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COMMISSION FOR BASIC SYSTEMS

OPAG ON INTEGRATED OBSERVING SYSTEMS

**INTER-PROGRAMME EXPERT TEAM ON THE
OBSERVING SYSTEM DESIGN AND EVOLUTION
(IPET-OSDE)**

SECOND SESSION

(IPET-OSDE2)

Geneva, Switzerland, 11 – 14 April 2016

FINAL REPORT



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CONTENTS

Agenda		p. 5
Executive Summary		p. 7
General Summary		p. 11 - p. 44
Annex I	List of Participants	p. 45
Annex II	Action sheet from IPET-OSDE-2	p. 49
Annex III	Updated IPET-OSDE workplan with status of tasks	p. 60
Annex IV	Procedure for update, validation and approval of SoGs within the RRR process	p. 65
Annex V	Proposal for an impact study on Aircraft Based observations	p. 66
Annex VI	Status of Existing Statements of Guidance	p. 69
Annex VII	Proposed science questions to be addressed for observing system design	p. 77
Annex VIII	Template for annual reporting by NFPs	p. 79
Annex IX	Updating and maintenance procedure for OSCAR/Space and OSCAR/Requirements	p. 84
Annex X	Template of Statements of Guidance	p. 84
Annex XI	Outcome of breakout Group 1 on OSCAR/Surface	p. 97
Annex XII	Outcome of breakout Group 2 on OSCAR Project	p. 100
Annex XIII	Outcome of breakout group 3 on EGOS-IP Action review (Space part)	p. 101
Annex XIV	Outcome of breakout group 4 on EGOS-IP Action review (Surface part)	p. 106
Annex XV	Outcome of breakout group 5 on the EGOS-IP High Level document	p. 108
Annex XVI	Outcome of breakout group 6 on the Vision for space-based component of WIGOS in 2040	p. 111
Annex XVII	Outcome of breakout group 7 on the Strategy for updating the Vision in 2025 (focusing on the surface part)	p. 112
Annex XVIII	Issues with regard to humidity and turbulence observations from aircrafts	p. 114
Annex XIX	Comments regarding the Statement of Guidance for Agricultural Meteorology	p. 115
Annex XX	Draft Vision for the space-based component of WIGOS in 2040	p. 116
Annex XXI	Draft list of hazards and extreme events	p. 126
Acronyms		p. 129

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AGENDA

1. ORGANIZATION OF THE SESSION

- 1.1 Opening of the meeting
- 1.2 Adoption of the agenda
- 1.3 Working arrangements

2. REPORT OF THE CHAIRPERSON

3. GUIDANCE FROM CHAIRPERSON OF THE OPAG-IOS

4. WMO INTEGRATED GLOBAL OBSERVING SYSTEM (WIGOS)

- 4.1 WIGOS progress relevant to the activities of IPET-OSDE

5. REVIEW OF ACTIONS FROM IPET-OSDE-1

6. REVIEW OF OTHER ACTIVITIES RELATED TO IPET-OSDE AND OPAG-IOS

- 6.1 Recommendations of IPET-WIFI
- 6.2 Update on GCOS activities
- 6.3 Update on GCW activities

7. ROLLING REVIEW OF REQUIREMENTS AND STATEMENTS OF GUIDANCE

- 7.1 Review database of User Requirements (OSCAR/Requirements)
- 7.2 Review database of Observing System Capabilities (OSCAR/Space & OSCAR/Surface)
- 7.3 Gap analysis using OSCAR
- 7.4 Statements of Guidance (SoGs)
 - 7.4.1 Overview of status
 - 7.4.2 Consider newly revised SoGs
 - 7.4.3 Consider areas requiring revised SoGs
 - 7.4.4 Consider any new areas requiring SoGs

8. OBSERVING SYSTEM STUDIES

- 8.1 Update on recent observation impact experiments
- 8.2 Proposal for new observation impact experiments to be promoted by IPET-OSDE
- 8.3 Plans for 6th Workshop on "The impact of various observing systems on NWP", Shanghai, 10-13 May 2016.

9. IMPLEMENTATION PLAN FOR THE EVOLUTION OF GLOBAL OBSERVING SYSTEMS (EGOS-IP)

- 9.1 Review of Guidance from Congress, and ICG-WIGOS on the EGOS-IP and its status as part of WIGOS implementation
- 9.2 Current EGOS-IP (2025)
 - 9.2.1 Review of progress since IPET-OSDE-1, including Actions
 - 9.2.2 Proposals for future review and reporting
- 9.3 Review of interactions with NFPs
- 9.4 High-level document on the EGOS-IP

10. VISION FOR THE EVOLUTION OF GLOBAL OBSERVING SYSTEMS

- 10.1 Vision for the space-based component of WIGOS in 2040
- 10.2 Updating the Vision for 2025

11. OBSERVING NETWORK DESIGN (OND) - PRINCIPLES AND GUIDANCE

- 11.1 Outcome of the OSDW2 workshop (Geneva, Feb. 2015)
- 11.2 Development of material for WIGOS Guide
- 11.3 IPET-OSDE perspective on RBON concept
- 11.4 Roadmap for the development of OND Principles and Guidance

12. PREPARATION FOR FORTHCOMING CBS ACTIVITIES AND MEETINGS

- 12.1 IPET-OSDE Updated work-plan for 2013-2016
- 12.2 Reports to ICT-IOIS-9 and CBS (2016)

13. ANY OTHER BUSINESS

14. ACTION PLAN

15. CLOSURE OF THE SESSION

EXECUTIVE SUMMARY

The Second Meeting of the Inter Programme Expert Team on Observing System Design and Evolution (IPET-OSDE) of the Open Programme Area Group for Integrated Observing Systems (OPAG-IOS) of the Commission for Basic Systems (CBS) was held at the WMO Headquarters in Geneva, Switzerland from 11 to 14 April 2016 and was chaired by the Chair of the IPET-OSDE, Dr John Eyre (United Kingdom).

The Team received guidance from its Chair and from the OPAG-IOS Chair. It took into account the decisions and guidance from the Seventeenth World Meteorological Congress (Cg-17, Geneva, Switzerland, 25 May to 12 June 2015) and it reviewed progress on the development of the WIGOS pre-operational phase 2026-2019 activities relevant to the IPET-OSDE. Guidance was also received from the Fifth meeting of the Inter-Commission Coordination Group on the WMO Integrated Global Observing System (ICG-WIGOS-5, Geneva, Switzerland, 25 to 28 January 2016), and from the OPAG-IOS Inter-Programme Expert Team on WIGOS Framework Implementation Matters (IPET-WIFI).

The Team received an update on several activities related to its work, and particularly from the WMO-IOC-UNEP-ICSU Global Climate Observing System (GCOS), and the Global Cryosphere Watch (GCW). The Team took note of the development of the new GCOS Implementation Plan, and invited the Team members to provide comments on the draft GCOS-IP as part of the limited review (June 2016) or the public review (July 2016).

As part of the Rolling Review of Requirements (RRR) process, the Team reviewed the status of the WMO database of observational user requirements and observing systems capabilities, which has been integrated into the Observing System Capability Analysis and Review tool (OSCAR). The Team took note of a few issues, and provided guidance to the Secretariat on how to address them. The Team noted with appreciation the imminent release of the second version (v2) of OSCAR/Space, and requested its members to participate in the beta testing phase. Noting that maintaining information in OSCAR/Space requires a lot of effort, the ICT-IOS-9 was invited to discuss the OSCAR resourcing issue in the view to formulate a recommendation to CBS-16, and requested the Chair to bring this issue to ICT-IOS-9. The Team also expressed its appreciation to MeteoSwiss, and in particular of the OSCAR Project Committee Chair and Project Owner/Lead at MeteoSwiss, Dr Bertrand Calpini (Switzerland) for their strong support to the development of OSCAR/Surface, which is now planned for becoming operational on 2 May 2016. Some guidance was also given on how to perform gap analysis using OSCAR in the future.

Also in the context of RRR, the Team reviewed the status of the Statements of Guidance (SoGs) for WMO Application Areas. The Team reviewed available updates to individual SoGs as provided by the nominated Point of Contacts. The IPET-OSDE assessed which SoGs should be revised, and it discussed whether there were any new areas requiring SoGs. A synthesis of the Team's review and decisions with regard to the SoGs is summarized in Annex VI. The Team also made some recommendations to the GCW and the Disaster Risk Reduction programme, in order for observing requirements of the two programmes to be better taken into account in the RRR process.

The Team reviewed the current activities regarding observing system studies, with emphasis on the design of future observing systems contributing to WIGOS. It considered proposals for additional studies (e.g. the impact of additional Aircraft Based observations over Regional Association I (Africa), high elevation cryospheric observations in the Third Pole region) to be promoted by the IPET-OSDE, and it agreed to promote them through the ICT-IOS-9, which was planned to meet in Geneva the following week. The Team discussed the plans for the 6th Workshop on "The impact of various observing systems on NWP", Shanghai, 10-13 May 2016, and noted that the final workshop report including the recommendations will be delivered to CBS-16.(2016).

Concerning the current Implementation Plan for the Evolution of Global Observing Systems (EGOS-IP), which is responding to the Vision of the GOS for 2025 and WIGOS needs, the Meeting reviewed the progress on Actions contained in the Plan since IPET-OSDE-1 and discussed how status of these Actions could be further updated. The Team discussed proposals

for future review of and reporting against EGOS-IP. In particular, the Team agreed that an annual cycle for the monitoring of progress on EGOS-IP Action was needed. The Team agreed to update its workplan according to its decisions in this regard. Regarding the interactions with the National Focal Points (NFPs), the Team agreed that there is a need to provide feedback to the NFPs regarding the monitoring of actions against the EGOS-IP on the basis of their national reports and other sources of information. The Team also decided to establish a small sub-group, led by Jay Lawrimore, to work during the intersessional period on the issue of getting improved feedback from the NFPs on the implementation of EGOS-IP actions, and on synthesizing such feedback. The Team requested the Secretariat to write to the WMO Members before CBS-16 for promoting the EGOS-IP, and the implementation of EGOS-IP actions by them.

The Team discussed development of the Vision for WIGOS component observing systems in 2040, including its role in such development. The Team considered progress to develop a Vision for the space-based component of global observing systems in 2040 ("Vision 2040 Space"), together with planning for developing the surface-based component of the Vision. In particular, the Team agreed that there is a clear need for an updated Vision for surface-based observing systems (Surface Vision). It agreed on a work plan and identified some elements to be considered in that Vision. The Team decided to establish an IPET-OSDE sub-group, led by John Eyre and Frank Grooters, for drafting the Surface Vision. The Team agreed that the core members of the sub-group should meet in September 2016 to develop a first draft of the Surface Vision. It was noted that the sixty-ninth Session of the Executive Council (EC-69 in 2017) was an important milestone to deliver work in progress, and it was proposed that a draft Vision to integrate both Surface and Space Visions should be developed during 2017. The Team also agreed that the draft Surface Vision should be submitted to CBS-16. The ICT-IO5 would discuss and agree on the roadmap for developing the integrated (surface plus space) Vision.

The Team recalled that, according to its Terms of Reference, the IPET-OSDE is tasked to propose guidance regarding observing system network design principles. Work has been initiated at IPET-OSDE-1, and two *ad hoc* Workshop on Observing System Design were organized in 2014 and 2015. The outcome of this first workshop was considered by IPET-OSDE-1 and ICT-IO5-8 and as a result Observing Network Design (OND) Principles were eventually included in the WIGOS Manual following Cg-17 approval. The second workshop therefore focused on developing high level guidance materials addressing the OND principles. The Team reviewed and updated the draft ONG guidance materials. The Team agreed that the OND guidance materials deserved some further editing, and requested Stephan Klink (Germany) to lead the effort of finalizing the document by the end of June 2016. The Team requested the ICT-IO5 to clarify the roadmap for further developing and approving the guidance materials, and requested the Chair to relay this request to ICT-IO5-9. The Team invited the ICT-IO5-9 to propose the proper mechanism for having the OND guidance approved according to foreseen availability of such materials.

The Team discussed and agreed on the IPET-OSDE perspective on the development of the concept of WIGOS Regional Basic Observing Network (RBON) eventually to replace the GOS Regional Basic Synoptic Network (RBSN) and the Regional Basic Climate Network (RBCN). The Team invited the Chair of ICT-IO5 to bring the IPET-OSDE perspective to the WIGOS workshop, which is planned on the development of the RBON concept (Geneva, Switzerland, 18-20 May 2016).

The Meeting requested the Chair to update the current IPET-OSDE workplan for 2013-2016 to reflect status of actions and decisions of IPET-OSDE-2. The meeting also requested the Chair to draft a new workplan for 2017-2020 on the basis of the new draft Terms of Reference of IPET-OSDE proposed by the CBS Management Group and to be submitted to CBS-16. The new workplan should be submitted to CBS-16 through ICT-IO5-9. It was noted that according to the new IPET-OSDE draft Terms of Reference, the central duties of the IPET-OSDE should continue in the next inter-sessional period. The Chair was invited to propose an updated version of these draft ToRs for submission to the ICT-IO5-9.

The meeting discussed the preparation of documents to CBS-16. The Team requested the Chair to work with the Secretariat and update the IPET-OSDE report to be submitted to

IPET-OSDE2, Final report

CBS-16 through ICT-IOS-9 taking into account the actual decisions and recommendations of the IPET-OSDE-2.

Finally, under any other business, the Team discussed how it could contribute, from a Rolling Review of Requirements perspective, to addressing Resolution 68 (Cg-17) - Establishing a WMO Cross-Cutting Urban Focus. It also discussed WMO collaboration with the Sustained Arctic Observing Network (SAON), and recommended ICT-IOS to request ICG-WIGOS to clarify how WIGOS is going to work with partner organization, including SAON, e.g. through Memorandum of Understanding or special agreement based on generic WIGOS template, for example allowing partner organization observing stations metadata to be reflected in OSCAR.

The Team agreed on its action plan for the period until the next IPET-OSDE meeting.

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GENERAL SUMMARY

1. ORGANIZATION OF THE SESSION

1.1. Opening of the meeting

1.1.1. The Second Meeting of the Inter Programme Expert Team on Observing System Design and Evolution (IPET-OSDE) the Open Programme Area Group for Integrated Observing Systems (OPAG-IOS) of the Commission for Basic Systems (CBS) opened at 10.00 hours on Monday, 11 April 2016, at the WMO Headquarters in Geneva, Switzerland.

1.1.2. Dr Wenjian Zhang, Director, WMO Observing and Information Systems Department, opened the meeting on behalf of WMO. He welcomed the participants and explained the significant developments relevant to CBS and especially OPAG-IOS since the first Session of the IPET-OSDE in March 2014. He particularly recalled the decisions of the Seventeenth World Meteorological Congress (Cg-17, Geneva, Switzerland, 25 May to 12 June 2015) regarding the WMO Strategic Planning for 2016 to 2019, and the seven WMO strategic priorities¹, all of which are relevant to the Team's activities. Dr Zhang recalled that Cg-17 acknowledged that EC-66 had requested CBS to take the lead in developing a Vision for WIGOS in 2040, which will include a "Vision for the WIGOS component observing systems in 2040" for its submission to Cg-18 in 2019. CBS will have to engage with other Technical Commission, the Regional Associations, and partner Organizations when developing the new Vision. In closing, Dr Zhang wished for a successful and productive session and an agreeable stay in Geneva.

1.1.3. Dr John Eyre (United Kingdom), Chair of IPET-OSDE, also welcomed the participants and wished for a successful meeting.

1.1.4. The list of participants is given in **Annex I**.

1.2. Adoption of the agenda

1.2.1. Small change was proposed to the agenda for adding an item on a proposal for an impact study on additional Aircraft Based observations over Regional Association I under agenda item 8.2.

1.3. Working arrangements

1.3.1. The Team agreed on its working hours and adopted a tentative time table for consideration of the various agenda items.

1.3.2. The Secretariat introduced the documentation plan of the meeting. The Chair thanked all those who have contributed to the documentation plan.

1.3.3. The Team established the following working groups for the duration of this IPET-OSDE Session:

1. OSCAR/Surface - technical issues and gap analysis (led by Stuart Goldstraw) (outcome of the breakout group discussion is provided in **Annex XI**);
2. OSCAR project - management and governance [incl. Observational user requirements, Surface and Space capabilities] (led by Jochen Dibbern) (outcome of the breakout group discussion is provided in **Annex XII**);
3. EGOS-IP Actions review - space part (led by Rosemary Munro) (outcome of

1 1) Disaster Risk Reduction, 2) Global Framework for Climate Services, 3) WMO Integrated Global Observing System, 4) Aviation meteorological services, 5) Polar and high mountains regions, 6) Capacity Development, and 7) Governance.

- the breakout group discussion is provided in **Annex XIII**);
4. EGOS-IP Actions review - surface part (led by Jay Lawrimore) (outcome of the breakout group discussion is provided in **Annex XIV**);
 5. EGOS-IP – high-level document (led by Russell Stringer) (outcome of the breakout group discussion is provided in **Annex XV**);
 6. Vision for space-based component of WIGOS in 2040 (led by Anthony Rea) (outcome of the breakout group discussion is provided in **Annex XVI**);
 7. Strategy for updating Vision 2025 [focusing on surface part] (led by Frank Grooters) (outcome of the breakout group discussion is provided in **Annex XVII**);
 8. OND guidance (led by Stefan Klink) (work to be completed after the session); and
 9. IPET-OSDE report and recommendation to ICT-IO-9 and CBS (led by John Eyre) (work to be completed after the session).

2. REPORT OF THE CHAIRPERSON

2.1. The IPET-OSDE Chairperson, Dr John Eyre (United Kingdom) reported on the activities carried out since the last meeting of the IPET-OSDE (IPET-OSDE-1, Geneva, Switzerland, 31 March – 3 April 2014). He recalled that the IPET-OSDE is established as a Team under the Open Programme Area Group for Integrated Observing Systems (OPAG-IO) of the CBS of WMO. All the Terms of Reference of IPET-OSDE and all the elements of its Work Programme are related to the goals and activities of the WMO Integrated Global Observing System (WIGOS).

2.2. He drew attention to the following:

- A GRUAN²-GSICS³-GNSSRO⁴ Workshop on “Upper-air observing system integration and application”, held 6-8 May 2014, in Geneva, which discussed how to realize benefits from observations of the “upper air” with qualities which make them well suited for use as “reference” observations, and thus to a special role within WIGOS (see report on the website⁵).
- The activities of the Working Group on GRUAN (WG-GRUAN), on which he represents CBS.
- The 2nd *ad hoc* Workshop of the IPET-OSDE on Observing System Design (OSDW-2) was held in Geneva, 2-4 February 2015 (see workshop report on the website⁶), which is considered in more detail in section 11.
- Progress on the Observing System Capabilities Analysis and Review tool (OSCAR⁷), which is discussed in detail in section 7.
- An invitation to IPET-OSDE, in August 2015, to respond to a questionnaire from the Tropical Pacific Observing System project (TPOS-2020) concerning observational requirements for the tropical Pacific. Several IPET members and Application Area points of contact contributed to this.
- The development a “Vision for the space-based component of WIGOS in 2040”, taken forward chiefly through activities of the Secretariat within the WMO Space Programme and under the leadership of the OPAG-IO Expert Team on Satellite Systems (ET-SAT). A

2 GCOS Reference Upper air Network

3 Global Space-Based Inter-Calibration System

4 Global Navigation Satellite Systems for Radio Occultation

5 <https://www.wmo.int/pages/prog/www/WIGOS-WIS/reports.html>

6 <http://www.wmo.int/pages/prog/www/CBS-Reports/IOS-index.html>

7 <http://www.wmo-sat.info/oscar/>

Workshop on this topic was held in Geneva, 18-20 November 2015 (the report will be made available on the website⁸). This topic is considered in detail in section 10.

- Work to gather material for the Review of Progress against the Actions in the Implementation Plan for the Evolution of Global Observing Systems (EGOS-IP), which has proved more difficult than anticipated and is discussed in section 9.
- Preparations for the 6th WMO Workshop on "The Impact of various observing systems on NWP" will be held in Shanghai, China, 10-13 May 2016, which is discussed in section 8.
- Drafting of a high level letter to Permanent Representatives, on EGOS-IP and its benefits, to be developed further at IPET-OSDE-2.

2.3. Dr Eyre suggested that, at IPET-OSDE-2, the Team should give particular attention to the following issues:

- The continuation and extension of the OSCAR facility.
- The review, improvement and elaboration of material for the section of the Guide on WIGOS covering Observing Network Design.
- Progress on developing the Vision for the space-based component of WIGOS in 2040, and consideration of equivalent activities on the Vision for the surface-component of WIGOS.
- Progress on Actions in EGOS-IP, recalling that reviewing and monitoring progress is not sufficient, and that it should be the role of IPET-OSDE, with the support of OPAG-IOS and WIGOS as a whole, not only to monitor progress but also actively to promote it.
- The Team's Recommendations to take forward to ICT-IOS-9 and CBS.

3. GUIDANCE FROM CHAIRPERSON OF THE OPAG-IOS

3.1. The Chair of OPAG-IOS, Dr Jochen Dibbern (Germany), highlighted the results presented to Cg-17 were a milestone in completing most critical activities of the WIGOS Framework Implementation. The WMO Congress approved the WMO Technical Regulations (WMO-No. 49), Volume I, Part I – WIGOS and its Annex - Manual on WIGOS as well as the revised Manual on the GOS. In addition Cg-17 decided that the development of WIGOS will continue into a Pre-operational Phase in the seventeenth financial period with the aim of having Members benefit from a fully operational WIGOS from 2020 onward.

3.2. Dr Dibbern explained that many aspects of the IPET-OSDE work programme are relevant to the WIGOS Pre-operational phase and will be discussed at this meeting.

3.3. To implement WIGOS within the WMO Regions it is necessary to develop guidance material on the concept of the Regional Basic Observing Networks (RBON). Conceptually the RBON would replace the existing Regional Basic Synoptic Networks (RBSN) and the Regional Basic Climate Networks (RBCN) and consist of all stations and systems that provide or make observational data available via the WMO Information System (WIS) and the Global Telecommunication System (GTS). The Chair of OPAG-IOS requested IPET-OSDE to review the existing draft text for RBON and give advice which aspects of the EGOS-IP and the OND principles and guiding material should be included in the RBON concept.

3.4. The Chair of OPAG-IOS also informed the meeting about the decisions from the latest CBS-Management Group meeting concerning the future working structure of OPAG-IOS. In particular,

- The MG recommended that the IPET-WIFI activities should be fully integrated in the Inter-Commission Coordination Group on the WMO Integrated Global Observing System (ICG-WIGOS) teams or other CBS expert teams after CBS-16 and the IPET-WIFI being

⁸ <http://www.wmo.int/pages/prog/www/CBS-Reports/IOS-index.html>

dissolved.

- A WMO weather radar coordination group should be established to take on the role of a coordination group for radar systems for the wider WIGOS and not just in support of the applications under the WWW. It should be formed as an Inter-Programme Expert Team under the authority of the Commission for Instruments and Methods of Observation (CIMO) and guided by CIMO/CBS coordination.
- CBS-MG supported the decision of ICG-WIGOS to establish a WIGOS Editorial Board .

3.5. The meeting was informed that the Commission for Basic Systems will have its sixteenth Session (CBS-16) from 23 to 29 November 2016, preceded by a Technical Conference on 21 to 22 November. The China Meteorological Administration (CMA) had offered to host the meeting in Guangzhou. The topic of the Technical Conference (TECO) will be "Emerging Trends in Information and its use". The TECO is open to all Members and interested organizations and a call for papers will be issued soon. IPET-OSDE recommendations will be submitted to CBS-16 through the ninth Session of the CBS Implementation-Coordination Team on Integrated Observing System (ICT-IOS-9, Geneva, Switzerland, 18 to 21 April 2016).

3.6. The Team noted that the IPET-OSDE recommendations will be submitted to CBS-16 through the ninth Session of the CBS Implementation-Coordination Team on Integrated Observing System (ICT-IOS-9, Geneva, Switzerland, 18 to 21 April 2016).

3.7. The Team also noted that the future working structure of OPAG-IOS has been drafted by the CBS MG and that IPET-OSDE was invited to provide comments.

3.8. Concerning the new proposed IPET on Weather Radar Coordination, the Team noted that it will in principle be managed by the Commission for Instruments and Methods of Observation (CIMO), and guided by CBS and CIMO. The IPET Chair will also in principle become a member of ICT-IOS, and get guidance from both CBS and CIMO. Radar aspects of OPAG-IOS Expert Team on Surface-Based Observing Systems (ET-SBO) would then be transferred to the new IPET. The Presidents of CBS and CIMO will support establishment of the new IPET Terms of Reference (ToR) to EC-68. The Team noted that there are coordination activities in Southeast Asia, and recommended consideration of including this region participation in the membership of the new IPET on Weather Radar.

4. WMO INTEGRATED GLOBAL OBSERVING SYSTEM (WIGOS)

4.1.WIGOS progress relevant to the activities of IPET-OSDE

4.1.1. Dr Igor Zahumensky (WMO Secretariat) briefed the meeting on the status of development of the WIGOS Pre-Operational Phase (2016-2019) based on decisions and guidance of Cg-17 and the fifth Session of the ICG-WIGOS, Geneva, Switzerland, 25 to 28 January 2016. In particular, the IPET-OSDE noted the five priority activities of the WIGOS Pre-Operational Phase, including key items and milestones, and agreed that the priority activities of WIGOS were all relevant to the Team's activities:

1. National WIGOS implementation.
2. WIGOS Regulatory Material complemented with necessary guidance material to assist Members with the implementation of the WIGOS technical regulations;
3. Further developing the WIGOS Information Resource (WIR), with special emphasis on the operational deployment of the OSCAR/Surface database;
4. Development and implementation of the WIGOS Data Quality Monitoring System (WDQMS); and
5. Concept development and initial establishment of Regional WIGOS Centres.

4.1.2. Regarding the Observing Network Design (OND) Principles guidance, IPET-OSDE noticed that the guidance was not listed in the draft Plan for the WIGOS Pre-

operational Phase (WPP). It was therefore not clear when the final version of the OND guidance should in principle be available for the Guide to WIGOS during the WPP. While further development of OND guidance was discussed under agenda item 11, the Team invited the ICT-IO-9 to advise on the way forward according to approved procedure, including endorsement of CBS-16.

4.1.3. The Team noted the following issues of concern regarding the list of Application Areas, and the maintenance of observational user requirements, and agreed to discuss them under agenda item 7:

- there are 14 application areas officially supported under the RRR (see website⁹) while 20 are listed in the OSCAR/Requirements database¹⁰;
- the content of OSCAR/Requirements is severely out of date in particular for the climate- and hydrology-related application areas.

5. REVIEW OF ACTIONS FROM IPET-OSDE-1

5.1. The meeting reviewed actions from the previous session of the IPET-OSDE, including progress made against each item, and updated its workplan accordingly (**Annex II**).

5.2. The meeting noted that while an important topic, there has been little activity on the impact per cost study since IPET-OSDE-1. The Team agreed to keep IPET-OSDE-1 action No. 80¹¹ open, and that progress on this activity should be presented and discussed at the 6th Workshop on "The impact of various observing systems on NWP", Shanghai, 10-13 May 2016 (**action; J. Eyre; May 2016**).

6. REVIEW OF OTHER ACTIVITIES RELATED TO IPET-OSDE AND OPAG-IO-9

6.1. Recommendations of IPET-WIFI

6.1.1. The meeting reviewed the recommendations of the OPAG-IO-9 Inter-Programme Expert Team on WIGOS Framework Implementation Matters (IPET-WIFI), which are relevant to its work. The IPET-OSDE response to these recommendations is provided below:

a) On recommendation 1 (to provide advice on the question of whether WIGOS would relax the requirement to make radio-sonde observations at prescribed synoptic observing times for the GOS (e.g. 12 and 00 UTC)), the Team noted the following:

- "Adjusting" the requirement may be more appropriate than "Relaxing" it. Such adjustment would impact the Manual on the Global Observing System (GOS), and the CBS should also discuss whether observations should still be made in a synchronous way as this is not strongly required anymore for Global Numerical Weather Prediction (GNWP). Adjusting the requirement could benefit Nowcasting, allowing Members to make soundings in the local morning. However, it will still be important to keep this requirement for some stations for climate applications. The Team agreed to make a proposal for studies to address the impact of changing the radio-sonde observing schedule on the basis of availability of other data sources (see EGOS-IP action G10). This proposal should be submitted by the ET-SBO to ICT-IO-9, and discussed at the 6th Workshop on "the impact of various observing systems on NWP", Shanghai, 10-13 May 2016. The Team requested the IPET-OSDE Chair to bring the Team's perspective at the ICT-IO-9 meeting with recommendation to raise CBS-16's attention on the issue (**action: IPET-OSDE Chair: asap**).

9 <http://www.wmo.int/pages/prog/www/OSY/GOS-RRR.html>

10 <http://www.wmo-sat.info/oscar/applicationareas/index/title:Go%20to%20application%20areas>

11 Action 80 : Team members to assist the chair in providing feedback on the methodology, as well as input on the estimates of the cost of the observing systems

- b) On recommendation 2 (to consult with the Application Area Points of Contact in order to receive their feedback on possible tools that could be useful for Rolling Review Requirements and the gap analysis), the Team referred to the discussion under agenda item 7.3.
- c) On recommendation 3 (to investigate switching from uncertainty currently defined using "1 sigma" in OSCAR, to uncertainty defined using "2 sigma"), the Team referred to the discussion under agenda item 7.1.
- d) On recommendation 4 (to prioritize further development of relevant guidance material responding to the Observing Network Design (OND) principles, as this work is of a high importance for the regions to enable them to design their observing networks), the Team referred to the discussion under agenda item 11.
- e) On recommendation 5 (to report to IPET-WIFI on (i) functional requirements with regard to the tools required for the Rolling Review of Requirements (RRR) process (i.e. tools for interrogating OSCAR for gap analysis purposes, see agenda item 7.2); and (ii) review content required for the RRR process including the observational requirements from relevant application areas), the Team referred to the discussion under agenda item 7.3 (gap analysis), and to IPET-OSDE-2 working group reports.

6.2.Update on GCOS activities

6.2.1. Caterina Tassone (GCOS Secretariat) reported on the WMO-IOC-UNEP-ICSU Global Climate Observing System (GCOS) activities that are relevant to observing systems and the RRR.

6.2.2. She recalled that following up on the request of the United Nations Framework Convention on Climate Change (UNFCCC) Subsidiary Body for Scientific and Technology Advice (SBSTA) to review the adequacy of observing system, GCOS is going to produce a new Implementation Plan (GCOS-IP). The GCOS-IP will incorporate input from the GCOS steering committee of 2015, from the Status report, from the panels meetings, from the GCOS Open Science Conference and from UNFCCC Needs from Paris Agreement.

6.2.3. The Status report was published in October 2015 and provides a basis for the new GCOS-IP. It describes how well climate is currently being observed, where progress has been made, where progress is lacking or where deterioration has occurred. The overall conclusion of the 2015 status report is that the global observing system for climate continues to progress nevertheless falling short of meeting some essential requirements for observationally based climate information.

6.2.4. The Team noted that the first GCOS Open Science Conference was held in Amsterdam on 2-4 March 2016, one of its purposes being to collect community's views as input for the GCOS-IP.

6.2.5. Covered themes included contributions that highlight the relevance of observations to climate science, adequacy of the current global climate observations, and planning for future global climate observations. The outcome of the conference will be summarized in a reviewed article to be published. Important points made at the conference and of relevance for the IP are the need of continuing in-situ observations and of developing a suite of indicators to describe other impacts of climate change, like heating of the ocean, rising sea level and ocean acidity; the need of observations of ocean and land surface stress, latent heat flux and sensible heat flux and also the emerging necessity of including biology in any description or modelling of the climate system.

6.2.6. The GCOS-IP will also include UNFCCC Needs from Paris Agreement, especially in regard of adaptation and mitigation, transparency and assessment of emissions and sinks for the carbon cycle.

6.2.7. Most of the drafting of the GCOS-IP has been taking place during the panels meetings and the writing team will meet at the end of May to draft a final version of the GCOS-IP. The GCOS-IP will go out for limited review (including WMO, Technical Commissions and RAs) in June and for public review in July, will be presented at the GCOS steering committee in October and finally submitted at the COP22 in November 2016.

6.2.8. While noting that the GCOS Status Report was already available online, the Team invited its members to provide further comments as they may still be useful for making progress on the development of the new GCOS-IP. The Team also invited its members to provide comments on the draft GCOS-IP as part of the limited review (June 2016) or the public review (July 2016) (**action; IPET-OSDE members; June & July 2016**).

6.2.9. The Team invited the GCOS Secretariat to discuss with the WMO Secretariat how to represent or refine representation of Essential Climate Variables (ECVs) in OSCAR (see also paragraph 7.4.6.30) (**action; GCOS Secr.; asap**). See also under agenda item 7.1 the Team's discussion with regard to the concern expressed under agenda item 4.1 that there are 14 application areas officially supported under the RRR (see website¹²) while 20 are listed in the OSCAR/Requirements database.

6.2.10. The Team agreed that the availability of Aircraft Based observations, including AMDAR¹³ ought to also be better considered by GCOS, and the Team invited GCOS to address the issue (**action; GCOS; asap**).

Tropical Pacific Observing System (TPOS) - 2020

6.2.11. The Team recalled that the GCOS Ocean Observations Panel for Climate (OOPC) was conducting systems based evaluations of the observing system, to ensure the mix of observing platforms meets evolving requirements, and considering advances in technologies. In 2014, OOPC supported a review of the tropical Pacific observing system in response to challenges sustaining major components (namely, the Global Tropical Moored Buoy array in the tropical Pacific, TAO¹⁴/TRITON¹⁵). As an outcome of the review, the Tropical Pacific Observing System, TPOS 2020 Project was established to oversee the redesign of the TPOS.

6.2.12. TPOS 2020 Steering Committee has since met twice, and established a number of Task Teams to oversee components of the redesign. The Planetary Boundary Layer Task Team conducted a community survey, to inform their priorities going forward, which IPET-OSDE members responded to. The Team noted that the key messages from TPOS 2020 are:

- We are expecting quite major changes to the tropical Pacific observing system design.
- The observing system design will be delivered through phased reporting; in 2016 (Interim Report), 2018 (Mid Term Report) and 2020 (Final Report)
- The interim report will be delivered by the end of this year, and the draft available for public review over the summer the main goal; articulate requirements and future design trajectory - including areas of uncertainty/where further design work is required.
- Requirements for winds and uncertainties in wind products require further attention.
- A parallel transition activity will be established to oversee the transition of the observing system and its governance into sustained mode. This will require engagement from WMO programmes (namely through CBS).

12 <http://www.wmo.int/pages/prog/www/OSY/GOS-RRR.html>

13 Aircraft Meteorological Data Relay

14 Tropical Atmosphere Ocean

15 Triangle Trans-Ocean Buoy Network

- TPOS 2020 are assessing the impact of, and potential responses to near term gaps in the observing system (i.e. the staged removal of TRITON Moorings in the Western Pacific).

6.2.13. Further information on the TPOS 2020 Project, including the TPOS 2020 Steering Committee Reports, and monthly status reports can be found on the TPOS website¹⁶.

6.2.14. It was noted that the Team had contributed to the TPOS questionnaire, and those comments have been taken into account. The Team requested its members to review the interim report on the TPOS Observing System Design, once available from the TPOS website¹⁶ in principle in mid-2016 (**action; Team members; June 2016**).

6.3.Update on GCW activities

6.3.1. Dr Michele Citterio (Denmark) informed the Team on the status in development and implementation of the Global Cryosphere Watch (GCW). He mentioned that Polar and High Mountain Regions became one of the WMO strategic priorities and that Cg-17 decided to implement GCW in the current intersessional period. He explained that GCW mission is to provide authoritative, understandable, and usable information, analyses on the past, current and future state of the cryosphere. He brought to the attention of the Team the Organizational structure of GCW as well as the GCW Working structure.

6.3.2. Dr Citterio introduced in some details current GCW activities, especially:

- (a) the development of the network of surface observation with a priority to establish a core standardized network called CryoNet, its concept and minimum requirements for stations/sites to be included in CryoNet;
- (b) the GCW Data Portal that is being interfaces with several data holders and data providers;
- (c) the GCW Website providing a dynamic information on all GCW activities, including information on the state of the cryosphere;
- (d) the Snow Watch and its work on snow data inventory as well as its effort to improve representation and availability of snow data in GTS;
- (e) measurement standards and best practices and a process to reach a consensus on best practices for each variable; and
- (f) current GCW observational requirements that are available on GCW Website and available also through OSCAR.

6.3.3. Finally, M. Citterio informed on GCW intention to improve observations in high mountains and presented an example of the 3rd Pole region where potentially 45 % of the total population depend on the High Asia Cryosphere. Finally, he introduced the work of GCW related to CryoNet Design Principles that follows IPET-OSDE guidance with an exception of tiered network.

6.3.4. The Team discussed the geographical distribution of the CryoNet Stations/Sites, and noted that it will take some time to get a more comprehensive list. It was also noted that there are criteria for selecting Sites/Stations, while there are more than 100 stations listed as potential candidates for becoming part of the GCW observing component. Dialogue with the regions is needed, and series of regional workshops has been initiated to address the issue and regional needs. In particular, it was noted that GCW has plans to organize a workshop for the tropical regions.

6.3.5. The Team noted that the Technical and Guidance materials from GCW need to

16 www.tpos2020.org

go through the CBS Session for approval, the CBS being the intergovernmental mechanism used by the GCW for that purpose. The GCW was invited to note that the next opportunity is CBS-16 and the deadline for submitting its input is of October 2016 (**action; GCW; end Oct. 2016**).

6.3.6. Further information is available at: <http://globalcryospherewatch.org/>.

7. ROLLING REVIEW OF REQUIREMENTS AND STATEMENTS OF GUIDANCE

7.1. Review database of User Requirements (OSCAR/Requirements)

7.1.1. The Team recalled that per CBS-Ext.(2014) decision, the role of the IPET-OSDE with regard to OSCAR lies with (i) defining functional requirements with regard to the tools required for the RRR process, and (ii) reviewing content required for the RRR process including the observational requirements from application areas.

7.1.2. The Meeting reviewed progress regarding the operations, maintenance and further development of the WMO Database of User Requirements, included as OSCAR/Requirements into the Observing Systems Capability Analysis and Review Tool (OSCAR). Since IPET-OSDE-1, observational user requirements have been maintained by the Points of Contact. Changes were particularly made concerning the following applications areas: (i) Ocean Applications; (ii) Nowcasting and Very Short Range Forecasting; and (iii) Aeronautical Meteorology. The tool itself has not be upgraded for including new functionalities.

7.1.3. The Team requested the Secretariat to update the Table (Table 1 of IPET-OSDE-2 Doc. No. 7.1) which lists Application area for which observational user requirements are recorded in OSCAR with indication of the responsible organization. The table should be updated to indicate who in the WMO is responsible for the Application Area, when applicable (**action; Secretariat; asap**).

7.1.4. Referring to the concern expressed under agenda item 4.1 that there are 14 application areas officially supported under the RRR (see website¹⁷) while 20 are listed in the OSCAR/Requirements database, the Team agreed that there was a need to assure consistency between the two lists and also with the WIGOS Manual. The Team agreed that there was a need to keep an historical record of the observational user requirements in OSCAR, and requested the Secretariat to consider changing the visibility of the historical Application Areas and their observational user requirements in OSCAR, and to investigate possible solutions for version control, and version archiving of the observational user requirements in OSCAR (**action; Secr.; end 2016**).

7.1.5. The Team encouraged the Application Areas Points of Contact (PoCs) to continue to update the observational user requirements of their Application Area in the OSCAR/Requirements database, and requested them to make sure that the user requirements not older than 4 years at any time (**action; PoCs; Ongoing**).

7.1.6. The updating and maintenance procedure of OSCAR, approved by the IPET-OSDE-1 for the OSCAR/Requirements part, and by IPET-SUP for the OSCAR/Space part is provided in **Annex IX**.

7.2. Review database of Observing System Capabilities (OSCAR/Space & OSCAR/Surface)

7.2.1. The Meeting reviewed the status of the space-based observing systems capabilities database (OSCAR/Space), and the status of the new surface-based observing systems capabilities database (OSCAR/Surface) that has been developed in

¹⁷ <http://www.wmo.int/pages/prog/www/OSY/GOS-RRR.html>

partnership with MeteoSwiss.

7.2.2. The Team reviewed and concurred with the recommendations of the Breakout Group 2 (OSCAR project – management and governance [incl. Observational user requirements, Surface and Space capabilities]), which are provided in **Annex XII**.

OSCAR/Space

7.2.3. The Team noted that OSCAR/Space receives more than 1000 visits per day in average, from users worldwide including space agencies, researchers, students, application centres, and consultants. It is used as reference for reports, application planning, gap analysis, socio-economic benefit studies, frequency management, etc. OSCAR/Space currently records references and details of more than 900 instruments and 600 satellites. Since 2015 it also contains details on the individual status of each instrument including for example its commissioning dates, with links to calibration information when available from satellite operators. Version 2.0, which is expected to be deployed operationally by June 2016, will rely on an expert system to provide improved assessments of the potential measurements of geophysical variables derived from the respective sensors, as a basis for performing gap analyses.

7.2.4. The Team recalled that in the initial version of OSCAR/Space, instruments were sorted into classes of similar design and performances, based on an implicit rationale (black-box). This is being replaced by an “expert system” approach. In this new version, for each variable, OSCAR records the key sensor specifications which are performance drivers and then analyses how the actual instruments are satisfying these specifications. The new version of OSCAR/Space also provides a “simplified analysis” function which is based on the mission objectives declared by the instrument providers, as well as an alternative “gap analysis by type of instrument” which compares e.g. what is planned to what is required. This new version OSCAR/Space V2.0 will be available for beta-testing between mid-April and end of May 2016. After successful internal review, the new version could replace the current version by the end of June. CBS-16 will be informed of the deployment. It is anticipated however that the space weather knowledge basis will still be preliminary and will continue to grow significantly throughout 2016 and 2017.

7.2.5. Once OSCAR/Space 2.0 is operational it is envisaged to keep the knowledge basis under review with the support of interested expert groups who would take the lead in their respective fields of expertise (for example the International Winds Working Group (IWWG), the International Precipitation Working Group (IPWG), the International Radio-Occultation Working Group (IROWG), the Inter-Programme Team on Space Weather Information, Systems and Services (IPT-SWISS), and GAW or GCW teams. In accordance with the decision made by CBS-Ext (2014), ET-SAT and IPET-SUP have a particular responsibility to oversee space-based capabilities and their assessment in OSCAR.

7.2.6. The Team noted that the new approach is expected to increase the value and reliability of OSCAR/Space as a reference tool for the rolling Review of Requirements, studies and applications. In engaging expert groups and pilot users, it could lead to a truly collaborative resource for the satellite community. While invited to provide guidance on the proposed collaborative approach, the Team agreed that a 1 or 1.5-month beta-testing phase and a subsequent Secretariat-internal review of user feedback were sufficient to decide on the replacement of the current OSCAR/Space by the new version 2.0. The Team requested its members to participate in the beta testing phase of OSCAR/Space v2.0 (**action; IPET-OSDE members; asap**).

7.2.7. Noting that maintaining information in OSCAR/Space requires a lot of effort, the ICT-IO5-9 was invited to discuss the OSCAR resourcing issue in the view to formulate a recommendation to CBS-16, and requested the Chair to bring this issue to ICT-IO5-9 (**action; chair; asap**). The Team also noted that there is no plan for Machine to Machine interface to import data to OSCAR/Space, but selected information

can be exported in JSON format as is currently the case to feed the WMO and the Coordination Group for Meteorological Satellites (CGMS) websites¹⁸; in addition an "Export" button is available to the users on the main tables to export data to Microsoft Excel.

Oscar/Surface

7.2.8. The meeting recalled that OSCAR/Surface, meant to become operational on 2 May 2016, was a tool for reporting the WIGOS metadata elements, and could be used in support of the critical review of the RRR by comparing the surface based observing systems capabilities with the observational user requirements. The critical review component of OSCAR, yet to be developed (see agenda item 7.3), is called OSCAR/Analysis. As of 2 May 2016, Members will be able to directly edit their observing station metadata using the online web interface of OSCAR/Surface. This will replace the manual and paper based process that has been used until now with WMO No. 9, Weather Reporting, Volume A, Observing Stations and WMO Catalogue of Radiosondes (VoIA).

7.2.9. The Team noted that a two year transition period was introduced, during which the Secretariat may still have to update OSCAR/Surface on behalf of those Members who will continue, although discouraged, to submit their WIGOS metadata using the former VoIA procedure. As of 2 May 2016, a legacy version of VoIA (almost identical to the former VoIA format) will also be automatically generated from OSCAR/Surface to provide compatibility with the former VoIA during the transition period (see Volume A homepage¹⁹ for more details). It was noted that OSCAR/Surface is meant to contain metadata on the capabilities declared by Members, as well as information on the actual observing performances, achieved through the linkage with the WIGOS Data Quality Monitoring System (WDQMS).

7.2.10. The Team noted potential issues with regard to the use of WIGOS Identification (ID) numbers in OSCAR, and communication about the structure of these IDs, but noted that it was on the agenda of ICT-IOS-9 and deferred the discussion to that meeting.

7.2.11. The Team invited the GCW to take steps to develop a road map for a provision of CryoNet and GCW contributing stations metadata into OSCAR/Surface (**action; GCW; July 2016**).

7.2.12. The Team requested the breakout group on OSCAR/Surface to discuss further development and evolution of OSCAR, and the priorities.

7.2.13. The Team reviewed and concurred with the recommendations of the Breakout Group 1 (OSCAR/Surface - technical issues and gap analysis), which are provided in **Annex XI**.

7.2.14. The meeting acknowledged with appreciation the key supporting role of MeteoSwiss, and in particular of the OSCAR Project Committee Chair and Project Owner/Lead at MeteoSwiss, Dr Bertrand Calpini (Switzerland), which allowed successful development of the OSCAR Platform development and implementation to the full satisfaction of the IPET-OSDE.

7.3. Gap analysis using OSCAR

7.3.1. The meeting recalled that the original concept of gap analysis using OSCAR was to be using a dedicated OSCAR component (OSCAR/Analysis) for comparing the observing systems capabilities as recorded in OSCAR, or as monitored by data centres,

18 <http://www.wmo.int/pages/prog/sat/satellitestatus.php>

19 <http://www.wmo.int/pages/prog/www/ois/volume-a/vola-home.htm>

with the observational user requirements (HR²⁰, VR²¹, OC²², U²³, Timeliness, and stability) also recorded quantitatively in OSCAR/Requirements. The primary challenge is to express the observing systems capabilities, or the monitored data in such a way that they can be compared quantitatively with the observational user requirements criteria as recorded in OSCAR. Since the last IPET-OSDE meeting, *ad hoc* workshops and teleconferences were organized in order to make progress on specifying the requirements for developing gap analysis tool(s) using OSCAR/Surface for the Critical Review of the WMO Rolling Review of Requirements (RRR). In particular, the IPET-OSDE Chair participated at the conjoint First Session of IPET-WIFI Sub-Group on OSCAR Development (SG-OD) and the *ad hoc* Workshop on the Rolling Review of Requirements Gap Analysis Requirements for OSCAR (RRR-OSCAR), Offenbach, Germany, 6-8 July 2015 (see final report on the website²⁴). The Team noted that the Offenbach workshop particularly reviewed the outcome of the previous workshops, and agreed or decided on the following:

- (i) It concurred with the approach proposed by the WMO Space Programme for gap analysis using OSCAR/Space (see details in IPET-OSDE-2 document no. 7.2(1)). The Workshop agreed that the output of OSCAR/Space should not be seen as an automatic "Gap Analysis" per se, but rather as an excellent tool to assist experts in performing a Gap Analysis in the context of a critical review, in complement to new tools to be provided for OSCAR/Surface.
- (ii) It reviewed and discussed the principles proposed by the Zurich workshop when developing the algorithms for the gap analysis using OSCAR. Some of the principles were agreed upon, while others required further discussion. The Zurich workshop also came up with a number of outstanding questions that the Offenbach meeting was invited to discuss, and possibly solve or suggest how they could be solved. The outcome of the Offenbach meeting's discussion in this regard is provided in Annex IV of that meeting's final report.
- (iii) It agreed that there was potentially a wide spectrum of possible solutions to address the gap analysis requirement, ranging from the production of simple status maps showing operational observing stations to a fully integrated gap analysis solution that included all surface- and space-based observing systems. The meeting proposed that OSCAR should provide a series of straightforward mapping tools to be made available to experts willing to conduct a gap analysis for an application area. Examples of more advanced tools that would be useful for a gap analysis should therefore be proposed to the OSCAR Project Team for evaluating their feasibility and development costs. The meeting requested the IPET-OSDE Chair to consult with the Application Area Points of Contact in order to receive their feedback on possible tools that could be useful for the gap analysis. The meeting also agreed that while the development of the OSCAR/Analysis module is less urgent, some simple tools could however be developed initially, including some of those by the end of 2015.

7.3.2. The Team noted the conclusions of the Offenbach workshop, and the pending actions from the workshop. The Team agreed that further review was needed, and requested the Chair to provide the IPET-OSDE feedback on behalf of the Team. Some of the pending actions may then be inserted in the IPET-OSDE action plan (**action; J. Eyre; asap**).

7.3.3. Following the recommendation of the Breakout Group 1 (OSCAR/Surface - technical issues and gap analysis) to initially focus on basic functionalities and tools in support of the RRR critical review (see **Annex XI**), the Team agreed that performing a gap analysis across the different observing systems is a scientifically and technically challenging task. In order to avoid over-engineering this project, the strategy is to

20 HR: Horizontal Resolution

21 VR: Vertical Resolution

22 OC: Observing Cycle

23 U: Uncertainty

24 http://www.wmo.int/pages/prog/www/OSY/Meetings/IPET-WIFI-SG-OD-1_2015/Final_Report_IPET-WIFI-SG-OD-1_final.docx

gradually implement OSCAR/Analysis by implementing specific reports requested by Members and to gradually generalize them to arrive at more integrated analysis capability. The Team agreed to support the development of OSCAR/Analysis by providing a list of reports that could support the RRR process.

7.3.4. The Team noted that the OSCAR/Analysis component will be specified and developed once the first version of OSCAR/Surface is released.

7.4. Statements of Guidance (SoGs)

7.4.1. Overview of status

7.4.2. The IPET-OSDE Chair recalled that the Statement of Guidance (SoG) is a gap analysis and is meant to help CBS formulate plans to address gaps in the observing system with respect to user requirements. Recommendations derived from these gap analyses eventually go into the Implementation Plan and the Vision for the WIGOS component observing systems. The RRR process informs the Points of Contact (PoCs) of all WMO Application Areas (and indirectly all Members, WMO constituent bodies, WMO Programmes and co-sponsored Programmes) on the extent to which their requirements are met by present systems, will be met by planned systems, or would be met by proposed systems. This would also allow Members, WMO constituent bodies, WMO Programmes and co-sponsored Programmes, to check whether their requirements have been correctly interpreted and update them through the relevant POC according to the RRR process. The procedure agreed by the Team for update, validation and approval of SoGs is provided in **Annex IV**.

7.4.3. The Team noted that, following IPET-OSDE-1 recommendations and further guidance from the Chair, some of SoGs have been updated during the last intersessional period. The Team reviewed available updates on individual SoGs as provided by the PoCs. Current status of SoGs is summarized in **Annex VI**.

7.4.4. The Team recommended that the Points of Contact use the template of Statements of Guidance as provided in **Annex X**. The Team recalled the IPET-OSDE-1 action requesting the Points of Contact to update their SoG to be consistent with the agreed template.

7.4.5. The Team recalled the definition of an Application Area, i.e. an activity involving primary use of observations, in a chain of activities which allow National Meteorological Services or other organizations to render services contributing to public safety, socio-economic well-being and development in their respective countries, in a specific domain related to weather, climate and water. The concept of a WMO Application Area is used in the framework of the WMO Rolling Review of Requirements (RRR) and describes a homogeneous activity for which it is possible to compile a consistent set of observational user requirements agreed by community experts working operationally in this area.

7.4.6. Consider newly revised SoGs

7.4.6.1. The Meeting reviewed available updates on individual SoGs provided by the nominated Point of Contacts within specific application areas.

Global NWP

7.4.6.2. The Point of Contact (PoC), Dr Erik Andersson (ECMWF²⁵), reviewed and updated the Statement of Guidance for Global Numerical Weather Prediction (GNWP) in April 2014. The new version proposed is taking into account recent changes in the global observing systems, and the increased importance of coupled assimilation with

25 European Centre for Medium-Range Weather Forecast

ocean and land surfaces. The PoC has involved experts on satellite data assimilation, conventional data and ocean analysis in preparing this update.

High Resolution NWP

7.4.6.3. John Eyre (UK) reported on the status of the SoG for High Resolution NWP on behalf of the Point of Contact, Thibault Montmerle (France) who has reviewed the Statement of Guidance in January 2016 and added the following comments:

- Emphasis has been put on the potential interest of considering more observations of sea surface temperature and of surface air temperature and humidity over sea, upstream of heavily populated areas or areas prone to high impact weather.
- the good spatial resolution of reports available from commercial aircrafts around airports has been pointed out.
- the possibility of assimilating data with a higher spatial density than in global NWP, thanks to the shorter background error horizontal correlations used in the data assimilation, has been added.

Nowcasting and Very Short Range Forecasting

7.4.6.4. The Point of Contact (PoC), Mr Paolo Ambrosetti (Switzerland) reviewed and updated the SoG according to the following:

- The SoG was edited to comply to the recommended IPET-OSDE template for SoG
- In OSCAR there was no requirement on lightning. The Chair invited the PoC to propose such requirements. The PoC made a review on the topic, made some proposals and consulted a few world scientists on lightning. Eventually a consolidated proposal was done and approved by the Chair. The SoG was then edited to include lightning as well in accordance with the requirements.
- The new version from the PoC approved by the chair was posted on the website in June 2015.

7.4.6.5. The Team requested the PoCs of other Application Area to consider/evaluate the inclusion of requirements for Lightning observations in OSCAR and in their SoG (**action; all PoCs; Dec. 2017**).

Sub-seasonal to longer range predictions

7.4.6.6. Dr John Eyre reported on the status of the SoG for Sub-Seasonal to longer range prediction on behalf of the Point of Contact, Dr Yuhei Takaya (Japan). The SoG was updated in February 2016 by the Point of Contact with consolidated inputs from Global Producing Centres of Long-Range Forecasts (GPCs) for IPET-OSDE-2. In this update, the PoC expanded the scope of the SoG to reflect emerging requirements of predictions at sub-seasonal to decadal timescales. Some elements such as sea ice (cover and thickness), deep sea, aerosol, Greenhouse gases (GHGs), solar irradiance in response to the new requirements were added. The PoC also thoroughly updated background and supporting information based on recent literature.

7.4.6.7. The Team noted that the CBS OPAG on Data Processing and Forecasting System (DPFS) Expert Team on Operational Predictions from Sub-Seasonal to Longer-Time Scales (ET-OPSL) was about to review the SoG.

7.4.6.8. Referring to the TPOS-2020 project (see agenda item 6.2), the Team noted that observations in the equatorial pacific are key and needed. The Team invited the PoC to update Section 2.1.2 of the SoG to reflect the need for such data (**action; PoC; May 2016**).

7.4.6.9. The Team noted the following statement of the SoG: “a general requirement for sub-seasonal to seasonal prediction is the availability of consistent historical observational data sets as well as a continuous provision of accurate observational data in the future”. With regard to this requirement, the Team noted that it was not in a position to propose a solution, but was rather stating requirements and gaps in this regard. The Team noted that the OPAG-ISS is responsible for developing WIS Part-C (data management issues), and invited it to be looking at solutions for addressing the Global Framework for Climate Services (GFCS) requirements.

Aeronautical Meteorology

7.4.6.10. The Point of Contact, Dr Jitze van der Meulen (the Netherlands) reviewed and updated the Statement of Guidance for Aeronautical Meteorology according to the following:

- The small number of comments and suggestions received after March, 2014 are implemented.
- Some updates on Volcanic Ash are implemented (references to new documentation).
- References to ICAO groups are modified, due to the restructure of the meteorological division (installation of the Meteorology Panel, METP in 2014); also references to CAeM ETs are modified.
- Weblinks in the footnotes were checked and updated.

7.4.6.11. Regarding Volcanic ash, the Team noted that there were some consistency issues between the requirements and guidance of the International Civil Aviation Organization (ICAO), the Global Data Processing and Forecasting System (GD PFS), and WIGOS. Some additional work may be needed in this area in order to fix those inconsistencies, liaising with appropriate groups. The meeting invited the PoC to address this issue in a future review of the SoG (***action; PoC; end 2016***).

7.4.6.12. The Team invited the PoC to add some references to observing techniques for addressing the requirements for icing and turbulence conditions; e.g. how to observe Super Cooled Liquid Water Content (SLWC). The Team also noted EDR was officially adopted by ICAO for the measurement of Turbulence, while the CBS Expert Team on Aircraft Based Observing Systems (ET-ABO), and CIMO Expert Team on Aircraft Based Observations (ET-AO) were looking at technology to be used for measurement of Turbulence. The Team invited the PoC to update the SoG to take into account the Team’s perspective on icing, turbulence, and humidity measurements (***action; PoC; May 2016***). See also ***Annex XVIII*** for issues with regard to humidity and turbulence observations from aircraft.

Atmospheric Composition

7.4.6.13. Geir Braathen (WMO Secretariat) reported on the status of the SoGs concerning Atmospheric Chemistry on behalf of the Point of Contact, Oksana Tarasova (WMO Secretariat). The Team recalled that IPET-OSDE-1 had recommended that the Atmospheric Chemistry application area should be split into sub-applications. This has now been done, and it has been replaced, and split into the following three new application areas:

- Forecasting Atmospheric Composition
- Monitoring Atmospheric Composition
- Providing Atmospheric Composition information to support services in urban and populated areas

7.4.6.14. The Team requested the Secretariat to make sure that Points of Contact

will be nominated by CAS for each of the three new Application Area (AA) (**action; Secretariat; asap**).

7.4.6.15. The Team noted with appreciation that observational user requirements have been developed for the 3 Application Areas and are about to be inserted in OSCAR. The SoGs will be developed after the URs are developed.

7.4.6.16. The Team noted that the Global Atmosphere Watch (GAW) Station Information System (GAWSIS) allowed to perform a gap analysis for the *in situ* observing systems capabilities addressing the requirements of the 3 Applications Areas. However, space-based observing systems capabilities have also to be taken into account. The Team invited the new PoCs, once nominated, to do the gap analysis taking into account both surface-based and space-based observing systems (**action; PoC; end 2016**).

Ocean Applications

7.4.6.17. The Point of Contact, Guimei Liu (China) reviewed and updated OSCAR/Requirements and the Statement of Guidance for Ocean Applications according to the following:

- The tables in the previous version of the SoG were removed since the observational user requirements appeared in a more complete form in the OSCAR database.
- Gap analysis was performed for Chlorophyll and nutrients variables.
- Some small typos were corrected.

7.4.6.18. The Team noted that the PoC was planning to make the following changes:

- Proposing tsunami related variables to be added into OSCAR/Requirements.
- Consideration of the requirements for sea ice variables in both OSCAR/Requirements and the SoG (**action; PoC; July 2016**).

7.4.6.19. The PoC explained that at the last JCOMM²⁶ Management Committee meeting (Bologna, Nov. 2015), it was proposed to revise the title of the 'Ocean Applications' Application Area to "Marine Meteorology and Ocean Applications" in order to better communicate to WMO audiences that this also included the more traditional WMO marine services activities such as the GMDSS. The Team invited the PoC with assistance of the Secretariat to liaise with the JCOMM Services Coordination Group (SCG) for its approval with regard to the proposed new name of the Application Area, and for documenting the set of sub-applications for which there are independent observational user requirements (**action; PoC & Secr.; July 2016**).

7.4.6.20. The Point of Contact drew the Team's attention to the fact that in the OSCAR database, in some instances of particular user requirements for a variable, an application area, a vertical layer, and an horizontal domain, the values of the requirements for Uncertainty, Horizontal Resolution, Vertical Resolution, Observing Cycle, Timeliness, or Stability, were identical for the threshold, breakthrough, or goal values. She suggested to coordinate with other Points of Contact to collect their views on requirements and priorities in the various WMO Application Area. The Team invited the PoC to discuss the issue with the Secretariat (**action; PoC; asap**).

7.4.6.21. The Team concurred with the proposal of the PoC that it would be useful to organize a workshop on observational user requirements and gaps for Ocean Applications, focusing on wave observations.

26 Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology

Agricultural Meteorology

7.4.6.22. Jose Camacho (WMO Secretariat) reported on the status of the SoG for Agricultural Meteorology on behalf of the Point of Contact, Robert Stefanski (WMO Secretariat).

7.4.6.23. The Team noted that the 16th Session of Commission for Agricultural Meteorology (CAgM) has created a Focus Area on Science and Technology in Agricultural Meteorology, and an Expert Team on Data Issues in Agrometeorology was established within that focus. This Expert Team is currently reviewing and updating the SoG. There have been delays in getting this accomplished and review and updates could not be done before this IPET-OSDE-2 meeting. This Expert Team must also liaise with the CAgM Task Teams on Soil Moisture Measurements, Flux Measurements in Agriculture and Weather, Climate and Fisheries. This review is expected to be done in 3rd quarter of 2016. All of the issues raised by the IPET-OSDE Chair will be addressed in the update. Further comments from Mr Camacho on the Statement of Guidance for Agricultural Meteorology are provided in ***Annex XIX***.

Hydrology and Water Resources

7.4.6.24. Claudio Caponi (WMO Secretariat) reported on the status of the SoG for Hydrology and Water Resources.

7.4.6.25. He explained that the Commission for Hydrology (CHy), through its president and one expert working in the WMO Hydrological Observing System (WHOS), together with the WMO Secretariat, have reviewed the current version of the Statement of Guidance for Hydrology and Water Resources, approved in July 2014. Although it doesn't contain any factual mistakes, it was felt that it is based on requirements of hydrological information for global climate modellers, but it doesn't represent the real needs of the hydrological community. Therefore, a revision was undertaken. At the time of the IPET-OSDE-2 a first draft had been prepared, which was not deemed suitable to be submitted to the meeting.

7.4.6.26. One of the difficulties found was that the requirements currently listed under the application "Hydrology and Water Resources" in the OSCAR database, are incomplete and outdated, making a gap analysis impossible. To define hydrological requirements at a global scale is not an exercise hydrologists are used to. Recent experiences in implementing pilot demonstrations of WHOS at regional level seem to indicate that the way forward could be to define either a set of regional requirements, or a set of "cases of representative basin requirements". As WHOS is still in a design phase, and its Phase II will be discussed at the fifteenth Session of the CHy in December 2016, the Advisory Working Group of CHy is proposing for the Commission's next intersessional period starting in 2017, to have a Focus Area consisting of three experts who would be tasked, among other WHOS-related activities, to review the requirements and prepare a new version of the Statement of Guidance, to be submitted to the IPET-OSDE Chair in the second half of 2017.

7.4.6.27. Team noted with appreciation CHy's efforts to make progress on providing a new version of the SoG. The Team encouraged CHy, when updating the user requirements and SoG, to focus on applications in which operational hydrologists make direct use of observations; it is not necessary to cover requirements for related applications, e.g. climate modelling requirements related to hydrology.

Climate Monitoring (GCOS)

7.4.6.28. The Team recalled that ET-EGOS-2 (July 2006) accepted as SOG the following documents:

- (i) GCOS Reports on the Adequacy of the global climate observing systems

- (ii) GCOS Implementation Plans and their updates
- (iii) Satellite Supplements to the GCOS Implementation Plan and their updates
- (iv) Progress Reports on the Implementation of the Global Observing System for Climate in Support of the UNFCCC

7.4.6.29. The Team recalled GCOS' efforts to update these documents, and produce a new GCOS-IP (see agenda item 6.2). The Team also noted that as part of the new GCOS-IP, GCOS is revising its satellite supplement, including the table of requirements for the Essential Climate Variables (ECVs). The revised table will be delivered together with the GCOS-IP.

7.4.6.30. For the GCOS Atmospheric Observation Panel for Climate (AOPC), experts will be asked to define requirements also for variables in the OSCAR table. However, it was mentioned, that some of the ECVs do not appear as variables in the OSCAR table of requirements, and therefore the process of compiling requirements for OSCAR will require additional efforts in terms of deciding how to better match ECVs with existing variables in the OSCAR table. Additional variables may have to be added to the OSCAR table in order to fully include the ECVs. Due to different histories and drivers, the process may differ slightly for ocean and terrestrial domains.

Climate Applications (Other aspects, addressed by the Commission for Climatology)

7.4.6.31. Peer Hechler (WMO Secretariat) reported on the status of the SoG for Climate Applications (other aspects, addressed by the Commission for Climatology) on behalf of the Point of contact, William Wright (Australia). He explained that the Commission for Climatology (CCI) established three entities that deal with observation areas:

- (v) A Group of Rapporteurs on Volunteer Observing Networks²⁷;
- (vi) A group of Rapporteurs on Observational issues²⁸; and
- (vii) A Task Team on the Statement of Guidance on Observational Needs (TT-SOGON)²⁹, with the key mandate to Investigate the need and feasibility for quantifying the CCI Statement of Guidance on observational needs.

7.4.6.32. It is expected that a meeting involving leaders of these entities will be held in Geneva late August-Early September 2016 to develop their work plans and synergies on cross-cutting topics, such as observations requirements and standards from CCI point of view.

7.4.6.33. The Team noted with appreciation that from the perspective of CCI input to the IPET-OSDE, a specific Task Team is established for the first time to deal with the CCI Statement of Guidance. The Task Team is comprised of membership from Regional Association I (RA-I), RA-II, RA-IV and RA-VI, while membership from RA-V and RA-III are still vacant. The TT-SOGON will be the CCI vehicle to carry out the formulation of CCI contribution to the IPET-OSDE Statement of Guidance. Meanwhile the most recent CCI SoG remains valid until further notice.

7.4.6.34. Based on above, CCI will undertake an overall revision of what requirements ought to be addressed in the framework of IPET-OSDE and how the formulation of such requirements could be done with complementarity and/or synergy with other commissions which are addressing climate observations from various angles (e.g. CIMO, CAgM, CHy, JCOMM) as well as with other programs

27 <http://www.wmo.int/pages/prog/wcp/ccl/opace/opace1/RP-VON-1-6.php>

28 <http://www.wmo.int/pages/prog/wcp/ccl/opace/opace1/RP-VON-1-6.php>

29 <http://www.wmo.int/pages/prog/wcp/ccl/opace/opace1/TT-SOGCON-1-5.php>

(GCOS and WCRP³⁰).

7.4.6.35. The Team took note of this new strategy by CCI for contributing to the Rolling Review of Requirements and recognized that the CCI input to the SoG will be provided pending on the progress made on elements above. Feedback is expected by the end of 2017.

7.4.6.36. The Team invited the CCI and the PoC to consider and focus on the areas this AA should be covering that GCOS is not already covering (**action; PoC; end 2016**).

7.4.6.37. Regarding the requirements for providing continuity of observations, and making long time series available, the Team referred to the Observing Network Design (OND) principles.

Space Weather

7.4.6.38. Jerome Lafeuille (WMO Secretariat) reported on the status of the SoG for Space Weather on behalf of the Point of Contact, Terry Onsager (USA).

7.4.6.39. The Team noted that the Inter-Programme Coordination Team on Space Weather (ICT-SW) was not submitting an updated SoG at this time. A considerable amount of work has been devoted to updating the Space Weather SoG. However, much more work is still needed to ensure the updated version is a meaningful improvement over the existing SoG.

7.4.6.40. The existing SoG for Space Weather is still current in its assessment of the observations required for space weather and the gaps. Following the IPET-OSDE guidance, effort has been devoted to restructuring the information in the SoG into the recommended format described by the template that was approved by IPET-OSDE-1. With this restructuring in place, it is clear that a significant effort is still required in the description of the requirements and in the gap analysis. One of the main issues faced in space weather is that there are still few quantitative assessments of the linkage between the parameters of the observations and the quality of products. The ICT-SW will be working over the next year on initiating studies that more clearly connect the observing requirements to product quality and reliability. This will be a valuable step toward more quantitative guidance in future SoGs.

All Applications Areas

7.4.6.41. Team members are invited to provide feedback and suggestions for changes to all SoGs to the Points of Contact and the IPET-OSDE Chair (**action; IPET-OSDE members; end of May 2016 and ongoing**).

7.4.7. Consider areas requiring revised SoGs

Global Cryosphere Watch (GCW)

7.4.7.1. Dr Michele Citterio (Denmark) reported on the ongoing work to define the GCW observational requirements, which have not yet been finalized. The current draft of GCW's requirements draws on various sets of existing science user requirements, notably the Integrated Global Observing Strategy (IGOS) Cryosphere Theme Report (2007³¹), OSCAR, the SoG for the 14 Application Areas, and an ongoing work to identify minimum observation requirements for GCW and CryoNet stations. The inconsistencies observed (e.g. some variables are in OSCAR for a particular application area but not in the corresponding SoG) are largely explained by the SoG representing a tool to identify and address observational gaps. M. Citterio

30 WMO-IOC-ICSU World Climate Research Programme

31 http://globalcryospherewatch.org/reference/documents/files/igos_cryosphere_report.pdf

showed tables of variables relevant for the cryosphere elements sea ice, snow, freshwater ice, ice sheets, glaciers, permafrost, icebergs, precipitation and others. GCW will continue to review these tables and the noted inconsistencies. The review of gaps relevant to GCW will also continue. GCW will identify application areas for each variable and the Team advised GCW to interact with the relevant existing Application Areas to ensure missing cryospheric variables are added and the existing ones satisfy the GCW requirements (**action; GCW; end 2016**). New application area may be suggested and corresponding Observational User Requirements defined in case some variables do not belong into existing AA and direct data users can be identified.

7.4.7.2. The Team noted the considerable differences between the lists of cryosphere variables from the IGOS Cryosphere Theme Report, the entries currently in OSCAR's cryosphere theme, and those that the other application areas have identified in their SoGs. For example, specific requirements, such as uncertainty and spatial resolution, for some variables in the IGOS Cryosphere Theme Report and in OSCAR vary significantly.

7.4.7.3. The Team concurred with the following recommendations:

1. GCW will identify application areas for each relevant variable in the IGOS Cryosphere list. New application area(s) for the RRR may be suggested, and corresponding Observational User Requirements independent from existing Application Areas entered in OSCAR. Note that GCW itself is not an application area as it is too broad.
2. GCW should engage the cryosphere community to update the IGOS Cryosphere requirements. This would be a major endeavor that would also depend on the availability of additional resources.
3. The Points of Contact of all application areas and the Polar Space Task Group (PSTG) should work with GCW to clarify their needs and to resolve any ambiguities and inconsistencies in cryosphere requirements. The Team invited the Points of Contact to respond to *ad hoc* requests from the GCW in this regard (**action; PoCs and GCW; early 2017**).

7.4.7.4. The Team invited the GCW to identify the operational or quasi operational activities under GCW that directly require observations and are independent of existing AAs. These activities may then be considered as new Application Area(s) (**action; GCW; end 2017**).

7.4.7.5. The Team requested the PoCs to look at the Cryosphere Theme variables, and identify whether these could be considered in their respective AA (**action; all PoCs; asap**). "Orphan" variables may then be identified where GCW could place focus.

7.4.8. Consider any new areas requiring SoGs

Disaster Risk Reduction

7.4.8.1. Alasdair Hainsworth (WMO Secretariat) reported on observational user requirements for Disaster Risk Reduction (DRR), and the Team discussed how such requirements could be captured through the ongoing RRR process.

7.4.8.2. WMO coordinates the efforts of National Meteorological and Hydrological Services (NMHS) to mitigate human and property losses through improved forecast services and early warnings, as well as risk assessments, and to raise public awareness. If our Members are going to (continue to) provide effective Multi-Hazard Early Warning Systems (MHEWS) for severe/high impact weather, their NMHS must have the fundamental underlying ability to observe the appropriate elements and risks in their communities to allow for complete analysis and on-going monitoring of the environment.

7.4.8.3. WMO Disaster Risk Reduction activities are integrated and coordinated with other international, regional and national organizations and are now linked with the principle outcome of the 3rd World Conference on Disaster Risk Reduction, which is the Sendai Framework for Disaster Risk Reduction 2015-2030.

7.4.8.4. The Sendai Framework calls on States to: (i) enhance and strengthen MHEWS, develop and invest in regional MHEWS mechanisms and achieve the global target for MHEWS; (ii) Provide support to strengthen and implement global mechanisms on hydrometeorological issues, in order to raise awareness and improve understanding of water-related disaster risks; (iii) maintain and strengthen *in situ* and remotely sensed Earth and climate observations; promoting the collection, analysis, management, and use of relevant data and practical information and ensure its dissemination and accessibility, taking into account the needs of different categories of users.

7.4.8.5. As such, the DRR requirement is for observations that deal with risks and hazards and these are not necessarily natural hazards, which is why our Members require access to a network of observational networks. The risks and hazards with which our Members may become involved through their civil protection agencies may not necessarily be meteorological or hydrological in nature. They could be geophysical, nuclear, biological, chemical or space based.

7.4.8.6. There will be an increasing emphasis on the link between Members and the health community. As links between different climatological, hydrological or weather phenomena and health effects are discovered, the requirement for increased weather related intelligence is highly likely to grow. This may take the form of observations and/or forecasts and early warnings.

7.4.8.7. Finally, there will be a strong requirement for Members to measure progress on Sendai. This may require measurements of elements we haven't recorded before, but it will certainly require databases of our observations that are interoperable to allow easy cross referencing to enable links between NMHS data and loss/damage databases. These latter databases maybe maintained by any number of entities.

7.4.8.8. In summary, the observational user requirements for DRR are similar to those for the Application Areas serving the Public Weather Service and Data Processing and Forecast Systems. However, with the overlay of the Sendai Framework, the requirement is now more comprehensive and overarching than before, although there are no additional requirements as yet. The interoperability of the databases in which the data is stored however, is an emerging requirement, which, while not necessarily being exclusive to DRR, will be an important DRR requirement in the longer term.

7.4.8.9. While not directly linked with the user requirements for observations, the Team noted that in order for meteorologists to be able to cope with amount of data being generated by the current observations networks, expert systems are becoming an increasingly important component of their tools. These are necessary not only to monitor the environment, but also to provide first guess solutions for expert analysis and in most cases, transmission. Forecasters cannot monitor everything anymore and these systems are now vital.

7.4.8.10. The Team noted that some of the polar and high mountain, and ocean related hazards and extreme events (e.g. glacier outflow, storm surge) could be added to the list developed by the WMO DRR Programme, and the GCW and JCOMM will be invited to review the list (see **Annex XXI**) (**action; Secretariat, GCW & JCOMM; end 2016**).

7.4.8.11. The Team noted that with regard to the process of issuing warning and

monitoring extreme events, there was a need to review what's already available in the current SoGs of all Application Areas (e.g. Hydrology, Ocean Applications), and then to identify what additional requirements may have to be considered in the RRR framework. Focus can also be made on observations required during hazard events. The Team noted that the Space Weather Application Area SoG already included DRR requirements.

7.4.8.12. The Team requested all PoCs (and IPET-OSDE members) to consider proposing additional Applications Areas or sub-applications for which user requirements and Statements of Guidance should be developed (**action; PoCs & IPET-OSDE members; IPET-OSDE-3**).

8. OBSERVING SYSTEM STUDIES

8.1. Update on recent observation impact experiments

8.1.1. Dr Erik Andersson (ECMWF) presented an overview of the current activities with observing system studies, summarizing recent progress on several observing systems in terms of benefit to NWP since the first session of IPET-OSDE. His report had been prepared by the co-Rapporteurs on Scientific Evaluation of Impact Studies undertaken by NWP Centres (R-SEIS), i.e. Dr Andersson, and Dr Yoshiaki Sato (Japan).

8.1.2. The Team noted the latest developments with regard to Observing System Experiments (OSEs), and Observing System Simulation Experiments (OSSEs), and in particular:

- Recent impact studies have shown that the parallel operation of Metop-A and Metop-B is important not only for the robustness of operation but also for the NWP performance.
- Impact of radiosonde balloon position information performed by Environment Canada, and the benefit that is being derived from accounting for the balloon drift during ascent using high-resolution radiosonde data in BUFR format that contains this location information;
- Adjoint-based sensitivity to forecast error studies performed by the United Kingdom (UK), ECMWF and others clearly demonstrating the exceptionally large impact of isolated, remote radiosonde stations e.g. in the Southern Oceans, Greenland and the E-ASAPs ships in the North Atlantic.
- Positive impact is derived from the use of the imager (GMI) and radar (DPR) instruments of the GPM.
- Significant progress in extending the use of microwave sounding data over challenging surfaces (land, snow, sea-ice) and in all-sky (cloudy and precipitating) conditions.
- Dependent on to the orbit, Megha-Tropiques can observe tropical cyclones several times a day which is shown to be beneficial for tropical cyclone track forecasts.
- JMA reported that the AMV (winds) and CSR (clear-sky radiances) from the new generation geostationary satellites (Himawari-8) are beneficial to both global and regional NWP.
- Some centres have confirmed the benefit of the addition of data from MWHS aboard FY-3B, MWTS-2 and MWHS-2 aboard FY-3C (operated by CMA) and assimilating these data in their operation.
- At around 50-60 degree latitudes, there are gaps of LEO and GEO AMV coverage. Since the gaps are located around the storm tracks, additional AMVs derived from LEO-GEO combinations have shown benefit.
- In January 2015, Russia cut its radiosonde operations from two per day to one. In

the operation, 12 UTC radiosonde operation in the East Russia and 00 UTC operations in West Russia were ceased. Russia returned to its normal two per day operation in April 2015. ECMWF conducted a dedicated impact study and showed 4-10% degradation in 500 hPa height fields over Russia due to the reduced availability of soundings in this period. JMA showed that such negative impact affected down-stream areas (including Japan) leading to degraded 3-day forecasts.

- Specific OSEs in support of COSMIC-2 have been conducted.
- The exceptional, high impact of surface pressure observations from buoys has been re-confirmed in data denial studies by ECMWF in response to a requested from the Data Buoy Cooperation Panel (DBCP).

8.1.3. Further details on the above studies can be found in IPET-OSDE-2 doc. 8.1.

8.1.4. The Team discussed these and other studies, and agreed to propose to CBS through the ICT-IOS a recommendation on Impact Studies focusing on the following items:

- encourage continued development and research of adjoint-based and ensemble-based observation impact assessment tools, as a complement to traditional OSEs,
- encourage OSEs for the optimization of regional composite networks,
- encourage NMHSs to conduct OSEs and OSSEs to address specific science questions

8.2. Proposal for new observation impact experiments to be promoted by IPET-OSDE

8.2.1. The Team recalled that a comprehensive proposal of specific studies and science questions of particular interest to IPET-OSDE had initially been developed for the Sixth Fifth WMO Workshop on "The impact of various observing systems on NWP" (Sedona, USA, 22-25 May 2012). Dr Erik Andersson (ECMWF) presented an updated list to the Team. The update is the result of a review carried out by the Scientific Organizing Committee for the Sixth WMO Workshop (Shanghai, China, 10-13 May 2016). The Team noted the updated list, which is reproduced in **Annex VII**, and to be submitted to the ICT-IOS-9 (**action; Chair; asap**).

8.2.2. The Team stressed the importance of regional networks being developed according to scientific principles supported by observing system experimentation, such as those listed here.

8.2.3. The team discussed the value of aerosol observations in NWP. It was noted that this is an area of research and development, but at the current time aerosol assimilation in NWP is limited. However, atmospheric composition forecasting systems are beginning to assimilate satellite-derived aerosol observations in routine operation.

Proposal for an impact study on Aircraft Based Observations

8.2.4. The Chair of ET-ABO made a proposal for a specific study to assess the impact of additional AMDAR data from Air France and British Airways B777 aircraft, that has recently become available over Africa and parts of the Atlantic. Africa is an identified priority area for improvement in profiling observation capability and wind observations, such as these. The data collection from these flights is currently (financially) secured for a period of 12 months, February 2016 to February 2017. A demonstration of impact is essential to potentially secure funding for continuing operation. The details of the proposal are provided in **Annex V**.

8.2.5. The Team concurred with the proposal, and invited NWP centres to make an impact study on the impact of additional B777 AMDAR data over RA-I, before the end of this year, and to consider appropriate period for the study. It requested the R-SEIS

to request NWP centres to relay this invitation to the NWP centres for such studies to be completed by the end of 2016 (**action; R-SEIS NWP centres; May 2016**). It was noted that the study could start immediately. The Team noted that FSOI statistics may be complement data denial experiments. It was agreed that priority ought to be placed on the impact of such observations for weather forecasting over Africa, but also as a second priority for Europe. While noting that there is a need to identify the data-set to consider, the Team invited the ET-ABO to provide the list of relevant aircraft identifiers to the R-SEIS (**action; ET-ABO; asap**).

Impact of high elevation meteorological data from the third pole region

8.2.6. The meeting noted that the CryoNet/Asia workshop (Salekhard, Russian Federation, February 2016), noting that there is currently only very sporadic meteorological and cryospheric information available from high elevation regions in central Asia³² for elevations over 4000m, has suggested establishing a project for implementing between 10 to 15 new Automatic Weather Stations (AWS) including cryospheric and meteorological measurements at an altitude over 4000m to 5000 m. The meeting agreed to include a new science question for assessing the impact of high elevation meteorological data from the third pole region (**action; R-SEIS; asap**).

8.3.Plans for 6th Workshop on “The impact of various observing systems on NWP”, Shanghai, 10-13 May 2016.

8.3.1. The Team recalled that since 1997, a comprehensive review of the impact of the different operational observing systems has been carried out through the WMO Workshops on the Impact of Various Observing Systems on NWP in Geneva, Switzerland (1997), Toulouse, France (2000), Alpbach, Austria (2004), Geneva (2008), and Sedona, USA (2012). The series of workshops has proved very successful providing substantial input for reviewing the Statements of Guidance for Global and High-resolution NWP, the Vision of the GOS for 2025 and the EGOS-IP.

8.3.2. The Team noted with appreciation that the sixth workshop will be held in Shanghai, China in 10-13 May 2016. The science organizing committee (SOC) comprises Erik Andersson (ECMWF, chair), Carla Cardinali (ECMWF), Jochen Dibbern (DWD), John Eyre (Met Office, UK), Ron Gelaro (NASA/GMAO), Rolf Langland (NRL), Thibaut Montmerle (Météo-France), Lars Peter Riishojgaard (WMO/WIGOS Project Office), Yoshiaki Sato (JMA), Jianjie Wang (CMA) and Wenjian Zhang (WMO). Since Dr. Andersson will not be able to attend the workshop, Mr. Sato will be acting as the chair of the workshop.

8.3.3. The first announcement was sent out in August 2015 and about 80 abstracts were received. Based on the SOC's discussion and decisions of the submissions, the draft programme was prepared by WIGOS project office in February 2016. The number of expected participants is 85 from 16 countries, while there were 59 from 13 countries in the last workshop. The workshop is organized in three oral sessions and a poster session: Session 1 (Global forecast impact studies), Session 2 (Regional forecast impact studies), Session 3 (Sensitivity forecast impact studies), and 41 poster presentations.

8.3.4. The final workshop report including the recommendations will be delivered to CBS-16.(2016).

9. IMPLEMENTATION PLAN FOR THE EVOLUTION OF GLOBAL OBSERVING SYSTEMS (EGOS-IP)

9.1.Review of Guidance from Congress, and ICG-WIGOS on the EGOS-IP and its

32 [Siberian Altai, Tien Shan (both Chinese and Kyrgyzstan territory), Pamir (Tajikistan)]

status as part of WIGOS implementation

9.1.1. The Meeting took into account the guidance from the Seventeenth Congress and the Inter-Commission Group on WIGOS (ICG-WIGOS) when discussing issues related to the EGOS-IP and its status as part of WIGOS Pre-Operational Phase (2016-2019).

9.2. Current EGOS-IP (2025)

9.2.1. Review of progress since IPET-OSDE-1, including Actions

9.2.1.1. Concerning the current EGOS-IP (responding to the Vision of the GOS for 2025 and WIGOS needs), the Meeting reviewed the progress on Actions contained in the Plan since IPET-OSDE-1 and discussed how status of these Actions could be further updated.

9.2.1.2. The Team noted that Actions in the current EGOS-IP are more difficult to monitor than those in the previous EGOS-IP, because they are written in a more general manner and their monitoring requires a range of expertise beyond that of members of IPET-OSDE.

9.2.1.3. The Team also noted that the ET-SBO has regularly requested input from its members, and little feedback has been received. The Team agreed that this situation is probably due to a sense of lack of ownership by the ET-SBO for some of the EGOS-IP Actions ET-SBO was invited to monitor. The Team noted that the following tools and mechanism should help to get better feedback: (i) OSCAR, (ii) the future WDQMS, and (iii) the exchange of monitoring information between NWP centres and the Regional WIGOS Centres (RWCs) when operational.

9.2.1.4. The Team reviewed and concurred with the recommendations and actions of the Breakout Group 3 (EGOS-IP Actions review - space part). These are provided in **Annex XIII**.

9.2.1.5. The Group reviewed and concurred with the recommendations and actions of the Breakout Group 4 (EGOS-IP Actions review - surface part). These are provided in **Annex XIV**. The Team requested Jay Lawrimore to follow up on the recommendations from the Breakout Group (**action; J. Lawrimore; ongoing**).

9.2.2. Proposals for future review and reporting

9.2.2.1. The Meeting discussed proposals for future review of and reporting against EGOS-IP. In particular, the Team agreed that an annual cycle for the monitoring of progress on EGOS-IP Action was needed. The Team agreed to update its workplan according to its decisions in this regard.

9.3. Review of interactions with NFPs

9.3.1. The meeting discussed the interactions with the National Focal Points (NFPs). The Team agreed that the NFPs are contributors to the effort of reviewing progress against EGOS-IP actions, but are not necessarily key for that purpose as other sources of information and mechanism are also used.

9.3.2. The Team recalled that NFPs were requested to provide national reports for 2014 and 2015 with feedback regarding status of some specific actions at the national level. The survey template that was used to request the reporting of information from the NFPs for 2015 was based upon the 2014 template (**Annex VIII**). For 2014, 19 reports³³ were received. For 2015, 22 reports³⁴ were received from 86 NFPs. (There

33 The 2014 reports from the NFPs can be found at: <https://drive.google.com/open?id=0BzxtAFnFpjaRbXp3TEh5Q01qeXc>

are 93 nominated NFPs for which 7 email addresses are bouncing).

9.3.3. The Team considered the following aspects of the process and results of reporting on the actions of the EGOS-IP:

- Is the template adequate for soliciting the required information from NFPs?
- How might we achieve a higher level of response?
- Is there a requirement to request Members to nominate NFPs?
- How might the information be analyzed by the IPET?
- What follow up action might be taken to assist Members in making better progress on the Actions?

9.3.4. Some recurring features were noted from the feedback of the NFPs:

1. Poor understanding of the question being asked:

- Change management (C7) - 12 reports
- User consultation (C4) - 9 reports
- Data sharing principles (C8) - 2 reports
- Radio frequencies (C12) - 3 reports
- HR radiosonde data (G14) - 4 reports
- Hourly data exchange (G2) - 3 reports

2. Poor understanding of responsibilities under WIGOS for international data exchange, particularly with respect to:

- Data sharing principles (C8)
- Exchange of hourly observations (G2)

Common issues:

- Some questions in the questionnaire do not encourage countries to tell us which observations are exchanged and which are not.
- However, responses to G40 (on Metadata, etc.) often show that many observations are made but not exchanged.
- Some worrying comments referring to:
 - "national data policy"
 - "standard UTC hours"
 - "WMO regulations and standards"
 - "hourly data are distributed as additional data"
 - "essential data" are exchanged
 - "not authorized to disseminate"

3. Most countries are happy with their access to information on WIS and WIGOS, but 2 countries said they didn't have convenient access to WIGOS standards:

- Algeria, Bosnia/Herzegovina

9.3.5. The Team agreed that there is a need to provide thanks and feedback to the NFPs regarding the monitoring of actions against the EGOS-IP on the basis of their national reports and other sources of information (**action; Secretariat & Chair; ongoing**).

34 The 2015 reports from the NFPs can be found at:
<https://drive.google.com/open?id=0BzDPKbZAaW6XSWpXOVVWaVVMUWc>

9.3.6. The Team noted that there is a lack of awareness and understanding in the Regions while one of the key priority task in the WIGOS Pre-Operational Phase was to bring WIGOS implementation into the Regions. The Team invited the WIGOS Project Office to consider further efforts that could be made in this regard, including enhancing communication on network design activities, and on the EGOS-IP and the required feedback concerning the implementation of EGOS-IP actions (**action; WIGOS PO; CBS-16**). Corresponding elements ought also to be considered for the Terms of Reference of the new IPET on Weather Radar Coordination.

9.3.7. The Team decided to establish a small sub-group, comprised of Jay Lawrimore (lead), Anthony Rea, Stuart Goldstraw, and John Eyre with assistance from the Secretariat to work during the intersessional period on the issue of getting feedback from the NFPs on implementation of EGOS-IP actions, and on synthesizing such feedback (**action; J. Lawrimore + sub-group; IPET-OSDE-3**). The Group should in particular consider improving the explanations in the questionnaire and issuing an e-survey for getting feedback.

9.4.High-level document on the EGOS-IP

9.4.1. The Team recalled its discussion at IPET-OSDE-1 regarding proposals for facilitating progress on EGOS-IP Actions and for supporting NFPs. The Team had recalled that the EGOS-IP, responding to the Vision for Global Observing Systems in 2025, represented a major achievement under the umbrella of WIGOS. Whilst monitoring progress against this Plan was important and necessary, the Team had recognized that it was not enough; and it was the role of IPET-OSDE, with the support of OPAG-IO and WIGOS as a whole, not only to monitor progress but actively to promote it.

9.4.2. IPET-OSDE-1 had also noted that progress had been relatively slow in areas dependent on action by WMO Members and Regions. A network of National Focal Points (NFPs) was established to facilitate reporting by Members against the Actions in EGOS-IP. This network could also be used to facilitate the necessary activity, but it needed support. The Team had agreed that a mechanism to do this should be developed, and supported by adequate resources.

9.4.3. To facilitate implementation of Actions by Members, the IPET-OSDE-1 had also agreed that efforts had to be made to raise awareness and commitment of the Permanent Representatives with regard to the EGOS-IP and the implementation of the 115 actions of the Plan, and had requested the Secretariat to prepare with the IPET-OSDE Chair a high level document (e.g. 4 pages) targeted to the Permanent Representatives on why we have the EGOS-IP, and what are the benefits.

9.4.4. Such a document has been drafted and the latest version was reviewed by the Team through email exchange. While discussing the draft with Team members and beyond, the Chair had proposed drafting a letter to the Permanent Representatives and provided some guidance in this regard. The details of the chair's guidance was discussed together with the feedback received from some of the Team members.

9.4.5. The Breakout Group 5 on the EGOS-IP High Level document reviewed and updated the draft document (**Annex XV**). The following changes were made:

- The text was shortened, and attachments included;
- The structure of the heading changed;
- The text for updated for a more natural flow, starting from WIGOS and benefits;
- Some context was added, e.g. where RRR fits in the WMO framework; and
- References to Technical Regulations were added.

9.4.6. The Team reviewed and concurred with the recommendations of the breakout

group 5 on the EGOS-IP High Level document, and agreed that the new version of the document was good enough for being finalized by the Secretariat and the Chair, and then used for communicating with the Permanent Representative (PR). The letter should be distributed before CBS-16, noting that the PRs will also receive material about the new WIGOS technical regulations that come into force on or after 1 July 2016 and the new Guide to WIGOS which is to be available in July 2016, and that the communication to them on those fronts should be clear enough (**action; Secretariat; July 2016**). The letter ought also include a description of the role of the EGOS-IP National Focal Points.

10. VISION FOR THE EVOLUTION OF GLOBAL OBSERVING SYSTEMS

10.1. Vision for the space-based component of WIGOS in 2040

10.1.1. The Team considered progress to develop a Vision for the space-based component of global observing systems in 2040 ("Vision 2040 Space"). The Team noted that the Vision for the Global Observing System (GOS) in 2025 ("Vision 2025") was approved by EC-LXI in 2009. The Vision 2025 has played a very useful role, and the current version of EGOS-IP is primarily a response to the Vision 2025. The Vision 2025 has been used widely within the WMO community and in discussions with partners, to provide a concise and easily intelligible statement of the types of developments in observing systems that would best serve the needs of WMO Members.

10.1.2. The Vision 2025 has been used by the WMO Space Programme in its interactions, on behalf of WMO Members, with space agencies through CGMS and other forums. Although this has been very valuable, the role of the Vision 2025 for this specific purpose has now become more limited, because of the long lead times for developing satellite programmes; space agencies are looking for a longer term vision to motivate their future programmes and to guide their collective response to WMO needs.

10.1.3. Following discussion at IPET-OSDE-1 and ICT-IO-8 in April 2014, it was agreed that an updated Vision, targeting 2040, should be developed. An initial draft of the Vision 2040 Space was prepared by the CBS Expert Team on Satellite Systems (ET-SAT), in consultation with the CGMS. This was refined following input from the "WIGOS Space 2040" workshop (Geneva, 18-20 November 2015) and additional input from the ICT-SW.

10.1.4. The new Vision 2040 Space represents an incremental approach with reference to the space-based components of the Vision 2025, in terms of what should be added, reinforced or improved, and what could be performed differently in the future in order to respond better to user needs.

10.1.5. A complete draft of the Vision 2040 Space (version 19 January 2016) – see **Annex XX** – was presented, along with the comments received on this version from: the Presidents of Technical Commissions meeting on 19-20 January 2016, the 13th session of the Consultative Meeting on High-Level Policy on Satellite Matters (CM-13, 28-29 January 2016), and IPET-SUP at its 2nd session (23-26 February 2016). Also, a draft schedule was presented for the further development of Vision 2040 Space, for its review by various stakeholders and for its eventual approval.

10.1.6. IPET-OSDE reviewed [in Break-out Group 6] the draft version of Vision 2040 Space and the comments on it from other groups. The Team provided its own comments and suggestion for revision. It also provided comments of the proposed schedule – see **Annex XI**. The Team concurred with the following recommendations from the breakout group:

1. **Recommendation 1:** the timeline as presented in the document was agreed and

the draft 2040 Vision (Space) should be presented to CGMS in June, and CBS in November.

2. **Recommendation 2:** ICT-IOS should consider the integration of the 2040 Vision for the Space-based and Surface-based components and develop a roadmap for this process. The roadmap is to be presented to CBS in November.

10.1.7. The Team recognized that there are certain elements that can be difficult to anticipate in 2040, e.g. data management issue (data stewardship, third party data), and should therefore be addressed in general terms and at the higher level in the draft Vision.

10.1.8. The Team noted that regarding the provision of the surface-based observing systems to the space-based part, the complementarity of both components was recognized in the draft Vision.

10.1.9. The Team agreed that the split between space-based and surface-based components should not be allowed to inhibit the addressing of technology-free user requirements in an integrated way. However, the Team agreed that for practical reasons, the split is necessary.

10.2. Updating the Vision for 2025

10.2.1. The Team noted that since IPET-OSDE-1, equivalent planning for the surface-based component had not progressed. Several of the Actions from IPET-OSDE-1 on the topic of the Vision for 2040 were not restricted to space-based systems, but covered the evolution of user requirements and technological capabilities for all observing systems. However, the only substantial response had been in relation to space-based systems, as summarized above. Also, the Vision 2025 was less specific in what it recommended for the surface-based component than it was for the space-based component.

10.2.2. For these reasons, the Chair asked the Team to consider the activities that should be proposed in relation to the extension of the Vision for surface-based component. He suggested some options: (a) to initiate a development parallel to that for the space-based component, targeting 2040, (b) to update the Vision for the surface-based component in 2025, to make it more specific and to respond to recent technological advances, and (c) to maintain the current Vision for the surface-based component in 2025 and to focus activities and resources on achieving this Vision.

10.2.3. In response to option (a), the Secretariat had already developed some ideas regarding the development of the Vision for surface-based observing component in 2040. A concept note has been developed by the WIGOS Project Office, together with a proposed roadmap.

10.2.4. The Team reviewed and concurred with the recommendations of the Breakout Group 7, Strategy for updating Vision 2025 [focusing on surface part]. These are provided in **Annex XVII**. In particular, the Team agreed that there is a clear need for an updated Vision for surface-based observing systems (Surface Vision), it agreed on a work plan, and identified some elements to be considered in that Vision. The Team decided to establish an IPET-OSDE sub-group, comprised of John Eyre (co-lead & core member), Frank Grooters (co-lead & core member), Daniel Michelson (core member), John Eyre (core member), Jay Lawrimore (core member), Jochen Dibbern (core member), Jitze van der Meulen (core member), JCOMM representative (core member), Michele Citterio, Russell Stringer, Stephan Klink for preparing a draft of the Surface Vision by correspondence. The Team agreed that the core members of the sub-group should meet, possibly in Offenbach (Germany), in September 2016 for developing a first draft of the Surface Vision. It was noted that EC-69 (2017) was an important milestone to deliver work in progress, and it was proposed that a draft Vision to integrate both Surface and Space Visions should be developed during 2017. The Team

also agreed that the draft Surface Vision ought to be submitted to CBS-16. The ICT-IOOS will discuss and agree on the roadmap for developing the integrated (surface plus space) Vision.

10.2.5. The Team agreed that all WIGOS component observing systems (GOS, GAW, GCW, WHOS), and co-sponsored observing systems (GCOS, GOOS³⁵) should be engaged in contributing to the 2040 Vision, taking into account both surface-based and space-based observing components.

10.2.6. The Team discussed and identified some elements that should in principle differ when developing the surface-based component of the Vision versus the space-based component. These are considered in **Annex XVII**.

10.2.7. The Team noted that CIMO discussed an Instrument and Methods of Observation Programme (IMOP) Vision for 2040, and has developed a draft a two-pager. The Team agreed that CIMO should be involved in the process of developing the new Vision for the surface-based component.

10.2.8. The Team noted that the new Vision will be appropriate material to be used to develop a business case for accessing externally sourced data, as this may be an issue in the future.

11.OBSERVING NETWORK DESIGN (OND) - PRINCIPLES AND GUIDANCE

11.1. Outcome of the OSDW2 workshop (Geneva, Feb. 2015)

11.1.1. The Team recalled that according to its Terms of Reference, the IPET-OSDE is tasked to propose guidance regarding observing system network design principles. To initiate the work in this regard, an *ad hoc* Workshop on Observing System Design (OSDW1) was organized in Geneva, Switzerland, from 12 to 14 November 2014. The outcome of this first workshop was considered by IPET-OSDE-1 and ICT-IOOS-8 and as a result Observing Network Design (OND) Principles eventually included in the WIGOS Manual following Cg-17 approval.

11.1.2. The second *ad hoc* Workshop on Observing System Design (OSDW2) was held over 2-4 February 2015, in Geneva, Switzerland. A full report on the meeting is available on the web³⁶. The main goal of the workshop was to respond to the WIGOS Implementation Key Activity Area No. 3 (KAA#3) on design, planning and optimized evolution of WIGOS and its regional, sub-regional and national component observing systems. In particular this workshop also followed up on the work commenced in the first workshop and the related activities by the IPET-OSDE, which had proposed Observing Network Design (OND) principles to be included in the Manual on WIGOS. These OSND Principles, included in this document within Appendix A, were endorsed by CBS Ext.(2014) and approved by Cg-17.

11.1.3. The OSDW2 took these Principles as its starting point and continued work to prepare high-level guidance material on how the Principles should be interpreted and implemented. Following OSDW-2, participants continued to refine this guidance material with the intention of it becoming part of the Guide on WIGOS. In July 2015, a version of the draft guidance material was sent to IPET-OSDE members and other stakeholders for comment. The document was further reviewed and revised in December 2015.

11.1.4. OSDW2 also agreed on a revised workplan and roadmap for the further development of guidance for OSND.

35 IOC-WMO-UNEP-ICSU Global Ocean Observing System

36 <http://www.wmo.int/pages/prog/www/CBS-Reports/IOS-index.html>

11.1.5. The Team's follow up decisions are discussed under agenda item 11.2 below.

11.2. Development of material for WIGOS Guide

11.2.1. The meeting was invited to propose changes to the OND guidance and roadmap with the goal of inserting the OND guidance in the WIGOS Guide.

11.2.2. The Team noted that amongst WIGOS guidance materials being developed for the priority areas of the WIGOS Pre-Operational Phase, the OND guidance belongs in principle to the "National Implementation" priority, which was given third priority for its development and approval.

11.2.3. The Team further noted that the ICG-WIGOS established an editorial board, chaired by Russell Stringer (Australia). The Board is planning to meet in principle from 13 to 15 June, i.e. before EC-68).

11.2.4. The Breakout Group 8 reviewed of the draft OND Guidance to some extent, and addressed about 75% of the comments. The Team agreed that the OND guidance materials deserved some further editing, and requested Stephan Klink (Germany) to lead the effort of finalizing the document in liaison with Breakout Group 8 members by the end of June 2016 (**action; S. Klink; end June 2016**). The Team requested the ICT-IOS to clarify the roadmap for further developing and approving the guidance materials, and requested the Chair to relay this request to ICT-IOS-9 (**action; J. Eyre; asap**). The Team invited the ICT-IOS-9 to propose the proper mechanism for having the OND guidance approved according to foreseen availability of such materials. The chair was requested to relay this proposal to the ICT-IOS-9 (**action; J. Eyre; asap**).

11.3. IPET-OSDE perspective on RBON concept

11.3.1. The meeting discussed the IPET-OSDE perspective on the development of the concept of WIGOS Regional Basic Observing Network (RBON) to eventually replace the GOS Regional Basic Synoptic Network (RBSN) and the Regional Basic Climate Network (RBCN).

11.3.2. The Chair of the IPET-WIFI, Jochen Dibbern (Germany) reported on the latest developments in this regard. He explained that the concept of the RBON involves the development of a network classification scheme for observing systems and stations that incorporates and allows the classification of all WIGOS Component Observing Systems and their various sub-systems that together serve to meet the requirements of all WMO Application Areas. Conceptually and eventually in practice, the RBON would replace the existing RBSN and the RBCN and consist of all stations and systems that provide or make observational data available via the WMO Information System (WIS) and the GTS.

11.3.3. The (draft) concept for RBON was presented to CBS at its Extraordinary Session (CBS-Ext, 2014),

11.3.4. The Team recalled that according to WMO No. 544 (Manual on the GOS), Regional Associations (RAs) are responsible for the determination and coordination of the composition of the current regional basic networks within the general framework established by CBS. It is expected that the composition of the RBON would similarly be determined and maintained at the regional level by WMO RAs. Therefore, the proposed RBON and its procedural framework would require the endorsement and approval of the six WMO RAs and relevant Technical Commissions (TCs) prior to adoption by the Executive Council and Congress under WMO regulated practices.

11.3.5. It was therefore proposed that the WIGOS Project Office, together with the CBS Inter-Programme Expert Team on WIGOS Framework Implementation Matters (IPET-WIFI) and in consultation with relevant CBS teams, should develop a full

“concept document” that can be used to define and establish the roles and practices for operation and maintenance of RBON, through a process of consultation with the WMO Executive Council, RAs and TCs. The basic elements of the concept document were initially proposed to be:

- A preamble introducing the RBON concept and the purposes it serves.
- The rationale for the RBON structure and a description of the relevant elements and aspects upon which it is justified and designed.
- A qualitative description of the RBON.
- The definition of the roles and requirements for operation and maintenance of the RBON.

11.3.6. The IPET-OSDE discussed the draft RBON Concept Document and agreed that the following points ought to be considered in a future review:

- Which aspects and actions of the EGOS-IP are relevant to the RBON and might be incorporated into the concept document (e.g. frequency of observations; engagement on non NMHSs; contribution of weather radars, AWS, enhanced availability of data during hazard events). The meeting requested OPAG-IOG chair to identify during the RBON workshop those actions of the EGOS-IP which are relevant to the RBON and coordinate with chair of IPET-OSDE (**action, J. Dibbern, end May 2016**) (**action; J. Dibbern; end May 2016**); and
- Regulatory and guidance material will be needed in support of the operation and maintenance of the RBON. In the Manual on the GOS, the different types of contributing observing stations are described in terms of what each type of station has to report. Something similar will have to be developed for the RBON. It is expected that ETs of OPAG-IOG will be invited to contribute to this work..

11.3.7. The Team agreed that all of the OND Principles developed by IPET-OSDE were relevant to the RBON and should be incorporated within the concept document.

11.3.8. The Team invited the Chair of ICT-IOG, Jochen Dibbern (Germany) to bring the IPET-OSDE perspective to the WIGOS workshop, which is planned on the development of the RBON concept (Geneva, Switzerland, 18-20 May 2016) (**action; J. Dibbern; May 2016**). It was noted that the outcome of the RBON workshop will be submitted to CBS-16. Regional Associations, starting with RA-II in February 2017, will then be invited to address how to apply the generic RBON concept applicable at the regional level. Technical Regulations and guidance materials are meant to be approved by the end of the financial period by Cg-18 in 2019.

11.4. Roadmap for the development of OND Principles and Guidance

11.4.1. The IPET-OSDE recommendations will be submitted to ICT-IOG-9 in preparation for CBS-16 (see also paragraph 11.2.4).

12. PREPARATION FOR FORTHCOMING CBS ACTIVITIES AND MEETINGS

12.1. PET-OSDE Updated work-plan for 2013-2016

12.1.1. The Meeting requested the Chair to update the current IPET-OSDE workplan for 2013-2016 to reflect status of actions and decisions of IPET-OSDE-2 (**action; J. Eyre; asap**). The meeting also requested the Chair to draft a new workplan for 2017-2020 on the basis of the new draft Terms of Reference of IPET-OSDE proposed by the CBS Management Group and to be submitted to CBS-16. The new workplan ought to be submitted to CBS-16 through ICT-IOG-9 (**action; Chair, asap**). It was noted that according to the new IPET-OSDE draft Terms of Reference, the central duties of the IPET-OSDE should continue in the next inter-sessional period. The Chair was invited to

propose an updated version of these draft ToR for submission to the ICT-IOS-9 (**action; Chair; asap**).

12.2. Reports to ICT-IOS-9 and CBS (2016)

12.2.1. The meeting discussed the preparation of documents to CBS-16. The Team requested the Chair to work with the Secretariat and update the IPET-OSDE report to be submitted to CBS-16 through ICT-IOS-9 taking into account the actual decisions and recommendations of the IPET-OSDE-2 (**action; Chair; asap**).

13. ANY OTHER BUSINESS

13.1. WMO Cross-Cutting Urban Focus

13.1.1. The Team recalled that through Resolution 68 (Cg-17) - Establishing a WMO Cross-Cutting Urban Focus, the WMO Congress requested the Technical Commissions (1) to define relevant urban activities to be addressed by the relevant commissions in their upcoming sessions, including as elements of the agreed WMO priorities; (2) to request their working bodies to integrate the urban dimension in their activities in a coherent manner; and (3) to include reference to urban activities in their reports to the Executive Council. The Team discussed implications for the IPET-OSDE of that Resolution, and addressed the three following questions:

How can urban requirements be taken into account in existing AAs ?

13.1.2. The Team noted that there is currently only one AA, which is explicitly considering Urban requirements, i.e. the new AA Providing Atmospheric Composition information to support services in urban and populated areas.

13.1.3. It further noted that the following Application Areas may have a direct interest in Urban issues: High-resolution NWP, Nowcasting, Aeronautical meteorology, Climate Application (CCI).

13.1.4. Nevertheless, the Team requested all Application Area Points of Contact to review and update their SoG if necessary to take account of the Urban focus (**action; PoCs; end 2016**).

Are there observational user requirements that we have missed in the existing AAs ?

13.1.5. The meeting agreed that the answer to the question depended on the review of all Application Areas as proposed above under the first questions. Only after such review such new observation user requirements could be identified.

Should a new AA be considered where some independent user requirements exist ?

13.1.6. The Team agreed that there was no need at this point to consider an new Application Area taking into account the Urban requirements.

13.2. Collaboration with the Sustained Arctic Observing Network (SAON)

13.2.1. The meeting discussed WMO collaboration with the Sustained Arctic Observing Network (SAON). It was noted that the WMO is responsible for two SAON Tasks: (a) "WMO contribution to SAON through the WMO Rolling Review of Requirements (RRR)" and "WMO Surface Synoptic and Climatological Observing Stations Operated by its Members in the Arctic and the AMAP Areas". In these Tasks, the GCS should engage with the user community to help determine which cryospheric data types are most important, to identify the spatial, temporal, and knowledge

gaps, and to address other aspects of data usability such as error assessments and data formats requirements may vary regionally. GCW is also tasked to promote the use of OSSE to evaluate gaps in the spatial distribution of measurement sites. Optimizing an observing network requires the use of numerical models to establish observing priorities and identify gaps.

13.2.2. The Team agreed that such collaboration with SAON was beneficial to both WMO and SAON. The Team was ready to assist SAON and the GCW in this regard. In addition, GCW is contributing to SAON through the CryoNet and the GCW contributing observing stations.

13.2.3. The meeting recommended ICT-IOS to request ICG-WIGOS to clarify how WIGOS is going to work with partner organization, including SAON, e.g. through Memorandum of Understanding or special agreement based on generic WIGOS template, for example allowing partner organization observing stations metadata to be reflected in OSCAR. The meeting requested the chair to bring this issue to ICG-WIGOS through ICT-IOS-9 (**action; ICT-IOS; J. Eyre; asap**).

14..ACTION PLAN

14.1. Actions decided by this meeting, are recorded in **Annex II**. The updated workplan – with status of tasks – for the IPET-OSDE, taking into account the outcome of this IPET-OSDE1 Session, is provided in **Annex III**.

14.2. The Team recommended that the key outcome of IPET-OSDE-2 and ICT-IOS-9 should be reflected in EC-68 documents.

15.CLOSURE OF THE SESSION

15.1. The Chair thanked the Team members and the Secretariat for contributing to the successful outcome of the meeting. The Team agreed that this has been a very productive meeting thanks to good planning, preparatory documents of good quality, engagement of all Team members, the Application Area Points of Contact, and the EGOS-IP National Focal Points. The breakout group discussions also helped facilitating and focusing the discussion.

15.2. The meeting also expressed its appreciation to all Secretariat staff who contributed to the discussion.

15.3. The Director of the Observing and Information Systems Department, Dr Zhang, thanked the chair for his leadership, and all Team members for their active contribution to the meeting. He recalled that the EGOS-IP was an important document guiding Members for the evolution of the observing systems contributing globally to WMO activities. He stressed that there was a need to further consider how to promote the implementation of actions of the EGOS-IP. For example, efforts remain to be made to address the EGOS-IP Action G2 regarding distribution of hourly observations where progress has been slow. He invited the Team and the ICT-IOS, which is going to meet the week after this meeting to discuss how WMO Members obligations towards implementing the actions of the EGOS-IP could be further enforced. Finally, Dr Zhang recalled the importance of reaching out with partner organizations, especially regarding open ocean observing systems, which need to be sustained.

15.4. The meeting closed at 16:30 on Thursday 14 April 2016.

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ACTION SHEET RESULTING FROM IPET-OSDE-2, AND PREVIOUS MEETINGS

Note: Action items arising from the IPET-OSDE-2 meeting are highlighted in blue.

No.	Ref ¹	TOR ²	WP ³	Action	By	Deadline	Comment/Status
				I. RRR PROCESS – general			
				II. RRR process – OSCAR/Requirements (URs) and Statements of Guidance (SoGs)			
				1) General actions			
1	O2/7.1.3 .	(a)	2	to update the Table (Table 1 of IPET-OSDE-2 Doc. No. 7.1) which lists Application area for which observational user requirements are recorded in OSCAR with indication of the responsible organization. The table should be updated to indicate who in the WMO is responsible for the Application Area, when applicable	Secretariat	asap	
2	O2/7.1.4 .	(a)	2	to consider changing the visibility of the historical Application Areas and their observational user requirements in OSCAR, and to investigate possible solutions for version control, and version archiving of the observational user requirements in OSCAR	Secr.	end 2016	
3	O2/7.1.5 .	(a)	2	to continue to update the observational user requirements of their Application Area in the OSCAR/Requirements database, and requested them to make sure that the user requirements not older than 4 years at any time	PoCs	Ongoing	
4	O2/7.4.6 .5.	(a)	2	to consider/evaluate the inclusion of requirements for Lightning observations in OSCAR and in their SoG	all PoCs	Dec. 2017	
5	O2/13.1.4.	(c)	4	to review and update their SoG if necessary to take account of the Urban focus	all PoCs	end 2016	
6	O2/7.4.6 .41.	(c)	4	to provide feedback and suggestions for changes to all SoGs to the Points of Contact and the	IPET-OSDE members	end of May 2016 and	

1 Ref: reference to paragraph number of IPET-OSDE and ET-EGOS meeting reports as appropriate (e.g. E6/8.1.11 = Para 8.1.11 of ET-EGOS-6 Final Report, O2 refers to IPET-OSDE-2).

2 TOR: reference to the IPET-OSDE Terms of Reference to which the action item applies

3 WP: reference to the item number of the CBS work programme for IPET-OSDE to which this action item applies.

IPET-OSDE2, Final report

No.	Ref ¹	TOR ²	WP ³	Action	By	Deadline	Comment/Status
				IPET-OSDE Chair		ongoing	
7	O1/7.1.6 .2.	(a)	2	to better define the stability criterion	GCOS	IPET-OSDE-3	
8	O1/7.1.6 .3.	(a)	2	to document the stability requirements for climate monitoring	GCOS	IPET-OSDE-3	
9	O1/7.1.6 .4. E5/8.1.8	(a)	2	through OSD, to manage the OSCAR/Requirements database according to a well-defined procedure, in a coherent and sustained manner	Secretariat	Ongoing.	
10	O1/7.1.6 .5.	(a)	2	to ensure that there is an annual review of the user requirements by the Points of Contact.	Secretariat	Ongoing	
11	O1/7.1.6 .6.	(a) (c)	2, 4	to write to the PoCs and remind them about their role, and thank them for their contributions	Chair	Soon after each IPET-OSDE meeting	
12	O1/7.1.6 .7.	(a)	2	References to the sources of requirements (documents, papers) should be provided in the "Source" field of OSCAR/Requirement, where available (with assistance from the Secretariat).	All PoCs	ongoing.	
13	O1/7.3.1 .4.	(c)	4	to update SoG, assuring consistency with agreed template	Points of Contact	Before next IPET-OSDE meeting	
14	O2/7.4.8 .12. O1/7.3.4 .2.	(c) (d)	4	to consider proposing additional Applications Areas or sub-applications for which user requirements and Statements of Guidance should be developed	PoCs & IPET-OSDE members	IPET-OSDE-3	
15	O1	(a)	2	To add a reference on the statement on uncertainty (confidence interval) in the OSCAR website; this reference (by weblink) will be an on-line document, containing explanations and advise on how to determine the required uncertainties in line with the internationally adopted rules	J. Eyre in consultation with J. vd Meulen	IPET-OSDE-3	There is a conflict, which is more substantial than initially thought
16	E4	(c)	4	Review all revised SoG	Chair	ongoing	
17	E4	(c)	4	Refer revised SoGs to appropriate "owners" for endorsement	Chair	ongoing	
				2) Global NWP			
				3) High Resolution NWP			
				4) Nowcasting and very short range			

IPET-OSDE2, Final report

No.	Ref ¹	TOR ²	WP ³	Action	By	Deadline	Comment/Status
				forecasting			
				5) Sub-Seasonal to longer Predictions (SSLP)			
18	O2/7.4.6 .8.	(c)	4	to update Section 2.1.2 of the SoG to reflect the need for observations in the tropical pacific (see TPOS 2020 project)	PoC	May 2016	
				6) Aeronautical Meteorology			
19	O2/7.4.6 .11.	(c)	4	to liaise with appropriate groups and address the issue of inconsistencies between the requirements and guidance of the International Civil Aviation Organization (ICAO), the Global Data Processing and Forecasting System (GDPFS), and WIGOS in a future review of the SoG	PoC	end 2016	
20	O2/7.4.6 .12.	(c)	4	to add some references to observing techniques for addressing the requirements for icing and turbulence conditions, e.g. how to observe Super Cooled Liquid Water Content (SLWC), and to update the SoG to take into account the Team's perspective on icing, turbulence, and humidity measurements	PoC	May 2016	
				7) Atmospheric Chemistry			
21	O2/7.4.6 .14.	(c)	4	to make sure that Points of Contact will be nominated by CAS for each of the three new AA	Secretariat	asap	
22	O2/7.4.6 .16.	(c)	4	to do the gap analysis for the 3 AAs taking into account both surface-based and space-based observing systems	PoCs of the 3 AAs	end 2016	
23	O1/7.3.2 .22.	(c) (h)	4	to follow up on CBS Ext. (2014) proposal for introducing a new Application Area under OPAG DPFS responsibility regarding air quality forecasting	Secretariat	Sep. 2016	OPAG DPFS to clarify their responsibility DPFS to propose an AA for AQF and to nominate a PoC, with practical details then to be agreed by CBS MG.
				8) Ocean Applications			
24	O2/7.4.6 .18.	(c)	4	to make the following changes: (i) proposing tsunami related variables to be added into OSCAR/Requirements, and (ii) consideration of the requirements for sea ice variables in both OSCAR/Requirements and the SoG	PoC	July 2016	
25	O2/7.4.6	(c)	4	with assistance of the Secretariat to liaise with	PoC & Secr.	July 2016	

IPET-OSDE2, Final report

No.	Ref ¹	TOR ²	WP ³	Action	By	Deadline	Comment/Status
	.19.			the JCOMM Services Coordination Group (SCG) for its approval with regard to the proposed new name of the Application Area, and for documenting the set of sub-applications for which there are independent observational user requirements			
26	O2/7.4.6 .20.	(a)	4	to discuss the issue with the Secretariat of identical reporting of some of the user requirements in OSCAR	PoC	asap	
27	O1/7.3.2 .25.	(c)	4	to update the SoG for Ocean Applications to include the sub-application requirements for biogeochemical measurements	PoC	Apr. 2016	Ocean chlorophyll, nitrate, silicate and phosphate concentration are included. Is this enough?
				9) Agricultural Meteorology			
				10) Hydrology			
				11) Climate monitoring (GCOS)			
28	O2/6.2.8 .	(c)	4, 6	to provide comments on the draft GCOS-IP as part of the limited review (June 2016) or the public review (July 2016)	IPET-OSDE members	June & July 2016	
29	O2/6.2.9 .	(a)	4, 6	to discuss with the WMO Secretariat how to represent or refine representation of ECVs in OSCAR (see also paragraph 7.4.6.30)	GCOS Secr.	asap	
30	O2/6.2.1 0.	(c)	4, 6	to address the issue of better consideration by GCOS of the availability of Aircraft Based observations, including AMDAR	GCOS	asap	
31	O2/6.2.1 4.	(c)	4, 6	to review the interim report on the TPOS Observing System Design, once available from the TPOS website in principle in mid-2016	Team members	June 2016	
				12) Climate Applications (other aspects – CCI)			
32	O2/7.4.6 .36.	(c)	4	to consider and focus on the areas this AA should be covering that GCOS is not already covering	CCI PoC	end 2016	
				13) GTOS			
				14) Space weather			
				15) Global Cryosphere Watch			
33	O2/6.3.5 .	(c)	4, 8	to note that the next opportunity for	GCW	end Oct. 2016	

IPET-OSDE2, Final report

No.	Ref ¹	TOR ²	WP ³	Action	By	Deadline	Comment/Status
				submitting Technical and Guidance materials is CBS-16 and the deadline for submitting GCW input is of October 2016			
34	O2/7.4.7 .1.	(a)	4, 8	to interact with the relevant existing Application Areas to ensure missing cryospheric variables are added and the existing ones satisfy the GCW requirements	GCW	end 2016	
35	O2/7.4.7 .3(3)	(c)	4, 8	to respond to <i>ad hoc</i> requests from the GCW for the Points of Contact of all application areas and the Polar Space Task Group (PSTG) to work with GCW to clarify their needs and to resolve any ambiguities and inconsistencies in cryosphere requirements	PoCs and GCW	early 2017	
36	O2/7.4.7 .4.	(c)	4, 8	to identify the operational or quasi operational activities under GCW that directly require observations and are independent of existing AAs. These activities may then be considered as new Application Area(s)	GCW	end 2017	
37	O2/7.4.7 .5.	(a)	4, 8	to look at the Cryosphere Theme variables, and identify whether these could be considered in their respective AA - "Orphan" variables may then be identified where GCW could place focus	all PoCs	asap	
				16) Global Framework for Climate Services			
				17) Global Ocean Observing System (GOOS)			
				18) Disaster Risk Reduction			
38	O2/7.4.8 .10.	(c)	4	to review the list (Annex XXI) of DRR hazards and propose additions if needed (e.g. glacier outflow, storm surge)	Secretariat, GCW & JCOMM	end 2016	
				III. RRR PROCESS – OSCAR/Space and OSCAR/Surface			
39	O2/7.2.6 .	(b)	3	to participate in the short term in the beta testing phase of OSCAR/Space v2	IPET-OSDE members	asap	
40	O2/7.2.7 . O"/Anx-12	(b)	3	to bring the issue of OSCAR resourcing to ICT-IOS-9, and invite ICT-IOS to draft CBS-16 Recommendation (noting progress, new challenges, how it is used, importance of the content and its correctness, the need for QC and	chair	asap	

IPET-OSDE2, Final report

No.	Ref ¹	TOR ²	WP ³	Action	By	Deadline	Comment/Status
				coordination, risks; and requesting the Secretariat to put appropriate resources into the management of OSCAR information content, and the required coordination)			
41	O2/7.2.1.1.	(b)	3	to take steps to develop a road map for a provision of CryoNet and GCW contributing stations metadata into OSCAR/Surface	GCW	July 2017	
42	O2/7.3.2.	(b)	3	to insert in the IPET-OSDE action plan some of the pending actions from the Offenbach workshop on OSCAR development	J. Eyre	asap	Done as immediate post-meeting action See Annex 11 , and action 43 below.
43	O2/7.3.2	(b)	3	To advise about the use of the concept of cloud of points for assessing observing systems capabilities for the gap analysis	S. Goldstraw	asap	Results from the July 2015 Offenbach workshop on gap analysis, action no. 7, and subsequent discussions.
44	O2/Anx-12	(b)	3	To perform and assessment of what's required in terms of resources to maintain information in the three components of OSCAR (requirements, space, surface)	Secretariat	July 2016	
IV. IMPACT STUDIES, OSEs, OSSEs							
45	O1/8.2.3.1.	(e)	5	to provide proposal of climate monitoring science questions to the R-SEIS	GCOS	ASAP.	Open GCOS Open Science conference coming.
46	O2/8.2.1.	(e)	5	to submit the updated list of specific studies and science questions to the ICT-IOS-9	Chair	asap	
47	O2/8.2.5.	(e)	5	to request NWP centres to relay the IPET-OSDE invitation to the NWP centres for them to undertake an impact study on the impact of additional B777 AMDAR data over RA-I; and the NWP centres to consider appropriate period for the study while the latter should be completed by the end of 2016.	R-SEIS	Refer May 2016; studies end 2016 if possible	
48	O2/8.2.5.	(e)	5	to provide the list of relevant aircraft identifiers to the R-SEIS for the proposed impact study	ET-ABO	asap	Done shortly after the meeting, and included in Annex V of the final report
49	O2/8.2.6.	(e)	5	to include a new science question for assessing the impact of high elevation meteorological data from the third pole region	R-SEIS	asap	
50	O2/6.1.1	(j)	1	to bring the Team's perspective at the ICT-IOS-9	IPET-OSDE	asap	

IPET-OSDE2, Final report

No.	Ref ¹	TOR ²	WP ³	Action	By	Deadline	Comment/Status
	(a)	(k)		meeting with recommendation to raise CBS-16's attention on the issue of adjusting the requirement to make radio-sonde observations at prescribed synoptic observing times for the GOS	Chair		
V. COST.BENEFIT STUDIES							
51	O2/5.2.	(d)	1	to present and discuss progress on this activity at the 6th Workshop on "The impact of various observing systems on NWP", Shanghai, 10-13 May 2016; report outcome to ET-SBO and ICG-WIGOS via Ch.OPAG-IOS	J. Eyre	May 2016	
52	O1/8.4.3 .1.	(d)	1	to participate at the next ICG-WIGOS and present the work of the IPET-OSDE with regard to cost-benefit studies for observing systems	Chair	Early 2017	
53	O1/8.4.3 .2.	(d)	1	to assist the chair in providing feedback on the methodology, as well as input on the estimates of the cost of the observing systems	IPET-OSDE members	IPET-OSDE-3	<p>IPET-OSDE-2:</p> <ul style="list-style-type: none"> • J. Lawrimore: Efforts could also be made with regard to drought monitoring • ET-ABO: there are clear ABO benefits identified. • Satellite community: EUMETSAT should contribute to the exercise • GCW: Need to better communicate the benefits <p>7/3/2016: Comments from J. Key: First, well done. He laid out a process for something that is very difficult to do. Second, we need to be sure to include other applications. John obviously knows this, and explained it in paragraphs 1.2, 2.2.2, and elsewhere. Nevertheless, when I looked at the table, I couldn't help but think that the impact/cost value for imagers -- both optical and passive microwave -- is low in NWP but much, much higher for ice operations and climate work. Don't let the general public see this table yet!</p>

IPET-OSDE2, Final report

No.	Ref ¹	TOR ²	WP ³	Action	By	Deadline	Comment/Status
							7/3/2016: Comments from P. Ambrosetti: it is difficult to develop an appropriate metric to assess the cost/impact of single data sources, like the proposed one for NWP. Nevertheless at global scale the cost-benefit analysis for NWP could be extended without any relevant changes for Nowcasting and VSRF. Near specific area a local cost/impact approach would be often required. 4/3/2016: Comments on chairs' document from J. Lawrimore 2/3/2016: Comments on chair's document provided by S. Boukabara
54	O1/8.4.3 .4.	(d)	1	to start considering appropriate impact metrics for their Application Areas	All PoCs	IPET-OSDE-3	
				VI. PREPARATION OF THE NEW EGOS-IP, AND FOLLOW UP			
55	O2/9.2.1 .5.	(f)	9	to follow up on the recommendations from the Breakout Group 4 (EGOS-IP Actions review - surface part, Annex XIV)	J. Lawrimore	ongoing	
56	O2/9.3.5 .	(f) (g)	1, 9	to provide thanks and feedback to the NFPs regarding the monitoring of actions against the EGOS-IP on the basis of their national reports and other sources of information	Secretariat & Chair	ongoing	
57	O2/9.3.6 .	(g)	1	to consider further efforts that could be to enhance WIGOS implementation in the Regions, including enhancing communication on network design activities, and on the EGOS-IP and the required feedback concerning the implementation of EGOS-IP actions	WIGOS PO	CBS-16	
58	O2/9.3.7 .	(f)	9	to work during the intersessional period on the issue of getting feedback from the NFPs on implementation of EGOS-IP actions, and on synthesizing such feedback	J. Lawrimore + sub-group	IPET-OSDE-3	
59	O2/9.4.6 .	(g)	1	to distribute the letter on the EGOS-IP to the PRs before CBS-16	Secretariat	July 2016	
60	E7/Anx-XI	(c) (d) (f)	1	Agree relationship between EGOS-IP and WIGOS-IP communication plans	Secretariat	IPET-OSDE-3	Open (no specific guidance received from ICG-WIGOS)

IPET-OSDE2, Final report

No.	Ref ¹	TOR ²	WP ³	Action	By	Deadline	Comment/Status
61	O2/Anx 13/2.2	(f)	9	1. EGOS-IP Action S7: to cross-check elements of EGOS-IP Report relevant to climate against GCOS-195; 2. EGOS-IP Action S19: to propose revision of statement on which LEO imaging missions will and will not include a WV channel;	R. Munro	May 2016	
62	O2/Anx 13/2.1 & 2.2	(f)	9	to propose metrics against which progress on EGOS-IP Actions S14 and S16 can be measured and check currently available reports against these metrics	J. Eyre	June 2016	
63	O2/Anx 13/2.1	(f)	9	To reinforce the need for continuity of the CMA contribution to the early morning orbit through discuss with CMA (EGOS-IP Action S13).	L.P. Riishojgaard	May 2016	
64	O2/Anx 13/2.4	(f)	9	to provide updated information as available regarding EGOS-IP actions W3-W8	S. Bojinski	May 2016 & ongoing	
65	E7/9.3.7	(j)	9	Address concerns and misunderstanding of the NFPs	J. Lawrimore (Sub-Group)	IPET-OSDE-3	
VII. OBSERVING SYSTEM NETWORK DESIGN PRINCIPLES AND GUIDANCE							
66	O2/11.2.4.	(i)	1, 10	to lead the effort of finalizing the draft OND Guidance document in liaison with Breakout Group 8 members by the end of June 2016	S. Klink	end June 2016	
67	O2/11.2.4.	(i)	1, 10	to clarify the roadmap for further developing and approving the guidance materials, and to relay this request to ICT-IOS-9	J. Eyre	asap	
68	O2/11.2.4.	(i)	1, 10	to propose the proper mechanism for having the OND guidance approved according to foreseen availability of such materials. The chair was requested to relay this proposal to the ICT-IOS-9	J. Eyre	asap	
VIII. VISION							
69	O2/Anx-16	(h)	1	to present the draft 2040 Vision (Space) to CGMS in June, and CBS in November	Secretariat.	Jun. 2016 & Nov. 2016	
70	O2/Anx-16	(h)	1	To bring to ICT-IOS-9 the recommendation that ICT-IOS should consider the integration of the 2040 Vision for the Space-based and Surface-based components and develop a roadmap for this process. The roadmap is to be presented to CBS in November	J. Eyre	Apr. 2016	

IPET-OSDE2, Final report

No.	Ref ¹	TOR ²	WP ³	Action	By	Deadline	Comment/Status
71	O2/10.2 & O2/Anx-17	(h)	1	to identify JCOMM representative in the IPET-OSDE Sub-Group on the "surface" Vision	Secretariat	asap	
72	O2/10.2 & O2/Anx-17	(h)	1	to initiate email discussion in preparation of the September workshop for drafting the "surface" Vision	J. Eyre	Asap	
73	O2/10.2 & O2/Anx-17	(h)	1	to identify venue and propose date for the September workshop for drafting the "surface" Vision	Secretariat	Asap	
74	O2/10.2 & O2/Anx-17	(h)	1	to agree by email on the outline of the "Surface" Vision, and documentation plan for the September workshop	Sub-group on the "Surface" Vision	Jul. 2016	
75	O1/11.2.3.1.	(h)	1	to review the webpage on additions to the Vision of the GOS, and propose other additions or changes to the Secretariat and Chair if needed; ongoing	IPET-OSDE members	ongoing.	
IX. PLANNING & REPORTING TO CBS							
76	O2/12.1.1.	(j) (k)	1	to update the current IPET-OSDE workplan for 2013-2016 to reflect status of actions and decisions of IPET-OSDE-2	J. Eyre	asap	
77	O2/12.1.1.	(j) (k)	1	to submit the new IPET-OSDE workplan for 2016-2020 to CBS-16 through ICT-IOS-9	Chair	asap	
78	O2/12.1.1.	(j) (k)	1	to propose an updated version of these draft ToR for submission to the ICT-IOS-9	Chair	asap	
79	O2/12.2.1.	(j) (k)	1	to work with the Secretariat and update the IPET-OSDE report to be submitted to CBS-16 through ICT-IOS-9 taking into account the actual decisions and recommendations of the IPET-OSDE-2	Chair	asap	
IX. OTHER ISSUES							
80	O2/11.3.6	(i)	1	to identify during the RBON workshop those actions of the EGOS-IP which are relevant to the RBON and coordinate with chair of IPET-OSDE	J. Dibbern	End May 2016	

IPET-OSDE2, Final report

No.	Ref ¹	TOR ²	WP ³	Action	By	Deadline	Comment/Status
81	O2/11.3.8.	(i)	1	to bring the IPET-OSDE perspective to the WIGOS workshop, which is planned on the development of the RBON concept (Geneva, Switzerland, 18-20 May 2016)	J. Dibbern	May 2016	
82	O2/13.2.3	(i) (k)	1	to bring to ICG-WIGOS through ICT-IO5-9 the need for ICG-WIGOS to clarify how WIGOS is going to work with partner organization, including SAON, e.g. through Memorandum of Understanding or special agreement based on generic WIGOS template, for example allowing partner organization observing stations metadata to be reflected in OSCAR.	J. Eyre	asap	
83	E5/11.3	(c) (d)	6	Coordinate responses to any issue regarding GRUAN implementation with regard to CBS	Secretariat with L P Riishojgaard and J Eyre	Ongoing	

**UPDATED WORK PLAN WITH STATUS FOR
THE INTER PROGRAMME EXPERT TEAM ON OBSERVING SYSTEM DESIGN AND EVOLUTION (IPET-OSDE)
FOR THE PERIOD 2012-2016**

(Workplan as decided by IPET-OSDE-1, April 2014; status of tasks as of 16 April 2016)

I d	Pr io rit y	Objective	Outcome	Deliverabl e	Activity	Leader	Due	OtherETs	Effort	Status Report
1	1	To contribute to the implementation of WIGOS, including WIGOS Manual, and provide relevant advice and support to the chairperson of ICT-IOS	Address relevant items of WIGOS Implementation Activities agreed by Congress XVI, and then ICG-WIGOS	Relevant WIP activities addressed	Meeting	Chair IPET-OSDE	Ongoing	ICG-WIGOS, IPET-WIFI		<p>OND Principles included in WIGOS Manual</p> <p>OND Guidance addressing the Principles almost complete</p> <p>Vision 2040 Space well developed and reviewed at IPET-OSDE-2</p> <p>Vision 2040 Surface preparation initiated at IPET-OSDE-2</p>

IPET-OSDE2, Final report

I d	Pr io rit y	Objective	Outcome	Deliverabl e	Activity	Leader	Due	OtherETs	Effort	Status Report
2	1	Survey and collate user requirements for observations for WMO and WMO-sponsored programmes	Review and update WMO database of observational user requirements, through Points of Contact for application areas.	OSCAR/Re quirements up to date	Review by FPs	Chair IPET- OSDE	Ongoing / Annual review			Ongoing; PoCs regularly contacted for updates
3	1	Survey and collate observing systems capabilities for surface-based and space-based systems that are components or candidate components of WIGOS	Review and update WMO database of observing system capabilities, in collaboration with other OPAG IOS ETs and other Technical Commissions as appropriate.	OSCAR/Sp ace & OSCAR/Sur face up to date	Review by Members (coordina tion via NFPs)	Chair IPET- OSDE	Ongoing / Annual review	ICT- IOS, ET- ABO, ET- SBO, ICG- WIGOS/ TT- WMD		Ongoing for space-based, and recorded in OSCAR/Spac e. Ongoing for surface- based through new developments with OSCAR/Surfa ce, to be used when operational in 2016
4	1	Maintain Rolling Review of Requirements (RRR) for observations in several application areas, using subject area experts, including appropriate liaison with Technical Commissions and programmes and co-sponsored programmes (e.g.	Continue RRR process for the listed application areas and expand to new areas as required: review and update as necessary Statements of Guidance on the extent to which present/ planned observing system capabilities meet user requirements, through	Statements of Guidance for all Application Areas	Applicati on Area Contact Points; Meeting	Chair IPET- OSDE	Ongoing / Annual review			Ongoing; some SoG reviewed. Overall review done by IPET- OSDE-1 and IPET-OSDE- 2. Some updates to user requirements and SoGs

IPET-OSDE2, Final report

I d	Pr io rit y	Objective	Outcome	Deliverabl e	Activity	Leader	Due	OtherETs	Effort	Status Report
		CAS, JCOMM, CAeM, CAgM, CHy, CCI, GCOS, GFCS, and GCW)	Points of Contact on application areas.							made during the period.
5	1	Prepare and maintain reviews of observation impact studies undertaken by NWP centres and provide information for consideration by IPET-OSDE and OPAG-IOS	Rapporteurs on Impact Studies and NWP experts, review results of impact studies relevant to the evolution of observing systems. Organize and hold next NWP Impact Studies Workshop in 2016.	Findings of impact studies	Impact studies	Rapporteurs on Scientific Evaluation of Impact Studies undertaken by NWP Centres	2016: workshop			Report of the 5 th NWP "Impact" workshop (Sedona, 2012) published. Ongoing: recent findings, and proposals for new impact studies discussed at IPET-OSDE1 and approved by CBS Ext.(2014). Preparations well advanced for 6 th workshop (Shanghai, May 2016)

IPET-OSDE2, Final report

I d	Pr io rit y	Objective	Outcome	Deliverabl e	Activity	Leader	Due	OtherETs	Effort	Status Report
6	1	Promote CBS activities in support of GCOS goals	Review the implications of the progress on the GCOS Implementation Plan for the activities of CBS. Bring relevant issues to the attention of the IPET-OSDE	RRR consistent with GCOS	Meeting	Rapporteur on GCOS matters	2013 2016			Ongoing interactions between IPET-OSDE Chair and GCOS.
7	1	Promote CBS activities in support of GFCS goals	Review the implications of the GFCS IP for the activities of CBS. Bring relevant issues to the attention of the IPET-OSDE	RRR consistent with GFCS	Meeting	Chair IPET-OSDE	2016			Relevant activities reviewed at IPET-OSDE1. GCOS/GFCS interaction encouraged.
8	1	Promote CBS activities in support of GCW goals	Review the implications for the activities of CBS of the GCW developments, including the GCW Implementation Plan, and the Cryosphere theme report for the IGOS partnership. Bring relevant issues to the attention of the IPET-OSDE	RRR consistent with GCW	Meeting	Chair IPET-OSDE	2016			Relevant activities reviewed at IPET-OSDE-1 and IPET-OSDE-2. CBS CWP submitted to the AOS1.

IPET-OSDE2, Final report

I d	Pr io rit y	Objective	Outcome	Deliverabl e	Activity	Leader	Due	OtherETs	Effort	Status Report
9	1	Monitor progress and actions by Members and partner Organizations per the approved Implementation Plan for the Evolution of the global observing systems (EGOS-IP), fully responding to the "Vision for the GOS in 2025", and promote activities in support of progress	Seek feedback from National Focal Points, Expert Teams, relevant Technical Commissions, and other groups on the implementation of EGOS-IP, and keep the EGOS-IP progress report up to date. Initiate and monitor activities which promote progress.	EGOS-IP progress report	Survey with FPs, TCs; meeting	Chair IPET-OSDE	Ongoing / Annual review			Ongoing. Feedback against the new EGOS-IP requested to the NFPs for 2013, 2014 and 2015. 2013 input reviewed at IPET-OSDE-1. 2014 and 2015 input reviewed by IPET-OSDE-2. New feedback by EGOS-IP action "owners" reviewed by IPET-OSDE-2.
10	1	Propose guidance regarding observing system network design principles	Draft guidance document on network design (to be further discussed at IPET-OSDE-1 in 2014)	Guidance document on network design	Meeting	Chair IPET-OSDE	End 2013 2014			2 workshops organized in Nov. 2013 and Feb. 2015. OND Principles approved with WIGOS Manual. Draft OND guidance almost complete.

**PROCEDURE FOR UPDATE, VALIDATION AND APPROVAL
OF STATEMENTS OF GUIDANCE WITHIN THE WMO ROLLING
REVIEW OF REQUIREMENTS PROCESS**

(As of 3 April 2014, and approved by IPET-OSDE-1)

1. The Point-of-Contact (PoC) for the Application Area reviews the latest version of the SoG and proposes amendments, in the form of a Microsoft Word document using the "track changes" option. (If there is no pre-existing version, then the PoC drafts the first version of the SoG.) In performing this update, the PoC is expected to refer to some or all of the following: (i) the latest version of the user requirements for the Application Area; (ii) the latest version of the database Observing System Capabilities; (iii) his / her own expertise on the Application Area; (iv) advice from other international experts on the Application Area including, where relevant, WMO constituent bodies, and WMO Programmes and co-sponsored Programmes);
2. The PoC refers the new draft version of the SoG to the Chair of the ET-EGOS, with copy to the WMO Secretariat staff responsible for ET-EGOS;
3. The Chair of the ET-EGOS decides the appropriate review process for the new draft. If a meeting of ET-EGOS is imminent, the new draft becomes a document for this meeting and is reviewed by the Meeting. If a meeting is not imminent, the new draft may be referred to the ET-EGOS for comment(s) by correspondence;
4. The Chair of the ET-EGOS refers the comments of the ET-EGOS to the PoC, either by reference to the report of an ET-EGOS meeting or otherwise, as appropriate;
5. The PoC updates the draft to take account of comments received. Contentious issues are discussed with the Chair of ET-EGOS, as necessary. Microsoft Word "track changes" option continues to be used at this stage;
6. The PoC refers the revised draft version of the SoG to Chair of ET-EGOS, with copy to WMO Secretariat staff responsible for the ET-EGOS;
7. The Chair of the ET-EGOS considers the revised draft and adopts it, or refers it back to the PoC with comments for further revision (by steps 5 and 6 mentioned above);
8. The Chair of the ET-EGOS informs the WMO Secretariat staff responsible for the ET-EGOS when the revised version has been adopted;
9. The WMO Secretariat staff responsible for the ET-EGOS updates the WMO documentation (website, etc.) with the new version of the SoG, with due attention to version control procedures; and
10. At each ET-EGOS meeting, the WMO Secretariat staff responsible for the ET-EGOS reports to the ET on changes since the last meeting, in relation to the SoG version and its review and adoption status.

PROPOSAL FOR AN IMPACT STUDY ON AIRCRAFT BASED OBSERVATIONS

The Chair of CBS Expert Team on Aircraft Based Observing Systems (ET-ABO), Mr Frank Grooters (the Netherlands) reported on a strategy developed by ET-ABO for the implementation of ABO programmes following a regional approach, in accordance with requirements and opportunities expressed by the individual WMO Regional Associations. In doing so, task teams supported by their Regional Offices are developing ABO Regional Implementation Plans (A-RIPs) for the enhancement of the upper air observations network by the use of aircraft as observation platforms.

Together with the development of the A-RIPs, the ET-ABO also has identified areas, which are sparsely covered by aircraft observations, as key-areas for the development of ABO (in general AMDAR) programmes.

Africa is one of these key-areas and the A-RIP for RA I is in an advanced stage of completeness. Currently there is one active AMDAR programme, operated by the South African Weather Service in collaboration with the South African Airways. This programme covers mainly the southern part of the continent. A few airlines within the European E-AMDAR programme are providing AMDAR data from the northern part of Africa, together with a limited number of observations from long haul flights to South African destinations.

In a joint effort by Air France, Météo France, E-AMDAR and the ET-ABO, software development and implementation was funded for the 67 Air France Boeing 777 aircraft. Started in February 2016, this fleet will make AMDAR observations in specifically defined geographical boxes over the Pacific, Atlantic and Africa.

Almost at the same time a development for providing AMDAR data by 58 British Airways Boeing 777 aircraft was completed and became operational, jointly supported by British Airways and E-AMDAR. That fleet will provide AMDAR observations from the Caribbean, Africa and Singapore, but not limited by geographical observation areas as is the case by the Air France B777 fleet.

At the Joint Meeting of the CBS ET-ABO and the CIMO ET-AO (December 2015) it was agreed that the first year of operations of the two B777 fleets over Africa would be funded by the AMDAR Trust Fund. That period started in February 2017 and will end in March 2017. For the benefit of the potential users of the AMDAR data provided by the B777s over Africa, which is supplementary to the current data provided by the South African and E-AMDAR programmes, an OSE on the impact of this additional data on global and regional NWP would be necessary.

The ET-ABO therefore proposed to the IPET-OSDE to support a request to ECMWF, and possible other NWP centres, to do an Observing System Experiment (preferably before the end of 2016) in order to provide valuable information on the impact of this new AMDAR data on global (and regional) NWP products. All data is available on the GTS.

The outcome of such OSE(s) will be helpful in securing funding for the provision these observations in the future.

AFR and BAW B777 Coverage, BUFR Headers and Aircraft Identifiers in RA-I

The Air France (AFR) B777 aircraft will provide AMDAR data in the geographical boxes as given in Figure V-1. Initially these aircraft will be activated only in the boxes 1 (30S-24N/70-180W), 3 (10-90N/20-70W) and 5 (25S-30N/20W-80E).

The British Airways (BAW) B777 aircraft are programmed for providing AMDAR data over Africa, Singapore and the Caribbean, not following the AFR geographical box structure.

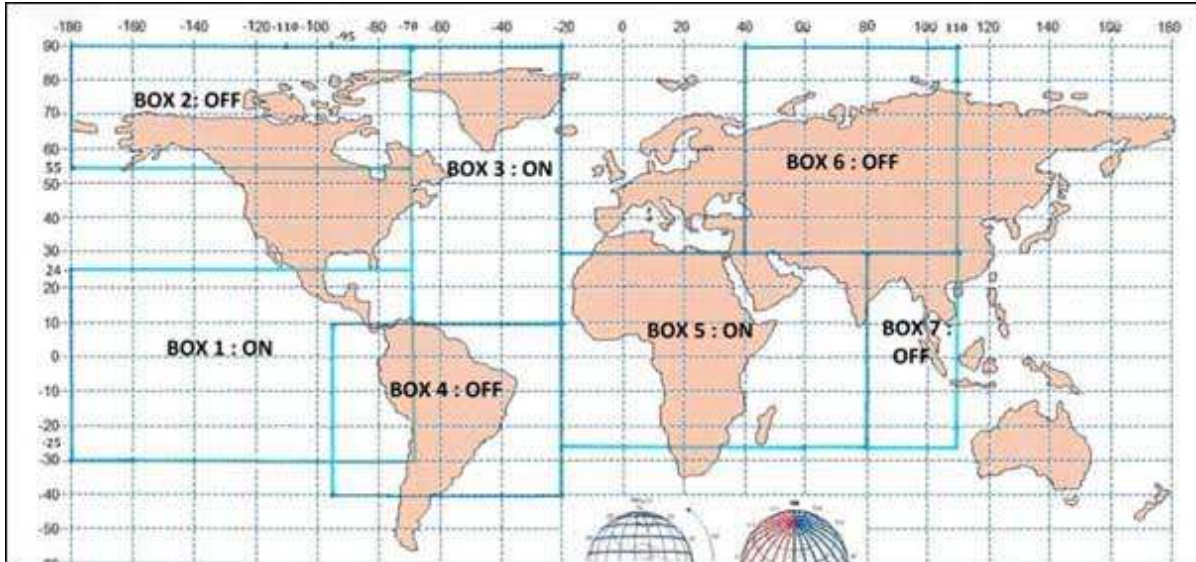


FIGURE V-1: Geographical Boxes for Air France B777 Fleet to provide AMDAR

The BUFR header for the B777 AMDAR data from RA-I is defined as **IUAX01 EGRR**,

where: I signifies BUFR code;

U signifies upper air data;

A signifies single level AMDAR data; and

X signifies the geographical region, according to the following table:

	180W	90W	0	90E	180E
90N	B	A	D	C	
23.5N	F	E	H	G	
23.5S	J	I	L	K	
90S					

Note: If the BUFR bulletin contains data from several aircraft flying in different sectors of the globe, X should be coded 'X'.

IPET-OSDE2, Final Report

Since box 5 (RA-I) has the coordinates 30N-25S/20W-80E, the X can be A, D, E, H, I and L in the BUFR headings:

IUAA01 EGRR
IUAD01 EGRR
IUAE01 EGRR
IUAH01 EGRR
IUAI01 EGRR
IUAL01 EGRR

The AFR and BAW B777 fleets are in the process to be implemented with the appropriate AMDAR Onboard Software (AOS). Currently (early May) aircraft with the following Aircraft Identification are operational and providing AMDAR data:

EU0911
EU0912
EU0913
EU0914
EU0915
EU0916
EU0917
EU0918
EU0919
EU0920
EU0922
EU0923
EU0924
EU0925
EU0986

On request, the actual status of implementation (Aircraft Identifiers) can be provided by the Chair of the ET-ABO (fgrooters@gmail.com).

STATUS OF EXISTING STATEMENTS OF GUIDANCE

(as of 14 April 2016)

This document provides for an overview of the status of statements of guidance regarding the WMO Application Areas.

No.	Application	Contact	Formal version – web (date)	New draft version (date)	Comment
1	Global NWP	Erik Andersson (ECMWF)	April 2014		Approved by Ch.IPET-OSDE 27/7/2014 IPET-OSDE-2: The Point of Contact (PoC), Dr Erik Andersson (ECMWF), reviewed and updated the Statement of Guidance for Global Numerical Weather Prediction (GNWP) in April 2014. The new version proposed is taking into account recent changes in the global observing systems, and the increased importance of coupled assimilation with ocean and land surfaces. The PoC has involved experts on satellite data assimilation, conventional data and ocean analysis in preparing this update
2	High Resolution NWP (previously Regional NWP)	Thibaut Montmerle (France)	July 2014		Approved by Ch.IPET-OSDE 21/7/2014 IPET-OSDE-2: Point of Contact, has reviewed the Statement of Guidance in January 2016 and added the following comments: <ul style="list-style-type: none"> • Emphasis has been put on the potential interest of considering more observations of sea surface temperature and of surface air temperature and humidity over sea, upstream of heavily populated areas or areas prone to high impact weather. • the good spatial resolution of reports available from commercial aircrafts around airports has been pointed out. • the possibility of assimilating data with a higher spatial density than in global NWP, thanks to the shorter background error horizontal correlations used in the data assimilation, has been added.
3	Nowcasting and Very Short Range Forecasting	Paolo Ambrosetti (Switzerland)	June 2015		New version from the PoC approved by the chair posted in June 2015. See also note 3. Approved by Ch.IPET-OSDE 11/6/2015 15.4.1.1. IPET-OSDE-2: The Point of Contact (PoC) reviewed and updated the SoG according to the following: <ul style="list-style-type: none"> • The SoG was edited to comply to the recommended IPET-OSDE template for SoG • In OSCAR there was no requirement on lightning. The Chair invited the PoC to

IPET-OSDE2, Final Report

No.	Application	Contact	Formal version – web (date)	New draft version (date)	Comment
					<p>propose such requirements. The PoC made a review on the topic, made some proposals and consulted a few world scientists on lightning. Eventually a consolidated proposal was done and approved by the Chair. The SoG was then edited to include lightning as well in accordance with the requirements.</p> <ul style="list-style-type: none"> The new version from the PoC approved by the chair was posted on the website in June 2015.
4	Sub-seasonal to longer prediction	Yuhei Takaya (Japan)	Oct. 2014		<p>IPET-OSDE-2: The SoG was updated in February 2016 by the Point of Contact with consolidated inputs from Global Producing Centres of Long-Range Forecasts (GPCs). In this update, the PoC expanded the scope of the SoG to reflect emerging requirements of predictions at sub-seasonal to decadal timescales. Some elements such as sea ice (cover and thickness), deep sea, aerosol, GHGs, solar irradiance in response to the new requirements were added. The PoC also thoroughly updated background and supporting information based on recent literature.</p> <p>The Team noted that the CBS OPAG on Data Processing and Forecasting Systems (DPFS) Expert Team on Operational Predictions from Sub-Seasonal to Longer-Time Scales (ET-OPSLs) was about to review the SoG.</p> <p>Referring to the TPOS-2020 project (see agenda item 6.2), the Team noted that observations in the equatorial pacific are key and needed. The Team invited the PoC to update Section 2.1.2 of the SoG to reflect the need for such data.</p>
5	Aeronautical Meteorology	Jitze van der Meulen (NL)	March 2014		<p>IPET-OSDE-2: The Point of Contact reviewed and updated the Statement of Guidance for Aeronautical Meteorology according to the following:</p> <ul style="list-style-type: none"> The small number of comments and suggestions received after March, 2014 are implemented. Some updates on Volcanic Ash are implemented (references to new documentation). References to ICAO groups are modified, due to the restructure of the meteorological division (installation of the Meteorology Panel, METP in 2014); also references to CAeM ETs are modified. Weblinks in the footnotes were checked and updated. <p>15.4.1.2. Regarding Volcanic ash, IPET-OSDE-2 noted that there were some consistency issues between the requirements and guidance of the ICAO, the GDPFS, and WIGOS. Some additional work may be needed in this area in order to fix those</p>

IPET-OSDE2, Final Report

No.	Application	Contact	Formal version – web (date)	New draft version (date)	Comment
					<p>inconsistencies. The meeting invited the PoC to address this issue in a future review of the SoG. The Team also invited the PoC to add some references to observing techniques for addressing the requirements for icing and turbulence conditions; e.g. how to observe Super Cooled Liquid Water Content (SLWC). The Team invited the PoC to update the SoG to take into account the Team’s perspective on icing, turbulence, and humidity measurements.</p>
6	Forecasting Atmospheric Composition	Oksana Tarasova (WMO)	Not available	Not available	<p>See also note 1 IPET-OSDE-2: PoC to be nominated and gap analysis taking into account both surface-based and space-based observing systems. Overlap with DPFS responsibility for Air Quality Forecasting still to be resolved.</p>
7	Monitoring Atmospheric Composition	Oksana Tarasova (WMO)	Not available	Not available	<p>See also note 1 IPET-OSDE-2: PoC to be nominated and gap analysis taking into account both surface-based and space-based observing systems.</p>
8	Providing Atmospheric Composition information to support services in urban and populated areas	Oksana Tarasova (WMO)	Not available	Not available	<p>See also note 1 IPET-OSDE-2: PoC to be nominated and gap analysis taking into account both surface-based and space-based observing systems.</p>
9	Ocean Applications	Guimei Liu (China)	March 2014		<p>Comments from Ch.IPET-OSDE to PoC 15/7/2014. IPET-OSDE-2: PoC reviewed and updated OSCAR/Requirements and the Statement of Guidance for Ocean Applications according to the following:</p> <ul style="list-style-type: none"> • The tables in the previous version of the SoG were removed since the observational user requirements appeared in a more complete form in the OSCAR database. • Gap analysis was performed for Chlorophyll and nutrients variables. • Some small typos were corrected. <p>The Team noted that the PoC was planning to make the following changes:</p> <ul style="list-style-type: none"> • Proposing tsunami related variables to be added into OSCAR/Requirements. • Consideration of the requirements for sea ice variables in both

IPET-OSDE2, Final Report

No.	Application	Contact	Formal version – web (date)	New draft version (date)	Comment
					<p>OSCAR/Requirements and the SoG.</p> <p>JCOMM Management Committee meeting (Bologna, Nov. 2015) proposed to revise the title of the 'Ocean Applications' Application Area to "Marine Meteorology and Ocean Applications" in order to better communicate to WMO audiences that this also included the more traditional WMO marine services activities such as the GMDSS. The Team invited the PoC with assistance of the Secretariat to liaise with the JCOMM Services Coordination Group (SCG) for its approval with regard to the proposed new name of the Application Area, and for documenting the set of sub-applications for which there are independent observational user requirements.</p> <p>The Point of Contact draw the Team's attention to the fact that in the OSCAR database, in some instances of particular user requirements for a variable, an application area, a vertical layer, and an horizontal domain, the values of the requirements for Uncertainty, Horizontal Resolution, Vertical Resolution, Observing Cycle, Timeliness, or Stability, were identical for the threshold, breakthrough, or goal values. She suggested to coordinate with other Points of Contact to collect their views on requirements and priorities in the various WMO Application Area. The Team invited the PoC to discuss the issue with the Secretariat.</p>
10	Agricultural Meteorology	Mr Robert Stefanski (WMO)	June 2011 (approved by ET-EGOS-6)	Not available	<p>ET-EGOS-7 noted that a CAgM / JCOMM Task Team on Weather, Climate and Fisheries would meet in 2013 and would undertake a review of requirements for the fisheries side of the Agricultural Meteorology Programme. Therefore these have not been included in the SoG at the time but it was anticipated that the SoG would be updated once the fisheries review is completed.</p> <p>Based on the discussions at the ET-EGOS-7, several outstanding issues still need to be reviewed or revised (no progress ET-EGOS-7).</p> <p>A CAgM / JCOMM Task Team on the Weather, Climate and Fisheries met in 2013 and has not completed the review of requirements for the fisheries side of the Agricultural Meteorology Programme. Therefore these have not been included in this SoG but it is anticipated that the SoG will be updated once the fisheries review is completed. This review will probably not be completed until the last quarter of 2014.</p> <p>There was difficulty in organizing a CAgM group to address these issues in the past two years. The 16th Session of CAgM will take place from 10-15 April 2014 and a new Open Panel Structure of the CAgM will be proposed. A dedicated Task Team or Expert Team will be created to look at the observation issues in agricultural meteorology. A dedicated Point of Contact will be named from this Team to liaise directly with the IPET-OSDE.</p> <p>CAgM team will examine all of these outstanding issues. A revised requirements table and</p>

IPET-OSDE2, Final Report

No.	Application	Contact	Formal version – web (date)	New draft version (date)	Comment
					<p>SoG for agricultural meteorology will be provided at the next session of IPET-OSDE. The Point of Contact will liaise with the WMO Secretariat involved in this process to ensure that the revision is done properly. A revision of these documents are proposed to take place by June 2015.</p> <p>IPET-OSDE-1 recognized the anticipated progress, and encouraged CAgM to move as proposed and to report progress at IPET-OSDE-2.</p>
11	Hydrology	Claudio Caponi (WMO)	July 2014		<p>Approved by Chair of IPET-OSDE 30/7/2014</p> <p>IPET-OSDE-2: The Commission for Hydrology (CHy), through its president and one expert working in the WMO Hydrological Observing System (WHOS), together with the WMO Secretariat, have reviewed the current version of the Statement of Guidance for Hydrology and Water Resources, approved in July 2014. Although it doesn't contain any factual mistakes, it was felt that it is based on requirements of hydrological information for global climate modellers, but it doesn't represent the real needs of the hydrological community. Therefore, a revision was undertaken. At the time of the IPET-OSDE-2 a first draft had been prepared, which was not deemed suitable to be submitted to the meeting.</p> <p>One of the difficulties found was that the requirements currently listed under the application "Hydrology and Water Resources" in the OSCAR database, are incomplete and outdated, making a gap analysis impossible. To define hydrological requirements at a global scale is not an exercise hydrologists are used to. Recent experiences in implementing pilot demonstrations of WHOS at regional level seem to indicate that the way forward could be to define either a set of regional requirements, or a set of "cases of representative basin requirements". As WHOS is still in a design phase, and its Phase II will be discussed at the fifteenth Session of the CHy in December 2016, the Advisory Working Group of CHy is proposing for the Commission's next intersessional period starting in 2017, to have a Focus Area consisting of three experts who would be tasked, among other WHOS-related activities, to review the requirements and prepare a new version of the Statement of Guidance, to be submitted to the IPET-OSDE Chair in the second half of 2017.</p>
12	Climate Monitoring	GCOS Secretariat	2010 (GCOS IP) and 2011 (Sat. supplement)	Not available	<p>IPET-OSDE-1 (2014) noted and supported GCOS efforts to work closely with GFCS in order to capture observational requirements of GFCS. This would then allow the RRR process to capture the observational requirements of GFCS (either wholly or mainly) via the detailed input that is expected from GCOS over the next two years.</p> <p>ET-EGOS-2 (July 2006) accepted as SOG the following documents: (i) GCOS Reports on the Adequacy of the global climate observing systems, (ii) GCOS Implementation Plans and their updates, (iii) Satellite Supplements to the GCOS Implementation Plan and their updates, and (iv) Progress Reports on the Implementation of the Global Observing System for Climate in Support of the UNFCCC.</p>

IPET-OSDE2, Final Report

No.	Application	Contact	Formal version – web (date)	New draft version (date)	Comment
					GCOS initiated effort for producing a new progress report (target 08/2015), and implementation plan update (target Mid-2016).
13	Climate Applications (other aspects - CCI)	William Wright (Australia)	May 2012 (approved by ET-EGOS-7)	Not available	<p>IPET-OSDE-2: It was noted that the CCI has established a Task Team on the Statement of Guidance on Observational Needs (TT-SOGON), with the key mandate to Investigate the need and feasibility for quantifying the CCI Statement of Guidance on observational needs. It is expected that a meeting involving leaders of these entities will be held in Geneva late August-Early September 2016 to develop their work plans and synergies on cross-cutting topics, such as observations requirements and standards from CCI point of view. The TT-SOGON will be the CCI vehicle to carry out the formulation of CCI contribution to the IPET-OSDE Statement of Guidance. Meanwhile the most recent CCI SoG remains valid until further notice.</p> <p>Based on above, CCI will undertake an overall revision of what requirements ought to be addressed in the framework of IPET-OSDE and how the formulation of such requirements could be done with complementarity and/or synergy with other commissions which are addressing climate observations from various angles (e.g. CIMO, CAgM, CHy, JCOMM) as well as with other programs (GCOS and WCRP). Feedback is expected by the end of 2017.</p> <p>The Team invited the CCI and the PoC to consider what are the areas this AA should be covering that GCOS is not already covering.</p> <p>ET-EGOS-7: GFCS Implementation Plan, adopted by Cg. Ext.(2012) should also be considered. ET-EGOS-7 encouraged GFCS to follow the WMO RRR in the view to eventually contribute to it.</p>
14	Space Weather	Terry Onsager (USA)	May 2012 (approved by ET-EGOS-7)	Not available	<p>IPET-OSDE-2: The Team noted that the Inter-Programme Coordination Team on Space Weather (ICTSW) was not submitting an updated SoG at this time. A considerable amount of work has been devoted to updating the Space Weather SoG. However, much more work is still needed to ensure the updated version is a meaningful improvement over the existing SoG.</p> <p>The existing SoG for Space Weather is still current in its assessment of the observations required for space weather and the gaps. Following the IPET-OSDE guidance, effort has been devoted to restructuring the information in the SoG into the recommended format described by the template that was approved by IPET-OSDE-1. With this restructuring in place, it is clear that a significant effort is still required in our description of the requirements and in the gap analysis. One of the main issues we face is that in space weather, there are still few quantitative assessments of the linkage between the parameters of the observations and the quality of products. The ICTSW will be working over the next</p>

IPET-OSDE2, Final Report

No.	Application	Contact	Formal version – web (date)	New draft version (date)	Comment
					<p>year on initiating studies that more clearly connect the observing requirements to product quality and reliability. This will be a valuable step toward more quantitative guidance in future SoGs.</p> <p>See also note 4.</p>
15	GTOS	Wenjian Zhang (WMO Secretariat)	No	No	<p>Situation with regard to GTOS evolved. The Chairman of GTOS Steering Committee resigned in March 2013, and the John Latham (FAO) is not responsible anymore for GTOS since 2012. WMO is trying to resolve this issue with FAO at the higher level, and discussing new responsibilities and resources with FAO management. Meanwhile, GCOS took over full responsibility for the TOPC and GEWEX. The Point of contact is now the Director of the OBS Department at the WMO Secretariat, Wenjian Zhang.</p> <p>See also notes 4 and 5.</p> <p>IPET-OSDE-1 noted that GTOS may not be seen as a true Application Area, and may include observational user requirements for several applications. For example, some of the requirements may fall under Hydrology.</p>

Notes:

1. IPET-OSDE-1 recommended that the Atmospheric Chemistry application area should be split into sub-applications. This has now been done, and it has been replaced, and split into the following three new application areas, i.e. (i) Forecasting Atmospheric Composition, (ii) Monitoring Atmospheric Composition, and (iii) Providing Atmospheric Composition information to support services in urban and populated areas. Statements of Guidance for the three new application areas are under preparation.

2. ET-EGOS-7 considered that the GCW could not be regarded as an Application Area. However, there are many sub-applications to be addressed in the GCW context, and the Team agreed to use the IGOS Cryosphere Theme document as a basis for addressing GCW requirements in the new EGOS-IP.

ET-EGOS-6 responded to the requirements of CBS-Ext.(2010) to ensure that any particular requirements of Polar Meteorology are captured through the ongoing RRR process. The Team agreed that the Global Cryosphere Watch (GCW) should not to be regarded as this stage as a specific Application Area. Instead, the Team requested the Points of Contact of all Application Areas to review the information provided by the Secretariat during the meeting (ET-EGOS-6 doc 8.3.2(10/3)) and revise their user requirements and SoGs if necessary. ET-EGOS-6 proposed to adopt the same approach than for GCOS, i.e. regarding a list of documents maintained by the GCW as Statement of Guidance. Such documents include for example the Integrated Global Observing Strategy (IGOS) Cryosphere Theme ("CryOS") report.

3. Per ET-EGOS-5 recommendation, the Synoptic Meteorology Application Area has been merged into the Nowcasting and Very Short

Range Forecasting Application Area.

4. ET-EGOS-5 suggested that the following applications should be addressed:

- (i.) Space Weather. Space weather events affect the meteorological infrastructure through their impact on environmental satellites, navigation satellites (e.g. GPS) and space-based telecommunication systems; they also represent a potential hazard for aviation and some large ground-based facilities. Critical phenomena to be monitored include solar radiation storms, high-energy particle rain, ionospheric and geomagnetic storms, and radio black-out by X-ray photons. This requires permanent measurements in the area of e.g. Solar imagery, High- and Low-energy particle detection, and Electron density. Refining these observation requirements is a prerequisite towards the standardization of Space Weather instruments that WMO is now expected to support.;
- (ii.) GTOS requirements for understanding the global carbon cycle and related climate change issues. For consistent and comprehensive monitoring of the carbon cycle, ecosystems, forests and land dynamics in general, both long-term sustained observations of Essential Climate Variables as well as regionally-focussed, intermittent measurements of other variables (and their fluxes) for process-type studies are required. A comprehensive gap analysis of existing capabilities in relation to needs is yet to be undertaken. Such an analysis should build on the existing SoG for Climate Monitoring (ie. the GCOS Second Adequacy Report, the GCOS IP and its 2010 Update) as well as the status reports on the development of standards for terrestrial ECV (<http://www.fao.org/gtos/topcECV.html>).

ET-EGOS-5 invited the Inter-programme Coordination Team on Space Weather (ICT-SW) to address user requirements on space weather, and provide feedback to the ET-EGOS Chair on the list of relevant Applications.

5. ET-EGOS-5 recognized that many GTOS requirements are being already considered by GCOS, but not all of them. The Team requested the Secretariat to identify PoC who should be invited to identify those requirements that are not covered by GCOS (i.e. the non GCOS requirements of GTOS).

Reference: Current versions of Statements of Guidance - <http://www.wmo.int/pages/prog/www/OSY/GOS-RRR.html#SOG>

**PROPOSED TOPICS FOR NWP IMPACT STUDIES RELEVANT TO THE EVOLUTION OF
GLOBAL OBSERVING SYSTEMS (REVISED 2016)**

(as proposed by IPET-OSDE2, April 2016, and submitted to ICT-IOS-9 for its review; the list may be further updated until the end of June 2016 by the R-SEIS, and for submission to CBS-16)

Short name: Full name	Science question
Surface-based	
S1Marine: Surface pressure over ocean	What density of surface pressure observations over ocean is needed to complement high-density surface wind observations from satellites? What is the required coverage of SCAT winds?
S2AMDAR: Coverage of AMDAR	What are the priorities for expansion of the AMDAR network? How does the impact vary over the globe? Provide guidance for AMDAR optimisation. Evaluate the impact of MODE-S data in high-resolution NWP.
S3Radar: Radar observations	What are the impacts of current radar observations, including wind profiles, radial winds and reflectivities?
S4Strat: <i>In situ</i> observations of the stratosphere	What network of <i>in situ</i> profiling observations is needed in the stratosphere to complement current satellite observations (including radio occultation)? Assessments addressing the Tropics are encouraged.
S5PBL: Observations of the PBL for regional and high-resolution NWP	What should be the focus of improvements for observations of the planetary boundary layer (PBL) in support of regional and high-resolution NWP? Which variables and what space-time resolution?
Space-based	
S6SatLand: Satellite sounding over land and ice	What is the impact of new developments in the assimilation of radiance data over land and sea ice?
S7Sounders: Impact of multiple satellite sounders	What benefits are found when data from more than one passive sounder are available from satellites in complementary orbits, e.g. the current unprecedented availability of four hyper-spectral sounders?
S8AMVs: Atmospheric Motion Vectors	Based on evidence from current AMV impacts, which AMV characteristics should be enhanced for the next generation of GEO satellites? What are the impacts of recent new types of AMVs such as MISR-AMV?
General	

S9UA: Regional upper-air network design studies

Upper-air network design studies such as those that have been performed for the European composite observing system (EUCOS) are required also in other Regions, especially in Region I where the basic networks are under pressure. Assessments of recent changes in the networks, including the impact of launching radiosondes once per day.

S10AdjEns: Application of adjoint and ensemble methods

What insights can be gained from adjoint and ensemble-based impact measures tailored for applications such as severe weather, aviation and energy? Specific impact metrics may be required.

S11Ocean: Impact in ocean-coupled assimilation

Which ocean observations are particularly important for NWP? Investigate the role of ocean observations in coupled atmosphere-ocean data assimilation with a focus on the 7-14 day range.

S12Land: Impact in land-coupled assimilation

Which land-surface observations are particularly important for NWP at all forecast time ranges? Investigate the role of surface observations in coupled atmosphere-land data assimilation with a focus on the 7-14 day range.

S13 Time frequency

What is the required time frequency of observations? Consider AMDAR, GEO satellites and ground-based remote sensing observations (such as Doppler radar, wind profiler, ground based GNSS receivers) for regional and global NWP.

S14 Atmospheric composition

Study observation impact in atmospheric composition and air quality application and the impact of atmospheric composition observations (e.g. aerosol) on NWP.

S15 OSSEs

Observing system simulation experiments are encouraged in support of satellite system design criteria such as orbit optimization for GPS-RO satellites, or configurations for hyperspectral IR sounders on geostationary orbit.

**TEMPLATE FOR ANNUAL REPORT ON
PROGRESS AND PLANS BY NATIONAL FOCAL POINTS (NFPS) REGARDING ACTIONS OF THE IMPLEMENTATION PLAN FOR
EVOLUTION OF GLOBAL OBSERVING SYSTEMS (EGOS-IP)**

(as proposed by IPET-OSDE-1, March 2014, and then modified by IPET-OSDE Chair and Secretariat for the 2014 and 2015 reporting)

Year: **2015**

Country: _____

Point of Contact:

Full name: _____

E-mail address: _____

1. GUIDANCE FOR REPORTING ON THE STATUS OF ACTIONS:

The Implementation Plan for Evolution of Global Observing Systems (EGOS-IP) (*responding to the vision for the GOS in 2025 and WIGOS needs*) was approved by EC-65 (Geneva, 2013) following recommendation from the fifteenth Session of the CBS (Jakarta, Indonesia, 10-15 September 2012). The EGOS-IP is also available on the WMO website in four languages using the links below:

English: <http://www.wmo.int/pages/prog/www/OSY/Publications/EGOS-IP-2025/EGOS-IP-2025-en.pdf>

French: <http://www.wmo.int/pages/prog/www/OSY/Publications/EGOS-IP-2025/EGOS-IP-2025-fr.pdf>

Spanish: <http://www.wmo.int/pages/prog/www/OSY/Publications/EGOS-IP-2025/EGOS-IP-2025-es.pdf>

Russian: <http://www.wmo.int/pages/prog/www/OSY/Publications/EGOS-IP-2025/EGOS-IP-2025-ru.pdf>

The CBS, through the Inter Programme Expert Team on the Observing System Design and Evolution (IPET-OSDE) is regularly reviewing status of actions and progress from various sources as part of the Rolling Review of Requirements (RRR) process. From that review, an updated EGOS-IP progress report is issued, further recommendations to Members are made, and the information from the progress report and gaps taken into account for producing a future version of the EGOS-IP amongst other materials.

While there are various mechanisms (e.g. through the WMO Space Programme, the relevant CBS Expert Teams, and interactions with other

IPET-OSDE2, Final Report

Technical Commissions such as JCOMM and CAS) to collect feedback on such status and progress of actions, the IPET-OSDE has recommended that the National Focal Points for the EGOS-IP should focus on some of the overarching and cross cutting actions, as well as some of the surface-based observing systems actions. These are listed in the template below.

It should be noted that the NFPs may provide feedback on activities beyond their own NMHS, so they are encouraged to also play a facilitating role within their countries on all relevant EGOS-IP activities if they wish.

Therefore, we strongly encourage all NFPs to take the opportunity to provide feedback and have their views and experiences taken into account.

To make the analysis of reports easier, we would be grateful if you could provide the Secretariat (dlockett@wmo.int) with your national feedback on actions of the new EGOS-IP per the template below at your earliest but preferably by 31 March 2015.

Thank you for your valuable contribution.

2. TEMPLATE FOR THE NATIONAL FEEDBACK ON THE IMPLEMENTATION OF ACTIONS AT THE NATIONAL LEVEL

Please fill in the last column of the table below taking into account the guidance above, and the additional guidance provided in the fourth column.

Action No.	Action	Performance indicator	Additional guidance for NFPs	Feedback on the implementation of action at the national level
C3	WIS Standards – Ensure all operators producing observations adhere to the WIS standards.	Extent to which WIS standards are applied.	Do you already have access to documentation that defines these standards? Is it in all WMO languages?	
C4	Users consultation – Careful preparation is required before introducing new (or changing existing) observing systems. The impact needs to be assessed through prior and ongoing consultation with data users and the wider user community. Also, data users need to be provided with guidance on data reception/acquisition, processing and analysis infrastructure, the provision	Extent to which user community concerns are captured.	What approach are you taking to these issues in your country?	

IPET-OSDE2, Final Report

Action No.	Action	Performance indicator	Additional guidance for NFPs	Feedback on the implementation of action at the national level
	of proxy data, and the provision of education and training programmes.			
C7	"Change management" procedures – Ensure time continuity and overlap of key components of the observing system and their data records, in accordance with user requirements, through appropriate change-management procedures.	Continuity and consistency of data records.	What approach are you taking to these issues in your country?	
C8	Data sharing principles – For WMO and co-sponsored observing systems, ensure continued adherence to WMO data sharing principles irrespective of origin of data, including data provided by commercial entities.	Continued availability of all essential observational data to all WMO members.	How do you interpret your responsibility on this issue? What channels/routes do you use for international exchange of your observational data?	
C12	Radio frequencies – Ensure a continuous monitoring of the radio frequencies which are needed for the different components of WIGOS, in order to make sure they are available and have the required level of protection.	Observation frequency bands available/not available with required level of protection.	How do you see your role and the role of your NMHS in this regard?	
G2	Hourly data exchange – Ensure, as far as possible, a global exchange of hourly data which are used in global applications, optimized to balance user requirements against technical and financial limitations.	The standard monitoring indicators used in global NWP.	How do you see your role and the role of your NMHS in this regard?	
G4	WIGOS Standards – Ensure exchange of observations from atmosphere, ocean, terrestrial observing system, according to the WIGOS standards. If needed, organize different levels of pre-processed observations in order to satisfy	Statistics on the data made available to each application.	Do you already have access to documentation that defines these standards? Is it in the desired WMO language (Arabic, Chinese, English, French, Russian and Spanish) for your country?	

IPET-OSDE2, Final Report

Action No.	Action	Performance indicator	Additional guidance for NFPs	Feedback on the implementation of action at the national level
	different user requirements.			
G7	Radiosondes in data-sparse areas – Expand radiosonde stations, or re-activate silent radiosonde stations, in the data sparse areas of Regions I, II and III which have the poorest data coverage. Make all possible effort to avoid closing of existing stations in these data sparse areas, where even a very small number of radiosonde stations can provide an essential benefit to all the users.	The standard monitoring indicators used in NWP	Please provide a list of new stations and stations that are having difficulty maintaining operations.	
G13	Radiosonde data availability – Identify radiosonde stations that make regular measurements (including radiosondes operated during campaigns only), but for which data are not transmitted in real-time. Take actions to make data available.	A number of the above radiosonde stations providing data to GTS, plus standard monitoring indicators on radiosonde data availability and timeliness.	Please identify these stations.	
G14	HR Radiosonde data – Ensure a timely distribution of radiosonde measurements at high vertical resolution, together with position and time information for each datum, and other associated metadata.	Number of radiosonde sites providing the high resolution profiles.	Please summarize progress on this issue in your country.	
G17	Regional remote sensing profiling stations – Develop networks of remote-sensing profiling stations on the regional scale in order to complement the radiosonde and aircraft observing systems, mainly on the basis of regional, national and local user requirements (although part	A number of profiling stations providing quality-assessed data in real-time to WIS/GTS.	Please summarize progress on this issue in your country.	

IPET-OSDE2, Final Report

Action No.	Action	Performance indicator	Additional guidance for NFPs	Feedback on the implementation of action at the national level
	of the measured data will be used globally).			
G18	Processing & exchange of profiler data – Ensure, as far as possible, the required processing and the exchange of profiler data for local, regional and global use. When profiler data can be produced more frequently than 1 hour, a dataset containing only hourly observations can be exchanged globally following the WIS principles.	A number of profiling stations exchanged globally.	Please summarize progress on this issue in your country.	
G40	Metadata & representativeness of special stations – Ensure, as far as possible in real-time, exchange of observations, relevant metadata, including a measure of representativeness made by surface-based stations serving specific applications (road transport, aviation, agricultural meteorology, urban meteorology, etc.).	A percentage of observations from the above stations exchanged regionally and globally in real-time.	Please summarize progress on this issue in your country.	
G45	Dual polarization radars – Increase the deployment, calibration and use of dual polarization radars in those regions where it is beneficial.	Data coverage obtained from this type of radar for each Region.	Please summarize progress on this issue in your country.	
G47	Weather radars for developing countries & DRR – For areas in developing countries which are sensitive to storms and floods, a special effort has to be made to establish and maintain weather radar stations.	The number of operational weather radar stations in the above areas.	Please summarize progress on this issue in your country.	

OSCAR UPDATING/MAINTENANCE PROCEDURE ¹**WIGOS Information Resource****OSCAR/Space updating/maintenance procedure
V1.2 (Draft)****Document change record**

Date and Version	Description	Authorized by
10.04.2013 / v0.1	Initial draft	
29.04.2013 / v0.2	Edits by J. Lafeuille	
29.04.2013 / v0.3	Editorial changes, paragraph on content versioning, paragraph on user feedback	
1.10.2013 / v1.0	Implementation	J. Lafeuille C/SBOS
21.2.2014 / v1.1	Insertion of Section 3 OSCAR/Requirements updating process	
3.4.2014	Section 3 approved by IPET-OSDE1	IPET-OSDE1
29.2.2016 / v1.2 (Draft)	- Section 4.2 and Step 2.1 for OSCAR/Space V. 2 - Section 8: IPET-SUP	

¹ Note: the OSCAR/Requirements parts added to the ET-SAT approved document are highlighted in green. IPET-OSDE concurred with the Space part, and approved the Requirements part.

OSCAR UPDATING/MAINTENANCE PROCEDURE

1. INTRODUCTION

1.1 **Purpose and scope**

This procedure defines the roles, responsibilities and steps to be followed to update content, functionality and interface of the OSCAR/Requirements and OSCAR/Space modules with the aim to ensure that OSCAR content is up-to date, correct, quality-controlled, accessible and fit for purpose.

Note: OSCAR/Space feeds another information resource, the CGMS Satellite Status list, which is thus indirectly covered by this procedure.

1.2 **Document plan**

The document contains seven sections:

- Section 1: Introduction
- Section 2: Roles
- Section 3: [OSCAR/Requirements updating process](#)
- Section 4: OSCAR/Space content updating process
- Section 5: Updating of functionality and interface
- Section 6: User feedback and evaluation
- Section 7: Resources for Oscar updating and maintenance
- Section 8: Evolution of the procedure

1.3 **Background documents**

- OSCAR/Space Software Requirements Specification
- WIGOS Information Resource (WIR) functional requirements specification
- ISO/IEC 14764:2006 Software Maintenance
- [CIMO Guide Part 3 Chapter 1 Quality management](#)
- [Rolling Review of Requirements \(RRR\) process](#)

1.4 **Definitions**

Acronym	Definition
OSCAR	Observing System Capability Analysis and Review Tool
WIGOS	WMO Integrated Global Observing system
WIR	WIGOS Information Resource
CEOS	Committee on Earth Observation Satellites
CGMS	Coordination Group for Meteorological Satellites

2. Roles

The updating and maintenance processes involve the following roles. In practice, one person can take multiple roles.

Role name	Description
SP Office	Space Programme Office (Including external contractors acting by delegation of the SP Office staff and in accordance with the present procedure)
PoC	Point of Contact in charge of reviewing and updating the requirements for a given Application Area identified in the RRR process
IPET-OSDE	CBS Inter-Programme Expert Team on Observing System Design and Evolution
ET-SAT	CBS Expert Team on Satellite Systems
Satellite Operators	Satellite operators with missions recorded in OSCAR
Science Groups	International Science Groups that partner with WMO, e.g. IPWG, IROWG, ICTSW
WIR Project Manager	Person responsible for coordinating the overall WIGOS Information Resource (WIR) developments including OSCAR developments
OSCAR Developer	Person(s) responsible for the technical developments of the OSCAR tool
OSCAR Technical Administrator	Person(s) responsible for the maintenance and operation of the OSCAR tool <i>[Note: possibly different persons for OSCAR/Requirements, OSCAR/Space, OSCAR Surface]</i>

3. OSCAR/REQUIREMENTS UPDATING PROCESS

3.1 EXPLANATIONS

This section applies to the updating of the contents of OSCAR/Requirements. For changes to the functionality of OSCAR, please refer to Section 5.

The variables registered in OSCAR are generally shared by several application areas. Each variable has the following attributes, which can only be updated by the administrator.

TABLE 1: Attributes of a variable in OSCAR

Attribute	Example
Name	<i>Sea surface temperature</i>
Applicable cross-cutting tags	<i>Cryosphere, Tropical Meteorology</i>
Domain or sub-domain	<i>Ocean</i>
Definition	<i>Temperature of the sea water at surface. The "bulk" temperature refers to the depth of typically 2 m, the "skin" refers to within the upper 1 mm.</i>
Comment	<i>Detailed SST definitions are available from GHRSSST: https://www.ghrsst.org/ghrsst-science/sst-definitions/</i>
Measuring unit	<i>K</i>
Uncertainty unit	<i>K</i>
Stability unit per decade	<i>K</i>
Unit for horizontal resolution	<i>km</i>
Unit for vertical resolution	
Applicable layers	<i>Sea surface, Bulk</i>

3.2 NEW VARIABLES OR CHANGES TO THE ATTRIBUTES OF A VARIABLE

The following steps shall be followed when entering a new variable or updating any attribute of an existing variable:

Step	Description	Responsibility	Frequency
1	When identifying the need to either register a new variable or amending the attributes of an existing variable, the Point of Contact or a relevant expert submits the proposed attributes (as listed in Table 1) to the administrator with a brief justification.	PoC or other expert	When needed
2	The administrator checks the formal consistency of the recommended change, seeking clarification from the initiator if necessary. If the change is minor (e.g. adding a layer, or editorial correction on the definition, etc.) the administrator jumps to step 5.	Administrator	When contacted by a PoC or other expert
3	If the recommended change is substantial and/or has a potential impact on the requirements of several applications, the administrator seeks confirmation from the IPET-OSDE Chair	Administrator	When appropriate
4	The IPET-OSDE Chair either confirms the proposed change, or contacts the expert for further discussion, or submits the proposal to discussion by IPET-OSDE	IPET-OSDE Chair	When appropriate
5	Upon confirmation by the IPET-OSDE Chair, or endorsement by the IPET-OSDE group, or if the recommended change is minor, the OSCAR/Requirements administrator implements the change.	Administrator	When a proposed change is confirmed

3.3 REQUIREMENTS APPLICABLE TO AN EXISTING VARIABLE

The provisions below are applicable when a requirement is updated, or a new requirement is entered, for a variable which is recorded in OSCAR, without changing the definition, unit, or applicable layers of this variable.

Step	Description	Responsibility	Frequency
1	The PoC reviews the requirements of his/her application area in consistency with the Statement of Guidance, taking into account the evolution occurred in the application area.	PoC	Yearly
2	If updates are necessary, the PoC logs in as Editor, and updates the requirements or enters new requirements as appropriate. If necessary he/she contacts the administrator for assistance.	PoC	Yearly
3	When the update is ready, the PoC informs the OSCAR/Requirements administrator that requirements are in draft status	PoC	When update is ready for validation
4	The administrator checks the formal consistency of the new or updated requirement. If the updates are purely editorial or a factual correction, the administrator jumps to step 7	Administrator	When requested
5	If the updates are substantial, the administrator seeks confirmation from the IPET-OSDE Chair	Administrator	When relevant
6	The IPET-OSDE Chair either confirms the updated requirement, or contacts the PoC for further discussion, or submits the proposed update to IPET-OSDE for discussion.	IPET-OSDE Chair	When relevant
7	Upon confirmation by the IPET-OSDE Chair, or endorsement by IPET-OSDE, or if the draft update is minor, the OSCAR/Requirements administrator validates the update.	Administrator	When confirmed

4. OSCAR/SPACE Content updating Process

There are two levels of content updates:

- First level: updates based on non-controversial factual evidence,
- Second level: other updates, resulting of expert assessment.

4.1 First level: updating of factual content

Scope: Refers to update, insertion or deletion of factual content, based on non-controversial factual evidence (e.g. satellite launch dates, new satellite plans, start or end of operational service, orbit characteristics, instrument specifications, ground segment and programme description).

Step	Description	Responsibility	Frequency
1	SP Office keeps track of publicly available information from official satellite operator sources and updates OSCAR accordingly [If necessary, updates are confirmed with Satellite Operator focal points]	SP Office	Continuous, Delay of max 2 months
2	Satellite Operators inform SP Office of important changes or factual errors in OSCAR	Satellite operators	As necessary
3	CGMS satellite operators regularly validate factual information within their responsibility through annual reports to CGMS	Satellite operators	yearly
4	For non-CGMS members, updates are collected either via CEOS or, if relevant (e.g. non-CEOS Members), through direct call from the SP Office	SP Office in consultation with CEOS	yearly

4.2 Second level: updating of assessments

Scope: Refers to assessments of the suitability of certain instruments for fulfilling pre-defined capabilities or measuring specific variables. Since these assessments can be subject to discussion, effort is made to seek endorsement by representative or authoritative experts. As of OSCAR/Space Version 2, these assessments rely on expert rules based on remote sensing science principles. Expert groups will be invited to engage in the validation and update of this knowledge basis.

Step	Description	Responsibility	Frequency
1	Instruments are classified and assessed according to objective design features	SP Office	As new satellites/instruments are added
2.1	Thematic science groups and IPET-SUP are invited to review the rules determining the instrument rating per product, in their respective fields of expertise	Science groups (e.g. IPWG, IROWG, ICTSW) and IPET-SUP	Typically 2-yearly, or when major updates are entered
2.2	ET-SAT validates the assessments and other details in their field of expertise	ET-SAT	yearly
3	SP Office implements changes requested by ET-SAT and/or science groups,	SP Office	yearly

4.3 Traceability of updates

All operations (insert, update, delete) are automatically recorded by the system. An administrator can access these logs and reverse changes if necessary.

A list of major content updates (e.g. structural changes, assessments) is maintained by the SP Office.

5. Updating of functionality and interface of the tool

Conceptual and/or technical changes to the structure, functionality and interface of the tool can be differentiated in "system maintenance", "adaptive/corrective maintenance" and "feature updates".

5.1 System maintenance

Scope: Maintenance tasks necessary to provide 24/7 accessibility and recovery services in case of failure. Includes the regular maintenance of hosted server environment.

	Description	Responsibility	Frequency
Process 1	Ensure maintenance of application backups and keep recovery versions. (Application and Content)	OSCAR Technical Administrator	Continuous
Process 2	Monitor and configure technical platform (web server, database systems etc) Inform OSCAR Developer of any significant changes in environment	OSCAR Technical Administrator	As needed, at least bi- annually, or if necessary

5.2 Adaptive/corrective maintenance

Scope: Refers to analysis and correction of discovered bugs or incompatibilities arising through the use of new devices and browsers, as well as minor changes to the presentation (wording, layout).

Step	Description	Responsibility	Frequency
1	Recording, prioritizing and validating requests	SP Office	continuous
2	Implementation and test of update, inform users (if applicable / relevant)	OSCAR Developer	as applicable, with delay of max 2 months

5.3 New features, new functionalities and presentation

Scope: This refers to adding new functionalities, or significantly changing current behaviour of the tool, including presentation and user interface.

Step	Description	Responsibility	Frequency
1	Recording of general feedback and feature requests from Expert Groups, Satellite operators, users, OSCAR	SP Office	Continuous

	development team		
2	ET-SAT provides guidance on evolution of functionality and interface [WIR development team is consulted if requests have effects on other OSCAR modules]	ET-SAT [WIR project manager]	yearly
3	Approved features are recorded in the Software Requirements Specification for OSCAR/Space	SP Office	
4	Changes are implemented in accordance with overall OSCAR procedures and schedules	OSCAR Developer	
5	OSCAR manual(s) are updated as necessary	SP Office, OSCAR Developer	

5.4 Traceability

- A list of discovered bugs, incompatibilities and problems, along with their priority and status is maintained by the OSCAR Developer
- A list of all feature requests is maintained by the WMO SP
- Approved functionalities/ features or changes of such are recorded in the Oscar "Software Requirements Specification" (SRS) Document.

6. User feedback and evaluation

User feedback is collected through an email address indicated on the OSCAR homepage, which is checked on a regular basis by the administrator.

User emails are responded and appropriate actions are taken in accordance with the processes outlined in Section 3 and Section 4, for instance:

- an explanation is provided to the user, added in OSCAR views or in the user manual;
- a modification is brought to the interface or the functionality;
- contents are corrected, or a proposal for correction submitted to a satellite operator or a science group for validation.

Structured online surveys are used at regular intervals (every 1-2 years, as appropriate) to collect information on visitor characteristics and feedback on user satisfaction and possible areas for improvement.

Visitor statistics (number, origin, access characteristics) are collected. These statistics are reviewed on an annual basis within the SP Office.

7. Resources for Oscar updating and maintenance

The CBS Recommendation 1 (CBS-15) on Implementation and Sustainability of the Database of Observation Requirements and Observing Capabilities states:

(1) That resources be assigned with high priority within the Secretariat to complete the software development and, on a sustained basis, for technical maintenance, first-level contents updating and, through consultancy, for technical-level updating and quality control, as a key activity of the WMO Integrated Global Observing System;

(2) That Members, expert teams of the Open Programme Area Group on Integrated Observing Systems, satellite operators including the Expert Team on Satellite Systems

and members of the Coordination Group for Meteorological Satellites, support the database updating process through submitting inputs and providing reviews and feedback.

8. Evolution of the Procedure

This procedure is maintained by the SP Office, in consultation with the WIR development team, IPET-OSDE, IPET-SUP and ET-SAT.

**TEMPLATE FOR
STATEMENTS OF GUIDANCE (SOGs)**

(as approved by IPET-OSDE-1, April 2014)

The Statement of Guidance (SoG) for a WMO Application Area¹ is a gap analysis; it provides an assessment of the adequacy of observations to fulfill the observational user requirements and suggests areas of progress towards improved use of space-based and surface-based observing systems. Only the most significant variables in a given Application Area are analyzed in the SoGs.

The aims of the SoG are:

- to inform WMO Members on the extent to which their requirements are met by present systems, will be met by planned systems, or would be met by proposed systems. The Statement of Guidance is essentially a gap analysis with recommendations on how to address the gaps. It also provides the means whereby Members, through the Technical Commissions, can check that their requirements have been correctly interpreted.
- to provide resource materials useful to WMO Members for dialogue with observing system agencies regarding whether existing systems should be continued or modified or discontinued, whether new systems should be planned and implemented, and whether research and development is needed to meet unfulfilled aspects of the user requirements.

The Statement of Guidance for an Application Area is one element of the Rolling Review of Requirements (RRR²) process. It is used by the Commission for Basic Systems to complete the RRR process and contribute to the "Vision for the GOS"³, and hence to the Implementation Plan for the Evolution of Global Observing Systems (EGOS-IP⁴).

The SoG is prepared by the Point of Contact (PoC) nominated for the considered Application Area. The PoC is responsible for coordinating the development of the SoG with his/her community. He/she shall submit the SoG and future updates to the Chair of the Commission for Basic Systems (CBS) Inter-Programme Expert Team on the Observing System Design and Evolution (IPET-OSDE) for his/her review and submission to the IPET-OSDE for discussion. SoGs are approved by the Chair of IPET-OSDE and/or the IPET-OSDE.

The SoG shall be structured as follows. The inclusion of annexes is discouraged.

1 <http://www.wmo.int/pages/prog/www/wigos/wir/application-areas.html>
2 <http://www.wmo.int/pages/prog/www/OSY/GOS-redesign.html>
3 <http://www.wmo.int/pages/prog/www/OSY/gos-vision.html>
4 <http://www.wmo.int/pages/prog/www/OSY/gos-vision.html#egos-ip>

**STATEMENT OF GUIDANCE FOR
[NAME OF APPLICATION AREA]**

*(Point of contact: name of point of contact who prepared the SoG)
(Version number, approval status, and date)*

1. Introduction

[1/2 to 1 page]

This section shall briefly describe the Application Area and its possible sub-areas addressed in the document, and provide some information on the purpose and end users of those applications.

It also provides some general information on how the Application Area depends on observations.

2. Description of requirements

[1 to 2 pages]

As observational user requirements are not independent between Application Areas, duplication shall be avoided. This section shall therefore explain how the requirements of other Application Areas could be relevant to this Application Area; such requirements shall not be repeated in this SoG.

This section shall briefly describe the observational user requirements. They are listed by observed variable, and if needed by sub-application.

As the observational user requirements are described quantitatively and exhaustively in the User Requirements Database (i.e. OSCAR/Requirements⁵), the requirements listed in this section shall not duplicate the database, and therefore remain short and generic. It shall include a textual description of the issues that it is necessary to understand in order to interpret the numbers in the OSCAR/Requirements⁵.

3. Gap analysis

[n pages]

This section provides the results of the critical review and gap analysis for the most important variables to highlight where the main gaps exist. The critical review involves comparing the capabilities of the surface- and space-based observing systems with the quantitative observational user requirements from the OSCAR/Requirements⁵ database.

The process of preparing the gap analysis is necessarily more subjective than that of the critical review. Moreover, whilst a review attempts to provide a comprehensive summary, a Statement of Guidance is more selective, drawing out key issues. It is at this stage that judgements are required concerning, for example, the relative importance of observations of different variables. If impact studies have been conducted, the results of such studies should also be considered for the gap analysis.

As in section 2 above, duplication shall be avoided between Statements of Guidance when one Application Area depends on the requirements of another Application Area.

This section shall be organized by observed variable, and for each variable, and possibly for each sub-application, describe where there are gaps and how they might be addressed

⁵ <http://www.wmo-sat.info/oscar/observingrequirements>

in order to have substantial impact on the Application Area.

The following terminology has been adopted in the SoGs.

- **"Marginal"** indicates minimum user requirements are being met,
- **"Acceptable"** indicates greater than minimum but less than maximum requirements (in the useful range) are being met, and
- **"Good"** means close to maximum requirements are being met.

4. Recommendations on how to address the gaps.

[1/2 to 1 page]

This section shall summarize the recommendations on how to address the gaps described in section 3 above. It may include a first section with some generic recommendations, followed by a second section listing the critical variables that are not adequately measured by current or planned systems are (in order of priority).

References

This section may include sources of additional relevant information concerning the Application Area and its requirements.

OUTCOME OF BREAKOUT GROUP 1

OSCAR/SURFACE - TECHNICAL ISSUES AND GAP ANALYSIS

Lead: Stuart Goldstraw

Members: Paolo Ambrosetti, Erik Andersson, Frank Grooters, Stefan Klink, Jay Lawrimore, Guimei Liu, Russell Stringer, Werner Thomas, Jitze van der Meulen, Daniel Michelson

A wide ranging discussion resulted in a series of basic query functions being requested. The following summarises the set of query functions that were requested. The detailed definition of each query needs reviewing but the summary is as follows:

Queries

4 dimensional selection (H, V & T) of spatial / temporal boxes. Selection of Box to include point, lat / long box, shape, region (pre-defined selectable), RA area, Poles, Hemisphere, Globe

Ability to query current status (spot status)

Ability to query change of status over selectable period of time (change status)

Ability to query trends over selectable period of time (trends)

Ability to query densities over selectable period of time (averages)

Ability to query changes over a selectable period of time (changes)

Ability to query a forward look, using 'real'+ 'theoretical' source information

Ability to query status of observing systems

Ability to query parameters - from a list of parameters as defined in OSCAR Requirements

Ability to query specific systems

Ability to query operational programmes

Ability to query nations

Ability to use Boolean Operators to conjoin parameters / systems / programmes – at least AND and NOT

Ability to query proportion of stated user requirement being met per parameter, for H, V, cycle, delay & uncertainty.

Wider user engagement

Further engagement of users is required, specifically the Members and Operational Programme Managers, this breakout session focused on Application Area PoC needs.

Presentation of results

Results to be available as a dataset and/or image and/or layer within a GIS system

Storage of queries

Ability to sort queries for use in future – this implies the creation of a query library?

Next Steps

Once we have these basic tools the Application Area PoCs can develop more complex methodologies to analyse the status of implementation as part of their SoG review.

Notes from Dean

Intro

- Workshop held in 2015
- There is inter-relation and inter-dependence of systems (e.g. radar and rain gauges for precip measurement)
- Overlap is useful
- Can OSDE compile a list of reports that might be useful to users?
- Reports can be based on one single network or programme and on integrated networks (variables or parameters)

JL: Historical capabilities?

TP: Quality is handled by WDQMS but OSCAR will have a connection (e.g. reporting status).

Evolution of capabilities should be able to be shown based on selection of:

- time
- area
- country
- region (4 dimension)

SG: Question: Are we meeting requirements? needs to be answered.

At what level of detail can queries can be made.

Who are the users?

- National programme operators (metadata input/output/display functions)
- National, regional and global Programme Managers (variable and metadata output/display functions)
- IPET-OSDE (Gap Analysis - variable output/display functions)

FG What is OSCAR For?

SK: Need to be able to focus on variables (technology independent) to be able to analyse gaps

- Need a density of observations in 3D

SG: May need function to average over time/space to accommodate moving objects

JL: Show where requirements are being met or not in areas and over time.

SG: Outputs - Data can be:

- Displayed on maps
 - Colour coding according various selections
- Downloaded

IPET-OSDE2, Final Report

- TP: OSCAR provides 2 primary functions:
 - Make it easier for Members to report their metadata - repository for metadata
 - Undertake a gap analysis through the RRR process

 - LPR: Ability to compare technology capabilities with others (e.g. radiosonde/AMDAR) is important
 - SK: Show what is the current availability of data - trend over time less important.
 - SG (summary):
 - Algorithms to be used for averaging/massaging metadata to provide capabilities needs to be specified - probably by programs
 - Need to cater for geographically based shapes (e.g. tropical belt)
 - Selection based on themes: programmes, applications, variables etc.
 - Selection based on "not": e.g. programs/systems measuring one parameter but not others
 - Mapping requires layers and 3D
 - Proportion/extent of requirements being met should be able to be defined.
 - Queries should be able to be saved (favourites).

 - LN: Two ways of showing capabilities; theoretical and actual (based on performance)
 - DL: 3rd way may also be future or theoretical (i.e. addition or reduction).
 - TP: For theoretical study might be better to leave these outside of OSCAR Analysis.
 - SG: Queries not create by SQL?
-

OUTCOME OF BREAKOUT GROUP 2

OSCAR PROJECT – MANAGEMENT AND GOVERNANCE [INCL. OBSERVATIONAL USER REQUIREMENTS, SURFACE AND SPACE CAPABILITIES]

Lead: Jochen Dibbern

Members: John Eyre, Bai Li, Anthony Rea,

- Guidance will be needed from the OPAG IOS Expert Teams on how to evolve OSCAR, and undertake the necessary software developments in accordance with approved standards (they may also play a role for making the standards evolve). Responsibilities of OPAG IOS Team for OSCAR as a whole has been defined by CBS Ext(2014). The table of responsibilities agreed at CBS Ext.(2014) needs to be updated and submitted to CBS-16 on the basis of the new foreseen working structure of CBS OPAG IOS.
- There is a need for human resource to maintain the information. Regional WIGOS Centres are expected to play a role in the future. Interim solution is needed, but even in the long term global coordination effort will be required. Maintenance of each component is needed. Secretariat should have sufficient resources (human, or financial) to be able to fulfil the task. For OSCAR/Space, master users will also be identified to help monitoring satellite capabilities (facts on the satellites and their instruments), and suggesting corrections when needed. An assessment is needed of what's required in terms of resources to maintain information in the three components of OSCAR (requirements, space, surface) (**action; Secretariat; July 2016**).
- Per IPET-OSDE-2 and foreseen ICT-IOS-9 recommendation, CBS-16 to make the call for proper resourcing the management of OSCAR in the long term, and starting as soon as possible. Draft CBS-16 Recommendation on the resourcing of OSCAR needs to be drafted by ICT-IOS-9 (noting progress, new challenges, how it is used, importance of the content and its correctness, the need for QC and coordination, risks; and requesting the Secretariat to put appropriate resources into the management of OSCAR information content, and the required coordination) (**action; ICT-IOS-9; asap**).
- OSCAR/Space critical review part: the new version, once the rules are implemented should facilitate the exercise. Scientific oversight board for OSCAR/Space is needed under IPET-SUP to look at the rules.

OUTCOME OF BREAKOUT GROUP 3

EGOS-IP ACTIONS REVIEW - SPACE PART

Lead: Rosemary Munro

Members: John Eyre, Anthony Rea, Werner Thomas

1. Status of Reporting on EGOS-IP Actions

Overall the status of the reporting on Actions was good with a small number of exceptions. These exceptions to this overall assessment were discussed in the breakout group and the conclusions were as follows:

EGOS-IP Action S7 – this action was felt to be too general for easy monitoring and reporting, addressing both the planning and deployment of the nominal operational space segment for near-real time use, and areas of relevance for climate applications. It was considered that the following actions adequately address the planning and deployment of the nominal operational space segment and that with regard to the part of the action of relevance to climate applications, GCOS-195 was an appropriate report to be used for cross-checking. See Action BG#3 – AI1 below.

EGOS-IP Actions S14 and S16 – these actions relate to potential improvements in data availability timelines and the use of DBNet for this purpose. Here it was felt that information was likely to be available but that it would be helpful to define an easily useable metric to enable concise and meaningful reporting. See Action BG#3 – AI2 below.

EGOS-IP Action S22 – relating to RO sounder OSSEs, although no dedicated report was available in this action, there is information in the published literature which has also been reported e.g. at the IROWG, therefore there is no need to trigger specific reporting.

EGOS-IP Actions W3 to W8 – these actions relate to the deployment of a space weather system. IT was agreed that it would be possible for the secretariat to provide further information relating to these actions, see Action BG#3 – AI6 below.

2. Progress on Implementation of EGOS-IP Actions

With regard to the progress on implementation of the EGOS-IP actions, this report is organised in three groups: those where there is continuous and good progress; those with continuous and moderate progress but with some areas of concern; and those with no progress. Actions relating to Space Weather are also addressed in a dedicated section. A more detailed summary of these groups of Actions is given below.

2.1 EGOS-IP Actions with Continuous and Good Progress

EGOS-IP Actions S1, S2, S3, S4, S5, S6, S9, S13, S14, S15, S17, S18, S21, S22, S23, S24, S34, S35

The following section summarises the status of the EGOS-IP Actions for which there is continuous and good progress.

Actions S1 to S4 relate to provision of user information, training and data stewardship, documentation of the generation of satellite data products in all steps of the product generation and validation process, ensuring long-term preservation of satellite data records, and fostering satellite education and training respectively. For all these actions there is good visibility of the many on-going activities and no cause for concern.

Action S5, stating that regions should determine and maintain requirements for satellite datasets and products, has been taken as a recommendation at CBS-15 and adopted as a resolution an EC resolution (Res.12/EC-65). Subsequently regional groups for satellite

requirement definition and maintenance have been established in all regions except RA VI (which is covered by the EUMETSAT user consultation process).

With regard to Action S6 recommending maintenance and further development of the GSICS operational capabilities, GSICS is providing operational inter-calibration of geostationary satellites in the IR using a reference instrument in polar orbit, and extending its activities in the UV, VIS and MW domains.

For Action S9 on the capabilities of the next generation of geostationary imagers, a number of space agencies and satellite operators have made a commitment to launch imagers with enhanced capabilities, the first of which is Himiwari-8.

For Action S13 on ensuring the continuity of LEO sun-synchronous polar orbiting missions with core meteorological payloads in a minimum of three orbits with ECT equal to 13:30, 17:30 and 21:30 (local time), this will be ensured if CMA confirms their plan, expected at Cg-17, to maintain a polar satellite mission on an early morning orbit. Confirmation is still required of the intention of CMA to maintain a core meteorological mission in this orbit in the longer term. This will be addressed by the Secretariat (see BG#3 – AI3).

Action S14 addresses LEO data timeliness with the aim of improving timeliness of LEO satellite data, especially of the core meteorological missions on the three orbital planes, by developing communication and processing systems which achieve delivery in less than 30 minutes (as done with DBNet – Direct Broadcast Network for near real-time relay of low-Earth orbit satellite data– for some datasets). The main progress in this area is the initiative to expand DBNet, which includes the NOAA Direct Broadcast Real-Time Network (DBRTN) which is under discussion. See also Action BG#3 – AI2 on defining a metric to monitor progress.

Action S15 is related, focussing on the maintenance and improvement of direct readout communication and processing systems. An update of the Satellite Data Dissemination Strategy is being prepared in consultation with CGMS and will be presented to CBS in due course, however it is clear that it is not straightforward to baseline and monitor the volumes of LEO satellite data accessible by direct read-out.

For Action S17 on filling the gap in planned coverage of microwave sounders in the early morning orbit, this is very closely related to Action S13 and is expected to be addressed by the plans of CMA to maintain a polar satellite mission on the early morning orbit. Tentatively, this would be implemented as of 2017, starting with FY-3E.

With regard to Action S18 on the generation of cloud (or water vapour) track winds from polar orbiting imagers, EUMETSAT and NOAA are now routinely producing these products.

Action S21, regarding the deployment of GNSS receivers on a number of platforms, is progressing well, with currently operational and planned deployments on 5 platforms. It should be noted however that COSMIS-2 Phase II is still subject to confirmation of U.S. funding.

With regard to S22, a number of OSSE's have been performed and published in the peer-reviewed literature (Scaling of GNSS Radio Occultation Impact with Observation Number Using an Ensemble of Data Assimilations, F. Harnisch, S. B. Healy, P. Bauer, and S. J. English Monthly Weather Review 2013 141:12, 4395-4413).

Action S23 on the implementation of an altimeter constellation has been adopted as part of the CGMS baseline and plans are progressing well.

Action S24 relating to the availability of a dual-angle view imager for SST is satisfied with Sentinel-3A and Sentinel-3B.

With regard to Action S32, addressing the assessment of benefits of satellite demonstration missions such as SMOS (missions based on low-frequency microwave radiometers) on atmospheric, hydrological and oceanic models, in a quasi operational context, and whether a similar operational mission can be designed, much progress has been made in this area with JCDSA investigating the assimilation of blended soil moisture products including SMOS data.

Action S34 addresses the area of GEO ocean colour, vegetation, clouds and aerosol. Here Korea is taking the lead with the Geostationary Ocean Color Imager (GOCI) on orbit on the COMS satellite. This is being used operationally and will be followed by GEO-KompSAT-2B in

2018.

2.2 EGOS-IP Actions with Continuous and Moderate Progress

EGOS-IP Actions S7, S8, S10, S11, S12, S16, S19, S20, S25, S26, S27, S28, S29, S30, S31, S35

As noted above, Action S7 was felt to be too general for easy monitoring and reporting, addressing both the planning and deployment of the nominal operational space segment for near-real time use, and areas of relevance for climate applications. It was considered that other actions adequately address the planning and deployment of the nominal operational space segment and that with regard to the part of the action of relevance to climate applications, GCOS-195 was an appropriate report to be used for cross-checking. Action BG#3 – AI1 addresses the need to check progress in the area of climate applications.

Action S8 reinforces the need to maintain at least six operational geostationary satellites along the equator, ideally separated by no more than 70° of longitude, this plan has been adopted as part of the CGMS baseline. However, the <70° condition is not met over the Pacific (85°) nor over the Atlantic (75°). It seems no clear justification was found for this 70° value, in the concept of an integrated observing system comprising GEO and LEO satellites and surface or altitude systems (although there is likely interest from some members) so the general relevance of this action is questioned.

With regard to Action S10, there is progress towards producing hourly winds with EUMETSAT providing full disk hourly winds from MSG and JMA (Himawari) providing hourly wind products over the Northern half-disc. NOAA is currently providing winds from the GOES satellites every three hours. It is expected that with the new generation imagers with more rapid repeat cycles more hourly winds will become available. In addition, KMA and CMA are considering the coordination of their planned GEO imager scanning schedules with the Himawari-8 AHI scan (this could result in staggered scans every five minutes by 2018).

Action S11 addresses the desire for all meteorological geostationary satellites to be equipped with hyper-spectral infra-red sensors. Currently this is planned by CMA for the FY-4 series from 2016 and EUMETSAT plans to fly the IRS on the MTG-S platform in the 2021 timeframe. Further equivalent deployments on other GEO platforms would be needed to fulfill the current Vision.

Action S12 targets the need for meteorological geostationary satellites to be equipped with a lightning imager able to detect cloud-to-cloud and cloud-to-ground strokes. The deployment of GEO lightning imagers is progressing well and is supported by a number of satellite operators.

Action S16 refers specifically to ground segments for hyper-spectral infra-red sounders requesting the definition and implementation of a data reduction strategy which optimizes the information content accessible within the timeliness and cost constraints, whilst addressing the needs of different user communities. This action is being addressed within the DBNet coordination group, and further work is needed in his area.

With respect to water vapour winds, Action S19 refers to the inclusion of the water vapour channel in LEO imagers to facilitate the provision of WV winds, rather than the production of the winds themselves. Here we are still in the situation where a small number of LEO imagers do include a water vapour channel (e.g. MODIS on EOS Terra and EOS Aqua, and METImage planned by EUMETSAT to be flown on EPS-SG) while a number of number of other imagers (e.g. including VIIRS, VIRR, MERSI-2) do not.

For Action S20 which aims to ensure availability of MW imagers for SST, JAXA have launched GCOM-W1 which has an AMSR-2 instrument and there are efforts on-going to secure GCOM-W1 follow-on satellites.

Actions S25 and S27 refer to the requirement for GPM precipitation radar missions in an inclined orbit to be available and the need to secure an operational follow-on mission also taking account of the requirement for operational NRT data delivery. NASA & JAXA have launched the GPM-Core observatory on February 28, 2014. Efforts are required to secure continuity following on from this research mission. JAXA have also commenced test dissemination of near-real-time GPM-Core data to JMA.

Actions 26 referring to the availability of a passive MW mission in a low-inclination orbit in support of GPM is an area of concern as Megha-tropiques is in orbit but its MW sensor has failed. GPM-Brazil is planned for 2016. Other MW sensors are currently flying on polar orbiters.

Action S28 states the need to ensure the continuity of ERB type global measurements by maintaining operational broad-band radiometers and solar irradiance sensors on at least one LEO polar orbiting satellite. A number of missions are in-orbit or planned however it is noted in order to maximise the value of the data it is necessary to pay attention to ensuring continuity and consistency among these different data series.

With respect to atmospheric composition, S29 recalls the need to ensure the operational continuity of ultra-violet/ visible/near-infra-red sounders, including high spectral resolution ultra-violet/visible sounders on GEO, and at least one ultra-violet/visible sounder on 3 well-separated polar orbits and also to ensure the continuity of limb-sounding capability. This is a very broad action and is not homogeneous in terms of progress. With respect to the availability of high spectral resolution ultra-violet/visible sounders on GEO, and at least one ultra-violet/visible sounder on 3 well-separated polar orbits there is very good progress with the planned launch of the polar-orbiting Copernicus ESA/Dutch Sentinel-5 Precursor and upcoming Copernicus Sentinel-5 on EPS-SG. In GEO orbit the Copernicus Sentinels-4 on MTG-S, NASA's TEMPO mission, and Korea's GEMS mission are all planned. Limb-sounding however remains a significant gap. OMPS-Limb will be available on Soumi NPP and -2 however OMPS limb does not measure at high spectral high resolution.

Action S30 requests that the experience of a demonstration mission such as ADM-AEOLUS is used to plan and design an operational observing system based on Doppler wind measurements (providing global coverage of wind profiles). There is currently no progress on this action as ADM-AEOLUS is planned to launch in 2017. However, more progress is expected after this time.

Action S31 refers to the requirement for provision of operational cloud/aerosol lidar data produced from satellite missions to operational data processing centres and users with the aim of using this experience to decide about a possible cloud/aerosol operational mission (integrated or not with an operational Doppler wind lidar mission). Currently Calipso data are provided with two- or three-day delay and are available for evaluation.

For Action S35 regarding planning and designing a demonstration HEO mission for the polar region, both Russia and Canada have announced plans for HEO missions. The Russian missions Arctica-1 & 2 were nominally planned for 2015 and 2016 however it is clear that the exact schedule may need clarification. The Canadian PCW mission is still to be confirmed.

2.3 EGOS-IP Actions with No Progress

EGOS-IP Action S33

Action S33 focuses on the need for a GEO MW mission to provide significant improvement in real-time observation of clouds and precipitation. Here no progress has been made. JCSDA are planning an OSSE for this type of platform.

2.4 EGOS-IP Actions on Space Weather

EGOS-IP Actions W1, W2, W3, W4, W5, W6, W7, W8

Regarding Action W1 on the planning for the continuity of Space Weather measurements, this is part of the four-year work plan for space weather, which will be submitted to Cg-17.

Similarly, for Action W2 on ground-based solar observations, this is also part of the four-year work plan for space weather, which will be submitted to Cg-17.

For Actions W3 to W8 no reporting was available. An update will be provided by the WMO Space Programme.

Actions from IPET-OSDE Breakout Group #3 – Progress on EGOS-IP Actions relevant to the satellite part.

BG#3 – AI1: Elements of EGOS-IP Action S7 relevant to climate activities to be cross-checked against GCOS-195. (R. Munro)

IPET-OSDE2, Final Report

BG#3 – AI2: To propose a metric against which progress of EGOS-IP Actions S14 & S16 can be measured and to check any currently available reporting relevant to this metric. (J. Eyre)

BG#3 – AI3: To reinforce the need for continuity of the CMA contribution in the early morning orbit through discussion with CMA (WMO, L. P. Riishojgaard)

BG#3 – AI4: W3 – W8: To provide updated information on the state of deployment of a space weather observing system as as available. (WMO, S. Bojinski)



OUTCOME OF BREAKOUT GROUP 4**EGOS-IP ACTIONS REVIEW - SURFACE PART**

Lead: Jay Lawrimore

Members: Paolo Ambrosetti, Erik Andersson, Jochen Dibbern, Stuart Goldstraw, Frank Grooters, Stephan Klink, Bai Li, Guimei Liu, Russell Stringer, Jitze van der Meulen, Daniel Michelson

Breakout group 4 was tasked with the following primary objective: Provide recommendations for improving the rate of response to requests regarding progress of actions in the EGOS-IP for Surface actions.

The team reviewed the following summary of review status. The actions for which there has been no response were larger than the total number of actions with yellow or red progress. No actions were indicated as green. The actions needing the most attention are those associated with land observing systems as shown in the table below.

Recommendations from the breakout group are included on pages 3 and 4.

Summary of Review Status

		No Report	Yellow	Red
Generic	G1-G6	4	1	1
Upper Air/Land	G7-G28	12	10	0
Surface Obs/Land	G29- G41	7	6	0
Hydrological/Land	G42- G44	3	0	0
Weather Radar	G45- G48	4	0	0
Upper Air/Ocean	G49 G50-	0	1	0
Surface Obs/Ocean	G56	0	4	3
Sub-surface	G57-			
Obs/Ocean	G58	0	2	0
R&D/Pathfinders	G59	0	1	0
		30	25	4

Slightly more than 20 National Focal Points have responded in the past two years; primarily from small countries. It is assumed that national focal points from large countries find the task overwhelming. There were also a large number of actions assigned to WIGOS PO and ET-SBO that have had no response.

The breakout group noted the following:

There must be a clear sense ownership. For instance in the weather radar community, radar activities that are currently under various technical commissions will be consolidated under the responsibility of a single IPET. This is expected to occur within this year and should facilitate better interaction and response from the community.

It was noted that a single year's snapshot is not as meaningful as gaining information over time. A sustained effort will provide a more complete picture from all members. Although we may only receive a 20% response the first year, over time a complete picture of the progress against actions will be built.

The future release and operational capability of the Oscar Surface database will help support better assessments of progress against actions. Equally beneficial is expected to be the

WDQMS (WIGOS Data Quality Management System); once it is operational it will provide for global summaries of progress against requirements. It is expected to become operational in this period; a pilot to run this year and by 2019 will be operational.

The group noted that offices (e.g., WIGOS) and expert teams (e.g., SBO) committed to more fully engaging in requests for information in the coming year.

There is potential to leverage support through the future Regional WIGOS Centers who can more easily reach out to others in their region. It may be possible to include such a requirement in TORs of a new Regional WIGOS Center.

It was also noted that the planned future release of a WMO Dashboard for PRs; containing information requesting their attention, could be beneficial in engaging PRs when necessary.

There was some discussion about using direct phone calls to national focal points but the general feeling was that this would not be feasible given the large number of national focal points.

Along those lines there was a suggestion regarding the potential for augmenting e-mail communication using taped robo-calls in the language of the national focal point. There was little support for this recommendation.

Several expressed the benefit of using online survey forms and services such as survey monkey to query an external community. This also can facilitate communication by providing previous years' responses as a starting point when requesting an annual update. Responses from other countries also can be provided.

Recommendations for improving response to requests for information:

- The group recommended use of the Oscar Surface and WDQMS when they become available to facilitate analysis of progress against actions.
- It is recommended that the current practice of sending requests directly to national focal points be continued; and to rely on the focal point to further distribute to others as necessary. If the focal point does not respond and a second attempt at communication fails to garner a response, then a request should be escalate to the PR.
- For those countries without national focal points it was recommended to communicate directly with the PR; to ask for a response and a point of contact.
- The group recommended using the WMO Dashboard for communicating with PRs when the capability becomes available.
- The group recommended that focal points be provided with information regarding the way in which the information they provide is beneficial to progress on the evolution of the global observing system.
- The group further recommended that focal points be notified that any response they can provide is helpful even if information on all actions can't be provided.
- The development of a table of countries and response received from each was recommended. This can be provided in CBS session documentation for CBS '16. The list of countries with and without responses can be communicated in table and map form.
- The group recommended establishing a subgroup to deal with this issue in the following way; to spend some time to establish the format of the next request for progress against actions including through survey questions to provide and how best to receive quantitative information.
 - This small group will liaise with the Secretariat. Those asked by Etienne to participate in the group include Stuart Goldstraw and Anthony Rea. Jay Lawrimore volunteered to participate. The sub-group will be formed in this meeting and will report back at the next IPET-OSDE meeting. In the intervening years the team will work on the 2016 and 2017 reports.

OUTCOME OF BREAKOUT GROUP 5**EGOS-IP – HIGH-LEVEL DOCUMENT**

Lead: Russell Stringer

Members: Paolo Ambrosetti, Jochen Dibbern, John Eyre, Jay Lawrimore, Frank Grooters, Stefan Klink, Anthony Rea

Draft High Level Document on the EGOS-IP ("4-pager")

(A high level information document for Permanent Representatives of WMO Member countries and territories with the WMO)

DRAFT – v1.0 19/11/2015

version	date	author	comments
1.0	19/11/2015	Secretariat	First draft as per IPET-OSDE-1 action
x	07/04/2016	Chair and members of IPET-OSDE	All additions and comments marked in the document
2a	13/04/2016	IPET-OSDE-2 session	New partial draft developed
2b	13/04/2016	IPET-OSDE-2 session	Partial draft progress to full concept
2c	14/04/2016	IPET-OSDE-2 session	Full draft by IPET-OSDE (some finishing work still needed)

New ways to contribute to and benefit from WMO global observing systems: through the Implementation Plan for the Evolution of Global Observing Systems (EGOS-IP)

Purpose

To bring to your attention, as the Permanent Representative with WMO for your country, the EGOS-IP and what you are being asked to contribute to its implementation¹.

Background

The World Meteorological Organisation (WMO) facilitates cooperation amongst its 191 Members so they are each better able to perform their weather, water and climate related functions. A prominent element of this is the sharing of observations through the WMO global observing systems.

Can you imagine running numerical weather prediction without observations from your neighbours, or using NWP guidance from an international centre if they didn't use your observations? Can you imagine a forecaster in Fiji giving advance warning of the next devastating tropical cyclone without access to weather satellite imagery from Japan, U.S.A. or China?

¹ The EGOS-IP was initially conveyed to you in letter xxx of xxx. The document is available at <http://xxxx>

WMO global observing systems are well established, regulated and standardised as documented in WMO's technical regulations and supporting guidance material. Most recently has been the introduction of new technical regulations including the new Manual on the WMO Integrated Global Observing Systems (WIGOS), covering matters such as station identifiers and observational metadata. Your contributions are valuable and appreciated.

However there is a need to evolve in response to changing requirements for observations and new technological capabilities. WMO gathered together technical experts to develop a Vision for the Global Observing System in 2025², then a coordinated set of actions to pursue this vision. These actions were published as the EGOS-IP xxx and approved as follows xxx.

An ongoing process, the Rolling Review of Requirements (described further in ATTACHMENT 1), is maintained to monitor and assess changes in requirements for observations and capabilities in collecting and sharing observations.³

The EGOS-IP and your contributions

The EGOS-IP contains activities to be implemented during the period 2012 to 2025 aiming at maintaining and developing all WMO component observing systems. These systems have a collective identity as the WMO Integrated Global Observing System (WIGOS). WMO observing systems also make major contributions to co-sponsored observing programmes (GCOS⁴, GOOS⁵), the Global Earth Observation System of Systems (GEOSS) and to the Global Framework for Climate Services (GFCS).

There are 115 actions in the EGOS-IP of which 15(+?) depend on implementation Members. These 15(+?) actions are summarised in ATTACHMENT 2, though the full document should be consulted for elaborative information and the relevant context.

As resolved by CBS, Cg, ???, (direct approval of EGOS-IP, also by approval of WIGOS Manual which invokes the EGOS-IP) you are requested to ...⁶

For some of the 15(+?) actions, in your efforts to make progress you may find assistance through collaboration with your WMO Regional Association and other sources of assistance for capacity development.

Other parties have been asked to give attention to the other actions, although their implementation efforts may in some cases lead them to seek your collaboration.

Monitoring progress

WMO regularly monitors progress on all the EGOS-IP actions and seeks to resolve any problems and assist the understanding and ability to implement the actions. To report annually against the 15(+?) actions, all Permanent Representatives were asked to nominate a National Focal Point (NFP) for the EGOS-IP. The current list of NFPs is available on the WMO web site⁷ and reproduced in ATTACHMENT 3. A copy of the call for nominations is reproduced in ATTACHMENT 4. To date around 90 Members have nominated an NFP; a nomination for your country is requested if you have not provided one already.

Reports against other actions are sought from those other parties.⁸

The NFPs play a critical role by providing annual reports on progress. It is intended that an

2 Put the web reference here.

3 [Editorial Note: Possibly delete this paragraph]

4 WMO-IOC-UNEP-ICSU Global Climate Observing System

5 IOC-WMO-UNEP-ICSU Global Ocean Observing System

6 [Editorial note: Needs checking and completion]

7 At http://www.wmo.int/pages/prog/www/CBS/Lists_WorkGroups/CBS/opag_ios/fp_egos-ip

8 [Editorial Note: Possibly delete this paragraph]

overall annual report will be compiled and made available to you. So far only a brief assessment has been undertaken, as indicated in the relevant agenda paper⁹ of the WMO Commission for Basic Systems expert team responsible for this activity.

Request

It is recommended that you:

- Note the information in this letter about the EGOS-IP,¹⁰
- Note the attached list of actions and consider¹¹ how you may address them, and
- Ensure that your country has a National Focal Point for the EGOS-IP.

ATTACHMENT 1: The Rolling Review of Requirements process¹²

ATTACHMENT 2: actions for Members

ATTACHMENT 3: call for NFPs¹³

ATTACHMENT 4: current list of NFPs

⁹ The agenda paper is available on the WMO web page at xxxx

¹⁰ [Editorial note: Possibly delete this bullet point]

¹¹ [Editorial note: Stronger word needed]

¹² [Editorial note: No, this material not needed as attachment]

¹³ [Editorial note: Check that this includes the terms of reference for NFPs, if not then attach that too]

OUTCOME OF BREAKOUT GROUP 6

VISION FOR SPACE-BASED COMPONENT OF WIGOS IN 2040

Lead: Anthony Rea

Members: John Eyre, Rosemary Munro, Werner Thomas and Stephan Bojinski

The group consisted of Anthony Rea, John Eyre, Rosemary Munro, Werner Thomas and Stephan Bojinski. The group undertook to review the draft Vision document, respond to specific stakeholder comments and discuss the timeline and process for finalisation of the vision.

The draft vision was reviewed and a number of minor adjustments to the text suggested. In particular, the terminology around 'tiers' was replaced with 'components' to avoid any implications of a hierarchy between the components.

Stakeholder comments from the Consultative Meeting on Satellites (CM-13), PTC(2016) and IPET-SUP-2 were reviewed. Many of these were addressed through altering the terminology on tiers. Others were noted and a number were taken into account and will be incorporated into a revised draft to be finalised after the meeting.

The group also discussed the process for finalising and approving the document. In doing this, the potential timeline for developing the Surface-based component of the Vision was taken into account and the need to integrate the two components of the Vision was recognised. The group noted that there was insufficient time to integrate the two components of the Vision before CBS in November. As a result, it was agreed that the Space-based component of the Vision would be presented regardless of the readiness of the Surface-based component, which would also be presented if ready.

The group noted the need to develop a roadmap for the integration of the two components of the Vision, subsequent to their approval by CBS, and that the development of this roadmap should be considered and actioned by ICT-IO-9, with a view to the roadmap being presented to CBS.

Recommendation – the timeline as presented in the document was agreed and the draft 2040 Vision (Space) should be presented to CGMS in June, and CBS in November.

Recommendation – ICT-IO-9 should consider the integration of the 2040 Vision for the Space-based and Surface-based components and develop a roadmap for this process. The roadmap is to be presented to CBS in November.

OUTCOME OF BREAKOUT GROUP 7**STRATEGY FOR UPDATING THE VISION IN 2025 (FOCUSING ON THE SURFACE PART)**

Lead: Frank Grooters

Members: Erik Andersson, Jochen Dibbern, Stuart Goldstraw, Stefan Klink, Jay Lawrimore, Bai Li, Guimei Liu, Russell Stringer, Jitze van der Meulen, Daniel Michelson

The breakout group discussed the workplan for contributing to the WIGOS Vision for the surface-based observing systems part, and based on the current 2025 vision, identified some elements to be added for providing such contribution.

Workplan:

- IPET-OSDE-2 to set up the sub-group on the surface Vision (Frank Grooters, Daniel Michelson, John Eyre, Jay Lawrimore, Jochen Dibbern, Jitze van der Meulen, JCOMM, Michele Citterio, Russell Stringer, Stephan Klink). Offenbach as an option for the venue.
- Secretariat to identify JCOMM representative (**action; Secretariat; asap**)
- Chair to initiate email discussion in preparation of the September workshop (**action; Chair: asap**)
- Secretariat to identify venue and propose date for the September workshop (**action; Secretariat; asap**).
- Email exchange to agree on outline of the Vision, and documentation plan for the September workshop (**action; sub-group; July 2016**)
- Mid-Sept. 2016: An *ad hoc* IPET-OSDE drafting workshop for the Surface-based observing systems part of the WIGOS Vision.
- End Sept. 2016: CIMO Technical Conference (TECO-2016, Madrid, Spain, 27-30 September 2016) to note the draft, and propose some changes and guidance from its perspective.
- October 2016: The draft from the IPET-OSDE sub-group is considered by the larger WIGOS community (workshop), with participation from all WIGOS component observing systems, and co-sponsored observing systems stakeholders.
- End November 2016: The 16th Session of the CBS (CBS-16, Guangzhou, China, 23-29 November 2016) notes work in progress, and may suggest some changes and guidance from its perspective.
- Jan. 2017: ICG-WIGOS-6 to review draft and propose changes and further guidance.
- May 2017: EC-69 notes availability of first draft and provides further guidance (work in progress).
- Jan. 2018: ICG-WIGOS-7 makes a final review of the draft and approves its submission to EC-70, while inviting the CBS through IPET-OSDE and ICT-IOS to make some adjustments.
- April 2018: IPET-OSDE-3 and ICT-IOS-10 to further review the draft according to EC-69 and ICG-WIGOS-7 guidance.
- End 2018: If there is a CBS-Ext(2018) Session, the CBS to review and recommend the draft to be submitted to EC-70 and Cg-18.
- May 2018: EC-70 agrees that the available draft is good enough for submission to Cg-18.

- Mid-2018: CIMO-17 Session to review the draft.
- May 2019: Cg-18: Congress approves the WIGOS Vision for 2040.

Changes needed in the vision:

The breakout group agreed that there is an immediate need for updating the vision for 2025. It is proposed to look at what's still relevant (most of it), update what's necessary, and add new elements as needed taking into account the latest technological developments, etc.:

1. Changing environment in the NMHSs (evolving role of NMHSs, e.g. changing the role of NMHSs in the relation to product delivery)
2. Changes in the way the public and private sectors are working together
3. Risks of private sector being directly involved in the business of what NMHSs are currently doing in data management
4. Risks of evolving data policies, private sector sailing data and restricting access to data
5. Financial situation in many NMHSs (e.g. budgetary restrictions)
6. Who is the authoritative source of weather/climate information and warnings
7. New ways of disseminating data
8. New technologies for making observations (e.g. mobile phones, sensors on cars, crowdsourcing and use of social networks)
9. Reference networks to expand in other countries (needed for calibration of satellite data and the foundation for standards)
10. Finding and building on potential synergies between different technologies, using the best mix of observing systems, balance between space-based and surface-based observing systems (shift of balance compared to the current situation)
11. Supporting developing countries having difficulties maintaining their observing networks. Commitment needed from developed countries.
12. There will be a need to clarify who owns the data for the new sources of data; then engage with those defining data policies as appropriate.
13. Best practices to be formulated on how to safeguard public interest: articulating data policies, availability of data, for acting in the public interest for data to be shared with the WMO Members (current examples: TAMDAR, GNSS radio-occultation, lightning detection).
14. Multi-functional observing stations addressing multiple user requirements for better effectiveness and efficiency
15. Write details on architecture design of global observing systems, emphasizing the composite observing system, what observations are needed, where, how often ...

ISSUES WITH REGARD TO HUMIDITY AND TURBULENCE MEASUREMENTS FROM AIRCRAFTS

The WMO Aircraft Based Observations programme (ABOP) has been working actively on implementation plans for both humidity and turbulence (Eddy Dissipation Rate - EDR) monitoring as a component of the global AMDAR observing system and has been concerned regarding the perceived lack of urgency and support from Members in prioritising the enhancement of the AMDAR observing system to incorporate monitoring of these variables. While the requirement for AMDAR expansion generally in support of several application areas is understood and is being addressed, the measurement of humidity, requiring the addition of a relatively expensive humidity sensor (and currently limited to a single viable sensor, the WVSS-II system by SpectraSensors) and EDR (requiring the addition of an additional avionics software package - itself requiring tuning) is less clear.

At the current time, there are around 140 WVSS-II sensors deployed, predominantly within the USA MDCRS/AMDAR programme and, apart from 9 sensors in Europe, there appears to be only small interest in a wider global deployment.

The development of the WVSS-II sensor has taken a long time to reach maturity, with significant WMO Member resources having been invested in collaboration with the developer/vendor and recent trials and inter-comparisons have indicated that the sensor now provides a very high quality measurement of humidity - consistent of better in quality to radiosonde humidity measurement. However, the manufacturer has indicated concern for the future viability of the production of the sensor, given the apparent lack of interest and commitment of resources for implementation from the aviation and meteorological communities.

The situation is similar for EDR, where support for deployment of EDR only is strong and moving ahead in the USA under the leadership of the Federal Aviation Administration, responding to a requirement within both the national aviation and meteorological communities for EDR data for assimilation and validation of NWP applications of turbulence prediction.

For both these variables, the ABOP community would benefit from a clearer signal from WMO Applications Areas regarding the perceived benefit from and priority for wider enhancement of AMDAR with deployment of humidity and turbulence monitoring. Having met with representatives of ICAO and the WAFCs in a workshop on the future of aircraft observations in 2015, it would be very useful if ICAO and the WAFCs could themselves assess and define requirements for aircraft based observations of humidity and turbulence, which might be incorporated in the SoGs.

**COMMENTS REGARDING THE STATEMENT OF GUIDANCE FOR
AGRICULTURAL METEOROLOGY**

(submitted by Jose Camacho (WMO Secretariat), 12 April 2016)

- Agricultural meteorology is a multidisciplinary area and includes several sub-areas as rain fed agriculture, irrigated agriculture, livestock and pastoralism, artisanal fisheries, forest management, and rangelands and environmental protected areas.
 - Supports decision making in different time scales for tactical and strategic decisions and data are needed at site level but also covering wide spatial areas. One important application of data is to feed crop models and one important outcome are crop and yield estimations. That is highly relevant on food security and food production at national, regional and world level.
 - Data needed include parameters of three different categories: atmospheric, soil and living beings status (mostly vegetation).
 - Sand and dust and atmospheric pollution is an issue in agriculture. Joint work is developed with Atmospheric Research and Environment Branch to define requirements on observation parameters that would needed to evaluate and forecast vegetation damages and reduced yields.
 - Agricultural meteorology is one of the fields of hydrometeorology for which satellite data are very important. Agrometeorological parameters are naturally variable in time and space. Ground observations alone cannot provide sufficient spatial and temporal resolution for the purposes of large scale environmental monitoring. The increasing availability of more frequent high resolution remote sensing data is expected to open up new areas for agricultural applications.
 - This Statement of Guidance (SOG) has two sections: one for in-situ observations and a second for space-based observations. In some cases a given parameter may have both types of observations as part of its description. Below there is a summary of key comments and recommendations.
-

DRAFT VISION FOR THE SPACE-BASED COMPONENT OF WIGOS IN 2040**DRAFT (version 20160119)****Document Change Record**

Date	Status
12 Nov 2015	ET-SAT-10 Working Paper 3.1
21 Dec 2015	Modifications based on input from ET-SAT-10 (17 Nov 2015), WIGOS Space 2040 Workshop (18-20 Nov 2015, Geneva) and ICTSW (18 Dec 2015)
11 Jan 2016	Revision based on comments by Chair IPET-OSDE and WMO Secretariat (OBS/SAT)
13 Jan 2016	Corrections to mission tables for Tier 1 and 2
19 Jan 2016	Additional comments by Chair IPET-OSDE

1. Introduction

This document describes a new vision of the space-based observing components contributing to the WMO Integrated Global Observing System (WIGOS) in 2040. This new vision (henceforth referred to as the "WIGOS Space Vision 2040" or simply "Vision") is formulated based on two main elements: expected evolution of space-based observing technology, and an anticipation of user needs for satellite-based observations in the 14 application areas that are recognized and documented by WMO¹, by 2040.

The initial draft of the Vision was provided by the WMO/CBS Expert Team on Satellite Systems (ET-SAT) composed of representatives of space agencies, in consultation with the Coordination Group for Meteorological Satellites (CGMS), building on the outcome of the WIGOS Space 2040 workshop², Geneva, 18-20 November 2015) and additional input from the Inter-Programme Coordination Team on Space Weather (ICTSW) .

It should be first recalled that the current space-based observing system as described in the Manual on WIGOS includes a constellation of advanced geostationary satellites, a three-orbit constellation of polar-orbiting satellites supporting atmospheric sounding and other missions, other operational missions on various orbits suited e.g. for altimetry or radio-occultation, with a general principle of operational continuity and near real-time data availability. Although there remain gaps and scope for improvement, this system is a solid foundation underpinning the successful operation of the World Weather Watch and other major WMO programmes.

The new Vision will thus be considered through an incremental approach with reference to the current baseline, in investigating what should be added, reinforced or improved, and what could be performed differently in the future in order to best respond to the needs.

The following main drivers of change are identified:

- Emerging user requirements from new applications that are not, or only partly captured in the current Vision for 2025. Today, these are mainly related to atmospheric composition, cryosphere, hydrology and space weather;

¹ <http://www.wmo.int/pages/prog/www/OSY/GOS-RRR.html>

² <http://www.wmo.int/pages/prog/sat/meetings/WIGOSSpace2040.php> (Presentations);

<http://www.wmo.int/pages/prog/sat/meetings/documents/ListofParticipants.pdf> (List of participants)

- Recent or anticipated advances in remote sensing technology, satellite system design and satellite programme management, which will enable to meet currently unfulfilled performance requirements, implementation of currently experimental or newly demonstrated techniques, and possibly alternative, more cost-effective approaches;
- Changes in the satellite providers' community which will involve more space-faring nations, increased maturity of satellite industry, and increasing pressure to demonstrate benefit to cost of public satellite investment, and to face commercial satellite initiatives.

This Vision addresses specifically the space-based components of WIGOS, mainly because of the long lead times in space programme development cycles. It is clear however that the space segment will be supplemented by the surface-based components of WIGOS, for example to provide surface-based reference measurements, in the many applications where both satellite and surface-based data are required, or for measurements that cannot be achieved from space. In addition, satellite ground segments are critical such that users can effectively exploit satellite missions, i.e., sufficient investments in application development and user training; maintenance of efficient data dissemination systems meeting user needs for timeliness and completeness; new approaches for data processing, storage, and access (including big data analytics), given increasing data volumes; effective user-provider feedback mechanisms; and NRT access to operational and R&D mission data when relevant.

This Vision does not provide guidance regarding data policy.

2. General trends in user requirements

It is difficult to predict the requirements for satellite data in support of weather, water, climate and related environmental applications in 2040. Nevertheless, for the purpose of developing the Vision, an attempt has been made to anticipate the evolution of user needs, based on broad consultation with users and general expected trends in the use of satellite data; compared to the present, it is expected that users will require in 2040:

- higher resolution observations, better temporal and spatial sampling/coverage,
- improved data quality and consistent uncertainty characterization ,
- novel data types, allowing insight into Earth system processes hitherto poorly understood,
- efficient and interoperable data representation, given the exponential growth of data volumes.

These trends are reinforced by the growing role of integrated numerical Earth system modeling that will serve many applications and cover a seamless range of forecast ranges. More data streams are expected to be assimilated in numerical modeling frameworks, and this more effectively due to improvements in Earth system process understanding, refined assimilation methods, and better handling of observation uncertainty. Simultaneous observations of several variables/phenomena, as well as multiple observations of the same phenomenon will be beneficial to numerical weather prediction, to atmosphere, ocean, land and coupled reanalyses, and to many other applications. Sustained observations of the ECVs will provide the baseline for global climate monitoring and related climate applications. Seasonal-to-decadal predictions will, among others, require higher-resolution ocean surface and sub-surface observations, such as of salinity, SST and sea ice, as well as information on the stratospheric state, solar spectral irradiance, and soil moisture. Ocean applications will,

inter alia, require operational satellite-based observations of essential ocean variables that can be measured from satellites, including ocean surface topography, SST, ocean colour, sea ice, winds and sea state. Nowcasting, severe weather forecasting, disaster risk reduction and climate adaptation will particularly require impact-related data, such as on precipitation, temperature, sea level rise, and winds. Managing and monitoring climate change mitigation as follow-up to the 2015 Paris Agreement will need greenhouse gas and other carbon budget-related observations, as well as information related to renewable energy generation such as on winds and solar irradiance. Applications related to health and the environment will require all observations needed for a “chemical weather forecast”, with variables characterizing atmospheric composition at the forefront, such as ozone, aerosols, trace gases, and atmospheric pollutants. Satellites will play a particularly important role in supporting applications in the data-sparse Polar Regions and provide insight into changes in ice sheets, sea ice, and glaciers.

The need to maintain continuous data records for real time and for reanalysis purposes calls for robustness of the whole data chain: contingency plans need to ensure continuity and regularly assess and thus minimize the risk of sensor gaps; the integrity of the radio frequency spectrum that is critical for space-based sensing needs to be preserved; data processing infrastructures require protection against damage or intrusion through appropriate IT security measures.

Rigorous error characterization, through intercalibration with reference standards (on-ground or in-orbit), will leverage the quality of the whole system. Measurement traceability will also be a key for the use of future space-based observations for climate monitoring and modeling, which also puts particular priority on ensuring long-term performance stability, comparability of new sensors with heritage datasets, long-term continuity of Essential Climate Variables, and generation and long-term preservation of Fundamental Climate Data Records. Accuracy requirements for reference standards should consider the full range of research and applications for space based Earth Observations, although decadal climate change observations are likely to dominate the need for high accuracy.

Specific observations are required, already in the near term, in several specific application areas:

- limb sounding for atmospheric composition in the stratosphere and mesosphere, for climate modelling;
- lidar altimetry in support of cryosphere monitoring, needed to support the new emphasis of Arctic activities in particular;
- hydrology, with the increasing importance of water resource management and flood prevention, should benefit of lidar altimetry but should progressively exploit gravity field measurements for operational monitoring of groundwater;
- SAR imagery and high-resolution optical imagery should be more systematically exploited for applications in the cryosphere, for example for ice sheet and glacier monitoring, deriving refined sea ice parameters, snow properties and permafrost changes;
- water cycle modeling will benefit of sub-mm imagery for cloud phase detection;
- atmospheric radiation budget modeling will be improved through systematic assimilation of multi-angle, multi-polarization radiances allowing a better specification of aerosols and clouds;
- the accuracy of surface pressure derived from NIR spectrometry and 3D fields of horizontal winds from Doppler lidar should be assessed, with a view to improve the atmospheric dynamics in NWP models;

- finally, solar observations on and off the Earth-Sun line (e.g. at L1, and L5), *in situ* solar wind at Lagrange point L1, and possibly beyond, magnetic field measurements at L1 and GEO, measurement of energetic particles at GEO, LEO and across the magnetosphere, will be needed on a fully operational basis to support the warning of major space weather events.

It will be beneficial to invest in further development of forward operators (for model-based simulation of observations) and, related to this, improved radiative transfer models and spectroscopic databases that are needed to enhance the utility of observations in numerical model frameworks.

The following sections describe trends in satellite systems and programmes. These, together with anticipated user needs outlined above, have led to the formulation of the WIGOS Space Vision 2040 that represents an ambitious, but at the same time realistic and cost-effective target (section 5).

3. Trends in system capabilities

It is anticipated that rapid progress on remote sensing technology will lead to higher signal sensitivity of sensors, which translates into higher spatial, temporal, spectral and/or radiometric resolution. However, progress will not only result of doing the same measurements with better performance, but also from a better use of the electromagnetic signal by different ways:

- the remote sensing frequency spectrum used for optical measurements will expand in both directions, towards UV and far IR, and wider use will also be made of the MW spectrum, subject to adequate frequency protection;
- hyperspectral sensors will be used not only in IR but also in the UV, VIS, NIR and MW ranges, providing a wealth of information, opening new fields for research and generating a dramatic increase in data volumes and processing demand;
- polarization of radiation can be further exploited, for example in Synthetic Aperture Radar imagery;
- combinations of active and passive measurements including bi-static measurements by formation-flying spacecraft can be exploited;
- radar scatterometry can be supplemented by GNSS-based reflectometry;
- the radio-occultation technique can also be generalized, in using additional frequencies (beyond the current L1, L2 and L5 GPS frequencies) to maximize the sensitivity to atmospheric variables, and monitoring more systematically the ionosphere including ionospheric scintillation.

Satellite observations are also determined by the choice of orbit; more diversity will be possible in this respect, too, thanks to a wider community of space faring nations, provided that the overall planning can be optimized under the auspices of WMO, with the aim to make the various satellite programmes complementary and interoperable (rather than overlapping and duplicating each other). The future space-based observing system should rely on the historical geostationary and low-Earth orbit sun-synchronous constellations, but also include high eccentricity orbits that would permanently cover the Polar regions, low-Earth orbit satellites with low or high inclination for a comprehensive sampling of the global atmosphere, and lower-flying platforms, for example with short-life nanosatellites serving as gap fillers. A space station could be used for demonstration of new sensors, and, in the overlap region of

space-based and surface-based observing systems, sub-orbital flights of balloons or unmanned aerial vehicles will also contribute. Calibration references should be an integral part of the system, including Earth surface targets, in-orbit reference standards, and lunar observatories to use the Moon as a transfer standard.

Using a diversity of orbits will improve sampling the Earth's environment and remove sampling biases that a single source of measurement can introduce. They will facilitate simultaneous observations of several variables/phenomena, as well as multiple observations of the same phenomenon, both with benefits to applications. Multiple orbits will also increase the overall robustness of the system, but require a special effort on interoperability (on the provider side) and agility (on the user side). The diversity of mission concepts goes along with a diversity in programmatic approaches: the overall system should be composed of, on the one hand, the classical series of recurrent large satellite programmes which provide a solid and stable foundation with a visibility over two decades, and on the other hand, smaller satellite programmes with shorter life cycles, more limited scope, more experimental payloads, and with faster, more flexible decision processes.

Data management and data access will remain a challenge over the coming decades, as progress in information technology is constantly challenged by the growth of data volumes and the requirements for increasing timeliness of data delivery by many users. At the same time, for building the historical record, long-term data preservation of these data must be managed. Higher connectivity and more providers of satellite data raise the question of interoperability and IT security which must be addressed with very high attention. Handling the growth of data volumes requires an expansion of telecommunications capacity, through identified networks, cloud concepts or collaborative systems. For example, DBNet (formerly named RARS) is a collaborative, default-tolerant network using the Direct Broadcast service available for many satellite systems. DBNet is a cost-effective complement or alternative to more expensive ground station networks. A trade-off needs to be found between exchanging data and exchanging products derived from the data, which raises the question of where the processing is performed, and how it is controlled. The prospect of distributed processing using multiple data sources is critically dependent on consistent data representation, detailed quality information, and comprehensive, standardized metadata. WMO provides a framework in the area of data management, for developing best practices and fostering cooperation with the goal to achieve maximum overall efficiency and quality.

4. Evolving paradigm of satellite programmes

The space-based observing system will continue to rely on both operational and R&D missions, which are pursuing different objectives and are optimized along different priorities. This is in no way an impediment: operational users are encouraged to make use of R&D mission data, and R&D missions may benefit of flight opportunities on operational programmes. Moreover, the transition process from mature research programmes to operational missions should be systematically supported and controlled in considering the technological maturity (robustness, availability, affordability), the operational maturity (possible long-term and real-time service continuity), the user maturity (evidence of a user community and applications with demonstrated benefit), and organizational maturity (established structures and mechanisms for user-provider interaction on requirements, system specifications, feedback, assessment of benefits, and funding schemes).

As the number of space-faring nations increases, it will be justified to aim at a wider distribution of the space-based observation effort among WMO Members. This is an opportunity, but with associated challenges: the need for an increasingly strong international cooperation to avoid duplication of efforts and to ensure the interoperability of all components.

While the WMO Space Programme is an overall framework for global coordination, different models will be followed to implement truly international satellite programmes: bilateral cooperation between agencies, inter-governmental regional organizations such as EUMETSAT and ESA, more flexible regional programmes (e.g. a potential future African Space Programme) or consortia under private law with governmental stakeholders (like e.g. the current DMC constellation or CLS-Argos).

Another evolution to be considered with attention is the evolving role of the commercial sector. While satellite industry has historically assumed a role of contractor delivering a system to the governmental customer, industry might act in different ways in the future: as the implementing agent of the government to deliver data rather than systems; by sharing the financial and technical risk in a public/private partnership; by implementing satellite missions on a purely commercial basis, either by adding a mission as a payload hosted on a commercial telecommunication platform, or by designing an environmental satellite programme on its own. These possible paradigm shifts could open opportunities to enhance the observing system, thanks to the potentially high reactivity of some private companies. There are also major risks associated with a changing role of industry which should be anticipated, and addressed with caution, in the following areas:

- Limitations to exchange of data due to its commercialization, resulting in overall less availability of data;
- Lack of publicly-available information on the detailed technical specifications of the system, resulting in loss of traceability and reliability;
- Inability to participate in global coordination under the auspices of WMO, since a private company has its own market objectives and cannot be bound by the same international commitments as a governmental agency;
- Risk that the political attractiveness and potential benefits of commercial initiatives in the short term undermine the decision processes and funding mechanisms of long-term national or regional programmes which are essential to meet national, regional or global requirements.

Given these opportunities and threats, it is important to identify the conditions under which commercial initiatives addressing space-based observing systems could make a successful contribution to society.

There is a continuing need for governmental commitments by WMO Members, implemented by governmental agencies or any other government-designated agent, to preserve the possibility of coordinated, global optimization of the system, including gap assessments and contingency planning, international data exchange and interoperability under WMO auspices. WMO Resolution 40 (Cg-XII)³ provides a conceptual framework to define how public and private data provision can complement each other: in order to ensure the provision of "essential data" freely, Members must have governmental control on a WMO-coordinated backbone observing system, while commercial operators could enhance the system in providing "additional data". Public/private partnerships may combine these two aspects, for instance, with a programme delivering a freely accessible "essential" service responding to the specifications defined by the governmental authority, and an "additional" service marketed by the commercial operator towards specific customers. Without pretending any coordination of commercial initiatives, the WMO Vision can have a beneficial influence on the provision of observations by commercial operators through setting overall system aims and priorities and highlighting the importance of data quality and interoperability standards.

³ https://www.wmo.int/pages/about/Resolution40_en.html

5. The Vision

Trying to outline the architecture of the space-based observing system envisioned for 2040, the first difficulty for space agencies is to anticipate and understand the user needs 25 years ahead, and for users to anticipate the potential future capabilities. The needed dialogue was the motivation for the WMO WIGOS Space 2040 workshop held in November 2015. Below, an outline is given of the possible configuration of the Vision. Rather than prescribing every component, a balance has been struck between being specific enough to provide clear guidance on how to achieve a robust and reliable system, and being open to opportunities and initiatives that can currently not be anticipated. The proposed Vision consists of 4-tiers:

1. A detailed specified backbone system, the basis for Members' commitments, addressing the vital needs for "essential data" with pre-determined orbital configuration and measurement approach. This specified backbone should as a minimum include all the elements of the 2025 Vision and current CGMS baseline with a few necessary additions and improvements; it would ensure the long-term stability of the system;
2. An equally important component to provide other "essential data" is defined in a more open way, without predetermining the final orbital configuration or measurement approach, in order to preserve the flexibility necessary to optimize the system based on latest demonstrated technologies and impact studies;
3. Operational pathfinders, and technology or science demonstrators should be planned, to pave the way for future evolution of the system beyond 2040;
4. The observing system should also take advantage of other contributions of WMO Members and third parties including governmental, academic or commercial initiatives, which could augment the backbone elements to provide more "essential" or "additional" data.

Tier 1: Backbone system with specified orbital configuration and measurement approaches

The backbone system, building on/enhancing current vision of the observing system should include:

Instruments:	Geophysical variables and phenomena:
<i>Geostationary ring</i>	
Frequent multi-spectral VIS/IR imagery	Cloud amount, type, top height/temperature; wind (through tracking cloud and water vapour features); sea/land surface temperature; precipitation; aerosols; snow cover; vegetation cover; albedo; atmospheric stability; fires; volcanic ash
IR hyperspectral sounders	Atmospheric temperature, humidity; wind (through tracking cloud and water vapour features); rapidly evolving mesoscale features; sea/land surface temperature; cloud amount and top height/temperature; atmospheric composition (aerosols, ozone, greenhouse gases, trace gases)
Lightning mapper	Lightning (in particular cloud to cloud), location of intense convection.
UV/VIS/NIR sounder	Ozone , trace gases, aerosol, humidity, cloud top height
<i>Low-Earth orbiting sun-synchronous core constellation in 3 orbital planes (morning, afternoon, early morning)</i>	
IR hyperspectral sounders	Atmospheric temperature and humidity; sea/land surface temperature; cloud amount, water content and top height/temperature; precipitation; atmospheric composition (aerosols, ozone, greenhouse gases, trace gases)
MW sounders	
VIS/IR imager including Day/Night band	Cloud amount, type, top height/temperature; wind (high latitudes, through tracking cloud and water vapour features); sea/land surface temperature; precipitation; aerosols; snow and ice cover; vegetation cover; albedo; atmospheric stability
MW imagers	Sea ice; total column water vapour; precipitation; sea surface wind speed [and direction]; cloud liquid water; sea/land surface temperature; soil moisture
Scatterometers	Sea surface wind speed and direction; sea ice; soil moisture
<i>Low-Earth orbit sun-synchronous satellites at 3 additional Equatorial Crossing Times, for improved robustness and improved time sampling particularly for monitoring precipitation</i>	
<i>Other Low-Earth orbit satellites</i>	
Wide-swath radar altimeters, and high-altitude, inclined, high-precision orbit altimeters	Ocean surface topography; sea level; ocean wave height; lake levels; sea and land ice topography
IR dual-angle view imager	Sea surface temperature (of climate monitoring quality); aerosols; cloud properties
MW imagery at 6.7 GHz	Sea surface temperature (all-weather)
Low-frequency MW imagery	Soil moisture, ocean salinity, sea surface wind, sea-ice thickness
MW cross-track upper stratospheric and mesospheric sounder	Atmospheric temperature profiles in stratosphere and mesosphere
UV/VIS/NIR sounder, nadir and limb	Atmospheric composition including H2O
Precipitation and cloud radars, in inclined orbits	Precipitation (liquid and solid), cloud phase/ top height/ particle distribution/ amount, aerosol, dust, volcanic ash
MW sounder and imager in inclined orbits	Total column water vapour; precipitation; sea surface wind speed [and direction]; cloud liquid water; sea/land surface temperature; soil moisture
Absolutely calibrated broadband radiometer, and TSI and SSI radiometer	Broadband radiative flux; Earth radiation budget; total solar irradiance; spectral solar irradiance
GNSS radio occultation (basic constellation)	Atmospheric temperature and humidity; ionospheric electron density
Narrow-band or hyperspectral imagery	Ocean colour; vegetation (including burnt areas); aerosols; cloud properties; albedo
High-resolution multi-spectral VIS/IR imagers	Land use, vegetation; flood, landslide monitoring
SAR imagery and altimetry	Sea state, sea ice, ice sheets, soil moisture, floods
Gravimetry mission	Ground water, oceanography
<i>Other missions</i>	

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Instruments:	Geophysical variables and phenomena:
Solar wind <i>in situ</i> plasma and energetic particles, magnetic field, at L1	Energetic particle flux and energy spectrum (Radiation storms, geomagnetic storms)
Solar coronagraph and radio-spectrograph, at L1	Solar imagery (Detection of Coronal Mass Ejections and solar activity monitoring)
In-situ plasma probes and energetic particle spectrometers at GEO and LEO, and magnetic field at GEO	Energetic particle flux and energy spectrum (Radiation storms, geomagnetic storms)
Magnetometers on GEO orbit	Geomagnetic field at GEO altitude (geomagnetic storms)
On-orbit measurement reference standards for VIS/NIR, IR, MW absolute calibration	

Tier 2. Backbone system – Open measurement approaches (flexibility to optimize the implementation)

Instruments:	Geophysical variables and phenomena:
GNSS reflectometry missions, passive MW, SAR	Surface wind and sea state
Lidar (Doppler and dual/triple-frequency backscatter)	Wind and aerosol profiling
Lidar (single wavelength) (in addition to radar missions mentioned in Tier 1)	Sea ice thickness
Lidar (DIAL)	Atmospheric moisture profiling
Sub-mm imagery	Cloud phase detection
NIR imagery	CO ₂ , CH ₄
Multi-angle, multi-polarization radiometers	Aerosols, radiation budget
Multi-polarization SAR, hyperspectral VIS	High-resolution land and ocean observation
GEO or LEO constellation of high-temporal frequency MW sounding	Atmospheric temperature, humidity and wind; sea/land surface temperature; cloud amount, water content and top height/temperature; atmospheric composition (aerosols, ozone, greenhouse gases, trace gases)
NIR spectrometry	Surface pressure
UV/VIS/NIR/IR/MW limb sounder	Ozone, trace gases, aerosol, humidity, cloud top height
HEO VIS/IR mission for continuous polar coverage (Arctic and Antarctica)	Sea ice; cloud amount, type, top height/temperature; wind (through tracking cloud and water vapour features); sea/land surface temperature; precipitation; aerosols; snow cover; vegetation cover; albedo; atmospheric stability; fires; volcanic ash
Solar magnetograph, solar EUV/X-ray imager and EUV/X-ray irradiance, both on the Earth-Sun line (e.g. L1, GEO) and off the Earth-Sun line (e.g. L5, L4)	Solar activity (Detection of solar flares, Coronal Mass Ejections and precursor events)
Solar wind <i>in situ</i> plasma and energetic particles and magnetic field off the Earth-Sun line (e.g. L5)	Solar wind; energetic particles; interplanetary magnetic field
Solar coronagraph and heliospheric imager off the Earth-Sun line (e.g. L4, L5)	Solar heliospheric imagery (Detection and monitoring of Coronal Mass Ejections travelling to the Earth)
Magnetospheric energetic particles	Energetic particle flux and energy spectrum (geomagnetic storms)

Tier 3. Operational pathfinders and technology and science demonstrators

Instruments:	Geophysical variables and phenomena:
GNSS RO additional constellation for enhanced atmospheric/ionospheric soundings, including additional frequencies optimized for atmospheric sounding	Atmospheric temperature and humidity; ionospheric electron density
Radar and lidar for vegetation	Vegetation parameters, Above-ground biomass

Instruments:	Geophysical variables and phenomena:
mapping	
Hyperspectral MW sensors	Atmospheric temperature, humidity and wind; sea/land surface temperature; cloud amount, water content and top height/temperature; atmospheric composition (aerosols, ozone, greenhouse gases, trace gases)
Solar coronal magnetic field imager, solar wind beyond L1	Solar wind, geomagnetic activity
Ionosphere/ thermosphere spectral imager (e.g. GEO, HEO, MEO, LEO)	
Ionospheric electron and major ion density	
Thermospheric neutral density and constituents	

This category of missions should include process study missions, for which the content and duration would have to be determined on a case by case basis, depending on process cycles considered. Such missions could rely on a diverse range of platforms. For instance, nanosatellites may be used for demonstration or science missions, and for contingency planning as gap fillers, without excluding the use of nanosatellites also in Tier 2 missions. At the other end of the platform size spectrum, the use of orbiting platforms (comparable to the International Space Station) can also be an option for demonstration or science missions.

Tier 4. Other contributions from WMO members and third parties

The observing system should also take advantage of other capabilities implemented by WMO Members and third parties, which could be governmental, e.g., academic projects, or commercial initiatives, willing to exploit particular technical or market opportunities. Such capabilities could augment the backbone elements in providing more “essential” or “additional” data.

WMO would not pretend to coordinate these contributions, but could recommend standards and best practices that the operators may consider to comply with in order to facilitate the user uptake of such capabilities and maximize the chance that the data provided are interoperable with the backbone system and provide a useful contribution to the community.

DRAFT LIST OF HAZARDS AND EXTREME EVENTS

Event types and metrics for characterization of hazard and extreme event information for loss and damage assessment

The Seventeenth Session of the World Climate Congress (Cg-17) decided to standardize hazard and extreme event information, including the creation or adoption of a system of assigning a unique identifier to each event so that events can be catalogued and linked to data on associated damages and losses.

Information will be validated with all relevant Commissions and Programmes, the Executive Council Working Group on Disaster Risk Reduction (ECWG-DRR), and by Members as appropriate and submitted to the EC-68/9 and Cg-18.

List of hazards and extreme events

- I. Weather
- Duststorm
- Sand haze
- Sandstorm
- Sandstorm/Duststorm.....
- Acid rain
- Black carbon.....
- Brown clouds.....
- Pollen pollution episodes
- Polluted air.....
- Radioactive contamination.....
- Sulphur rain
- Avalanche
- Blizzard.....
- Downburst
- Dry spell
- Fog.....
- Hoar frost.....
- Gale
- Hail
- Haze.....
- Heavy precipitation.....
- Heavy rain
- Ice storm
- Smog
- Snowstorm.....
- Squall
- Storm

Strong gale
Thunderstorm.....
Wet spell.....
Volcanian eruption.....
Volcanic ash
Hawaiian eruption
Plinian eruption.....
Strombolian eruption
Storm surges.....
Tsunami.....
Cyclone.....
Tropical cyclone
Sub-tropical cyclone
Extra-tropical cyclone
Hurricane
Typhoon.....
Severe tropical storm
Subtropical Storm
Tornado
Tropical storm

II. Climate
Cold wave
Heatwave/heat wave
Drought
Hydrological drought
Meteorological drought

III. Water
Annual flood
Coastal flood
Estuarine flood.....
Flash flood
Flood
Flooding..... **Error! Bookmark not defined.**
Fluvial (riverine) flood.....
Ice and debris-jam flood
Landslide/Mudslide
Mudflow
Multiple event flood
Seasonal flood
Single event flood
Snowmelt flood

IV. Space weather

Coronal mass ejections
Geomagnetic storms.....
Ionospheric storms.....
Radio blackout
Solar energetic particles.....
Solar flares.....
Solar radiation storm



ACRONYMS

AA	Application Area
AMDAR	Aircraft Meteorological Data Relay
AntON	Antarctic Observing Network
AOPC	GCOS Atmospheric Observation Panel for Climate
asap	As soon as possible
ASAP	Automated Shipboard Aerological Programme
AWS	Automatic Weather Station
CAeM	Commission for Aeronautical Meteorology
CAGM	Commission for Agricultural Meteorology
CAS	Commission for Atmospheric Sciences
CBS	Commission for Basic Systems
CCI	Commission for Climatology
CD	Capacity Development
CEOS	Committee on Earth Observation Satellites
Cg	Congress
CGMS	Coordination Group for Meteorological Satellites
CHy	Commission for Hydrology
CIMO	Commission for Instruments and Methods of Observation
CM	Climate Monitoring
CMA	China Meteorological Administration
CryoNet	Core network of GCW surface measurement sites/stations
DAOS	Data Assimilation and Observing Systems working group
DPFS	Data Processing and Forecasting System
DRR	Disaster Risk Reduction
E-AMDAR	EIG EUMETNET AMDAR programme
E-ASAP	EIG EUMETNET Automated Shipboard Aerological Programme
EC	Executive Council
ECMWF	European Centre for Medium-Range Weather Forecast
EC-PORS	Executive Council Panel of Experts on Polar Observations, Research and Services
ECV	Essential Climate Variable
EGOS-IP	Implementation Plan for the Evolution of Global Observing Systems
E-GVAP	EIG EUMETNET GNSS water vapour programme
EIG	Economical Interest Group
E-PROFILE	EIG EUMETNET Radar Wind Profilers and Backscatter Lidars programme
E-SURFMAR	EIG EUMETNET Surface Marine observation programme
ET-ABO	OPAG-IOS Expert Team on Aircraft Based Observing Systems
ET-AO	CIMO Expert Team on Aircraft Based Observations
ET-EGOS	Former OPAG-IOS Expert Team on the Evolution of Global Observing Systems
ET-ODRRGOS	Former OPAG-IOS Expert Team on Observational Data Requirements and Redesign of the Global Observing System
ET-OPSL	CBS/CCI Expert Team on Operational Predictions from Sub-Seasonal to Longer-Time Scales
ET-SAT	OPAG-IOS Expert-Team on Satellite Systems
ET-SBO	OPAG-IOS Expert Team on Surface-Based Observing Systems
EUMETNET	EIG Grouping of European Meteorological Services
EUMETSAT	European Organization for the Exploitation of Meteorological Satellites
E-WINPROF	EIG EUMETNET Operational Networking of Wind Profilers in Europe
FAO	Food and Agriculture Organization of the United Nations
FSO	Forecast Sensitivity to Observation
GAW	Global Atmosphere Watch
GAWSIS	GAW Station Information System
GCOS	WMO-IOC-UNEP-ICSU Global Climate Observing System
GCOS-IP	GCOS Implementation Plan
GCW	Global Cryosphere Watch
GCW-IP	GCW Implementation Plan

IPET-OSDE2, Final Report

GEO	Group on Earth Observations
GEO	Operational geostationary satellites
GFCS	Global Framework for Climate Services
GHGs	Greenhouse gases
GLAS	GEWEX Global Land/Atmosphere System Study
GNSS	Global Navigation Satellite System
GNSSRO	GNSS for Radio Occultation
GNWP	Global NWP
GOOS	IOC-WMO-UNEP-ICSU Global Ocean Observing System
GOS	Global Observing System
GPCs	Global Producing Centres of Long-Range Forecasts
GPS	Global Positioning System
GPSRO	GPS Radio Occultation
GRUAN	GCOS Reference Upper Air Network
GSG	GCW Steering Group
GSICS	Global Space-Based Inter-Calibration System
GSN	GCOS Surface Network
GSNMC	GSN Monitoring Centre
GTN-P	Global Terrestrial Network for Permafrost
GTS	Global Telecommunications System
HR	Horizontal Resolution
HRNWP	High Resolution NWP
IBCS	Intergovernmental Board on Climate Services
ICAO	International Civil Aviation Organization
ICG-WIGOS	Inter-Commission Coordination Group on WIGOS
ICSU	International Council for Science
ICT-IOS	CBS Implementation Coordination Team on Integrated Observing Systems
ICT-SW	WMO Inter-Programme Coordination Team on Space Weather
ID	Identification Number
IGOS	Integrated Global Observing Strategy
IMOP	Instrument and Methods of Observation Programme
IOC	Intergovernmental Oceanographic Commission (UNESCO)
IPET	Inter-Programme Expert Team
IPET-OSDE	OPAG-IOS IPET on the Observing System Design and Evolution
IPET-SUP	OPAG-IOS IPET on Satellite Utilization and Products
IPET-WIFI	OPAG-IOS IPET on WIGOS Framework Implementation Matters
IPT-SWISS	Inter-Programme Team on Space Weather Information, Systems and Services
IPWG	International Precipitation Working Group
ITU	International Telecommunication Union
IWWG	International Winds Working Group
JCOMM	Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology
JMA	Japan Meteorological Agency
KAAs	Key Activity Area
KNMI	Royal Netherlands Meteorological Institute
LAM	Limited Area Model
LEO	Operational low-Earth orbit satellites
MHEWS	Multi-Hazard Early Warning Systems
MoU	Memorandum of Understanding
NASA	National Aeronautics and Space Administration
NCEP	NOAA National Centers for Environmental Prediction
NFP	National Focal Point
NMHSs	National Meteorological and Hydrological Services
NOAA	US National Oceanic and Atmospheric Administration
NVSRF	Nowcasting and Very Short Range Forecasting
NWP	Numerical Weather Prediction
OC	Observing Cycle
OCG	JCOMM Observations Coordination Group

IPET-OSDE2, Final Report

OND	Observing Network Design
OPA	JCOMM Observations Programme Area
OPACE	Open Panel of CCI Experts
OPAG	Open Programme Area Group
OPAG-DPFS	CBS OPAG on DPFS
OPAG-IOS	CBS OPAG on Integrated Observing Systems
OPERA	EIG EUMETNET Operational Programme for the Exchange of Weather Radar Information
OSCAR	Observing System Capability Analysis and Review tool
OSCAR/Requirements	Observational user requirements component of OSCAR
OSCAR/Space	Space-based observing systems capabilities component of OSCAR
OSCAR/Surface	Surface-based observing systems capabilities component of OSCAR
OSDW	IPET-OSDE Observing System Design Workshop
OSE	Observing System Experiment
OSND	Observing system network design
OSSE	Observing System Simulation Experiment
PoC	Point of Contact
QM	Quality Management
R&D	Research and Development
RA	Regional Association
RBCN	Regional Basic Climatological Network
RBON	Regional Basic Observing Network
RBSN	Regional Basic Synoptic Network
R-MAR	OPAG-IOS Rapporteur on Marine Observing Systems
RRR	Rolling Review of Requirements
R-SEIS	OPAG-IOS Co-Rapporteur on Scientific Evaluation of Impact Studies undertaken by NWP centres
RTH	Regional Telecommunication Hub
R-WIP	Regional WIGOS Implementation Plan
SAG	Scientific Advisory Groups
SAON	Sustained Arctic Observing Network
SG-OD	IPET-WIFI Sub-Group on OSCAR Development
SG-RFC	OPAG-IOS Steering Group on Radio-Frequency Coordination
SIAF	Seasonal to Inter-Annual Forecasting
SLWC	Super Cooled Liquid Water Content
SOC	Science Organizing Committee
SoG	Statement of Guidance
TAMDAR	Tropospheric Airborne Meteorological Data Reporting
TAO	Tropical Atmosphere Ocean
TBD	To be defined
TC	Technical Commission
TDCF	Table Driven Code Form
TECO	Technical Conference
TOPC	GCOS Terrestrial Observation Panel for Climate
ToR	Terms of Reference
TPOS	Tropical Pacific Observing System project
TRITON	Triangle Trans-Ocean Buoy Network
TT-SOGON	CCI Task Team on the Statement of Guidance on Observational Needs
U	Uncertainty
UK	United Kingdom of Great Britain and Northern Ireland
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UR	User Requirement
USA	United States of America
VCP	Voluntary Cooperation Programme
VoIA	WMO No. 9, Weather Reporting, Volume A, Observing Stations and WMO Catalogue of Radio-sondes
VR	Vertical Resolution

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WAM	West African monsoon
WCRP	WMO-IOC-ICSU World Climate Research Programme
WDQMS	WIGOS Data Quality Monitoring System
WG-GRUAN	Working Group on GRUAN
WHOS	WMO Hydrological Observing System
WIGOS	WMO Integrated Global Observing System
WIP	WIGOS Framework Implementation Plan
WIR	WIGOS Information Resource
WIS	WMO Information System
WMO	World Meteorological Organization
WPP	WIGOS Pre-operational Phase
WRF	Weather Research and Forecasting
WWW	World Weather Watch

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