere is present and poses potential and serious risks to society related to water scarcity and disaster resilience"*;

Requests EC-PHORS to facilitate execution of this Decision and particularly engage with CHy with regard to high mountain activities;

Invites Members to actively participate in cooperation with the research community in the Year of Polar Prediction (YOPP) activities, and particularly in its Special Observing Periods (SOPs) between 2017 and 2019;

Urges Members to contribute to the EC-PHORS Trust Fund and to consider providing additional support to the PPP Trust Fund in order to ensure the continued momentum of the YOPP at a critical juncture;

Invites the Secretary-General to engage in promoting the funding of WMO polar and high mountain regions priority activity with the Green Climate Fund.

Decision 49 (EC-69)

WMO PRIORITY ACTIONS IN HYDROLOGY AND WATER RESOURCES MANAGEMENT

THE EXECUTIVE COUNCIL,

Noting that the fifteenth session of the Commission for Hydrology had been held in Rome from 7 to 13 December 2016, with 140 participants representing 57 Members of WMO, including a record 31% of women delegates,

Having considered the *Abridged Final Report with Resolutions and Recommendations of the Fifteenth Session of the Commission for Hydrology* (WMO-No. 1184),

Noting:

(1) That, through Resolution 2 (CHy-15), the Commission decided to continue the development of QMF-H consistently with the overarching WMO QMF, and to engage in a review and update of the regulatory material relevant to its mandate and responsibilities

by the time of Cg-18 in 2019, in accordance to the Roadmap to Enhanced WMO Technical Regulations Framework,

(2) That, as regards hydrological data operations, management and exchange, the Commission approved through Resolution 5 (CHy-15) the further implementation of WHOS Phase I as well as the initial concept of WHOS Phase II, and made arrangements to develop an initial implementation plan to be presented to EC-70 for its endorsement; and, in response to the request of Cg-17, initiated a process leading to the preparation of a report on the evolving role of the global data centres under its auspices, with respect to the monitoring and measurement of the achievement of the SDGs, their contributions to GFCS and their support to WHOS, GHSF and other CHy initiatives,

(3) That, through Resolution 8 (CHy-15), CHy decided to initiate the WMO Global Hydrological Status and Outlook system, building on the existing efforts from a number of Members to produce regular analyses of the current national hydrological condition complemented by forward looking assessments of how the water situation may change over sub-seasonal to seasonal time scales, and taking into consideration the need to link this initiative closely with other related WMO activities such as WIGOS (in particular by making use of the opportunities provided by WHOS) and the Global Data-processing and Forecasting System,

(4) That, in Resolution 9 (CHy-15), the Commission approved the WMO Strategy on Capacity Building in Hydrology and Water Resources Management, for the period 2017–2020, which includes the development of open source and community of practice solutions to promote the transfer of technology for the value chain of the most important products and services of the NHSs, in particular flood forecasting and warning and drought management;

Noting further that Recommendation 1 (CHy-15) - Data representations for hydrological information, was being considered by the Council under item 5.2 of its agenda and Recommendation 2 (CHy-15) - Contribution of the Commission for Hydrology to the formulation of the WMO Strategic Plan 2020–2023, under item 16.2, and that actions on flood forecasting and warning are discussed under agenda item 3.2(3),

Decides:

(1) To note the report;

(2) To note Resolutions 1 to 11 (CHy-15);

(3) To embody the substance of Recommendation 3 (CHy-15) – Review of the resolution of the Executive Council based on previous recommendations of the Commission for Hydrology, in Resolution 23 (EC-69) – Review of previous resolutions of the Executive Council;

Requests the president of CHy to do his utmost to ensure that the ambitious workplan of the Commission for Hydrology is successfully implemented and to continue his efforts in coordinating the Commission’s activities with other technical commissions and with the regional associations;

Requests the presidents of CHy and CCl to collaborate in supporting the development of a joint report of the state of the global climate with the hydrological status and outlook system, based on the results of the work of the expert task team established by CHy 15, in order to provide consistent climate and hydrological reports to future COPs;

Requests the Secretary-General:

(1) To support the presidents of CHy and CCl in the above endeavour within the limits of the available resources;

(2) To give high priority to the development of operational WHOS Phase II components;

(3) To provide scenarios for long term sustainability of the Global Hydrometry Support Facility;

Invites Members to support WHOS Phase II as an essential part of WIGOS and to grant free and unrestricted access to hydrological data.

Note: This resolution replaces Resolution 7 (EC-65), which is no longer in force.

Decision 50 (EC-69)

AN INTEGRATED RESEARCH AND DEVELOPMENT APPROACH

THE EXECUTIVE COUNCIL,

Recalling Resolutions 61 and 62 (EC-68) that endorsed the draft implementation plan of the World Weather Research Programme (WWRP) and of the Global Atmosphere Watch (GAW) Programme for the period 2016-2023,

Recalling Resolution 47 (Cg-17) that established the framework for GAW,

Recalling Resolution 45 (Cg-17) that established the framework of the WWRP, Resolutions 16 and 17 (EC-64) that initiated the Polar Prediction Project and the Sub-seasonal to Seasonal Prediction Projects, and Resolution 11 (EC-66) that founded the High-Impact Weather Project,

Recognizing that although research and development (R&D) and operations are distinctly different activities, the gap between them needs to be closed to exploit the best science for improving all components of the service value chain,

Recognizing that the World Climate Research Programme (WCRP) and the Commission for Atmospheric Sciences (CAS) Programmes (WWRP, GAW) bring in the capabilities of a much larger community than those in NMHSs, and that those capabilities are fundamental for advancing the WMO services delivery strategy,

Realizing the need to further increase connectivity between GAW, WWRP and WCRP to be able to offer enhanced capabilities in environmental analysis and forecasting,

Endorses the principles towards better integrated research and development support to Members of which the proposed process is provided in the Annex;

Requests the Secretary-General to actively work with Members to implement the endorsed principles;

Requests technical commissions, scientific programmes, and regional associations to actively work to implement the endorsed principles.

Annex to Decision 50 (EC-69)

PRINCIPLES TO FILL THE GAP BETWEEN RESEARCH AND OPERATIONS

1. Key principles for an integrated research and development approach

Filling the gap between research and development (R&D) and operations requires a move from a current linear model of transferring research to operations to an interactive model, in which stakeholders assess and articulate their future needs, researchers work in dialogue with stakeholders to define and implement appropriate research programmes, the research results are transferred into operations at appropriate intervals and the stakeholder needs and research programmes are refined taking into account the knowledge and experience gained. This interactive path to value innovation requires:

(a) A close collaboration between technical commissions and among scientific programmes of the WMO, and collaborating intergovernmental partners including the Commission on Basic Systems (CBS), the Commission on Atmospheric Sciences (CAS), and the Global Atmosphere Watch (GAW) Programme, the World Weather Research Programme (WWRP) and the World Climate Research Programme (WCRP), and the Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM);

(b) Commitment of the WMO operational community to exploit collaboration opportunities in the new implementation plans of GAW and WWRP, considering inputs from WCRP, and to develop joint activities;

(c) A continuous joint consultation of research and operations with the user community with a focus to build research guidance related to operational support for impact-based forecast, and risk-based warning systems;

(d) Use of research inputs to design and develop new products and services, and continuous provision of feedbacks to drive new research activities. As well as encouraging the use of operational infrastructure (observations, models, tools) to conduct research in order to facilitate effective research to operations transition.

Decision 51 (EC-69)

THE INTEGRATED GLOBAL GREENHOUSE GAS INFORMATION SYSTEM IMPLEMENTATION PLAN

THE EXECUTIVE COUNCIL,

Recalling Resolution 46 (Cg-17) that highlights the main objectives and the key activities required for the establishment of the Integrated Global Greenhouse Gas Information System (IG^3IS),

Recalling Decision 19 (EC-68) that approved the IG^3IS Concept Paper and calls for the development of the IG^3IS Implementation Plan by EC-70,

Recognizing the growing need for data and research related to understanding greenhouse gas sources and sinks on enhanced temporal and spatial scales, and the need for provision of such data in a facilitative, collaborative, and non-regulatory way. The data and research will provide information on the atmospheric distribution of greenhouse gases and have the potential to support the work of the greenhouse gas emission inventory compilers. The data also have the potential to contribute to the Paris Agreement adopted by the 21st Conference of the Parties (COP 21) to the United Nations Framework Convention on Climate Change (UNFCCC), the provision of climate services, and related Sustainable Development Goals,

Acknowledging that the Implementation Plan 2016 of the Global Climate Observing System (GCOS) approved by the GCOS Steering Committee and introduced at COP 22 in Marrakesh includes the new Essential Climate Variable (ECV) "Anthropogenic Greenhouse Gas Fluxes" measured through "Estimated fluxes by inversions of observed atmospheric composition", and that this ECV is directly supported by IG^3IS,

Noting that the Task Force on National Emission Inventories of the Intergovernmental Panel on Climate Change (IPCC) recognized the potential for atmospheric observations to identify areas for improvement of greenhouse gas emission inventories,

Noting the complementarity of IG^3IS to compilation of national emission inventories guided by the IPCC process and the added value of the information provided by IG^3IS as a scientific observations-based tool in support of policy, in the improvement of future climate scenarios and in fostering carbon cycle science,

Appreciating the steps taken by the Secretary-General and the Executive Director of the United Nations Environment Programme (UNEP) to promote collaboration on IG^3IS between the National Hydrometeorological Services, Research Institutions and National Environmental Agencies in Member countries,

Appreciating the efforts of the United Kingdom of Great Britain and Northern Ireland, and Switzerland in sharing their best practices in the implementation of IG^3IS and the efforts of Australia, New Zealand, Morocco, South Africa and Brazil in establishing the national pilot and demonstration projects,

Appreciating the role that has been played by the World Data Centre for Greenhouse Gases supported by Japan in the collection and dissemination of global greenhouse gas observations data,

Having considered the approval by the Commission for Atmospheric Sciences of the IG^3IS management structure, which includes an IG^3IS Steering Committee, a Science Advisory Team and an IG^3IS Office,

Having considered the outline of the IG^3IS Implementation Plan, a summary of which is provided in Annex 1,

Decides that the Commission for Atmospheric Sciences (CAS) should oversee the development of the IG^3IS Implementation Plan based on this outline and the plan should be delivered by EC-70;

Requests regional associations and technical commissions to provide their contribution to the IG^3IS Implementation Plan and improve collaboration on the aspects of IG^3IS that are of a cross-commission nature;

Requests the Secretary-General to:

(1) Provide support for the preparation of the detailed IG^3IS Implementation Plan;

(2) Provide support to the IG^3IS activities and assist in promoting IG^3IS with funding agencies, and work with those Members, especially in developing countries, who plan to undertake IG^3IS projects, in pursuing extrabudgetary resources to do so;

(3) Communicate with UNFCCC on the issues related to the implementation of IG^3IS in the context of UNFCCC processes, and report on progress at EC-70;

(4) Take all necessary actions to develop and maintain WMO collaboration on matters related to the implementation of IG^{3}IS with relevant organizations, agencies, groups and institutions, including IPCC, UNFCCC, UNEP, the United Nations Educational, Scientific and Cultural Organization (UNESCO), the International Maritime Organization (IMO), and the Food and Agriculture Organization (FAO);

Urges Members to implement pilot and demonstration projects following the IG^{3}IS best practices.

Annex to Decision 51 (EC-69)

SUMMARY OF THE INTEGRATED GLOBAL GREENHOUSE GAS INFORMATION SYSTEM IMPLEMENTATION PLAN OUTLINE

Guidance / Background: The IG^{3}IS Implementation Plan Outline is a working document that is provided with this decision for context. The plan will be further developed over the next year and presented to EC-70.

1. IG^{3}IS Concept

The IG^{3}IS concept and objectives are summarized in the IG^{3}IS Concept paper (http://www.wmo.int/pages/prog/arep/gaw/documents/EC_68_ConceptPaper_IG3IS_DRAFT_V14.pdf). IG^{3}IS will be built on existing practices where scientific and technical skills are proven and where IG^{3}IS information can meet the expressed needs of decision- and policy-makers who recognize the value of the information. This section describes specific principles and goals of the IG^{3}IS system.

2. IG^{3}IS Implementation

The IG^{3}IS team defined four initial implementation objectives: (1) reduce uncertainty of national emission inventory reporting to UNFCCC; (2) locate and quantify previously unknown emission reduction opportunities, such as fugitive methane emissions from industrial sources; (3) provide subnational entities, such as large urban source regions (megacities), with timely and quantified information on the amounts, trends and attribution by sector of their GHG emissions in order to evaluate and guide progress towards emission reduction goals; and (4) assess trends of GHG emissions in support of national pledges and the Paris Agreement global stocktake.

This section of the plan will detail the specific required steps to implement projects according to good practices for each objective area. The following is an introduction of each objective:

1) National Inventory Reporting

This section of the plan will document and propagate good practices and establish quality metrics for top-down methods, how top-down methods can be compared to GHG inventories developed from bottom-up methodologies that employ statistical activity data and emission factors, and how the results can be used to target improvements in bottom-up inventory data inputs. IG^{3}IS progress toward this objective is evident in the approved outline for the "2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories" and IG^{3}IS will contribute to the update of this Guideline.

2) Detection and Quantification of Anthropogenic Methane Emissions

Given that different methane sources overlap spatially, a key aspect of ongoing research has been the attribution of existing emissions to specific sources. This section of the plan will document best practices currently available for estimating methane emissions from the oil and gas sector. IG^{3}IS will extend these approaches to other methane emitting sectors as a subsequent initiative (such as rice production, waste and wastewater). This objective has close links with urban monitoring of methane emissions and will develop sector-appropriate methodologies. The measurement strategy through which it will be possible to constrain estimates of global oil and gas associated methane emissions will be recommended.

3) Support of City-Scale Mitigation Efforts

A number of research projects around the world, such as the Indianapolis INFLUX study, and the Los Angeles/Paris Megacity Project, have developed and tested methods for independent estimation of greenhouse gas emissions. This work has established a prototype urban greenhouse gas information system that combines atmospheric monitoring, data mining and model algorithms. IG^3IS will redesign this information system for deployment to different parts of the world, particularly in the low- and middle-income countries where GHG information needs are greatest and capacity is limited. The IG^3IS approach will aim to provide estimates of high resolution (~100m) GHG emissions for the urban domain on a weekly/monthly time-scale (faster than traditional inventory methods) to help guide mitigation efforts and track mitigation progress. Additional information should include attributes such as sector and fuel type.

4) GHG Emission Trends in support of the Paris Agreement Global Stocktake and NDCs

While the Paris Agreement does not specify how the global stocktake will be conducted, IG^3IS has a vision for how to define and support such an effort. This section of the plan will address a gap in current GHG observing system capabilities related to the skill to account for fossil fuel CO_2 emissions. This gap is related to large variability in atmospheric CO_2 concentrations from the biosphere. It has been demonstrated that CO_2 emissions from fossil fuels can be inferred by inverse model analyses with a combination of atmospheric measurements that include atmospheric CO_2 and radiocarbon ($^{14}CO_2$), with measurements of other co-varying atmospheric species. IG^3IS will advocate for enhancements to the measurement infrastructure for $^{14}CO_2$ to meet this objective.

3. IG^3IS Projects and Demonstrations

This section describes IG^3IS projects and demonstrations under development. It will also address the landscape of sponsorship and partnership opportunities and challenges.

4. Research and Development in Sensing and Modelling

This last section reflects the need for the new tools, such as enhancements to aircraft observations of greenhouse gases and isotopic measurements for source attribution, and developments in atmospheric transport modelling.

The full version of the IG^3IS Implementation Plan outline is available at **www.wmo.int/gaw**.

Decision 52 (EC-69)

EARLY CAREER RESEARCH SCIENTIST INVOLVEMENT IN WMO ACTIVITIES

THE EXECUTIVE COUNCIL,

Recalling Resolution 50 (Cg-17) - Capacity Development Programme, as well as Resolution 49 (Cg-XVI) - WMO Strategy for Capacity Development,

Recognizing:

(1) The demand for a new generation of Earth System scientists that will work across weather, climate, water and environment communities, to tackle challenges emerging from the growing and urbanizing global population;

(2) The need for encouraging, training and mentoring early career scientists to also prepare them for their future leadership in these fields of Earth System sciences, given the above-mentioned challenges;

(3) The limited resources of a finite world, and vulnerabilities to exceptional weather, climate, water and related environmental events;

(4) The ongoing joint effort of WMO research programmes (WCRP, WWRP and GAW), as detailed in the Annex, to support early career scientist activities;

Noting the endorsement made by the World Climate Research Programme's Joint Scientific Committee (WCRP-JSC 37, 2016), and the recommendation of the Commission for Atmospheric Sciences Management Group (CAS-MG 11, 2016),

Acknowledging the significant step forward made through the establishment of a coordination office for the Young Earth System Science (YESS) in the National Meteorological Service of Argentina,

Urges all Members to promote and support the early career scientist activities and make them beneficial and accessible to young researchers in their own countries and worldwide;

Requests the Secretary-General to facilitate all WMO Programmes' support for coordinated international and interdisciplinary early career scientist activities on topics relevant to WMO.

Annex to Decision 52 (EC-69)

SUPPORT FOR EARLY CAREER SCIENTIST ACTIVITIES

1. Early success

In recent years, the WMO Research Department that provides Secretariat support for the Weather Climate Research Programme (WCRP), the World Weather Research Programme (WWRP) and the Global Atmospheric Watch (GAW), made a concerted effort to reach out to early career scientists, particularly those in Earth System science (Young Earth System Scientists community, reference: http://www.yess-community.org/). Early outcomes of such efforts include:

(a) Extended network of cross-disciplinary young Earth System scientists. For example, the YESS community has now grown to over 800 members from over 80 countries, working closely with other networks including the Association of Polar Early Career Scientists (APECS), Young Hydrologic Society (YHS) and the ECR Network of Networks (NoN);

(b) The WCRP Joint Scientific Committee (JSC) and the WWRP Scientific Steering Committee (SSC) solidified their endorsement to YESS, resulting in close engagement of young scientists in the global research coordination;

(c) The WCRP/WWRP/GAW supported the Earth System Science Frontiers Workshop in Offenbach, Germany, in October 2015, resulting in a white paper published in the

Bulletin of the American Meteorological Society, outlining the YESS vision of the future of Earth System science, focused on four 'Frontiers': scale interaction, communication, user-needs, and interdisciplinarity;

(d) With the generous support of the Argentinean National Weather Service (SMN), a YESS Office is now open at SMN in Buenos Aires, Argentina, and a YESS officer is in position and operational as of 15 March 2017.

2. Key activities 2017-2019 and associated requirements

(a) Adequate support to the YESS office, by providing financial assistance for travel and resources for online activities (e.g. online conference tools), to enable worldwide outreach;

(b) An Early Career Researchers Workshop 'Towards regional weather and climate information', planned for 27 August to 1 September 2017 in Cape Town, South Africa. The workshop aims to bring together an international group of 20-30 early career researchers and practitioners to have an in-depth discussion about how to obtain and disseminate weather, atmospheric composition and climate information through an interdisciplinary approach that also considers novel methods on data usage, aspects of communication and user needs. Financial assistance is sought to realize its special focus on participation of developing countries and women;

(c) Active participation of early career scientists in Members institutions, including in research projects coordinated within the WMO's research programmes. Members are invited to enable and encourage their early career employees to be active in the relevant activities of WMO Programmes and/or early career scientists activities.

Decision 53 (EC-69)

PLANS AND GUIDANCE FOR WEATHER MODIFICATION ACTIVITIES

THE EXECUTIVE COUNCIL,

Recalling the EC-60 recommendation to the Commission for Atmospheric Sciences (CAS) to implement a regular review of the WMO Statement on Weather Modification, including an executive summary and the WMO guidance for the Planning of Weather Modification Activities through the Expert Team on Weather Modification,

Recalling further Article III of the United Nations Convention on the Prohibition of Military or any Other Hostile Use of Environmental Modification Techniques, allow States the right to participate in the fullest possible exchange of scientific and technological information on the use of environmental modification techniques for peaceful purposes,

Having examined:

(1) The previous update to the WMO statement and guidance documents on weather modification that was conducted in 2010;

(2) The growing interest in weather modification activities;

(3) The compilation by CAS of a plan of future activities with its extrabudgetary requirements, which includes a peer-reviewed assessment of the state of knowledge in the field of weather modification;

Decides to endorse the updated WMO "Guidance in the Development and Implementation of Operational Weather Modification Activities" (Annex 1), and the CAS plan for future activities and resources required to support these (Annex 2);

Notes with appreciation the contribution by the United Arab Emirates to the WMO trust fund for Weather Modification for the generation of a peer reviewed status report on rainfall enhancement processes;

Requests the Secretary-General, and CAS in collaboration with regional associations and technical commissions to conduct a survey among Members on their current scientific and operational involvement in weather modification activities in order to update the WMO weather modification database;

Invites interested Members to make use of the "Guidance in the Development and Implementation of Operational Weather Modification Activities" document and to contribute to the trust fund established by EC-LX to support the ongoing review on Weather Modification by CAS.

Annex 1 to Decision 53 (EC-69)

GUIDANCE IN THE DEVELOPMENT AND IMPLEMENTATION OF OPERATIONAL WEATHER MODIFICATION ACTIVITIES

1. Guidance

This guidance is addressed to WMO Members requesting advice or assistance in the development and implementation of operational weather modification activities.

1.1 Weather modification should progress through the following three types of activities:

(a) Continuing strategic research is required to investigate and test the scientific hypotheses on which the weather modification is based. This research is inherently focused on important atmospheric processes, and therefore it is relevant not only to weather modification, but also to the improvement of weather and climate prediction that supports a wide range of applications such as water management and climate change adaptation;

(b) With sound scientific understanding of the relevant atmospheric processes, a weather modification experiment can be designed and implemented in order to demonstrate the scientific and economic feasibility of the activity and the validity of the underpinning scientific hypothesis;

(c) Having completed a successful and validated experiment (e.g. as judged through the scientific peer-review process), and having conducted appropriate consultations with national and regional stakeholders and authorities who may be affected by the activity, it can be considered to undertake operational weather modification, in which the focus is on practical outcomes and environmental safeguards, while maintaining practices that allow continuing scientific evaluation of the results of the operations.

1.2 However, Members wishing to develop such operational activities in the field of weather modification should take into account the considerable uncertainties involved and the challenges related to the validation of the results of such activities. Members are advised not to perform operational weather modification activities without considering the above, particularly when these activities promote only commercial interests without scientific credibility.

1.3 It is recommended that measurements collected in all-weather modification activities should have a data management plan that ensures that the data are available for future analyses, and that Members should share their experiences in weather modification in order to avoid duplication.

Annex 2 to Decision 53 (EC-69)

WMO WEATHER MODIFICATION RESEARCH PLAN AND ACTIVITIES

1. Background

The number of WMO Members active in weather modification activities has steadily increased concurrently with the increase in said activities in several countries. Many of these activities are purely operational, often without a sound scientific basis. While funding for research in the field of weather modification has grown substantially in the past ten years and new results are providing more confidence in certain areas, there is still uncertainty in the quantitative effects of cloud seeding to enhance precipitation and even more so to suppress hail or mitigate severe weather. Major research programmes in this field are now ongoing in China, India, the Russian Federation, Thailand, the United Arab Emirates and the United States of America.

The CAS Expert Team on Weather Modification has received several requests in recent years from specific Members to provide them with guidance for planning weather modification activities, including fog dispersal and hail suppression. The expert knowledge of this team can help to understand the options and challenges for such activities.

During the World Weather Research Programme (WWRP) Scientific Steering Committee (SSC) meeting, which took place in October 2016, it became clear that the Expert Team on Weather Modification could also make substantial contributions to the WWRP Implementation Plan, especially as it relates to aerosol-cloud interactions in numerical models and in measurement programmes around the world.

2. Planned activities of the Expert Team on Weather Modification Research

In light of the different roles that the Expert Team can play in many fields, the team recommends the following core activities:

(a) To update the current review of global weather modification science and practices, also considering the contributions by relevant experimental facilities and numerical models, through a peer-reviewed document and/or publication to be available for Cg-18 in 2019. Depending on available funding, this can be done in two parts: Part A: only on precipitation enhancement, and Part B: on other phenomenon such as hail suppression and/or fog dispersal;

(b) To organize bi-annual meetings to keep under constant review any progress in the field of weather modification and to organize possible contributions to the goals of the WWRP Implementation Plan and the interactions with the other working groups (some of these meetings could be organized in conjunction with meetings of other working groups);

(c) To conduct workshops (ad hoc) with the focus on specific weather modification topics related to a specific region, as requested. These could be synchronized with such activities at the WMO Regional Training Centres.

3. Estimated budget for recommended activities

The Expert Team would continue to seek sponsors for local facilities to host the meetings and/or workshops. Assuming that facilities could be sponsored by a local host, the annual activity budget is presented in Table 1. In Table 2, a budget is provided for the compilation of a peer-reviewed document/publication. All these activities are dependent on contributions to the weather modification trust fund.

Table 1: Required financial support for regular WMO ET activities

	Function	**Estimated cost (US$)**
Recommendation 2.2	Bi-annual meeting of ET (10 ET members meet for 3 days)	30k every second year
Recommendation 2.3	Ad hoc workshop on specific topic in specific region (ET members for 5 days plus report)	20k per year

Table 2: Required financial support for WMO ET for peer-reviewed document/s

	Function	**Estimated cost (US$)**
Recommendation 2.1 (Part A)	Peer-reviewed document on the state-of-the-art practices on precipitation enhancement	75k over 2 years
Recommendation 2.1 (Part B)	Peer-reviewed document on the state-of-the-art practices on other phenomenon such as hail suppression and/or fog dispersal	25k over 2 years

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Decision 54 (EC-69)

IDENTIFICATION OF PRIORITIES FOR EDUCATION AND TRAINING

THE EXECUTIVE COUNCIL,

Recalling Decision 63 (EC-68) - Capacity Development Priorities for 2016-2019,

Recalling also Resolution 14 (EC-66) - Guidance for the Education and Training Programme for 2016-2019,

Having considered the need to ensure appropriate implementation of the WMO Strategic Plan 2016–2019 from the education and training perspective,

Agrees on the priorities listed in the Annex to this Decision;

Urges Members to take these priorities into consideration in their national and international activities on education and training;

Urges further Members to facilitate the national focal points in the delivery of their support to national and regional assessments of education and training needs;

Requests the Secretary-General to take these training needs into account in the development and implementation of education and training activities.

Annex to Decision 54 (EC-69)

PRIORITIES FOR EDUCATION AND TRAINING

1. Priorities for Education and Training

(a) Development and implementation of WMO competency frameworks and augmentation of existing curricula and learning outcomes with advances in science and technology;

(b) Continuous education and enhancement of research capability to keep pace with developments in science and technology research;

(c) Broadening of partnerships with other organizations and agencies;

(d) Fellowships for education of the future generation of needed human resources;

(e) Embedding education and training as critical elements in the management and modernization of all NMHSs;

(f) Embedding education and training as critical elements in all extrabudgetary funded projects of WMO;

(g) Promotion of research and operational capacity through stronger connections to WMO research programmes, graduate level fellowships and personnel exchanges;

(h) Exchange of experience and competencies through exchange of human resources, sharing learning resources, and dissemination of good practices;

(i) Enhancing the capacity of RTCs to deliver training in multiple formats to meet the regional needs;

(j) Regular updates of national and regional training needs analysis;

(k) Continue placing emphasis on the WMO Global Campus feasibility study as a potential mechanism to aid in meeting each of these priorities.

Decision 55 (EC-69)

ENHANCING BILATERAL AND MULTILATERAL ASSISTANCE FROM MEMBERS TO SUPPORT WMO EDUCATION AND TRAINING INITIATIVES

THE EXECUTIVE COUNCIL,

Recalling Decision 63 (EC-68) - Capacity Development Priorities for 2016-2019,

Considering that the WMO Education and Training Programme (ETRP) is an important part of the Organization's capacity development endeavours,

Noting the outcome of the survey on education and training needs, as contained in the Report on Education and Training Activities,

Noting further that the limited education and training opportunities is constraining optimum performance of many NMHSs, and likely impacting on Members ability to comply with and implement multilateral agreements and initiatives,

Considering the importance of management skills in the development and modernization of NMHSs,

Acknowledging the immense contribution of WMO Members to education and training, and encouraging them to continue,

Urges Members to enhance cooperation by putting in place initiatives such as study tours and bilateral and multilateral projects with significant focus on human resource development and enhancing management skills through education and training;

Requests the Secretary-General, as appropriate:

(1) To support training initiatives aimed at enhancing the management capacity of NMHSs;

(2) To encourage WMO Regional Training Centres to develop training activities in support of:

    (a) National socioeconomic sustainable development endeavours;

    (b) Implementation of international agreements;

    (c) Related initiatives;

(3) To facilitate bilateral cooperation and twinning arrangements between NMHSs in Member countries through a clearing house mechanism at WMO for regular exchange of experts to support enhanced Service Delivery.

Decision 56 (EC-69)

WMO REGIONAL TRAINING CENTRES

THE EXECUTIVE COUNCIL,

Recalling Decision 63 (EC-68) - Capacity Development Priorities for 2016-2019,

Acknowledging the Report on Education and Training Activities,

Appreciating the contributions of WMO Regional Training Centres (RTCs),

Considering the strategic importance of the WMO RTCs, their continued relevance and the need to have a more concerted approach to management, to enable them to make more effective contributions to socioeconomic and development issues,

Being mindful of the fact that the performance of the RTCs in the Region depends on the situation at the national level of the host country,

Urges Members hosting RTCs to increase their support to RTCs, and all Members to give maximum possible cooperation to RTCs in the Region, to enable them to serve more effectively;

Urges regional associations to take the lead on ETR within their Region by advising their RTCs of current and anticipated training needs;

Requests Members hosting RTCs to regularly update WMO on their status, particularly regarding organizational changes that could affect their relationship with WMO and counterpart RTCs;

Also requests Members hosting RTCs to ensure that the Centres:

(1) Align their courses with the recommended processes in the WMO publication *Guide on the Implementation of Education and Training Standards in Meteorology and Hydrology* and in compliance with WMO competency frameworks outlined in WMO-No. 49 and elaborated within other guidance material;

(2) Send to WMO ETR their annual reports and plans for their course offerings;

(3) Broaden the focus of their courses in the areas of management of NMHSs and application of meteorological and hydrological knowledge to socioeconomic development;

(4) Work more closely with other WMO Centres;

(5) Seek to broaden partnership with academic institutions;

(6) Aim at continuous improvement of their delivery of ETR, especially by using relevant information provided by WMO;

Agrees to:

(1) Reconfirm the RTCs in Argentina, Barbados and the Islamic Republic of Iran based on the recommendations made by the EC Panel on ETR;

(2) Extend the reconfirmation of the RTCs in China, Costa Rica, India, Qatar, the Republic of Korea and Uzbekistan based on the recommendations made by Regional Associations II and IV, until the next opportunity for external assessment by the EC Panel on ETR and the subsequent EC decision;

(3) Postpone the review of the RTC in Iraq until a suitable arrangement is made;

(4) Encourage the RTCs to continue documenting how they meet RTC criteria in their annual reports to the ETR Office;

(5) Encourage RTCs to cooperate with WMO in promoting the Global Campus initiative by offering to share their educational resources and to collaborate in ETR activities within their Regions;

Requests the Secretary-General to assist RTCs in positioning their programmes and activities to enable them to deliver support to NMHSs as they respond to challenges facing their Services.

Decision 57 (EC-69)

CRITERIA ON AWARD OF FELLOWSHIPS AND TRAINING SPONSORSHIPS

THE EXECUTIVE COUNCIL,

Recalling EC-65 report on guidance for consideration of request for familiarization visit by recently appointed Permanent Representatives,

Recalling also the EC-66 resolution on EC criteria for the award of WMO fellowships,

Considering the need to allow Members to have a consolidated view of WMO criteria on fellowships and training sponsorships,

Also considering the need to optimize the use of resources for capacity development through education and training of experts from least developed and developing countries and SIDS, and to ensure that the conclusions of the Impact Evaluation of Fellowships are taken into account,

Agrees on the criteria given in the Annex to this Decision;

Requests the Secretary-General to take these criteria and the conclusions of the Impact Evaluation of Fellowships into account when administering the resources available for education and training;

Urges Members to cooperate with the Secretariat in the application of these criteria.

Annex to Decision 57 (EC-69)

CRITERIA ON AWARD OF FELLOWSHIPS AND TRAINING SPRONSORSHIPS

1. Criteria for the award of WMO fellowships

1.1 The aim of the WMO Fellowship Programme is to support the education and training of qualified and suitable candidates, particularly from least developed and developing countries and small island developing States.

1.2 WMO may award both short-term (more than one month and less than six months) and long-term (6 months or longer) fellowships, based on recommendations of the Education and Training Committee (ETCOM) and in alignment with the priorities of the Education and Training Programme.

1.3 To be considered by the ETCOM for a fellowship, candidates must:

(a) Complete a Fellowship Nomination Form, which must be certified by the Permanent Representative of the recipient Member with WMO;
(b) Meet the entry requirements for the proposed course of study, and obtain a conditional offer/admission for the course;
(c) Be proficient in, or capable of learning in, the language of study;
(d) Be of sound health as confirmed by their completed medical certificate;
(e) Only apply for courses of study directly applicable to WMO Programme areas.

1.4 In awarding a fellowship, preference will be given to candidates who:

(a) Come from the NMHSs of least developed countries as well as developing countries, countries with economies in transition, small island developing States, and countries more vulnerable to natural disasters;
(b) Are supported by cost-sharing;
(c) Apply for courses at RTCs or other training institutions in their Region;
(d) Are expected to work and make a long-term contribution in the NMHS of their country in a suitable post on completion of the fellowship;
(e) Have not been awarded a long-term WMO fellowship within the previous four years;
(f) Have not recently benefited from a WMO fellowship.

1.5 In awarding a fellowship, account will be taken of:

(a) The need for regional proportional balance;
(b) The need to practice equal opportunity policies (Resolution 33 (Cg-XIV) – Equal opportunities for the participation of women in meteorology and hydrology);
(c) The Permanent Representative from the candidates' country has provided WMO with the required report from any previous fellowship.

2. Criteria for the award of WMO short-term training opportunities

2.1 Permanent Representative (PR): In making nominations for short-term training courses, the PR should:

(a) Annually set staff education and training requirements based on the Member's plans and requirements;
(b) Make nominations only for high priority training needs;
(c) Exercise discretion in requesting financial support, seeking internal funding first;
(d) Follow procedures for making nominations and requests for support;
(e) Meet the deadlines for course applications.

2.2 Nominees: In applying for short-term courses, the nominees should:

(a) Review the course qualification requirements;
(b) Be prepared with a serious intent to learn;
(c) Be timely in completing all steps in the process.

2.3 Supervisors: In having staff members apply for short-courses, the supervisor should:

(a) Be sure that only qualified staff make applications;
(b) Work to spread training opportunities among staff members.

3. Criteria for consideration of requests for a familiarization visit by recently appointed Permanent Representative (PR) of a country with WMO[1]

3.1 The aim of familiarization visits for recently appointed Permanent Representatives (PRs) is to support management capability of the suitable candidates particularly from least developed and developing countries.

3.2 To be considered for a familiarization visit the applicant must meet the following criteria:

(a) A formal notification of the appointment of the PR from the candidate's government must be provided to WMO before the request;
(b) Candidates applying for a familiarization visit must complete a Request Form for the visit;

[1] *The funds should be available, with the view to maintain annual expenditure on familiarization visits to less than 10% of the funds available to fellowships from the Regular Budget.*

(c) A minimum of six months and no more than four years has elapsed between the commencement of taking up her/his duties and the proposed start of the familiarization visit;
(d) The applicant is expected to continue her/his role as PR for a minimum of two years following the familiarization visit;
(e) The applicant has not had previous exposure to WMO activities that are relevant to the familiarization visit;
(f) The beneficiary country has not benefited from support for a familiarization visit in the past two years prior to the receipt of the visit request;
(g) Be able to undertake the visit within six months of an official offer by the Secretary-General;
(h) Opportunities should be sought to co-fund the proposed visit with other programmes, conferences, workshops, etc.

3.3 The visit is confined to a visit to WMO headquarters in Geneva and a visit to a Member close to WMO headquarters, or a visit to a Member within the Region, with a relatively more developed National Meteorological and Hydrological Service;

3.4 The visit is to be implemented in one working week;

3.5 During the visit the PR shall make a presentation to the WMO Secretariat and optional host Member on their NMHS services and requirements.

Decision 58 (EC-69)

WMO VOLUNTEERS

THE EXECUTIVE COUNCIL,

Recalling Resolution 50(Cg 17) - Capacity Development Strategy, especially as it calls for increased voluntary assistance,

Noting the expanding gap between the capabilities of developed and developing and least developed country NMHSs and the strong community spirit that exists among WMO Members,

Noting also the need for skilled and experienced individuals to assist developing and least developed countries with technical and organizational skills to reduce this gap,

Noting with satisfaction that the voluntary support provided by the Secretariat, individuals and countries through the Education and Training Programme, the Regional Programme, technical programmes, bilateral efforts and the Voluntary Contribution Programme (VCP) continue to be effective mechanisms for this purpose,

Being mindful that despite efforts to close the gap through the VCP and other national and international development partnerships, many NMHSs continue to lack the resources or capacity to improve their services due to budgetary limitations and human resource constraints,

Observing that competent and motivated individuals, if given the opportunity to share their skills and experiences with NMHSs to support weather, hydrology, marine and climate services for a wide-range of economic sectors and humanitarian and civil protection processes, could make significant contributions to the modernization of NMHSs in least developed and developing countries,

Considered that a specific “WMO Volunteers” programme to facilitate the voluntary provision of technical support, expertise and management support could be a cost-effective way to expand the possible sources of expertise and further reduce the gap in capabilities among NMHSs;

Recognizing the challenges of organizing such a programme (financial, logistical, legal, procedural and implementation mechanisms, etc.),

Requests the Executive Council Panel of Experts on Capacity Development to conduct a review of the overall concept, consider the challenges and prepare a proposal at EC-70, that includes the cost for establishing and managing the programme, for further consideration and possible approval at the next World Meteorological Congress (Cg-18);

Requests the Secretary-General, regional associations and technical commissions to assist the Panel in its work.

Decision 59 (EC-69)

NOMINAL ALLOCATION OF THE VOLUNTARY COOPERATION PROGRAMME TRUST FUND FOR 2017

THE EXECUTIVE COUNCIL,

Recalling the WMO Resource Mobilization Strategy approved by Decision 69 (EC-68) which highlighted that Climate Funds were an important mechanism to be targeted by WMO and its Members to seek additional investments,

Welcoming that in June 2016 the World Meteorological Organization became the first UN specialized agency to formalize its relationship with the Green Climate Fund (GCF) and that by signing its Accreditation Master with the GCF, the WMO can now receive financial resources for climate action programmes and projects (upon approbation of the GCF Board Members),

Noting with appreciation that in March 2017 WMO became the first Multilateral Implementing Entity to have a regional proposal approved by the Adaptation Fund Board under the Pilot Programme for regional projects and programmes. The AF Board endorsed a USD 6.8 million proposal submitted by WMO entitled “Agricultural Climate Resilience Enhancement Initiative (ACREI)” for Ethiopia, Kenya and Uganda,

Welcoming also the broad range of financing partners, including Canada, Ireland, Saudi Arabia, Germany, Norway, Republic of Korea, Japan, Switzerland, the United Kingdom of Great Britain and Northern Ireland, the United States of America, and others. The list of projects being implemented or in the pipeline are shown in Annex 1 to this decision,

Considering that the Voluntary Cooperation Programme has reached its 50th year of operation, expressed its appreciation to VCP donors including the above for the valuable efforts in supporting the Members through the VCP that clearly remains an important delivery mechanism for support to Members,

Having considered the proposed provisional allocation and priority areas for the VCP-TF for 2017,

Approves the proposed provisional allocation for the VCP-TF for 2017 as shown in Annex 2 to this decision;

Requests the Secretary-General to continue to monitor progress and evaluate the effectiveness of resource mobilization efforts and to continue efforts with OECD to increase

WMO's ODA Coefficients in the OECD DAC (Development Assistance Committee) listing for UN agencies to better reflect the actual situation in WMO with respect to Development Cooperation contributions to overall budget.

Annex 1 to Decision 59 (EC-69)

(A) OVERVIEW OF PROJECTS BEING IMPLEMENTED OR COMPLETED DURING THE REPORTING PERIOD

No.	Project	Donor	Budget	Implementation period
1	Adaptation and Disaster Risk Reduction in Africa (Norway 1): Southern, East and West Africa	MFA Norway/now NORAD	NOK 56,8 million	Dec. 2011-July 2016
2	Adaptation Programme in Africa (Norway 2): Malawi and the United Republic of Tanzania	MFA/now NORAD Norway	NOK 60 million	Jan. 2014-Dec. 2016
3	Programme for Implementing the GFCS at Regional and National Scales	Environment Canada	CAD 6.138 million	April 2013-March 2017
4	Improvement of Agrometeorological information for small-scale agricultural production in Tigray, Ethiopia	Irish Aid	EUR 400,000	2013-2017
5	Hydrometeorological Disaster Impact Mitigation Projects	USAID	USD 13.7 million	Sept. 2011-Sept 2016
6	Programme for building Regional Climate Capacity in the Caribbean	USAID	USD 5.085 million	Feb. 2014–Jan. 2017
7	Haiti Weather Systems Programme – Climate Services to Reduce Vulnerability	Environment Canada	CAD 6.5 million	Dec. 2012–March 2017
8	Climandes – Andes-Based Climate Services for Decision Makers - Phase II	SDC	CHF 3,135 million	2016-2019
9	Uzbekistan Climate Data Restoration Project	KMA - CS TF	USD 617,000	May 2015–July 2017
10	Mongolia - Modernization of Aviation Meteorological Centre of Mongolia	KMA - CS TF	USD 505,000	2014–2017

11	Lao People's Democratic Republic - Communication, Ocean and Meteorological Satellite (COMS) satellite data reception and processing system	KMA - CS TF	USD 264,000	Completed
12	Uganda – Climate analysis and prediction system	KMA - CS TF	USD 150,000	2015-2017
13	12 countries - Satellite receiving equipment for Himawari-8/9	Japan TF	CHF 714,546	2015-2017
15	Blue Peace –Water Security in the Middle East	SDC	USD 905,400	Feb. 2014-Dec. 2016
16	Contribution to the Modernization PME Saudi Arabia	Saudi Arabia PME	about USD 4 million	ongoing
17	Development of an Integrated Coastal Inundation Forecasting System in Fiji – Phase I (CIFDP)	KMA	2 M USD	2016-2019
18	Climate Change Adaptation and Improved Climate Services in sub-Saharan Africa - National Frameworks for Climate Services	USAID	USD 1 million	2016-2017
19	WMO Global HydroMet Facility	SDC	CHF 2.8 Million	2016-2020
20	Strategic Planning for NMHS (Africa)	DFID	GBP 450,000	2016-2017
21	Climate Data Management Systems Djibouti	KMA	USD 150,000	2016-2017
22	Severe Weather Forecasting Demonstration Project(SWFDP) in West Africa - Phase 1	KMA	USD 150,000	2015-2017

(B) OVERVIEW OF PROJECTS IN THE PIPELINE

No.	Pipeline Project	Donor	Budget	Implementation period	Status	Lead Department(s)
1	Adaptation Programme in Africa (Norway 3): West & East Africa	Norad Norway	NOK 80 million	June 16-Dec.2019	Concept Note submitted September 2016	CLW/WDS

2	Climate Change Adaptation and Improved Climate Services in sub-Saharan Africa - National Frameworks for Climate Services	USAID	USD 1 million	June 2016–Dec. 2017	Project document approved by USAID (November 2016)	GFCS
3	Applying seasonal climate forecasting and innovative insurance solutions to climate risk management in the agriculture sector in SE Asia	IKI (Germany)	EUR 13 million	2016-2020	BMU has requested the full proposal following teleconference in December	CLW
4	Enhancing Safety of Navigation and subsistence and commercial activities over Lake Victoria and its Basin by Strengthening Meteorological Services on the Lake	DFID	GBP 3.2 million	2017-2020	Proposal being finalized	WWRP/WCRP/WDS
5	MHEWS SIDS/SE Asia	Canada	CAD 10 million	2017-2019	Announced at COP 21 as part of the CREWS initiative - Funding received by WMO, project started in March 2017	CLW/WDS (DRR)
9	GFCS-ACP Programme	EU-DECVO (EDF 11)	EUR 80-85 million	2017-2021 (tbd)	Project Formulation Phase	RMDP and AMCOMET
11	Enhancing Early Warning Systems to build greater resilience to hydro and meteorological hazards in Pacific small island developing States (SIDS) – (Fiji, Papua New Guinea, Solomon Islands, Timor-Leste and Vanuatu)	Green Climate Fund	USD 48 million, including USD 46 million from GCF	2018-2022	Concept Note submitted in October 2016-Project Preparation Funding Application submitted in November 2016 – Feedback received, awaiting final decision for PPF	RMDP-RAP

12	Regional Programme: Linking climate knowledge action for resilience in the Sahel (Burkina Faso, the Niger, Senegal, Mali, Chad, Côte d'Ivoire, Cameroon)	Green Climate Fund	USD 50 million, including USD 46.5 million from GCF	2018-2022	Concept Note submitted in December 2016- Project Preparation Funding Application submitted in December 2016 – awaiting feedback from GCF	GFCS
13	Preparation of Global Climate Services for Energy (GCSE) – (Colombia, the United Republic of Tanzania and the Republic of Moldova)	Green Climate Fund	USD 49.5 million	2018-2022	Concept Note submitted in October 2016- Project Preparation Funding Application submitted in December 2016 – awaiting feedback from GCF	CLW
14	Enhancing Climate Resilience in the Third Pole	Green Climate Fund	USD 27 million	2018-2022	Concept Note submitted in November 2016- Project Preparation Funding Application in preparation	GFCS
15	Enhancing urban services capabilities to build Jakarta as climate smart city	Green Climate Fund	tbd	tbd	Concept Note in preparation	WWR, RMDP
16	Integrated Global GHG Information System Pilot Project (Morocco)	Green Climate Fund	tbd	tbd	Concept Note in preparation	AER
17	Agricultural Climate Resilience Enhancement Initiative (ACREI) – (Ethiopia, Kenya, Uganda)	Adaptation Fund	USD 6.8 million	2017-2020	Project approved by the Adaptation Fund Board in March 2017; project is expected to start in July 2017	RO Nairobi, RMDP
18	Burkina Faso	CREWS-Global	USD 2.2 million	2017-2019	Project to start in April 2017	CLW
19	Pacific	CREWS – Global	USD 1.4 million	2017-2019	Project to start in April 2017	RMDP-RAP

Annex 2 to Decision 59 (EC-69)

VOLUNTARY COOPERATION PROGRAMME TRUST FUND 2017

	VCP Trust Fund 2017		**Nominal** Allocation (USD)
	Balance at 01/01/17	100,000	2017
	Anticipated Contributions 2017	100,000	
	Anticipated Available 2017	200,000	
	Priority Areas		
	Spares/shipping		5,000
	Expert services		30,000
	(Short-term) fellowships and training activities		10,000
	Improvement of GTS		10,000
	Improvement of Observing Systems		10,000
	Improvement of GDPS		5,000
	Agricultural meteorology activities		10,000
	Support to CDMS and climatological activities		10,000
	Operational hydrology activities		10,000
	Sub Total		**100,000**
	Reserve		**100,000**

Decision 60 (EC-69)

POTENTIAL FUTURE COLLABORATION OF WMO AND THE INTERNATIONAL AIR TRANSPORT ASSOCIATION ON THE OPERATION AND DEVELOPMENT OF THE WMO AIRCRAFT METEOROLOGICAL DATA RELAY PROGRAMME

THE EXECUTIVE COUNCIL,

Noting:

(1) The WMO Integrated Global Observing System (WIGOS) Implementation Plan for the Evolution of Global Observing Systems (EGOS-IP) action G21, which is seeking to establish agreements with airlines and the aviation industry to ensure that the system, infrastructure, data and communications protocols are supported and standardized within relevant aviation industry frameworks so as to ensure continuity and reliability of the system, with Performance Indicator: Agreements made with aviation industry partners and organizations,

(2) That the International Air Transport Association (IATA), representing its Member airlines and other aviation entities, has approached WMO to consider a proposal for the two organizations to work together towards the possible future establishment of a collaborative arrangement for the continued operation, expansion and enhancement of the WMO Aircraft Meteorological Data Relay (AMDAR) programme,

Recalling WMO Resolution 40 (Cg-XII), which adopts the practice that, in addition to Members providing free and unrestricted basic essential data and products which are necessary for the provision of services in support of the protection of life and property and the well-being of all nations, also urges that Members should also provide the additional data and products which are required to sustain WMO Programmes at the global, regional, and national levels and, further, as agreed, to assist other Members in the provision of meteorological services in their countries,

Noting further:

(1) The growth over the past several decades of the AMDAR observing system and the volume of aircraft-based observations on the GTS that contribute to the significant positive impact on meteorological forecasting (including support to aviation) and other applications as a critical component of the GOS, WIGOS and the World Weather Watch Programme,

(2) The contribution of the aviation industry and AMDAR partner airlines to the operation of the AMDAR Programme as a mutually beneficial Public Private Partnership,

(3) HMEI have capability through their Members to support WMO and IATA in this engagement,

Recognizing that IATA member airlines that participate in the AMDAR Programme provide AMDAR data to be used by WMO Members for meteorological and climate purposes and applications while retaining ownership of the AMDAR data,

Having been informed that, under the collaboration, IATA wishes to actively assist WMO in the expansion and enhancement of the AMDAR Programme, particularly through greater airline participation (especially in data sparse regions) and the developments of wider turbulence reporting and water vapour measurement,

Being satisfied that IATA fulfils the United Nations Global Compact Ten Principles,

Endorses the establishment of a Working Arrangement between WMO and IATA under which the two organizations would work together to develop the terms of reference and concept of operations for future collaboration on AMDAR;

Requests the Secretary-General, in coordination with the president of the Commission for Basic Systems, to work with IATA to further finalize and establish the Working Arrangement between WMO and IATA and to subsequently develop the concept of operations for the future possible collaboration of WMO and IATA on the operation and development of the AMDAR Programme.

Annex to Decision 60 (EC-69)

DRAFT WORKING ARRANGEMENT

(available in English only)

WORKING ARRANGEMENT

BETWEEN

the International Air Transport Association

(IATA)

AND

the World Meteorological Organization

(WMO)

On the Operation of the AMDAR Programme

May 2017

The World Meteorological Organization, hereinafter referred to as ‘WMO’ is an intergovernmental organization having its seat at Geneva, Switzerland. WMO is a specialized agency of the United Nations (UN) and is the UN system’s authoritative voice on the state and behaviour of the Earth’s atmosphere, its interaction with the oceans and land as well as the climate it produces. The WMO's mandate is to provide world leadership in expertise and international cooperation in weather, climate, hydrology and water resources and related environmental issues and thereby contribute to the safety and well-being of people throughout the world and to the economic benefit of all nations.

The International Air Transport Association, hereinafter referred to as 'IATA' is an international, non-governmental organization having its seat at Montreal, Canada. It is the prime vehicle for inter-airline cooperation in promoting safe, reliable, secure and economical air services – for the benefit of the world's consumers.

IATA and WMO agree to discuss the establishment of a working arrangement regarding cooperation relative to matters of the automated measurement and transmission of meteorological (MET) data from an aircraft platform, currently operational as the WMO Aircraft Meteorological Data Relay (AMDAR) programme and recognized as a key component of the WMO Global Observing System.

EXECUTIVE SUMMARY

The World Meteorological Organization (WMO) Aircraft Meteorological Data Relay (AMDAR) is the automated measurement and transmission of meteorological (MET) data from an aircraft platform. AMDAR data collected by the National Meteorological and Hydrological Services (NMHSs) from the airlines through the AMDAR Programme is of high value to the global meteorological community for its ability to increase forecasting accuracy, for all users of weather forecasts, including aviation.

While the programme has been successfully functioning in Europe, North America, Asia and Oceania, other areas such as Africa, Southern and Central America, the areas of Eastern Europe, Western Asia, the Southwest Pacific and the Middle East remain data sparse often due to limited funding available in these regions for programme expansion.

Acknowledging the benefits of the AMDAR data to the meteorological community and, consequently, the aviation industry through improved meteorological forecast accuracy[1], IATA and WMO would jointly work on expanding the programme to new geographical areas whilst introducing new measures to give participating airlines better control over, and access to, the data they provide to the programme. This Working Arrangement envisages cooperation intended to achieve these objectives, and requests WMO Members and IATA member airlines to express their interest in this effort.

This Working Arrangement merely reflects the potential collaboration that the parties are currently contemplating and discussing.

The potential collaboration would be in compliance with WMO Resolution 40 (Cg-XII) - WMO policy and practice for the exchange of meteorological and related and products including guidelines on relationships in commercial meteorological activities[2].

The potential partnership would respect the UN Global Compact Ten Principles.

BACKGROUND

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1 See WMO WIGOS Technical Report 2014-1, The Benefits of AMDAR Data to Meteorology and Aviation: https://library.wmo.int/opac/index.php?lvl=notice_display&id=16116#.WQLgmGmGNtR

2 WMO Resolution 40 (Cg-XII) - Full text of the resolution is available on the WMO website at: http://www.wmo.ch/pages/prog/www/ois/Operational_Information/Publications/Congress/Cg_XII/res40_en.html

The Aircraft Meteorological Data Relay (AMDAR) observing system was established by the World Meteorological Organization (WMO) in collaboration with participating airline partners, commencing initial operations in the late 1980s. AMDAR facilitates the automated measurement and transmission of meteorological data (observations) from an aircraft platform. The system predominantly uses existing aircraft on-board sensors (the preferred and complete AMDAR configuration requires the addition of a water vapour measurement sensor to the aircraft platform) and is enabled by a specially-developed AMDAR avionics software application that ensures that the data produced meets meteorological requirements and specifications for data reporting and quality. The resulting AMDAR data is currently collected by the airlines within the WMO AMDAR Programme and then forwarded to the partner National Meteorological and Hydrological Service (NMHS), which is then responsible for making the data available on the WMO Global Telecommunications System (GTS) under the conditions of WMO Resolution 40 (Cg-XII). The data is of high value to the global meteorological community because, where implemented, it has good spatial and temporal resolution, has a significant and demonstrable positive impact on error reduction and forecast improvement to numerical weather prediction (NWP) and is useful in many other applications that require upper-air meteorological observations. The programme provides high-quality upper-air observations that complement traditional radiosonde observations, which are too sparse in many regions. In addition to its use in NWP in support of operational weather forecasts, AMDAR data is extensively used within most other meteorological monitoring, forecasting and verification applications used by NMHSs, thus contributing to the general public good through socioeconomic development and civil protection. The demonstrated significant positive impact of AMDAR data on NWP, other forecasting applications and aeronautical meteorological products, means that the observing system operation also strongly benefits all airlines (IATA members and non-members) and the wider air transport industry. AMDAR data, mainly due but not limited to their benefit of significant error reduction in NWP, is a critical component of the operation of two World Area Forecast Centres (WAFCs) within ICAO's World Area Forecast System (WAFS), supplying airlines and other aeronautical users with global forecast data of upper-air wind, temperature and other critical parameters used in flight planning and operations.

The AMDAR Programme has been successfully operating in Western Europe, North America, East Asia and Oceania for many years, while other regions such as Africa, Southern and Central America, portions of Eastern Europe, Western Asia, the Southwest Pacific and the Middle East remain data-sparse, often due to limited funding available in these regions/sub-regions for AMDAR Programme expansion. With 40 airlines presently (2017) contributing around 700,000 aircraft-based observations per day to the AMDAR Programme, it is believed there is a potential to at least double the number of carriers participating in the programme, thus significantly improving the coverage and impact of AMDAR. It is acknowledged that such an outcome would be greatly assisted, and potentially made more efficient, if an improved funding mechanism to support the development could be put in place.

IATA-WMO COLLABORATION

Acknowledging the benefits of the AMDAR data firstly for the global meteorological community and secondly for the aviation industry, and recognizing the significant resource investment of WMO Member NMHSs in the existing AMDAR observing system and its operation, IATA and WMO would jointly work on expanding the programme to new geographical areas (as described above) as well as improving some aspects of the programme so as to better protect the respective intellectual property of both parties and the control rights of the data by the participating airlines.

By working in cooperation, IATA and WMO aim to explore the following matters that are expected to bring additional benefits to airlines, the aviation industry, and WMO Member NMHSs:

(a) Improve and expand AMDAR data coverage and availability and, as a result, improve weather forecast accuracy and related services and products delivered by WMO and its Members, by:

  (i) Encouraging and facilitating participation in the AMDAR Programme, by all airlines, with a focus on those operating in current data-sparse areas;

  (ii) Encouraging and coordinating the enhancement of the AMDAR Programme through wider implementation of turbulence monitoring and water vapour measurement;

  (iii) Working with the aviation industry, including equipment manufacturers, to encourage greater efficiencies in the development and deployment of AMDAR avionics applications and related infrastructure and service costs;

  (iv) Establishing additional funding mechanisms and cost and resource-sharing initiatives, thus enabling the implementation of new national and regional AMDAR Programmes;

  (v) Negotiating directly with aviation data service providers to derive efficiencies and more equitable arrangements for AMDAR communications costs; and

  (vi) Collaborating with HMEI member companies active in the WMO Aircraft Based Observations Programme to maximize effectiveness through utilization of existing commercial infrastructures.

(b) Ensure improved and secured access to AMDAR data for WMO Members and data users, enabling adherence to agreements with commercial airline partners that license the provision and use of their data.

AMDAR PROGRAMME EXPANSION FUND

In order to address one of the key challenges in increasing airline participation, e.g. insufficient funding on behalf of NMHSs in data-sparse areas, IATA and WMO would evaluate the feasibility of establishing an AMDAR Programme Expansion Fund (APEF). Several sources of funding would be considered for contributing to the APEF, which would be used for the development of new AMDAR programmes or the expansion and enhancement of existing programmes.

GENERAL PROVISIONS

1. (i) Where appropriate and necessary, WMO would be invited to be represented in meetings of IATA groups or their subsidiary bodies or conferences convened by IATA. Such participation would be in accordance with the applicable IATA Procedures and Administrative Matters;

  (ii) Where appropriate and necessary, IATA would be invited to be represented as an observer in meetings of WMO subsidiary bodies or conferences convened by WMO. Such participation would be in accordance with the WMO Convention and General Regulations.

2. Each Party (IATA and WMO) shall be responsible for their own costs or funding sources to perform their respective activities under this Working Arrangement. In the event that financial support from one Party to the other is required, a mutually agreed decision shall be made in accordance with the applicable contracting rules and regulations.

3. Nothing contained in this Working Arrangement or future collaboration arrangement shall be deemed a waiver of any of the privileges or immunities enjoyed by WMO.

4. Any dispute between the Parties concerning the interpretation or application of this Working Arrangement which cannot be settled amicably would, at the request of either Party, be settled by arbitration in accordance with the Arbitration Rules of the United Nations Commission on International Trade Law (UNCITRAL).

5. The Parties shall meet at least annually to take stock of progress and identify possible new areas of cooperation.

6. This Working Arrangement may be amended by the Parties at any time. Any such amendment shall be agreed by mutual consent and shall be effected by an exchange of letters.

7. This Working Arrangement may be supplemented by additional arrangements between the Parties. These additional arrangements shall be in writing and fully respect the provisions of this Working Arrangement.

8. Each Party shall appoint a Representative who shall coordinate relations with the other Party, including between technical experts of the Parties, and who shall keep the Head of his or her organization informed. Any change of Representative shall be communicated in writing to the other Party.

9. This Working Arrangement shall enter into force the date after both Parties have signed the Working Arrangement and shall remain in force for a period of five years. It shall thereinafter be renewed automatically, each time for a new period of five years, unless a written notice of termination is given by one of the Parties to the other at least six months prior to the renewal date, or the Parties have agreed on its termination or on its renewal by another period.

10. Notwithstanding the above Section 9, this Working Arrangement may be terminated by either Party at any time by giving at least six (6) months prior written notice to the other Party.

11. It is understood that by entering into this Working Arrangement, neither Party is committing to entering into a collaboration working arrangement. This Working Arrangement merely reflects the potential collaboration that the parties are currently contemplating and discussing.

Done in duplicate in the English language.

Signed on behalf of the International Air Transport Association (IATA)	Signed on behalf of the World Meteorological Organization (WMO)
______________________	______________________
Mr XXXXXXX XXXXXX	Mr Petteri Taalas Secretary-General
<u>Done in XXXXXX the</u>	<u>Done in Geneva the</u>

Decision 61 (EC-69)

PUBLIC–PRIVATE ENGAGEMENT: A ROAD MAP TO THE EIGHTEENTH WORLD METEOROLOGICAL CONGRESS

THE EXECUTIVE COUNCIL,

Recalling Decision 73 (EC-68) – Cooperation between the public and private sector for the benefit of society,

Noting the progress made in pursuing the implementation of Decision 73 (EC-68) by: assessing experience, good practices, opportunities and risks associated with public-private sector engagement; considering short-, medium- and long-term perspectives and goals; developing draft principles for public-private-sector engagement; reviewing mechanisms and structures to foster dialogue and consultations; exploring options for guiding public-private engagement and directions for preparing WMO Members in the future; and engaging Permanent Representatives of Members in discussions and deliberations,

Noting with appreciation the preparation of the draft Policy Framework as provided by the President of WMO and the presidents of regional associations in Annex 1;

Recognizing that progress to date has placed emphasis on public-private engagement in the context of the larger "global weather enterprise",

Recognizing that growth of private sector involvement in all facets of meteorological and hydrological services are substantially expanding, making public-private engagement an urgent and important issue that will impact the future policies and strategies of WMO and its Members,

Noting the potential risks to NMHSs in the evolving relationship between public and private sectors, as well as the potential opportunities to better meet the needs of Members,

Acknowledging the important leadership role of WMO, through its Convention and through the authority of its Technical Regulations in helping to build a strong and strategic alliance between all of the parties contributing to a sustainable global weather enterprise for the benefit of society,

Acknowledging also that WMO can provide a neutral platform for fostering constructive dialogues among all the parties, taking into consideration the differences amongst its Members,

Acknowledging further that at a national level, the mechanisms, legal frameworks and regulations for engagement and partnership between NMHSs and private sectors organizations vary significantly, and that WMO can assist NMHSs through the development of a global policy framework, practical guidance material and tools, including the response to science and technological developments in the private sector, facilitation of dialogue at appropriate levels, and sharing of experiences,

Agrees:

(1) That there is some urgency to better equipping NMHSs, through WMO, to engage actively and positively with private sector organizations, not least to ensure that essential national mandates, including the importance of a single authoritative voice in relation to safety of life and property are sustained;

(2) That in accordance with the aims and purposes of the Convention of WMO, a policy framework on public-private engagement would be beneficial to the Organization and should be prepared for consideration and approval at the next World Meteorological Congress (Cg-18);

(3) That early engagement between WMO and key representatives of the private sector, such as the HMEI, as well as other relevant stakeholders, including academia, to explore areas for collaboration and to obtain feedback on the evolving policy framework would be beneficial and would assist its further development and implementation for net public benefit;

Emphasizes the fundamental importance of free and open data and products exchange, support to public good infrastructure, including the global observing networks, and the value of reinforcing the regulatory environment afforded by the WMO Convention as priority areas within the policy framework that require early attention to ensure security, sustained performance and growth of the global weather enterprise, including opportunities for public-private dialogue, noting in particular the overarching strategic priority of safety of life and property;

Endorses the Work Plan on Public-Private Engagement (thereafter referred to as "PPE Work Plan") as provided in Annex 2;

Requests that the President and the presidents of regional associations:

(1) To provide further oversight to the development of the Policy Framework and implementation of the work plan on Public Private Engagement as a guide to develop a more focused and active engagement plan;

(2) Further review the principles of engagement and refinement of the roles and responsibilities outlined in the Policy Framework, with a special focus on the role that WMO can play in leading engagement on behalf of the global weather enterprise;

(3) Continue to remain apprised of the evolving situation within the global weather enterprise, related trends, risks and the value for sustaining core public good services;

(4) Prepare and submit a resolution framing the PPE Policy to EC-70 for further consideration and approval at Cg-18;

(5) Solicit Members in providing relevant regional views, contribute to case studies and best practices to support the elaboration of the Compendium and inform the Secretary-General of events or opportunities for PPE in their respective Regions;

(6) To nominate individuals to serve as focal points to support the development of the Policy Framework and other tasks;

Requests the presidents of technical commissions to continue to identify and address issues/opportunities around public-private engagement in their mandated areas of expertise, offer analyses and recommendations on these issues, and contribute to the preparation of the Policy and Compendium;

Requests Members to submit to the Secretary-General: (a) case studies of relevant good practices and lessons learned; and (b) other issues, opportunities and interests involving PPE;

Requests the Secretary-General:

(1) To make appropriate arrangements to support the preparations of the PPE Policy framework and implementation of the PPE Work Plan;

(2) To invite other relevant stakeholders from academia, the private sector and civil society to contribute case studies to the compendium;

(3) To support Members and other stakeholders to take advantage of opportunities for public-private dialogue at global, regional and national levels;

(4) To explore and report on the experiences of other UN organizations in relation to their partnerships with the private sector and how this has translated to beneficial outcomes for their Members at global and national levels; and

(5) To conduct a survey among public and private sector actors to investigate the present status of Members and their future expectations vis-à-vis the public-private engagement.

Annex 1 to Decision 61 (EC-69)

DRAFT POLICY FRAMEWORK FOR PUBLIC–PRIVATE ENGAGEMENT

WORLD METEOROLOGICAL ORGANIZATION

OBJECTIVES OF THE POLICY FRAMEWORK

The Policy Framework for Public-Private Engagement guides global, regional and national action by the World Meteorological Organization and its Members to promote active engagement between the public and private sectors and all stakeholders to successfully manage and participate in the global weather enterprise. It outlines principles and guidelines aimed at maximizing the benefits of an inclusive weather-enterprise approach.

Developed in line with Resolution 67 (Cg-17) and Decision 73 (EC-68), the Policy Framework has been prepared for consideration by EC-69, outlining:

(a) Draft principles for public-private sector engagement based on the key issues outlined in Decision 73 (EC-68);
(b) Proposed mechanisms and structures to foster dialogue and consultations, taking into consideration global, regional and national contexts, with a focus on national circumstances;
(c) Options for guiding public-private partnerships and directions for development of WMO guidance to Members.

This framework is intended to serve as a first step in on-going work to address these concerns and shape a robust way forward in a changing environment. It aims to build understanding and enhance cooperation among stakeholders to sustain and expand the weather enterprise and to maximize its benefits to societies around the globe in the short- and long-term. The framework seeks to strengthen and enhance opportunities for Members, their NMHSs and the private sector, on the basis of ethical behaviour to ensure a level playing field, enable efficiencies and innovation, and utilize an inclusive approach to funding fundamental infrastructure and research.

The framework supports and builds upon the WMO Convention, existing policies as outlined in the Geneva Declaration, in Resolutions 25 (Cg-XIII), 40 (Cg-XII) and 60 (Cg-17) and related regulations and guidance. The Convention has ensured the world's nations do cooperate to create and sustain an international system to observe and predict weather, climate and water; provide reliable information and services to support effective decision-making; reduce the loss of life and property; further sustainable development; and preserve the environment and the global climate for present and future generations of humankind.

CONTEXT

Currently, the growth of private sector involvement in all aspects of meteorological and hydrological services are substantially expanding both opportunities and risks for all players, especially the NMHSs, within the global weather enterprise. The impact of these changes on the current institutional arrangements widely accepted by WMO Members for the collection, processing, and exchange of meteorological, hydrological, climatological and other environmental data, as well as for the generation and provision of respective information and services, could be far-reaching. While the potential exists to improve the efficacy and reach of forecasts and other services within societies around the world, concerns have been raised that these changes would erode the core observational assets usually managed by National Meteorological and Hydrological Services (NMHSs), as well as their status, funding and modes of operation. Such erosion would damage sustained long-term, national observing capabilities, and thereby harm national and global climate monitoring. There could be risks to the role of NMHSs as the single national authoritative voice for severe weather warnings and other core governmental purposes, all of which could have negative impacts on end users and other stakeholders of the weather enterprise.

The "weather enterprise" is a name used to describe the multitude of systems and entities participating in the production and provision of meteorological, climatological, hydrological, marine and related environmental information and services. For brevity, the name only refers to "weather"; however, the enterprise encompasses all business areas of WMO, including weather, climate and water; and all core activities – observations, modelling, data-processing and forecasting, and other services and related research. The weather enterprise includes public-sector entities (NMHSs and other governmental agencies), private-sector entities (such as equipment manufacturers, service-provider companies and private media companies) and academia, as well as civil society (community-based entities, NGOs, national meteorological societies, scientific associations, etc.). The weather enterprise has global, regional, national and local dimensions.

Within the weather enterprise, national, regional and international institutions and business models vary greatly. All stakeholders, however, help contribute to the core mission of the enterprise to help protect life and property, to help foster economic growth, and to improve quality of life. Government, private sector, academia and civil society all play important roles. By its Convention, WMO plays a key role in understanding and facilitating the contributions of Members participating in the weather enterprise.

While change within the weather enterprise is evident across the globe, recognizing that its manifestations vary greatly by region and country, five primary factors are influencing change:

1. Scientific and technological innovation;
2. Growing demand for meteorological, climatological, hydrological, marine and related environmental products and services;
3. Climate change and the United Nations Sustainable Development Goals;
4. Public-sector institutional and resource constraints;
5. Private-sector increased involvement, consolidation and globalization.

Amidst this change, it remains in the interest of all parties to have a robust national and global meteorological and hydrological infrastructure, as this forms the backbone of the global weather enterprise.

The public sector historically has led development of such infrastructure, mostly because weather, climate and water services are considered as "public goods" – making it difficult for providers to profit or offer them efficiently.[1] In the case of weather services, one of its distinguishing characteristics is its dependence on observational data from around the globe. No one nation could provide even basic services to its citizens without continuous, real-time access. While investments in obtaining these observations are made at the national level, the collective benefits only accrue if: (i) a sufficiently large number of nations decide to make these investments; and (ii) these nations share the resulting data with each other. Members have invested in public sector institutions because weather, climate and water services have proved essential to the safety and security of their citizens; a fundamental role of government.

At the same time, the private sector is also a valued contributor in well-being of nations and has been active in the weather enterprise for decades. It serves a number of very important roles, including as a source of investment, a driver of technological development and innovation, a partner in service development and delivery, and an engine for economic growth and employment.

PRINCIPLES OF ENGAGEMENT

In moving forward, public-private engagement activities should be guided and informed by the following set of principles, which are derived from the UN Global Compact as well as from guidance in Decision 73 (EC-68).

Advancing the over-arching goals articulated in the WMO Convention, namely:

(a) Protection of life and property;

(b) Safeguarding the environment;

(c) Contributing to sustainable development;

(d) Promoting long-term observation, collection and sharing of meteorological, hydrological and climatological data, including related environmental data;

(e) Promotion of endogenous capacity-building;

(f) Meeting international commitments;

(g) Contributing to international cooperation.

Shared value: Engagement between the public and private sectors should create shared value and seek "win-win" situations whereby both public entities and businesses can recognize the opportunities for innovation and growth in helping solve society's challenges. Creating shared value can be done by leveraging private-sector expertise and supporting technology transfer, by accelerating uptake of research and technological developments into operations and stimulating the generation, translation and dissemination of valuable knowledge, and by investing in local research and developing human capacity through training, thereby supporting the sustainability of global weather enterprise.

Sustainability: Public and private sectors should seek opportunities for engagement where they can provide leadership on matters critical to sustainability of the weather enterprise and

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[1] Public goods, in economic terms, are those that exhibit the following two characteristics:

- Non-rivalry of consumption – one person's consumption does not reduce the amount available to others; and
- Non-excludability – it is impossible or extremely expensive to exclude from benefit a person or organization that refuses to contribute to the cost.

These two characteristics mean that even in free-market economies, market processes do not provide them, or do not provide them at socially optimal levels.

where joint action is needed to gain efficiencies and better serve society. Public and private sectors should seek to identify opportunities to assume complementary roles, minimizing overlap or competition where this would lead to inefficiencies or be detrimental to the sustainability of the weather enterprise.

No country left behind: WMO and Member agencies should seek engagements that support and further provide quality products and services to users in all countries based on need, including efforts that help bridge existing gaps and develop capacity of developing countries, LDCs and SIDS.

Level playing field: Public and private sector communities should both have the opportunity to propose cooperative arrangements or other forms of engagement. WMO and Member governmental agencies can engage with the private sector for the purposes of development and provision of products and services that explicitly support and accelerate achievement of the goals of WMO and those of Member governments. However, engagement should not provide exclusivity or imply endorsement or preference of a particular private-sector entity or its products or services.

Integrity: WMO and the public agencies established by its Members should seek to engage in mutually beneficial relationships and partnerships with the private sector so as to benefit society. Engagement should maintain the integrity of the WMO and the agencies established by its Members, as well as their independence and impartiality.

Sovereignty: WMO and its Members and their agencies should not engage with private-sector entities that have no regard for the rights of sovereign nations or that undermine the global weather enterprise.

Transparency: Engagement with the private sector should be transparent. Information on the nature and scope of major arrangements should be available within the concerned entities and to the public at large.

GLOBAL, REGIONAL AND NATIONAL ROLES

Promoting better public-private engagement would require on-going consultation and action at global, regional and national levels.

<u>Global level - The World Meteorological Organization</u>

The World Meteorological Organization facilitates worldwide activity and cooperation around weather, climate and water for the benefit of all nations and humankind overall. The WMO role supporting effective public-private engagement includes:

1. Promulgating standards and recommended practices

WMO is a recognized standard-setting organization and its standards and recommended practices are developed for products and processes in the meteorology value chain. These regulations shall be respected by all providers in all Member countries of WMO. WMO should also play a key role in shaping effective engagement between public and private actors in the weather enterprise and in providing guidance for Members to ensure, to the extent possible, that proposed engagement activities are based on good national practices and provide appropriate incentives and structures to encourage private sector investment while at the same time ensuring a fair and equitable cost- and benefit-sharing scheme for NMHSs and other public entities. WMO in particular could provide guidance to Members on:

(a) Development of national legislation to determine Authoritative Voice through recommended best practices (with pros and cons);

(b) Data- and service-licensing models on national and global levels;

(c) Promotion of a culture of compliance with standards and regulations among all stakeholders;

(d) Potential impact of various new business models for the acquisition, dissemination and processing of meteorological data and for service delivery;

(e) Other strategies to help maintain a national authoritative voice on meteorological and hydrological matters for public safety warnings and promotion of economic growth.

2. Encouraging free and unrestricted exchange of data

Governments who signed the WMO Convention have committed to following its regulations, including standards and practices related to the collection and sharing of data and products between stakeholders to support the global infrastructure as outlined in Resolutions 25 (Cg-XIII), 40 (Cg-XII) and 60 (Cg-17) and relevant technical regulations. WMO will develop and adapt guidance for NMHSs and other stakeholders as needed on free and unrestricted exchange of data as it applies to the current environment, in which private-sector entities may assume larger roles in data provision.

3. Facilitating dialogue between all stakeholders

WMO should, together with its Members, formulate strategies to better communicate the value of public meteorological and hydrological services. Furthermore, WMO should proactively set up and participate in on-going global dialogue between public and private stakeholders, engaging players and tracking developments and trends. Over time, and seeking to adopt existing forums, it should lead development of a formal structure to support regular, on-going dialogue, providing a forum for exploration and resolution of issues. The governance structures of other international organizations may provide useful models. Technical commissions should actively seek to engage in the dialogue.

4. Investigate emerging issues as well as new roles, and implementing such roles as appropriate

As the weather enterprise evolves, WMO should both monitor issues emerging around public-private engagement that could significantly affect either its Members or the sustainability of the global weather enterprise, and also investigate the desirability of taking on new roles to help ensure quality in data and services. For example, to help ensure quality in increasingly crowded marketplaces, WMO could potentially gather, analyse and publish electronically its conclusions on the comparative quality of elements such as instruments, data and services. The WMO Secretariat also needs to continue to expand dedicated expertise in "meteorology as a business".

In addition, WMO may wish to expand its activities directed at maintaining, enhancing and publicizing the scientific credibility of the WMO community, from the fundamental importance of measurement and predictive science in delivering traceable observations and advanced predictive tools, to the transition of new research findings into innovative and high impact weather and climate services. It is well positioned to provide leadership in enhancing performance of global and regional models. Its activities may also be directed toward assisting countries to downscale data to serve national and local needs.

Regional level – regional associations

WMO regional associations interface with their Members, liaise with other stakeholders, designate and support regional centres for delivery of regional services to Members. To support engagement with private sector and other stakeholders, regional associations are urged to take on roles including:

1. Gathering and disseminating information and guidance
Regional associations are urged to facilitate change management and advocate for inclusive consultations, including knowledge and experience sharing, in order to enable Members to learn from each other and provide support as needed for effective public-private engagement. Knowledge can be shared globally through the WMO Secretariat to regional and national levels, as well as directly by regional associations with Members and other stakeholders.

2. Providing training to Member agencies such as NMHSs
Regional associations are urged to provide capacity-building training to agency staff and leadership in practices needed for effective public-private engagement.

3. Exploring regionalization of services as necessary
In anticipation of competition, regional entities may wish to consider with Members whether regionalization of certain services may allow them to improve competitiveness and services and to reduce costs.

4. Coordinating regional engagement in regional and/or cross-regional multi-stakeholder initiatives

<u>National level – Members and NMHSs</u>

Given the increasing participation of the private sector, Members and their designated agencies such as NMHSs are urged to take action to maintain and improve agency engagement with the private sector to strengthen the weather enterprise with the aim of maximizing benefits to the Members in the short- and long-term. Effective engagement also offers opportunities to strengthen NMHSs and all entities involved in the weather enterprise. Roles include:

1. Fostering structured dialogue with the private sector
Members and their designated agencies such as NMHSs are urged to reach out proactively to set up structured dialogue between public- and private sector stakeholders on issues of common interest. Regular dialogue would be more effective to improve mutual understanding and foster relationships. In this, Members and NMHSs may benefit from recognizing the opportunities where national objectives converge with those of the private sector.

2. Encouraging appropriate legislation, performing change management and building on core strengths
In an environment where private sector engagement in meteorological and hydrological services is likely to continue in the decades ahead, NMHSs should strongly consider building expertise, to develop their research and development capability, and to continuously enhance the quality and dissemination of their products and services to allow them to thrive in an increasingly competitive environment. They may also wish to undertake initiatives in order to understand and adapt to on-going changes in their business models, including potential initiatives involving national legislation.

3. Promoting uptake of WMO standards and guidance
On an on-going basis, Members' governments are urged to ensure that all national players providing meteorological or hydrological functions comply with WMO technical regulations (standards and recommended practices, procedures and specifications) that are designed to ensure global standardization and quality of data and products. WMO will also issue guidance for effective engagement between public and private actors in the weather enterprise and to provide some 'rules of engagement' for Members and other stakeholders. Members also are urged to promote awareness of and compliance with these standards and guidance among other stakeholders.

4. Fostering partnerships between public and civil society entities

In an evolving world, with societal vulnerabilities to weather and climate risks growing, designated Member agencies such as NMHSs are strongly encouraged to consider the needs and resources of public sector and civil society weather, climate, hydrological, marine and other related service consumers, and where opportunities exist to improve services for vulnerable end users, to seek to provide data and other information at cost-recovery rates or less.

5. Exploring regionalization of services as necessary

In anticipation of competition, Members may wish to consider whether regionalization of certain services may allow them to improve competitiveness and services and to reduce costs.

GLOSSARY

NMHSs: organizations (typically agencies) established by governments that undertake activities directed at improving our understanding of the weather, climate, and the hydrological cycle over both land and sea, undertake monitoring of weather-, climate- and water-related phenomena, provide forecasts, and provide operational weather, climate, water and related environmental services to a range of users to respond to relevant national, regional and global needs. In some countries, more than one agency deals with different aspects of such services.[2]

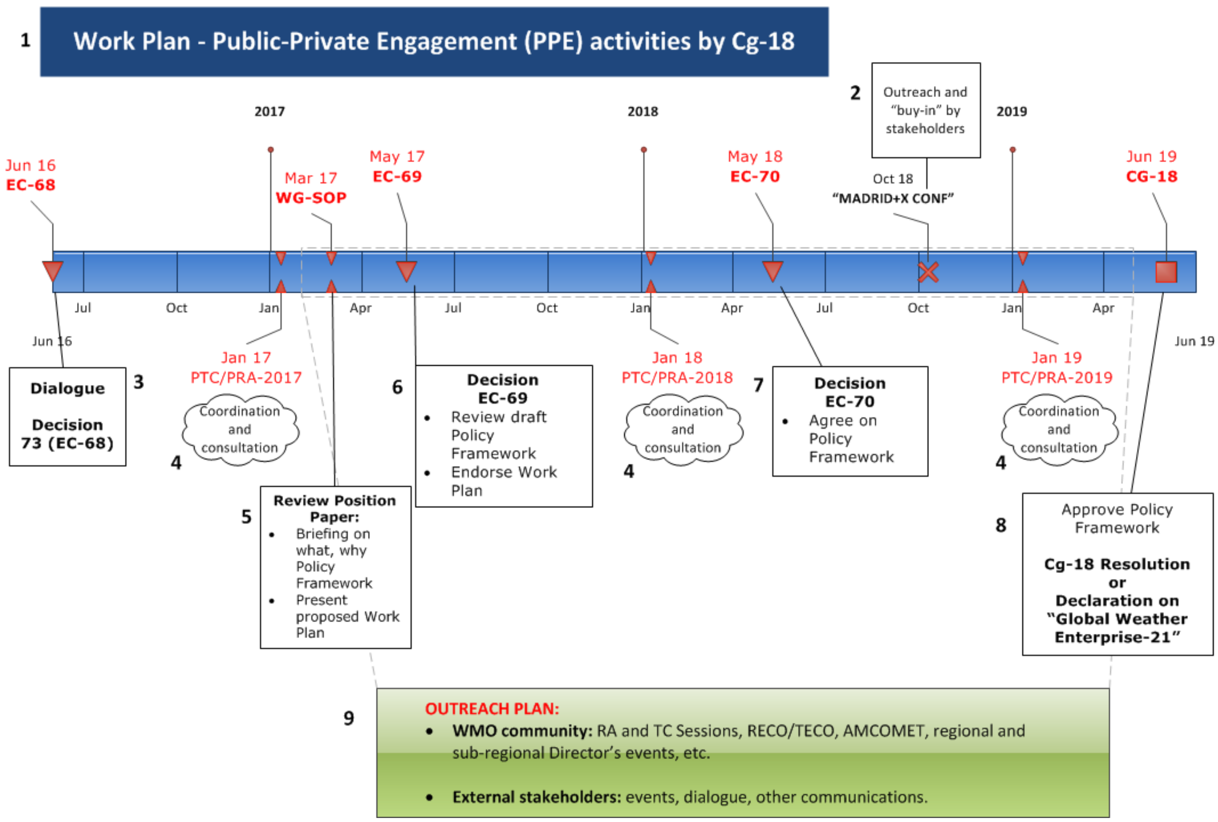
Private sector: The part of the economy run by private individuals or groups, usually as a means of enterprise for profit, that is not under direct state control. Areas of the economy directly controlled by the state are referred to as the 'public sector'.

Public-private engagement: Engagement by NMHSs (and/or other public agents) with the private sector in various modes in the production and delivery of weather, climate, water, marine and related environmental information and services while respecting the public interest and the mandates of NMHSs and keeping in mind budgetary constraints.

Weather Enterprise: A name used to describe the multitude of systems and entities participating in the production and provision of meteorological, climatological, hydrological, marine and related environmental information and services. For brevity, the name only refers to "weather"; however, the enterprise encompasses all business areas of WMO, including weather, climate and water; and all core activities – observations, modelling, data-processing and forecasting, and other services and related research. The weather enterprise includes public-sector entities (NMHSs and other governmental agencies), private-sector entities (such as equipment manufacturers, service-provider companies and private media companies) and academia, as well as civil society (community-based entities, NGOs, national meteorological societies, scientific associations, etc.). The weather enterprise has global, regional, national and local dimensions.

Annex 2 to Decision 61 (EC-69)

PROPOSED WORK PLAN ON PUBLIC–PRIVATE ENGAGEMENT 2017–2019



Decision 62 (EC-69)

CELEBRATING THE ONE HUNDRED AND FIFTIETH ANNIVERSARY OF THE INTERNATIONAL METEOROLOGICAL ORGANIZATION IN 2023

THE EXECUTIVE COUNCIL,

Noting that the one hundred and fiftieth anniversary of the founding of the International Meteorological Organization (IMO), which was the precursor to the World Meteorological Organization, will occur in the year 2023,

Decides to task the EC Working Group on the Strategic Operational Planning (WG/SOP) with elaborating a concept for a major conference marking this anniversary and presenting this concept to EC-70.

Decision 63 (EC-69)

WORLD METEOROLOGICAL DAY THEME FOR 2019

THE EXECUTIVE COUNCIL,

Noting that there was no strong support for the themes considered by the open-ended Committee on the theme for World Meteorological Day 2019 established by EC-69,

Decides that the theme for World Meteorological Day 2019 will be decided by the President who will recanvas EC members after the close of EC-69;

Invites Members to undertake activities to celebrate World Meteorological Day 2019 using this theme once finalized;

Further decides that for World Meteorological Days after 2019 the Secretary-General will solicit themes through consultation with National WMO Focal Points for Information and Public Affairs. The proposed theme will then be presented to the President for approval after consultations with the EC;

Requests the Secretary-General to notify Members in a timely manner once the theme is approved.

Decision 64 (EC-69)

CONSIDERATION OF THE REPORTS ON OVERSIGHT

THE EXECUTIVE COUNCIL,

Noting the report and considering the recommendations of the Financial Advisory Committee (FINAC) on financial matters and on the implementation of the results-based budget,

Noting the report and considering the recommendations of the WMO Audit Committee,

Noting with appreciation the unqualified opinion and the report and considering the recommendations of the External Auditor, in accordance with Financial Regulation 15.10,

Noting the Internal Oversight Office annual accountability report, in accordance with Financial Regulation 13.10,

Taking account of recommendations of the oversight bodies in making its decisions under the relevant related agenda items,

Further noting the recommendations of the Joint Inspection Unit addressed to Executive Heads,

Having considered the recommendations of the Joint Inspection Unit pertinent to WMO governing bodies, and examined the proposed responses to these recommendations as reviewed by the Audit Committee;

Endorses the proposed responses to the JIU recommendations addressed to WMO governing bodies;

Notes also that a shared services arrangement with ITU for an ethics function had been in place since November 2016 and requests annual reports of the Ethics Office to be provided to the Council starting with the next session.

Decision 65 (EC-69)

PREPARATION OF WMO STRATEGIC PLAN 2020–2023

THE EXECUTIVE COUNCIL,

Recalling the decision of the Seventeenth World Meteorological Congress (Cg-17) that the Global Societal Needs identified by the Organization based on post-2015 sustainable development goals, and which form the solid basis for the Strategic Plan for the period 2016–2019, represent relevant issues and directions that could still influence the focus of the Organization beyond the period 2016–2019, and should form the basis for the WMO Strategic Plan for the period 2020–2023,

Recalling also Resolution 71 (Cg-17) – Preparation of the Strategic and Operating Plans 2020–2023, requesting the Executive Council to organize a planning process, and Decision 82 (EC-68) – Preparation of WMO Strategic and Operating Plans 2020-2023,

Having considered the recommendations of its Working Group on Strategic and Operational Planning [EC-69/INF. 16.2(1), in Part II of the present report] and the first draft WMO Strategic Plan,

Noting that the draft Strategic Plan took into consideration the decisions of Congress and EC and key drivers influencing the directions of the Organization,

Endorses the following vision of the draft Plan: "We envision a world in 2030 where all WMO Members, especially the most vulnerable, are more resilient to the socioeconomic consequences of extreme weather, water, climate and other environmental events; and support their sustainable development through the best possible services, whether over land, at sea or in the air";

Endorses the overarching priorities and the structure of the draft Plan based on five long-term goals and associated objectives in the next planning period 2020-2023 as shown in the Annex;

Observes that further development of the draft Plan should be guided by: (a) an outcome-based approach expressing clear benefits to Members; (b) an interactive approach to science and services to address service needs; (c) the sharing of knowledge as a critical factor in developing capacities; and (d) cooperation with all actors, including the private sector, to enhance the generation of services yielding socioeconomic benefits;

Requests regional associations and technical commissions to continue to contribute to the preparation of the Strategic Plan to ensure that the needs of Members, as well as science and technology development, are taken into consideration;

Requests its Working Group on Strategic and Operational Planning to refine the draft Strategic Plan for further consideration by EC-70;

Requests further the Secretary-General to support the preparation of the Strategic Plan.

Annex to Decision 65 (EC-69)

WMO DRAFT STRATEGIC PLAN

WMO STRATEGIC PLAN

Draft

Contents

Foreword

... to be completed once main text approved... 1.5 to 1 page

Executive Summary

… to be completed once main text approved… page or 2 at most

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The Drivers *… this section could possibly become an annex*

Resilience and adaptation to threats of extreme weather and climate change

High-impact weather and climate extremes such as severe storms, excessive heat, droughts and floods are the causes of most natural disasters and are occurring with greater frequency and intensity due to climate change. Today, these significant changes in weather, climate, water, atmospheric composition, and other environmental conditions such as air pollution, are having compelling consequences for the safety of people, the resilience of natural and built environments, water security, and prosperity of nations. These events are even impacting the social fabric and stability of communities. The significant growth of human settlements, particularly in heavily populated urban settings, flood plains, and coastal zones, are further exacerbating society's exposure and vulnerabilities to these hydrometeorological hazards due both to climate variability and change. In 2017, the World Economic Forum identified weather extremes and natural disasters as their highest risk, as the costs for natural disasters in 2016 alone, spiralled upwards to US$ 175B; well above the 1986-2015 average of US$ 126B.

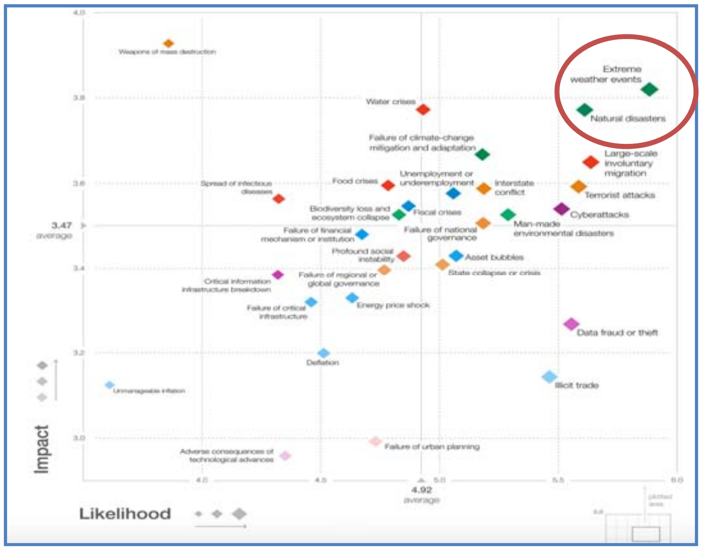

Figure 1: World Economic Forum 2017 Risk Assessment

These implications of changing weather and climate patterns, water availability and other environmental conditions are escalating the demand from governments, institutions and citizens for more useful, reliable and accessible multi-hazard information, products and services to mitigate, prepare and safely adapt to the threats of severe hydrometeorological hazards and of a rapidly changing climate.

Dramatic advancements in science, technology and social media

Monitoring and prediction services are recognized for their essential value for the protection of life and property from meteorological and hydrological hazards as well as for strengthening resilience of society to climate variability and change. Furthermore, they underpin responsible economic growth in sectors including agriculture and food production, transportation, energy and water resources. Thanks to dramatic advances in science and technology, now more than ever investments are necessary to strengthen monitoring infrastructures, handle large or complex datasets ('big data') and improve the quality of and access to predictions and services. This would result in effective disaster risk reduction, more timely and effective planning and decision-making and greater realization of socioeconomic benefits. This would further enable society to mitigate and adapt to high-impact weather, climate and hydrological extremes, over land or sea. Furthermore, the recent pace of scientific and technological innovations should have far-reaching impacts on institutional arrangements world-wide for meteorological and hydrological services. Consequently, decision-makers are becoming more capable and more demanding, along with the introduction of new service providers from the private sector and academia.

Widening capacity gap among National Meteorological and Hydrological Services

Many WMO Members face significant development and capability gaps in serving the weather-, climate- and water-related needs of their governments, institutions, socioeconomic sectors and citizens. Their capacity to sustain monitoring networks and quality services, in addition to on-boarding advances in science and technology, is limited due to infrastructure, financial and human resource challenges. Moreover, it is often these nations that are more vulnerable in coping with the natural disasters, protecting life and property and economic recovery. On the other hand, more advanced NMHSs are rapidly making significant performance strides through optimum use of advanced weather and climate prediction modelling, high performance computing platforms, advanced in-situ observing networks, and surface based and space based remote-sensed observational infrastructure systems, and data transmission methods. However, all depend upon reliable, high-quality services that prevent loss of life and property, contribute to economic growth and support environmental stewardship worldwide.

Demand for Actionable, Accessible and Authoritative Science and Information

The realization of societal well-being that underpin the 2030 Agenda for Sustainable Development, the Paris Agreement on Climate Change and the Sendai Framework for Disaster Risk Reduction, which all will serve as the centrepiece for national and international policymaking over the next years, is critically dependent upon *actionable, accessible and authoritative* (AAA) meteorological and hydrological information and services. National Meteorological and Hydrological Services contribute to these goals (SDGs) at national levels, while Members collaborating through WMO's mechanisms and Programmes further these goals at international levels. Through such initiatives as the WMO Integrated Global Observing System, the Global Framework for Climate Services and the World Weather Watch, networks of real-time data collection, management and processing, and global and regional prediction systems, support the enhancement of the core capabilities, competencies and performance of its Members to contribute to the global agenda as well as regionally and nationally based objectives. Dedicated efforts are required to overcome these challenges, and WMO actions will be guided by its long-term vision and three overarching Strategic Priorities.

WMO, a specialized agency of the United Nations, with 191 Member States and Territories, is its authoritative voice on the state and behaviour of the Earth's atmosphere, its interaction with the land and oceans, the weather and climate it produces and the resulting distribution of water resources.

Members own and operate the scientific infrastructure required for providing the weather, climate, water and related environmental services, primarily through national meteorological and hydrological organizations.

Our Vision

We envision a world in 2030 where all WMO Members, especially the most vulnerable, are more resilient to the socioeconomic consequences of extreme weather, water, climate and other *environmental events; and support their sustainable development through the best possible services, whether over land, at sea or in the air.*

Our Mission

The strategic plans of the organization are guided by the purposes of the Organization that are outlined under Article 2 of its Convention:

(a) To facilitate worldwide cooperation in the establishment of networks of stations for the conduct of meteorological observations as well as hydrological and other geophysical observations, and to promote the establishment and maintenance of centres charged with the provision of meteorological, hydrological and related services;

(b) To promote the establishment and maintenance of systems for the rapid global exchange of meteorological, hydrological and related information;

(c) To promote standardization of meteorological, hydrological and related observations and to ensure the uniform publication of observations and statistics;

(d) To further the application of meteorology to aviation, shipping, water management, agriculture, fisheries and other human activities;

(e) To promote activities in operational hydrology and to promote close cooperation between meteorological and hydrological services;

(f) To encourage research and training in meteorology, hydrology and, as appropriate, in related fields, and to assist in coordinating international aspects such as research and training.

WMO plays an essential, effective world-wide leadership role in enhancing the execution and performance of its Members, and in particular their NMHSs, through improved data interoperability, quality management systems, access to world-wide science and expertise, and support to the delivery and use of their high-quality, authoritative services enabling them to better fulfil their mandates, demonstrate their relevance and raise their visibility within national governments and with other stakeholder organizations.

Overarching Priorities

The Strategic Plan sets out long-term goals and strategic objectives as we strive to achieve our vision. As we translate these top level goals and objectives into detailed plans we will focus our resources in accordance with three overarching priorities:

1. **Reducing losses of life and property** from hydrometeorological hazards.

2. Supporting climate action to build **resilience and adaptation to climate risk**.

3. **Enhancing socioeconomic value** from hydrometeorological and climate services.

Long-term Goals and Strategic Objectives (SO)

Goal 1 Better serve societal needs: Delivering actionable, authoritative, accessible, user-oriented and fit-for-purpose services

Enhanced service capability of Members to provide high quality, on demand, geo- and impact-based weather, climate, water, marine and related environmental products and services, in support of sustainable development goals, disaster risk reduction, climate adaptation, and other risk-based decision-making to meet evolving societal needs.

SO 1.1 Integrating climate information

- Climate Service Information System for climate services operational information about climate archived, analysed, modelled, exchanged and processed to support the production and delivery of authoritative climate information products through operational mechanisms.

SO 1.2 Enhancing climate and hydrometeorological disaster flagship products to support decision-makers

- Enhanced WMO global consolidated products and services used by the UN system for weather, climate and hydrological information (statement on the state of the global climate, greenhouse gas and ozone bulletins, water assessment report, catalogue of extreme events, disaster impact reports, ENSO regular advisory, impact-based decision support systems).

SO 1.3 Enhancing weather warning systems worldwide

- Established or improved early warning systems, and developed alerting protocol frameworks which improve engagement with first responders and civil emergency managers for reducing life and property losses due to extreme weather.

SO 1.4 Supporting sustainable water management

- Designed and delivered hydrological services for water management considering socioeconomic development, population dynamics, changes in the cryosphere and climate change.

- Facilitated data exchange supporting the development of global status and outlook capabilities.

- Innovative ways to address the issue of declining observing networks and institutional and human capacity.

Goal 2 Enhance Earth system observations and predictions: Strengthening the technical foundation for the future

Modernized, enhanced, optimal, and integrated global observational network of the Earth system (the atmosphere, hydrosphere, oceans, cryosphere and biosphere), high-quality observations and the necessary data exchange, data management and data processing mechanisms to support research and operational services. New information sources and technologies applied and new stakeholders incorporated for improved observation, data processing, modelling, prediction and services.

SO 2.1 Ensuring adherence to the highest standards of observations

- High-quality meteorological observations ensured through setting of international standards and compliance by at least a majority of Members.
- Potential for large number of additional observations promoted and standards set for those datasets and for their exchange.

SO 2.2 Integrating observing networks and data management systems

- (Increase) quantity of high-quality observations in compliance with WMO Technical Regulations.
- (Number of) integrated data management systems facilitating the provision of scientific data to decision-makers.
- (Increase) number of Members implementing WIGOS at the national level.

SO 2.3 Filling critical gaps in global observations

- Availability of integrated in situ, space-based and model-derived observations and products to address critical gaps in observational coverage at national, regional and global scales.
- Increased number of CryoNet observations in high mountain and polar regions, integral to the aims of the Global Cryosphere Watch.
- Improved observing network design to complement and support evolving seamless prediction systems.

SO 2.4 Fostering broadest application of free and open data exchange

- Measuring Member compliance with WMO Resolutions 25 (Cg-XIII), 40 (Cg-XII) and 60 (Cg-17).
- Number of new or additional datasets made freely accessible to Members.
- Increase in products and services offered through WMO "Cascading Prediction System".

SO 2.5 Enhancing the value of cascading seamless prediction systems

- (Number of) common operational entities such as multi-hazard early warning centres or flood forecasting centres with Global Data-processing and Forecasting Systems functions established to enhance integration and interoperability of meteorological, climatological, hydrological and marine observations and prediction systems in a cascading seamless process from days to climate scales.

Goal 3 Advance targeted research: Leveraging leadership in science

Leveraged global research community resulting in fundamental advances in the understanding of the Earth system including the inter-relationships between atmosphere, ocean, cryosphere and biosphere, leading to improved predictive skill at all time scales in a seamless context. This results in a strengthened forecast and warning performance of all Members as the interface between research and operations applies the best science for improving all components of the service value chain.

SO 3.1 *Advancing scientific knowledge of the Earth system*

- (Number of) projects implemented or initiated addressing grand challenges in scientific research, modelling, analysis and observations: cryosphere, clouds and circulation, carbon sinks and their feedbacks, water availability and flooding, regional sea level and coastal impacts, aerosols impact on air quality, high-impact weather and climate predictions.

SO 3.2 *Applying scientific and technological advances to improve predictive capabilities*

- (Number of new) applications using results of scientific research and technological advances for improving predictive capabilities in high-impact weather forecasting, seasonal to sub-seasonal prediction, polar prediction, urban meteorological services, modelling and prediction of the water cycle.

SO 3.3 *Integrating greenhouse gas information*

- Integrated Greenhouse Gas Information System operational: an independent information system to help countries to improve the quality and confidence in national GHG emission inventories. This will be achieved by joining atmospheric observations and inverse modelling techniques – the "top-down" – with spatially and temporally explicit emission inventory data – the "bottom-up". The combination of these data sources will better inform emission reduction policies and measures.

Goal 4 Close the gap on service: Enhancing and leveraging existing capabilities among all WMO Members to bring capability to all

Sharing, exchanging and building global, regional and national capacity and cooperation to ensure equitable contributions to and benefits from the combined capabilities among all WMO Members. Gender specific considerations are also important dimensions in this strategy.

SO 4.1 *Understanding the needs of developing countries to provide better services*

- Monitored, assessed, understood and reported status of observing systems, staffing, service capacity, level of compliance, and overall status and needs of the NMHSs and the Members.

- Measured and aligned contributions of constituent bodies, development partners and national governments (including through supporting the development of national strategic plans and National Adaptation Plans) that address Member requirements.

SO 4.2 Strengthening core competencies and expertise

- Every Member has access to expertise, experience and knowledge exchanged among countries, including best practices for sustainability in the face of a changing business environment, through education and training at global, regional and national level.

- Exchange of expertise and collaboration established and maintained among weather, climate, hydrological and marine weather constituencies and between operational and research communities.

SO 4.3 Establishing strategic partnerships for the global weather enterprise

- (Number of) strategic, functional and mutually beneficial partnerships and alliances among Members and with academia, government departments, UN, international and nongovernmental organizations, the private sector and the civil society that support Member service obligations and reinforce the position of WMO as the global authoritative voice.

- Increased clarity on the different roles and responsibilities of those involved in the weather enterprise, with agreements in place between the centres/Members to make this work effectively.

- Established sustained capability and services in regions that lack this; targeted donor funding towards well judged, sustainable service delivery models.

Goal 5 Work smarter: Supporting effective policy- and decision-making and implementation in WMO

Effective functioning of policy- and decision-making, constituent bodies and oversight of the Organization, where WMO meetings and constituent bodies would yield more strategic and concrete outcomes and action which focus on the fundamental capabilities and services for the benefit of Members. Streamlined administrative processes to enhance the efficiency of the Secretariat and mobilizing new external financial resources and technical expertise to enhance Member performance. Gender equity would be mainstreamed in all WMO activities.

SO 5.1 Optimizing WMO structures and processes

- Optimal structures and processes of WMO designed and agreed on by constituent bodies.

- Clear project culture promoted placing emphasis on quality, timeliness and accountability, as well as forward-looking identification of emerging issues, guiding the relationship between WMO constituent bodies, Members and the Secretariat.

SO 5.2 *Mobilizing resources to implement WMO Programmes*

- Effective and comprehensive resource mobilization plans developed.
- Increased resources available to WMO Programmes to fully address the goals and priorities of the Organization and its Members.

SO 5.3 *Communicating effectively about the value of WMO's work*

- Visibility of WMO and NMHSs increased through informed products for decision-makers and civil society about the value of weather, climate, hydrology and related environmental observations, research and services.

SO 5.4 *Effectively supporting collaboration among Members*

- Members enabled and supported by the WMO Secretariat to effectively collaborate on activities, which deliver to the WMO vision.

Implementation of the Strategic Plan

Guiding Principles

The following principles underpin the WMO Strategic Plan ensuring better alignment with the core purposes of the Organization and enhancing its role within the UN system:

1. WMO should be cost-effective in delivering on its core mandate to better serve the Members, enhance their performance and strengthen the national role of NMHSs;

2. WMO should influence and inform the global agenda where it best serves the interest of Members through enabling strategic partnerships with the UN system and other international organizations, especially in the domain of disaster risk reduction and climate action;

3. Alliances and partnerships should be encouraged among Members, multilateral and bilateral development partners and other relevant actors to attract investment, enhance capability and performance, and deliver improved outcomes for society;

4. Relationships and cooperation should be strengthened among the public and private sector, academia and other non-state players to better serve the socioeconomic needs of societies around the world;

5. WMO should ensure an interactive approach to science and services by developing science priorities that are informed by our service needs now and into the future.

Key strategies

In supporting the vision and the achievement of the requisite Long-term Goals, there are **five key strategies** that contribute to their success:

1. Advocating for free and open and expanding the access to relevant Earth observations data to be integrated as part of the WMO Integrated Observational Systems;

2. Developing services and improved access to services at global and regional levels;

3. Leveraging the advances in science and technology for the benefit of all Members' operations and services;

4. Forging strategic partnerships and alliances among all the players in the "weather enterprise";

5. Developing competency and capacities to ensure that all NMHSs can provide the highest levels of consistent, quality weather, climate and water services that deliver increasing benefits to the user community. (*New principle added.)*

This strategic framework will guide the decisions and activities of WMO in helping to realize its 2030 vision, and will serve as the focus for the upcoming financial period 2020–2023, bringing the greatest benefits to Members. The integrated WMO Operating Plan 2020-2023 presents time-bound programme activities and projects, result-oriented budgets and success indicators. The Operating Plan forms the basis for resource allocation, and defines the risks and performance matrices against which to assess progress to achieve expected results through the WMO Monitoring and Evaluation System.

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Annex - Relationship between Long-term Goals, Strategic Objectives and the WMO Programme and budget structure *… consider relationship to WMO Convention; this annex could be removed*

Long-term Goals and Strategic Objectives	Major activity area	Theme	Relevant Programme Elements
1. Better serve societal needs: Delivering actionable, authoritative, accessible, user-oriented and fit-for-purpose services 1.1 Integrating climate information 1.2 Enhancing the climate and hydrometeorological disaster knowledge base to support decision-makers 1.3 Establishing weather warning systems worldwide 1.4 Supporting sustainable water management	**Specific Areas of Weather, Climate and Hydrology**	**Meteorology Applications**	• AgMP • AeMP • MMOP • PWSP • DRR • TCP • Gender
		Climate Applications	• AgMP • AeMP • PWSP • DRR • TCP • Gender
		Hydrology Applications	• HWRP and associated programmes
2. Earth system observations and predictions: Strengthening the technical foundation for the future 2.1 Ensuring adherence to the highest standards of observations 2.2 Integrating observing networks and data management systems 2.3 Filling critical gaps in global observations 2.4 Fostering broadest application of free and open data exchange	**Foundation Activity**	**Observation and Information Systems** ***Prediction Systems***	• WWW • WIGOS • GDPFS • GTS • ERA • WIS • IMOP • WMOSP • WWWDM

Long-term Goals and Strategic Objectives	Major activity area	Theme	Relevant Programme Elements
2.5 Enhancing the value of cascading seamless prediction systems			• WWWSSA • WMOAA • WHYCOS • WHOS • WMOQMFP • GCOS • Polar & High Mountain Activities
3. Advance targeted research: Leverage leadership in science 2.1 Advancing scientific knowledge of the Earth system 2.2 Applying scientific and technological advances to improve prediction capabilities 2.3 Integrating greenhouse gas information system	**Foundation Activity**	**Research**	• WWRP • GAW • WCRP
4. Close the gap: Enhancing and leveraging existing capabilities among all WMO Members to bring capability to all 4.1 Understanding the needs of developing countries to provide better services 4.2 Strengthening core competencies and expertise 4.3 Establishing strategic partnerships for the global weather enterprise	**Capacity Development and Partnerships**	**Capacity Development**	• VCP • ETRP • RP • LDC • SIDS-MITs • Gender
5. Work smarter: Supporting effective policy- and decision-making and implementation in WMO 5.1 Optimizing WMO structures and processes 5.2 Mobilizing resources to implement WMO Programmes 5.3 Communicating effectively about the value of WMO's work 5.4 Effectively supporting collaboration among Members	**Governance Administration**	**Executive Management Governing Bodies, Programme Support Services, Resource Management**	• Executive Management • Cabinet and External Relations • Strategic Planning • Information and Public Affairs Programme • Internal Oversight • Legal Services • Conference Services • Language Services • Resource Mobilization • Resource Mobilization

Decision 66 (EC-69)

OUTLINE OF THE OPERATING PLAN AND BUDGET 2020–2023

THE EXECUTIVE COUNCIL,

Recalling Decision 81 (EC-68) and Decision 82 (EC-68) and Financial Regulations Article 3 - Maximum expenditures for the financial period,

Recognizing the need to provide guidance to the Secretariat in the process of preparation of the Operating Plan and budget for the financial period 2020-2023, with particular regard to the definition of the maximum level of expenditure to be incurred in this period,

Noting that its Working Group on Strategic and Operational Planning considered the outlines of Operating Plan and budget for 2020-2023 similar to the new format used for the second biennium 2018-2019 of the seventeenth financial period 2018-2019 and recommended them to the Council for approval; the Group also emphasized the need for a more transparent budget process,

Noting that the 2017 Meeting of Presidents of Regional Associations and Technical Commissions agreed that the implementation of Organization's priorities set by Congress requires an Operating Plan with annual milestones and targets, and clear implementation responsibilities of regional associations, technical commissions, the Members and the Secretariat,

Having considered the recommendation of the Financial Advisory Committee on the outline of the Operating Plan and Budget 2020-2023;

Decides that:

(1) The Operating Plan and budget for the financial period 2020-2023 shall be prepared on the basis of the WMO Strategic Plan;

(2) Their structure should be aligned with the main structural elements of the Strategic Plan;

(3) The 2020-2023 budget shall be prepared in accordance with the following format:

(a) The budget shall be presented by Long-Term Goals, contain information by Programme, by object of expenditure, and their correlations, as well as graphics on resource trends, as appropriate;

(b) A clear and logical link shall be established among the Strategic Plan, the Operating Plan and the budget;

(c) Extrabudgetary resources expected to be made available (existing trust funds and possible new extrabudgetary resources) shall be presented in parallel to the regular budget resources in accordance with the programme structure (integrated budget presentation);

(d) Savings and efficiency measures, activities discontinued by 2019, and unfunded activities shall be specified, along with programmatic and budgetary implications (e.g. savings deriving therefrom, programmatic impact, and re-allocation of the savings for priority activities);

(e) In-kind contributions shall be recognized and specified with quantified budgetary implications where possible;

(f) Information on resource allocation for activities with regional aspects, across the WMO Scientific and Technical Programmes shall be provided;

(g) The budget document shall contain information on the non-cash expenditure, and its subsequent impact on the future surplus or deficit that is expected to be incurred during the financial period 2020-2023;

(h) Beyond areas identified in the Strategic Plan, capacity development activities shall be financed out of extrabudgetary activities;

(i) The budget document shall contain information on expected sources of income, including, inter alia, programme support costs determined on the basis of a full-cost recovery model;

Further decides that the 2020-2023 budget shall be presented in accordance with two scenarios, i.e.; (a) a zero-nominal growth scenario; and (b) a moderate budget growth scenario;

Requests the Secretary-General to prepare the draft Operating Plan and budget for the financial period 2020-2023 in accordance with the above decisions in time for consideration by the Council at its seventieth session.

Decision 67 (EC-69)

MONITORING AND EVALUATION

THE EXECUTIVE COUNCIL,

Recalling that the Seventeenth World Meteorological Congress requested adjustments and further improvements to the WMO M&E System based on lessons learned,

Noting that the EC Working Group on Strategic and Operational Planning (EC WG/SOP) reviewed the proposed enhancements to the Key Performance Indicators (KPIs) for 2016-2019 and agreed on a phased approach to reform,

Noting also that a streamlined set of KPIs shall be developed for the 2020-2023 financial period which will:

(1) Be more specific, objective and measurable,

(2) Encompass progress at the national, regional and global level,

(3) Capture the benefit that meteorological and hydrological services bring to society as well as the effectiveness in implementation of the Strategic Plan and Members' compliance with standards,

Being mindful that consistency with the Results-Based Management approach is required as well as continuity in performance measurement in the current financial period,

Recalling that mid-term performance data for the 2016-2019 monitoring cycle shall be collected in 2017,

Taking note that information is readily available at the Secretariat to establish baselines and/or measure performance on more than half of the KPIs,

Acknowledging that Member input will be required to measure performance on the rest of the KPIs by means of the Country Profile Database or another data collection tool,

Recognizing that new KPIs are necessary to measure progress on priorities, such as the GFCS and polar and high mountain regions,

Agrees to monitor the set of KPIs proposed for 2016-2019, as reviewed and adjusted by the EC WG/SOP;

Requests the Secretary-General to work on a methodology for monitoring performance in 2020-2023, which is in line with the draft Strategic Plan 2020-2023;

Requests also EC WG/SOP to continue providing guidance and overseeing the reform process taking into account a few, simplified indicators that measure the effectiveness of the Strategic Outcomes of the Organization, and communicate a return on investment to Members;

Urges Members to respond promptly to requests for monitoring data and updates to the Country Profile Database.

Decision 68 (EC-69)

WMO CONSTITUENT BODY REFORM

THE EXECUTIVE COUNCIL,

Recalling the Decision 84 (EC-68) – Governance Review, requesting EC Working Group on Strategic and Operational Planning to continue to review WMO governance and make further recommendations to the next session of the Council, and to consider also, within the context of the holistic review of the Organization, the effectiveness of the current and possible future composition and structure of the regional associations,

Having considered the proposal for WMO constituent body reform developed by the Working Group which has taken into consideration relevant guidance provided by the Congress and the Council and input and contributions by presidents of regional associations and technical commissions and identifies some of the key issues which require further consideration;

Agreeing with the need for change and the rationale presented by WG-SOP, and that the change should be implemented through a phased approach ensuring smooth and effective transformation of different kinds of WMO constituent bodies,

Observing that transformative and innovative processes have already started in several key areas, and encourages technical commissions and regional associations to work in an integrated fashion and explore possibilities of holding joint sessions in the current planning period,

Emphasizing the importance of both operational coherence and integration of core WMO systems, and visibility of key WMO themes: weather, water/hydrology, climate and other environmental applications and the need to maintain interfaces with relevant bodies of other specialized agencies such as ICAO, UNESCO and its IOC,

Emphasizing further the importance of both attracting the best experts in the technical work of constituent bodies, and the need to involve and build capacity of experts from all over the world under the principle of no country left behind,

Decides to proceed with the development of separate recommendations, for consideration of EC-70 and ultimately the Congress, for restructuring of the Executive Council, the technical commissions and the regional associations with associated terms of references, implementation schedules and other relevant details;

Requests its Working Group on Strategic and Operational Planning with support from the Secretariat to develop, for consideration by EC-70, a set of recommendations for Cg-18, which address the key issues identified in the current proposal for WMO constituent body reform, including:

(1) Prepare separate recommendations pertaining to each of the structures: the Executive Council, the technical commissions and the regional associations, including terms of reference of proposed bodies, step-by-step transition schedules and other relevant details explaining in particular inter-relations between various bodies in a holistic manner;

(2) Draft amendments to General Regulations supporting structural changes and updating processes and functionalities to bring them in line with the current realities;

(3) Clearly articulate on how the proposed structures would realize opportunities and bring benefits to WMO, the key risks, which could be introduced both during and after the transition period, and issues which will not be resolved by the proposals;

(4) Prepare a communication strategy, including consultations with Members and relevant external constituencies, such as IOC/UNESCO, FAO, ICAO;

(5) Review the WMO Programmes with the aim of streamlining and better alignment with the key foundational elements of WMO; and

(6) Elaborate the transition and change management processes.

Requests presidents of regional associations and technical commissions to facilitate consultations with Members on the proposed reform on the occasions of sessions of constituent bodies and provide feedback to the Working Group;

Requests further the Secretary-General to support the deliberations of the Working Group and consultations with Members on the occasions of sessions of regional associations, technical commissions and other events.

Decision 69 (EC-69)

PLAN FOR FUNDING THE AFTER-SERVICE HEALTH INSURANCE SCHEME LIABILITIES

THE EXECUTIVE COUNCIL,

Recalling Resolution 73 (Cg-17) – Plan for Funding Liability for After-Service Health Insurance, and Decision 87 (EC-68) – Interim Plan for Funding Liability for After-Service Health Insurance,

Noting with concern the growing level of financial liabilities that are estimated for the long-term financing of the After-Service Health Insurance scheme (ASHI) of WMO,

Noting also the views of the Staff Association and the importance of further consultations with staff in developing proposals on this matter,

Noting further that the cost saving measures being considered in the context of the work of the UN Advisory Committee on Administrative and Budgetary Questions (ACABQ) are not likely to deliver the expected benefits if applied by the WMO in isolation,

Being mindful of the importance of harmonizing with other UN common system organizations,

Recognizing the need to counter the growth of the financial liabilities for the long-term financing of ASHI,

Decides to keep in force Resolution 14 (EC-LXI) – Increasing the charges on Payroll Costs for the Funding of the Reserves for After-Service Health Insurance Benefits;

Requests the Secretary-General to develop, in consultation with staff, a more comprehensive proposal to be submitted to EC-70, including measures to reduce or contain overall costs of the scheme, a timeline for the implementation of the proposed plan, as well as the extent to which the scheme would benefit from harmonization with the progress of the UN-wide scheme and other UN system organizations.

Decision 70 (EC-69)

AMENDMENTS OF REGULATIONS AND RULES

THE EXECUTIVE COUNCIL,

Recalling Decision 88 (EC-68) – Amendments to staff rules and regulations,

Having considered the UN GA Resolution 70/244 on the UN common system,

Bearing in mind Articles 12.2 and 12.3 of the Staff Regulations,

Taking note of the amendments made by Secretary-General to the Staff Rules, as well as the development of one consolidated document for the Regulations and Rules,

Also taking note that the United Nations Secretariat has not yet amended its Staff Regulations to reflect an extended mandatory age of separation to 65 for staff members who joined the United Nations Joint Staff Pension Fund before 1 January 2014,

Decides to extend the mandatory age of separation to 65 for staff members who joined the United Nations Joint Staff Pension Fund before 1 January 2014, taking into account their acquired rights, with effect from 1 January 2018;

Requests the Secretary-General to submit to the Executive Council at its next session the amendment to the Staff Regulations, Article 9.5 in order to align the wording with the respective Staff Regulation of the United Nations.

Decision 71 (EC-69)

REVISED SALARIES AND PENSIONABLE REMUNERATION OF UNGRADED OFFICIALS

THE EXECUTIVE COUNCIL,

Recalling that the Seventeenth Congress had decided to authorize the Executive Council to carry out any adjustment of salary in respect of the Secretary-General, the Deputy Secretary-General and the Assistant Secretary-General, which might become necessary if an increase in the salaries of comparable United Nations staff occurred during the seventeenth financial period,

Recognizing the spirit of the decision of the Seventeenth Congress in this respect,

Having considered that comparable United Nations agencies (ITU and UPU) were adjusting the salaries of their ungraded officials,

Noting that there is no adjustment with regard to the pensionable remuneration of ungraded officials,

Decides to approve the annual rates of net basic salary of WMO ungraded officials with retroactive effect from 1 January 2017 as provided in the annex;

Requests the Secretary-General to take appropriate action as required by the decision thus taken, noting that this scale reflected an increase through the standard consolidation procedure of reducing post adjustment multiplier points and increasing base salary, i.e. on a no loss/no gain basis.

Annex to Decision 71 (EC-69)

SALARIES OF UNGRADED OFFICIALS

	Existing provision	**New provision**
Secretary-General	USD 168,648	USD 169,296
Deputy Secretary-General	USD 154,804	USD 155,398
Assistant Secretary-General	USD 142,218	USD 142,764

Decision 72 (EC-69)

SIXTY-SECOND INTERNATIONAL METEOROLOGICAL ORGANIZATION PRIZE AND OTHER AWARDS

THE EXECUTIVE COUNCIL,

Having considered the recommendations of the Selection Committee for the International Meteorological Organization (IMO) Prize,

Awarded the sixty-second IMO Prize to Mr Gordon McBean (Canada);

Invited Mr Gordon McBean to deliver a scientific lecture at the seventieth session of the Executive Council;

Having considered the recommendations of the Selection Committee for the WMO Research Award for Young Scientists,

Awarded the 2017 WMO Research Award for Young Scientists to Mr Nick Dunstone (United Kingdom of Great Britain and Northern Ireland) for the paper entitled “Skilful predictions of the winter North Atlantic Oscillation one year ahead” by Nick Dunstone et al. (Nature Geoscience – October 2016, DOI:10.1038/NGEO2824).

Decision 73 (EC-69)

DESIGNATION OF ACTING MEMBER(S) OF THE EXECUTIVE COUNCIL

THE EXECUTIVE COUNCIL,

Noted the exceptional situation that the seats of the three Vice-Presidents of the Organization became vacant after the last session of the Council;

Appreciated that the President consulted the Executive Council on the election process to fill these three (3) vacant Vice-President offices;

Noted that by the decision of the President the election by correspondence has already been opened to all States which are Members. The process of election of the First Vice-President did not meet the requirement of quorum and will be re-started;

Noted that Articles 11(a) (4) and 13 (a) of the Convention and General Regulation 15 clearly stipulate the process of election of Officers of the Organization and their status as ex-officio members of the Executive Council;

Noted further that five vacancies have occurred among the Council members elected in accordance with Article 13 (c) of the Convention and that acting members shall be designated by the Executive Council in accordance with Regulation 145;

Designated as acting members of the Executive Council Mr Louis Uccellini (United States of America) to replace Ms Laura FURGIONE (United States of America), Mr Kanduri J. Ramesh (India) to replace Mr Laxman Singh RATHORE (India), Ms LIU Yaming (China) to replace Mr ZHENG Guoguang (China), Mr Ahmed ABDELAAL (Egypt) to replace Mr Anthony C. Anuforom (Nigeria), and Mr Andrew Johnson (Australia) to replace Ms Sue L. Barrell (Australia).

Decision 74 (EC-69)

REVIEW OF SUBSIDIARY BODIES AND OTHER BODIES REPORTING TO THE EXECUTIVE COUNCIL

THE EXECUTIVE COUNCIL,

Decides to make the following replacements and changes in the composition of its working groups, panels and committees:

Executive Council Panel of Experts on Polar and High Mountain Observations, Research and Services

. J. Ekman (Ms) (Finland) name change of member J. Ikävalko

. A. Pope (United States of America) to replace V. Rachold (Germany) (IASC Secretariat)

. M. Mohapatra (India) to replace K. Satheesan

. M. Dumont (France) confirmed member

. K. Lahlal (Morocco) confirmed member

A. Devaris (Ms) (United States) reinstated member

D. Scott (Canada) new member

Zhaojun Zheng (China) new member

. R. Tatusko (Ms) (United States) new member

Executive Council Panel of Experts on Gender Mainstreaming

L. Uccellini to replace L. Furgione (United States)

Executive Council Panel of Experts on Education and Training

No change

Executive Council Panel of Experts on Capacity Development

No change

Executive Council Working Group on WMO Strategic and Operational Planning

A. Abd El Aal to replace A. Anuforom

A. Johnson to replace S. Barrell (Ms)

L. Uccellini to replace L. Furgione (Ms)

Y. Liu (Ms) to replace G. Zheng

A. Martis new member

Executive Council Working Group on Disaster Risk Reduction

President of RA III (Chairperson)

A. Martis to replace President of RA IV

L. Uccellini to replace L. Furgione (Ms)

Y. Liu (Ms) to replace G. Zheng

Executive Council Task Team on Data Policy and Emerging Issues

President of RA I (Chairperson)

A. Abd El Aal to replace A. Anuforom

K.J. Ramesh to replace L.S. Rathore

F. Teshome new member

Audit Committee

No change

Selection Committee for membership of the WMO Audit Committee

No change

Selection Committee for the membership of the JSC/WCRP

Y. Ko to replace L.S. Rathore

WMO Staff Pension Committee

G. Navarro to replace M. Ostojski

L. Bah to replace L. Makuleni

N. Kronig to replace alternate A. Hardej-Januszek

Selection Committee for the IMO Prize

Y. Liu (Ms) to replace G. Zheng

Selection Committee for the Young Scientists Award

C. Saulo (Ms) (Chairperson)

Selection Committee for the Vaisala Award

K.J. Ramesh to replace L.S. Rathore

Decision 75 (EC-69)

PUBLICATION OF A SCIENTIFIC LECTURE

THE EXECUTIVE COUNCIL,

Recalling that the sixty-eighth session of the Executive Council awarded the sixty-first IMO Prize to Mr Zeng Qingcun (China), and invited Mr Zeng to deliver a scientific lecture at EC-69,

Thanked Mr Zeng for his lecture entitled "Monitoring, predicting and management of meteorological disasters";

Requests the Secretary-General to arrange for the appropriate publication of the lecture;

Requests the Secretary-General to arrange a catalogue of the lectures by the IMO Prize laureates.

Decision 76 (EC-69)

REVIEW OF PREVIOUS DECISIONS OF THE EXECUTIVE COUNCIL

THE EXECUTIVE COUNCIL,

Noting the body of decisions agreed at the sixty-eighth session of the Executive Council,

Having examined its previous decisions still in force;

Decides:

(1) To keep in force the following decisions:

EC-68 1, 2, 3, 4, 5, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 23, 24, 26, 27, 28, 30, 33, 36, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 82, 83, 84, 85, 86, 93, 94;

(2) Not to keep in force the other decisions adopted before its sixty-ninth session;

Agrees to monitor the implementation of Decisions of the Council with a view to making recommendations for further action, as appropriate, at its seventieth session;

Requests the Secretary-General to publish the in-force decisions, including those with corrigenda in a new issue of *Resolutions of Congress and the Executive Council* (WMO-No. 508) and to bring this publication to the attention of all concerned parties.

APPENDIX 4. LIST OF PARTICIPANTS

1. Officers of the session

David GRIMES	President

2. Ex officio members

Abdullah A. ALMANDOUS	President of RA II
Julian BAEZ BENITEZ	President of RA III
Ivan CACIC	President of RA VI
Juan Carlos FALLAS SOJO	President of RA IV
Amos MAKARAU	President of RA I
Andi Eka SAKYA	President of RA V

3. Elected members

Gerhard ADRIAN	Member
Ahmed ABDELAAL	Member
Gerhard ADRIAN	Member
Mamadou Lamine BAH	Member
Silvio CAU	Member
Alexander FROLOV	Member
Ayman Salem GHULAM	Member
Ismail GUNES	Member
Toshihiko HASHIDA	Member
Andrew JOHNSON	Member
Agnes KIJAZI (Ms)	Member
Daouda KONATE	Member
Ravind KUMAR	Member
Jean-Marc LACAVE	Member
Yaming LIU (Ms)	Member
Miguel Angel LOPEZ GONZALEZ	Member
Linda MAKULENI (Ms)	Member
Albert MARTIS	Member
Guillermo NAVARRO	Member
Richard PHILIPPE	Member
Kanduri Jayaram RAMESH	Member
Andrea Celeste SAULO (Ms)	Member
Tyrone SUTHERLAND	Member
Fetene TESHOME	Member
Louis UCCELLINI	Member
Robert VARLEY	Member
Chin Ling WONG (Ms)	Member

4. Alternates and advisers to Executive Council members

ADRIAN Gerhard

Axel THOMALLA	Alternate
Ingeborg DETTBARN (Ms)	Adviser
Karolin EICHLER (Ms)	Adviser
Tobias FUCHS	Adviser
Wolfgang GRABS	Adviser
Sarah JONES (Ms)	Adviser
Thomas JUNG	Adviser
Claudia RUBART (Ms)	Adviser
Klaus STURM	Adviser

ALMANDOUS Abdullah A.

Ebrahim K. ALHOSANI	Alternate
Mohamed A. AL EBRI	Adviser
Jaser RABADI	Adviser

BAEZ BENITEZ Julian

José A. DE SOUZA BRITO	Adviser
Francisco de Assis DINIZ	Adviser

CAU Silvio

Leone MICHAUD	Alternate
Adriano RASPANTI	Alternate
Paolo CAPIZZI	Adviser
Angela Chiara CORINA (Ms)	Adviser
Umberto DOSSELLI	Adviser
Giancarlo PEDRINI	Adviser

FROLOV Alexander

Alexander NURULLAEV	Alternate
Irina BOUROVA (Ms)	Adviser
Ilia DEMIDOV	Adviser
Alexander GUSEV	Adviser
Marina PETROVA (Ms)	Adviser
Eduard SARUKHANIAN	Adviser
Alexander ZAYTSEV	Adviser

GHULAM Ayman

Mohammed BABIDHAN	Alternate
Fazi ALKHUZAIE	Adviser

GRIMES David

Heather AUCOIN (Ms)	Adviser
Dilhari FERNANDO (Ms)	Adviser

GUNES Ismail

Ercan BUYUKBAS	Alternate
Nur SOGUTCUKLU (Ms)	Adviser

HASHIDA Toshihiko

Hiroshi KOIDE	Alternate
Yasuo SEKITA	Alternate
Tatsuya KIMURA	Adviser
Naohisa KOIDE	Adviser
Hiroaki MINEMATSU	Adviser
Kenji OSHIO	Adviser
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KIJAZI Agnes (Ms)

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Geofrid Evarist CHIKOJO	Adviser

KO Yunhwa

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Jaecheol NAM	Alternate
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Jengeun LEE (Ms)	Adviser
Seungkyun PARK	Adviser
Yoonhee PARK (Ms)	Adviser
Ihncheol SEONG	Adviser
Minjeong YOUN (Ms)	Adviser

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Zhongfeng ZHANG	Adviser
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Xing ZHAO	Adviser
Heng ZHOU	Adviser

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Brittany CROLL (Ms)	Adviser
Richard JEFFERIES	Adviser
Mary Ann KUTNY (Ms)	Adviser
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Daniel MULLER	Adviser
Mark PAESE	Adviser
Robert RUTLEDGE	Adviser
Stuart SMITH	Adviser

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Ian LISK	Adviser
Steve MANKTELOW	Adviser
Jeremy TANDY	Adviser
Bruce TRUSCOTT	Adviser

5. Presidents of technical commissions

Bertrand CALPINI	Commission for Instruments and Methods of Observation (CIMO)
Oystein HOV	Commission for Atmospheric Sciences (CAS)
Michel JEAN	Commission for Basic Systems (CBS)
Byong Lyol LEE	Commission for Agricultural Meteorology (CAgM)
Harry LINS	Commission for Hydrology (CHy)
Thomas PETERSON	Commission for Climatology (CCl)
Chi Ming SHUN	Commission for Aeronautical Meteorology (CAeM)
Johan STANDER	Co-president of the Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM)

6. Regional hydrological advisers

Cristina ALIONTE EKLUND (Ms)	Adviser
John FENWICK	Adviser
Dora GONIADZKI (Ms)	Adviser
Sung KIM	Adviser
Ashraf ZAKEY	Adviser
Jose Alberto ZUNIGA MORA	Adviser

7. Representatives of WMO Members

Algeria

Said MEZIANE
Samir RAHEM

Brazil

Joao Carlos DE OLIVEIRA MOREGOLA
Emma Giada MATSCHINSKE (Ms)

Burkina Faso

Franck OUEDRAOGO

Colombia

Carlos A. CARRETERO SOCHA

Congo

Alphonse KANGA

Egypt

Mohammad ELSHAHED
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Finland

Maria HURTOLA (Ms)
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Roope TERVO

India

Khati ANAND
Ram Kumar GIRI

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Davood PARHIZKAR

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Peter AMBENJE
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Paulina CEBALLOS ZAPATA (Ms)
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Nigeria

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Manuel KELLER
Nora KRONIG (Ms)
Susanne ROSENKRANZ (Ms)
Alex RUBLI

Ukraine

Taras POPELNIUK

United States of America

Mary GLACKIN (Ms)
Paul KUCERA
Scott RAYDER

Zimbabwe

Charles CHISHIRI

8. Invited experts

Carl DE MONTIGNY
Philip Lawrence DECOLA
Franco DESIATO
Charles FIERZ
Detlev FROMMING
Fleming GERALD
Christophe GIRARD
Dennis HART
Jeffrey KEY
Maria LUNDBLAD (Ms)
Magdy REDA
Helge TANGEN

9. Representatives of international organizations and other bodies

Agence pour la Sécurité de la Navigation aérienne en Afrique et à Madagascar

Mahfoud MOCTAR	Observer

European Centre for Medium-Range Weather Forecasts

Florence RABIER (Ms)	Observer

European Organization for the Exploitation of Meteorological Satellites

Paul COUNET	Observer
Alain RATIER	Observer
Joachim SAALMUELLER	Observer
Anne TAUBE (Ms)	Observer

Food and Agriculture Organization of the United Nations

Yannick COUMARIN	
Silvano SOFIA	Observer

Gulf Cooperation Council

Said Hamed ALSARMI	Observer

Group on Earth Observations

Vanessa AELLEN (Ms)	Observer
Wenbo CHU (Ms)	Observer

Association of Hydro-Meteorology Equipment Industry

Francois LAURENT	Observer
Ashish RAVAL	Observer

International Civil Aviation Organization

Yong WANG	Observer

Intergovernmental Oceanographic Commission of UNESCO

Vladimir RYABININ	Observer
Albert Sok FISCHER	Observer

Islamic Educational, Scientific and Cultural Organization

Halim GRABUS	Observer

International Union of Geodesy and Geophysics

Arthur ASKEW	Observer

League of Arab States

Ahmed Abdel Aal MOHAMMED	Observer

United Nations Convention to Combat Desertification

Markus REPNIK	Observer

World Bank

Haleh KOOTVAL (Ms)	Observer
Daniel KULL	Observer
David ROGERS	Observer
Alan THORPE	Observer

10. Chairpersons of bodies reporting to the Executive Council

Hoesung LEE	Chair of the Intergovernmental Panel on Climate Change
Jens SUNDE	Chair of the Intergovernmental Board on Climate Services

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