Guide to the WMO Integrated Global Observing System

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Introduction

General

This is the first edition of the Guide to the WMO Integrated Global Observing System (WMO-No. 1165). It was developed following the decision of the Seventeenth World Meteorological Congress for the WMO Integrated Global Observing System (WIGOS) to proceed in a preoperational phase (2016–2019), as well as the approval by Seventeenth Congress of the Technical Regulations (WMO-No. 49), Volume I, Part I, and the Manual on the WMO Integrated Global Observing System (WMO-No. 1160), with effect from 1 July 2016. In essence, these two publications specify what is to be observed, as well as where, when and how, in order for Members to meet the relevant observational requirements.

To complement these activities, Seventeenth Congress requested the Secretariat of the World Meteorological Organization (WMO) to publish a set of guidelines incorporated in an initial Guide, which would be progressively revised and enhanced through the WIGOS preoperational phase. This was formalized in a decision of the WMO Executive Council at its sixty-seventh session to re-establish the Intercommission Coordination Group on the WMO Integrated Global Observing System (ICG-WIGOS), which has as one of its terms of reference to complement WIGOS regulatory material with the necessary guidance information and technical guidelines incorporated in the Guide to the WMO Integrated Global Observing System (WMO-No. 1165). The Guide was approved by the Executive Council at its sixty-ninth session via Resolution 2 (EC-69) – Initial Version of the Guide to the WMO Integrated Global Observing System.

This initial Guide thus aims to assist Members to comply with a number of new regulations which came into effect on 1 July 2016. It was developed by the Secretariat, in particular the WIGOS Project Office, with input from technical experts of the ICG-WIGOS task teams and the lead technical commissions (Commission for Basic Systems and Commission for Instruments and Methods of Observation).

Purpose and scope

This initial version of the Guide provides material relevant to some of the new WIGOS-related regulations. The topics cover the new system of WIGOS station identifiers, the new requirements to record and make available metadata as specified in the WIGOS Metadata Standard, the new Observing Systems Capability Analysis and Review (OSCAR) tool to be used by Members to submit metadata for WMO global compilation, and the new observing network design principles.

Future versions of this Guide will provide detailed guidance and technical guidelines on how to establish, operate and manage WIGOS component observing systems to make observations in compliance with the Technical Regulations (WMO-No. 49), Volume I, Part I, and the Manual on the WMO Integrated Global Observing System (WMO-No. 1160). These versions will explain and describe WIGOS practices, procedures and specifications and will be aimed at assisting the technical and administrative staff of National Meteorological and Hydrological Services responsible for the networks of observing stations in preparing national instructions for observers.

The Guide should be used in conjunction with the many other relevant WMO Guides, technical documents and related publications. For example, the Guide to Meteorological Instruments and Methods of Observation (WMO-No. 8) is the authoritative reference for all matters related to instrumentation and methods of observation. It should be consulted for more detailed descriptions and best practices. The subsequent step of how observations are to be encoded and reported is specified in the Manual on Codes (WMO-No. 306). The Guide to the Global Observing System (WMO-No. 488) is the authoritative reference for all matters related to the Global Observing System.

Procedures for amending the Guide

A detailed explanation of the procedures for amending WMO Guides that are under the responsibility of the Commission for Basic Systems can be found in the appendix to the General Provisions of the Manual on the WMO Integrated Global Observing System (WMO-No. 1160).

List of related publications

The development of this Guide takes a thin-layer approach, meaning that it aims only to publish additional, new material which complements the material in existing Guides. All guidance relating to observing systems in any of the WMO Guides or Manuals is effectively WIGOS guidance material.

Here is the list of the publications related to the Guide to the WMO Integrated Global Observing System (WMO-No. 1165). The most relevant are indicated by an asterisk (\*) following the publication name. Publications are also referenced within sections of this initial Guide where there is a very specific point to be highlighted. All these publications are available at <http://library.wmo.int/opac/index.php>. The search can be done by filling in either the “WMO/No.” or “WMO/TD-No.” fields with the corresponding publication number.

(a) Technical Regulations (WMO-No. 49), Volumes I–III\*

(b) Manuals:

(i) Manual on Codes (WMO-No. 306), Volumes I.1 and I.2

(ii) Manual on the Global Telecommunication System (WMO-No. 386)

(iii) International Cloud Atlas (WMO-No. 407)

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

(v) Manual on the WMO Information System (WMO-No. 1060)

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

(c) Guides:

(i) Guide to Meteorological Instruments and Methods of Observation (WMO-No. 8)\*

(ii) Guide to Climatological Practices (WMO-No. 100)\*

(iii) Guide to Agricultural Meteorological Practices (WMO-No. 134)

(iv) Guide to Hydrological Practices (WMO-No. 168), Volume I\*

(v) Guide on the Global Data-processing System (WMO-No. 305)

(vi) Guide to the Global Observing System (WMO-No. 488)\*

(vii) Guide to the Quality Management System for the Provision of Meteorological Service for International Air Navigation (WMO-No. 1001)

(viii) Guide to the Implementation of a Quality Management System for National Meteorological and Hydrological Services (WMO-No. 1100)

(ix) Guide to the WMO Information System (WMO-No. 1061)

(x) Guide to the Implementation of Education and Training Standards in Meteorology and Hydrology (WMO-No. 1083), Volume I

(d) Technical documents/technical notes:

(i) Baseline Surface Radiation Network (BSRN), Operations Manual, World Climate Research Programme Publication Series No. 121 (WMO/TD-No. 1274)

(ii) Global Atmosphere Watch Measurements Guide, GAW Report No. 143 (WMO/TD-No. 1073)

(iii) Guide to the GCOS Surface Network (GSN) and GCOS Upper-air Network (GUAN), GCOS Report No. 144 (WMO/TD-No. 1558; 2010 update of GCOS-73)

(iv) International Meteorological Tables (WMO-No. 188, TP 94)\*

(v) Manual on Sea Level Measurement and Interpretation, JCOMM Technical Report No. 31 (WMO/TD-No. 1339), Volume IV

(vi) Note on the Standardization of Pressure Reduction Methods in the International Network of Synoptic Stations, Technical Note No. 61 (WMO-No. 154, TP 74)

(vii) WMO Global Atmosphere Watch (GAW) Strategic Plan: 2008–2015 – A Contribution to the Implementation of the WMO Strategic Plan: 2008–2011, GAW Report No. 172 (WMO/TD-No. 1384)\*

(e) Guidelines and other related publications:

(i) WIGOS Metadata Standard (WMO-No. 1192)

(ii) Aircraft Meteorological Data Relay (AMDAR) Reference Manual (WMO-No. 958)

(iii) GAW reports

(iv) The GCOS Reference Upper-air Network (GRUAN) – Manual, WIGOS Technical Report No. 2013-02, GCOS Report No. 170

(v) The GCOS Reference Upper-air Network (GRUAN) – Guide, WIGOS Technical Report No. 2013-03, GCOS Report No. 171

(vi) Hydrology and Water Resources Programme (HWRP) manuals

(vii) JCOMM catalogue of practices and standards (WMO Manuals and Guides, and observation standards, such as manuals and guides of the Intergovernmental Oceanographic Commission)

(viii) Marine Meteorology and Oceanography Programme publications and documents

(ix) Sixth WMO Long-term Plan (2004–2011) (WMO-No. 962)

(x) Guidelines for the Education and Training of Personnel in Meteorology and Operational Hydrology (WMO-No. 258), Volumes I and II

Organization of the Guide

For ease of reference, the Guide, when completed, will follow as closely as possible the same structure as the Technical Regulations (WMO-No. 49), Volume I, Part I, and the Manual on the WMO Integrated Global Observing System (WMO-No. 1160). That structure consists of eight chapters.

Chapters 1 and 2 apply to all of the WIGOS component observing systems. Chapter 3 provides additional information applicable to the surface-based subsystem of WIGOS, while Chapter 4 provides further information applicable to the space-based subsystem of WIGOS. Chapters 5 through 8 (system-specific chapters) provide further information relevant to the Global Observing System of the World Weather Watch (Chapter 5), the Global Atmosphere Watch (Chapter 6), the WMO Hydrological Observing System (Chapter 7), and the Global Cryosphere Watch (Chapter 8), respectively.

When using future versions of the Guide, readers are strongly encouraged to consult all of the relevant chapters, recognizing the way in which they build upon each other.

The organization of this initial Guide is extremely abbreviated. Only Chapter 1 will remain in the same form in future versions. Other material is, for convenience, presented as Chapters 2 to 5 in this initial Guide but will become subsections in future versions.

1. Introduction to the WMO Integrated Global Observing System

1.1 Purpose and scope

It is specified in the Technical Regulations (WMO-No. 49), Volume I, Part I, and the Manual on the WMO Integrated Global Observing System (WMO-No. 1160) that the WMO Integrated Global Observing System is a framework for all WMO observing systems and for WMO contributions to co-sponsored observing systems in support of all WMO Programmes and activities.

1.2 WIGOS component observing systems

The component observing systems of WIGOS are the Global Observing System of the World Weather Watch Programme, the observing component of the Global Atmosphere Watch Programme, the WMO Hydrological Observing System of the Hydrology and Water Resources Programme and the observing component of the Global Cryosphere Watch, including their surface-based and space-based components.

The above component systems include all WMO contributions to the co-sponsored systems, to the Global Framework for Climate Services and to the Global Earth Observation System of Systems. The co-sponsored observing systems are the Global Climate Observing System, the Global Ocean Observing System and the Global Terrestrial Observing System, all joint undertakings of WMO and the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization, the United Nations Environment Programme and the International Council for Science.

1.3 Governance and management

Implementation and operation of WIGOS

The implementation of WIGOS is an integrating activity for all WMO and co-sponsored observing systems: it supports all WMO Programmes and activities. The Executive Council and regional associations, supported by their respective working bodies, have a governing role in the implementation of WIGOS. Technical aspects of WIGOS implementation are guided by the technical commissions, with leadership provided through the Commission for Basic Systems and the Commission for Instruments and Methods of Observation.

The WIGOS framework implementation phase occurred in the period 2012–2015. Implementation plans and activities followed a structure based on ten key activity areas which are listed below and represented schematically in Figure 1.1:

Figure 1.1. Ten key activity areas for the WIGOS framework implementation  
and how they relate

(a) Management of WIGOS implementation;

(b) Collaboration with the WMO co-sponsored observing systems and international partner organizations and programmes;

(c) Design, planning and optimized evolution;

(d) Observing system operation and maintenance;

(e) Quality management;

(f) Standardization, interoperability and data compatibility;

(g) The WIGOS Information Resource;

(h) Data discovery, availability (of data and metadata) and archiving;

(i) Capacity development;

(j) Communications and outreach.

Building on the WIGOS framework, the five priority areas of the WIGOS preoperational phase, which support the delivery of the WMO strategic priorities, are being addressed in the period 2016–2019. The five priority areas are listed below and are represented schematically in Figure 1.2:

(a) National WIGOS implementation;

(b) WIGOS regulatory and guidance material;

(c) WIGOS Information Resource;

(d) WIGOS Data Quality Monitoring System;

(e) Regional WIGOS centres.

Figure 1.2. The five priority areas of the WIGOS preoperational phase

2. WIGOS station identifiers

2.1 Fundamentals

2.1.1 System of WIGOS identifiers

The system of WIGOS identifiers is defined in the [Manual on the WMO Integrated Global Observing System](https://library.wmo.int/opac/index.php?lvl=notice_display&id=19223#.WV9WUWl95EY) (WMO-No. 1160), Attachment 2.1.

Each observing station must have at least one WIGOS station identifier. The station identifier(s) link(s) the station to its WIGOS metadata.

The structure of a WIGOS identifier is:

|  |  |  |  |
| --- | --- | --- | --- |
| WIGOS identifier series (number) | Issuer of identifier (number) | Issue number (number) | Local identifier (characters) |

Only the WIGOS identifier series 0 has been defined. This series is used to identify observing stations.

2.1.2 Advice for users of WIGOS identifiers

WIGOS identifiers do not have meaning in themselves. Users must not interpret any patterns they see in these identifiers; for WIGOS station identifiers, users should use [OSCAR/Surface](https://oscar.wmo.int/surface/index.html#/) to look up the metadata for the station associated with the identifier.

2.1.3 Recording the WIGOS station identifier in observation reports (in the standard WMO reporting formats)

WIGOS station identifiers cannot be represented in the traditional alphanumeric code forms, such as FM-12 SYNOP or FM-35 TEMP. The Table Driven Code Form equivalents have to be used (FM-94 BUFR or FM-95 CREX, or, in the future, model driven code forms). Further information on representing the WIGOS station identifier in BUFR/CREX is available in section 2.2.

Centres that are unable to process Table Driven Code Forms will not be able to access the reports from stations that only have WIGOS station identifiers.

2.1.4 Advice for people responsible for allocating WIGOS identifiers

As mentioned above, all observing stations must be associated with at least one WIGOS station identifier. A WIGOS station identifier can only be associated with one observing station. If you need additional help after reading this guidance, please contact the Secretariat at [wigos-help@wmo.int](mailto:wigos-help@wmo.int).

2.1.5 Assigning WIGOS identifiers to observing stations

The process for allocating a WIGOS station identifier is illustrated in the figure in this section.

Outline of procedure for allocating a WIGOS station identifier

Observing stations that had been allocated identifiers by a WMO Programme before the introduction of WIGOS station identifiers (that is, before 1 July 2016) may continue to use those identifiers and are not required to have additional ones created for them. For these observing facilities, the WIGOS station identifier can be deduced from the pre-existing identifier using the tables below. Further, should the station take on new responsibilities (such as an aviation station starting to report World Weather Watch synoptic information), the WIGOS identifier can also be used in that new context, even though it was derived from a station identifier associated with a different programme (in this example, the synoptic report could use the WIGOS station identifier derived from the International Civil Aviation Organization (ICAO) aerodrome indicator).

Although an observing station can have more than one WIGOS station identifier, it is desirable to associate as few identifiers as possible with one station. Therefore, if an observing station is already associated with a WIGOS identifier, or is associated with an identifier issued by a WMO or partner programme, an additional WIGOS station identifier should not be issued.

A Member for which there is an ISO 3166-1 numeric country code can assign its country code as the issuer of identifier value for its newly established observing stations. For example, the Korea Meteorological Administration can use “410” as the issuer of identifier number. This structure provides for an open range of station numbers that can be defined and allocated by the Republic of Korea to its expanding network (i.e. 0-410-0-XXXX).

Table 2.1 lists the issuer of identifier values that have been allocated for use for observing stations.

Table 2.1. Issuer of identifier values allocated for observing stations

|  |  |  |  |
| --- | --- | --- | --- |
| Range | Category of issuer | Allocation method | Procedures for assigning issue number and local identifier |
| 0 | Reserved for internal use by [OSCAR](https://www.wmo-sat.info/oscar/) | OSCAR allocates the value | Determined by OSCAR |
| 1–9999 | Member State or Territory for which there is an ISO 3166-1 numeric country code | Use of ISO 3166-1 three-digit numeric country code (by convention, leading zeroes are not shown in WIGOS identifiers). See the [ISO website](https://www.iso.org/obp/ui/#search). | Issuer determines its own procedures. Further guidance is available in section 2.3. |
| 10000–11999 | Member State or Territory for which there is no ISO 3166-1 numeric country code | WMO Secretariat allocates an available number on request | Issuer determines its own procedures. Further guidance is available in section 2.3. |
| 12000–19999 | Reserved for future use | To be determined | To be determined |
|  | Identifiers in the ranges 20000–21999 and 22000–39999 are intended to be used only to allocate WIGOS identifiers to observing facilities that have one or more pre-existing identifiers. | | |
| 20000–21999 | WMO Secretariat for identifiers associated with WMO Programmes | Details are provided in section 2.4. | Details are provided in section 2.4. |
| 22000–39999 | WMO Secretariat for identifiers associated with programmes of partner organizations | Details are provided in section 2.5. | Details are provided in section 2.5. |
| 40000–65534 | Reserved for future use | To be determined | To be determined |
| 65535 | Missing value (reserved value in Table Driven Code Forms) |  |  |

2.2 WIGOS-ID-BUFR

This section explains how to represent the WIGOS station identifier in WMO standard code forms.

2.2.1 Reducing ambiguity through systematic use of WIGOS station identifiers

An observing facility may have several WIGOS station identifiers. Using OSCAR, it is possible to discover all the WIGOS station identifiers associated with that facility. In theory, this allows any of the possible WIGOS identifiers to be used in a report of an observation, but in practice, doing so would result in a lot of additional work for all users of the observation. A disciplined approach to using WIGOS station identifiers in a report will reduce the work for end-users.

2.2.2 Choosing which WIGOS station identifier to use

The following practices will make it easier for users of observation reports to link observations from a single observing facility:

(a) Use the same WIGOS identifier for all reports of the same type from that observing facility. For example, always use the same identifier for surface synoptic reports;

(b) If there is one, use the WMO Programme station identifier that is associated with the type of observation being reported to derive the WIGOS station identifier. For example, a WIGOS station identifier associated with the World Weather Watch land-station identifier would be used for surface synoptic reports;

(c) There is no requirement to introduce new WIGOS station identifiers if the observing facility already has one. For example, whatever type of observation is reported, if the facility has a WIGOS identifier derived from a World Weather Watch station identifier, then that WIGOS identifier may be used for reporting any type of observation. However, following practice (a) above, different types of reports might use different pre-existing identifiers.

2.2.3 Messages containing only reports from stations that have a pre-existing station identifier for the type of report being exchanged

In many cases, such as for surface observations from World Weather Watch land stations that existed before the introduction of WIGOS station identifiers, no change is needed to report from those stations in BUFR or CREX. The existing identifier should be reported as in the past.

Nevertheless, it is good practice also to report the derived WIGOS station identifier.

2.2.4 Messages containing reports from stations that do not have a pre-existing station identifier for the type of report being exchanged

New observing facilities, or those reporting new types of observations, will need to report the full WIGOS station identifier. BUFR and CREX messages that include reports from stations that do not have a pre-existing station identifier appropriate to that type of report have to include the BUFR/CREX sequence 3 01 150 to represent the WIGOS station identifier.

If there is no pre-existing identifier, the value for the station identifier in the standard BUFR/CREX sequence should be set to the value representing "missing".

2.2.5 Reporting the WIGOS station identifier in a BUFR/CREX message

When constructing a BUFR or CREX message that refers to WIGOS station identifiers, the sequence 3 01 150 must appear in the message before the sequence describing the information from those stations.

That is, the message contents should be in the order:

< sequence for the WIGOS station identifier (3 01 150)>  
< sequence for the data being reported>

2.2.6 Reporting the WIGOS station identifier when the reporting environment can only handle traditional alphanumeric codes

Traditional alphanumeric code forms cannot represent WIGOS station identifiers. Furthermore, observations can only be exchanged in traditional alphanumeric code if the observing facility has been allocated a conventional World Weather Watch station identifier. Observation facilities that have not been allocated a World Weather Watch station identifier must exchange their observations using the Table Driven Code Forms.

In some circumstances, however, it may be necessary to report observations internationally from stations that do not have a pre-existing World Weather Watch station identifier and for which the technical environment only supports the traditional alphanumeric codes.

The recommended approach in this case is to agree on a national practice that meets the local technical constraints to identify the observing station in reports (or a bilateral practice where an arrangement is made to translate traditional alphanumeric code to Table Driven Code Format for international exchange). These national reports must be converted to Table Driven Code Format before the international exchange; the conversion must include a translation from the method of identifying the station used in the national report to the WIGOS station identifier for that station. Extreme care must be taken to ensure that the national report is not distributed internationally.

Examples of a possible national practice for a surface synoptic report might be to use five alphabetic characters for the identifier, or a numeric identifier in the range 99000 to 99999 (only two identifiers in that range, 99020 and 99090, were recorded in Weather Reporting (WMO-No. 9), Volume A, in April 2016). A look-up table from that identifier to the WIGOS station identifier would allow the translating centre to insert the WIGOS station identifier.

The situation is more complex for upper-air reports. In this case, the WMO Secretariat should be asked for assistance.

2.3 WIGOS-ID-Country

This section provides recommended practices for the allocation of issue number and local identifier for Member States and Territories.

2.3.1 Principles for allocating station identifiers

(a) Issuers of identifiers are responsible for guaranteeing that no two observing facilities share the same station identifier. Note that the structure of WIGOS station identifiers guarantees that issuers cannot create identifiers that have already been allocated by another issuer.

(i) Issuers of identifiers may choose to use the issue number to allow them to delegate the task of allocating local identifiers to other organizations responsible for managing individual observing networks. Assigning each organization a different issue number will allow those organizations to allocate local identifiers for their observing facilities.

(ii) The issuer of identifiers has to record which issue numbers have been allocated and which organization is responsible for managing local identifiers for each.

(b) An organization issuing local identifiers (and issue numbers if it has not had one assigned to it) must ensure that no two observing facilities share the same WIGOS station identifier.

(i) When issuing the local identifier:

a. If the organization is responsible for allocating both issue numbers and local identifiers, it must ensure that no two observing facilities have the same combination of issue number and local identifier.

b. If the organization is only responsible for allocating local identifiers then it is sufficient for it to ensure that it does not assign the same local identifier to more than one observing facility.

(ii) The organization must maintain a record of the local identifiers (and issue numbers) it has allocated (it may choose to use OSCAR for this).

a. The organization may choose to use an existing national identifier as the local identifier for the observing facility. Doing so in a systematic way may decrease its administrative load.

b. Historically, station identifiers may have been reused when observing facilities closed and new ones opened. If the organization has been allocated a range of issue numbers, it may wish to consider using different issue numbers to distinguish between the different locations, allowing the local identifier to retain the link to the other location.

c. Although a single WIGOS station identifier must not be issued to more than one observing facility, it is permitted for a station to have more than one WIGOS station identifier. For example, although all observing facilities with pre-existing World Weather Watch station identifiers have a WIGOS station identifier based on the World Weather Watch identifier, the organization may wish to create a new identifier that is linked to a national numbering scheme.

d. The WIGOS station identifier for a closed observing facility must not be reused unless the observing facility reopens.

(iii) The organization responsible for allocating the WIGOS station identifier should ensure that the operator of the observing facility has committed to providing and maintaining WIGOS metadata for that facility.

a. In cases where a station has more than one WIGOS station identifier, the organization issuing the local identifier should associate all these station identifiers with the same WIGOS metadata record so that only one WIGOS metadata record needs to be maintained. OSCAR will provide tools to document this linkage.

b. If a fixed observing facility is moved, the organization should consider whether it should be issued a new WIGOS station identifier, whether the WIGOS metadata should be updated to state that the observing facility at the previous position has closed and whether a new WIGOS metadata record should be created for the new location. The organization must use meteorological judgement on the impacts of the change in deciding whether to retain the WIGOS station identifier or to issue a new one. A move of a few metres is unlikely to be significant, but a move to the opposite side of a mountain would be treated as a new station.

Note: The structure of the WIGOS station identifier means that the range of WIGOS station identifiers is, for practical purposes, unlimited. This removes the need to reuse WIGOS station identifiers.

(c) Before issuing a station identifier, search [OSCAR/Surface](https://oscar.wmo.int/surface/index.html#/) to make sure that it has not already been allocated.

(d) Organizations are strongly advised to document their procedures for allocating WIGOS station identifiers in their quality management system.

2.3.2 Specifying the local identifier

The local identifier may be up to 16 characters long. It must not contain blanks (and any blanks added to the end of the identifier by IT systems must be ignored). The local identifier may contain only lower-case or upper-case Latin letters, numbers or the characters: - (dash), \_ (underscore) or . (full stop).

Leading zeroes in a local identifier are significant and must be treated as part of the character string. (Note that this differs from the treatment of leading zeroes in the issuer of identifier and issue number parts of the WIGOS identifier, which are omitted from the WIGOS station identifier.)

Example 1

(a) Consider a Member that has observing systems managed by many different organizations, including the National Meteorological Service (NMS), the National Hydrological Service (NHS) and the National Transport Department. Each of these organizations is independent, and each has its existing conventions for labelling observing facilities. For example, the Meteorological Service uses WMO World Weather Watch station identifiers for its synoptic network, its own numbering system for other weather observing facilities, and another numbering system for its climate observing facilities.

(b) In this situation, the Member (as an issuer of identifiers) might choose to use the following convention for assigning WIGOS station identifiers. In all cases, if an observing facility is closed its local identifier must not be re-attributed (with the same issue number).

| Issue number | Interpretation of issue number | Local identifier |
| --- | --- | --- |
| 1 | NMS synoptic observing facility | WMO World Weather Watch station identifier (with leading zeroes if necessary to make it five characters long). Initially, to ensure that plotting software can display local identifiers, the Member chooses to limit their length to five characters and to assign to new WIGOS stations identifiers that lie outside the block of identifiers allocated to the Member by the World Weather Watch. |
| 2 | NMS other weather observing facility | Existing national station identifier (with leading zeroes if necessary). The local identifier for a new observing facility is created using the existing procedures for national station identifiers. |
| 3 | NMS climate observing facility | Existing climate station identifier (without leading zeroes, as that was the convention for climate observing facility identifiers in the past). New observing facilities are allocated identifiers using the existing practices. |
| 100–200 | Used by NHS for allocating identifiers for its observing facilities. The NHS allocates one number to each of its regions. The NHS is organized according to river basins, and it uses its range of issue numbers to subdelegate the allocation of local identifiers to each river basin authority. | The NHS uses its existing river basin observing facility numbering system. |
| 1000–10000 | Used by the National Transport Department for allocating its observing facility identifiers. Each road has its own issue number. | Derived from the distance of travel along a road when travelling away from the national capital before reaching the observing facility. |

Example 2

(a) A Member has implemented a national system for managing its national assets. Each observing facility has to be registered on this system and as a consequence has been allocated an asset number used to track all information about the facility. Some of these assets are mobile platforms (such as moored buoys). Disposable observing platforms (such as radiosondes) are associated with the asset number of their base station.

(b) The Member wishes to align its WIGOS station identifiers with its national asset management system. It chooses to use the national asset number as the local identifier. The Member is concerned that it may move assets from one location to another. In consequence, the Member uses the issue number to record changes in location. Because it wishes to record past positions as well, it decides initially to use an issue number of 10000 and to increment it for an asset every time that asset is re-deployed. It uses issue numbers less than 10000 to record historical positions for that asset. By doing this, the Member ensures that the asset number will not result in misleading WIGOS metadata histories and the link to the asset number will be maintained.

2.4 WIGOS-ID-WMOProg

This section explains how to allocate issuers of identifiers for station identifiers associated with WMO Programmes.

2.4.1 Observing Programmes with an international system for assigning station identifiers

Table 2.2 defines the issuer of identifier values in the range 20000–21999 to be used for WIGOS station identifiers. This range is used to ensure that observing facilities that have pre-existing station identifiers can be allocated a WIGOS station identifier in a way that retains an association with the pre-existing identifier. Any new observing facility will be given an identifier within the range allocated to the Member operating the observing facility. The most up-to-date version of Table 2.2 can be found at <http://wis.wmo.int/WIGOSIdProgramme>.

Table 2.2. Issuer of identifier values in the range 20000–21999

|  |  |  |  |
| --- | --- | --- | --- |
| Issuer of identifier values | Category of station identifier | Issue number | Local identifier |
| 20000 | World Weather Watch land station with sub-index number (SI) = 0 | 0: station defined in Weather Reporting (WMO-No. 9), Volume A, on 1 July 2016  Any other positive number: to distinguish between different observing facilities that used the same station identifier in the past | Use the block number II, and the station number iii, as a single five-digit number IIiii (with leading zeroes).  Example: station 60351 would be represented by 0-20000-0-60351 |
| 20001 | World Weather Watch land station with sub-index number (SI) = 1 | 0: station defined in Weather Reporting, Volume A, on 1 July 2016  Any other positive number: to distinguish between different observing facilities that used the same station identifier in the past | Use the block number II, and the station number iii, as a single five-digit number IIiii (with leading zeroes).  Example: upper-air station 57816 would be represented by 0-20001-0-57816 |
| 20002 | World Weather Watch marine platform (moored or drifting buoy, platform, etc.) | 0: platform for which the identifier was in use on 1 July 2016  Any other positive number: to distinguish between different platforms that used the same identifier at different times | Use the region/platform number combination A1bwnbnbnb.  Examples:  The data buoy 59091 would be represented by 0-20002-0-59091  The World Weather Watch list of data buoys has two buoys with identifier 13001. The buoy most recently used at the time WIGOS station identifiers were introduced is allocated 0-20002-0-13001 and the second is issued identifier 0-20002-1-13001. |
| 20003 | Ship identifier based on the International Telecommunication Union call sign | 0: ship to which the identifier was most recently allocated on 1 July 2016  Any other positive number: to distinguish between different ships that used the same ship identifier at different times | Ship call sign  Example: the (now obsolete) weather ship C7R would be represented by 0-20003-0-C7R |
| 20004 | Ship identifier – issued nationally | 0: ship to which the identifier was most recently allocated on 1 July 2016  Any other positive number: to distinguish between different ships that used the same ship identifier at different times | Ship identifier  Example: the fictitious ship XY123AB would be represented by 0-20004-0-XY123AB |
| 20005 | AMDAR aircraft identifier | 0: aircraft to which the identifier was most recently issued on 1 July 2016  Any other number: to distinguish between different aircraft that used the same aircraft identifier at different times | Aircraft identifier  Example: aircraft EU0246 would be represented by 0-20005-0-EU0246 |
| 20006 | ICAO airfield identifiers | 0: airfield to which the identifier was most recently allocated on 1 July 2016  Any other positive number: to distinguish between airfields that used the same airfield identifier at different times | ICAO airfield identifier  Example: Geneva airport (LSGG) would be represented by 0-20006-0-LSGG |
| 20007 | International Maritime Organization (IMO) ship number (hull number) | 0: ship to which the IMO number was most recently allocated on 1 July 2016   Any other positive number: to distinguish between ships that used the same IMO identifier at different times | Ship identifier  Example: ship 9631369 would be represented by 0-20007-0-9631369 |
| 20008 | Global Atmosphere Watch (GAW) identifier | 0: station to which the GAW identifier was most recently allocated on 1 July 2016 | Three-character GAW identifier  Example: Jungfraujoch JFJ would be represented by 0-20008-0-JFJ |
| 20009 | WMO Satellite Programme | 0 | Three-digit satellite identifier with leading zeroes (recorded in Common Code table C–5 of the Manual on Codes (WMO-No. 306), Volume I.1)  Example: METEOSAT 10 (with identifier 057) would be represented by 0-20009-0-057 |
| 20010 | WMO Weather Radar | 0 | Unique key used to cross-reference information about a single radar within the WMO Radar Database (this key was not previously published)  Example: Station with record number 121 would be represented by 0-20010-0-121 |
| 20011–21999 | Reserved for future use | To be determined | To be determined |

2.4.2 Observing programmes/networks that do not have an international system for station identification

The following observing programmes/networks do not have a pre-existing international system for assigning station identifiers and have not been allocated issuers of identifiers. Members operating the stations supporting these observing programmes should allocate WIGOS identifiers using their national system.

Global Sea-level Observing System: Station identifiers have been issued according to national conventions. In cases where the identifier of another WMO Programme has been used (for example, a land-station identifier), the WIGOS station identifier corresponding to that Programme identifier should be used.

Global network of tsunameters: Station identifiers are issued according to national conventions. In cases where the identifier of a WMO Programme has been used (for example, a land-station identifier), the WIGOS station identifier corresponding to that Programme identifier should be used.

2.5 WIGOS-ID-Partner

2.5.1 Allocating issuers of identifiers for station identifiers associated with WMO co-sponsored programmes

Table 2.3 defines the issuer of identifier values in the range 22000–39999 to be used for WIGOS station identifiers.

Note: No issuer of identifier number in this range has yet been issued.

Table 2.3. Issuer of identifier values in the range 22000–39999

|  |  |  |  |
| --- | --- | --- | --- |
| Issuer of identifier values | Category of station identifier | Issue number | Local identifier |
| 22000 | Identifiers for marine systems administered through JCOMMOPS  Note: JCOMMOPS coordinates some marine observing systems to avoid technical incompatibilities. | Determined by JCOMMOPS | Determined by JCOMMOPS |
| 22001–39999 | Reserved for future use | To be determined | To be determined |

3. WIGOS metadata

3.1 Introduction

The availability of WIGOS metadata is essential for the effective planning and management of WIGOS observing systems. These metadata are also crucial for the Rolling Review of Requirements process and similar activities at national level.

WIGOS metadata are interpretation/description or observational metadata, that is, information that enables data values to be interpreted in context and permits the effective utilization of observations from all WIGOS component observing systems by all users.

The WMO Information System (WIS) is the single coordinated global infrastructure responsible for telecommunications and data management functions. WIS enables: (i) routine collection and dissemination of time-critical and operation-critical data and products; (ii) data discovery, access and retrieval; and (iii) timely delivery of data and products. WIGOS metadata give insight into the conditions and methods used to make the observations that are distributed through the WIS.

WIGOS metadata describe the station/platform where the observation was made, the system(s) or network(s) the station/platform contributes to, the instruments and methods of observations used and the observing schedules, in order to support planning and management of WIGOS observing systems.

WIGOS metadata also describe the observed variable, the conditions under which it was observed, how it was measured or classified and how the data have been processed, in order to provide the users with confidence that the use of the data is appropriate for their application. The Global Climate Observing System Climate Monitoring Principle (c) describes the relevance of metadata as follows:

The details and history of local conditions, instruments, operating procedures, data processing algorithms and other factors pertinent to interpreting data (i.e. metadata) should be documented and treated with the same care as the data themselves. (The Global Observing System for Climate: Implementation Needs (GCOS-200), Box 8)

Metadata can be static, for example the exposure of an instrument at a fixed station. Metadata can change with every observation, for example the location of a mobile station, in which case the metadata should be reported with the observations to which they apply.

The WIGOS Metadata Standard specifies the metadata elements that exist and that are to be recorded and made available. More information about the Standard can be found in the Manual on the WMO Integrated Global Observing System (WMO-No. 1160) and the WIGOS Metadata Standard (WMO-No. 1192). The Standard has been implemented in OSCAR/Surface, which is the WMO official authoritative repository of metadata on surface-based meteorological, climatological, hydrological and other related environmental observations that are required for international exchange. OSCAR/Surface is one of the components of the WIGOS Information Resource.

Observational metadata are to be submitted to and maintained in OSCAR/Surface by WMO Members, and in OSCAR/Space by relevant WMO Members according to the provisions of the Manual on the WMO Integrated Global Observing System (WMO-No. 1160). Metadata from a number of co-sponsored observing systems are also maintained in OSCAR. OSCAR/Surface replaces and significantly extends Weather Reporting (WMO-No. 9), Volume A. It highlights the much wider scope of all the WIGOS component observing systems.

This chapter provides guidance on recording metadata related to surface-based observations and submitting those to OSCAR/Surface.

3.1.1 Key terminology

Observing station/platform. “A place where observations are made; this refers to all types of observing station and platform, whether surface-based or space-based, on land, sea, lake or river, or in the air, fixed or mobile, and making in-situ or remote observations” ([Technical Regulations](https://library.wmo.int/opac/index.php?lvl=notice_display&id=14073#.WV-CQml95EY) (WMO-No. 49), Volume I, Part I). In many contexts this is abbreviated to “station”.

Observing facility. An alternative term for a place where observations are made and equivalent to the term “observing station/platform”.

Site. Also a term for a place where observations are made. However, it is generally used when taking into account the environmental conditions of the location.

Observation. “The evaluation of one or more elements of the physical environment” ([Technical Regulations](https://library.wmo.int/opac/index.php?lvl=notice_display&id=14073#.WV-CQml95EY), Volume I, Part I).

Note: It is the act of measuring or classifying the variable. The term is also often used to refer to the data resulting from the observation, even though the term “observational data” is defined as the result of an observation ([Technical Regulations](https://library.wmo.int/opac/index.php?lvl=notice_display&id=14073#.WV-CQml95EY), Volume I, Part I).

Measurand. “Quantity intended to be measured” ([International Vocabulary of Metrology – Basic and General Concepts and Associated Terms (VIM)](http://www.bipm.org/en/publications/guides/vim.html), JCGM 200:2012).

Note: Generally, it is the result of a measurement from an instrument.

(Observed) variable. “Variable intended to be measured [measurand], observed or derived, including the biogeophysical context” ([WIGOS Metadata Standard](https://library.wmo.int/opac/index.php?lvl=notice_display&id=19925#.WWOgp2l95EY) (WMO-No. 1192)).

Observational metadata. “Descriptive data about observational data: information that is needed to assess and interpret observations or to support design and management of observing systems and networks” ([Technical Regulations](https://library.wmo.int/opac/index.php?lvl=notice_display&id=14073#.WV-CQml95EY), Volume I, Part I).

Observing domain. The component of the Earth system which is being observed: atmospheric (over land, sea, ice), oceanic and terrestrial.

Observing (or observation) system. “A coordinated system of methods, techniques and facilities for making observations using one or more sensors, instruments or types of observation at one or more stations and platforms, acting together to provide a coordinated set of observations” ([Technical Regulations](https://library.wmo.int/opac/index.php?lvl=notice_display&id=14073#.WV-CQml95EY), Volume I, Part I).

Observation network. “One or more sensors, instruments or types of observation at more than one station or platform, acting together to provide a coordinated set of observations” ([Technical Regulations](https://library.wmo.int/opac/index.php?lvl=notice_display&id=14073#.WV-CQml95EY), Volume I, Part I).

3.1.2 Managing WIGOS metadata in accordance with the WIGOS Metadata Standard

### 3.1.2.1 Identification of functions and responsibilities

The following generic national functions and responsibilities need to be fulfilled:

(a) Network metadata manager: responsible for keeping network observational metadata up to date, correct, quality controlled and complete;

(b) Observational metadata manager: responsible for encoding and transmitting WIGOS metadata and ensuring that metadata meet the Standard;

(c) Station/platform metadata maintainer: responsible for recording and maintaining metadata for the station/platform.

The above labels might not be used, but the relevant functions need to be fulfilled.

### 3.1.2.2 Using the OSCAR/Surface tool

The key WMO tool to assist in the above functions is the OSCAR surface-based capabilities database.

The WIGOS Metadata Standard will be implemented in three phases over a five-year period (2016–2020). In practice this will be done through the OSCAR/Surface tool, which means that Members must transfer their WIGOS metadata, either in near real time or less frequently, to OSCAR/Surface for the observations they exchange internationally. All prescribed metadata are to be collected and stored by Members. Moreover, OSCAR/Surface contains a few additional metadata fields not explicitly specified in the Standard, such as population density. Members should include as many of the additional fields as possible in OSCAR/Surface.

Note that OSCAR/Surface provides a manual interface for the submission of metadata. This interface is accessed through the Internet using any Web browser. It is intended that machine-to-machine submission of metadata will be possible in the future; the guidance for exchanging WIGOS metadata in this way will be developed as soon as the XML schema is finalized.

Further guidance on using OSCAR/Surface is provided in Chapter 4 of this initial Guide.

3.2 General guidance on WIGOS metadata

The WIGOS Metadata Standard is an observation-focused standard. However, typically observations are grouped in terms of the observing station/platform where one or more sensors or instruments are located.

The following metadata elements of the Standard are mandatory for the first phase of its implementation (2016). The initial numbers refer to the elements in the Standard and the numbers in brackets refer to sections of this chapter:

1-01 Observed variable – measurand (3.2.2)

1-03 Temporal extent (3.2.1)

1-04 Spatial extent (3.2.2 and 3.3.1)

2-01 Application area(s) (3.2.2 and 3.3.1)

2-02 Programme/network affiliation (3.2.1 and 3.2.2)

3-03 Station/platform name (3.2.1)

3-06 Station/platform unique identifier (3.2.1)

3-07 Geospatial location (3.2.1, 3.2.1.1, 3.3.1 and 3.3.1.2)

3-09 Station operating status (3.2.1)

5-01 Source of observation (3.2.2)

5-02 Measurement/observing method (3.2.2)

6-08 Schedule of observation (3.2.2)

7-03 Temporal reporting period (3.2.2)

9-02 Data policy/use constraints (3.2.2)

10-01 Contact (nominated focal point) (3.2.3)

The following metadata elements of the Standard are mandatory when relevant conditions are met (referred to as conditional elements) for the first phase of implementation (2016):

1-02 Measurement unit (3.2.2)

3-01 Region of origin of data (3.2.1 and 3.3.1.1)

3-02 Territory of origin of data (3.2.1 and 3.3.1.1)

5-03 Instrument specifications (3.2.2)

5-05 Vertical distance of sensor (3.2.2 and 3.3.1.1)

6-07 Diurnal base time (3.2.2)

7-04 Spatial reporting interval (–)

7-11 Reference datum (3.2.2 and 3.3.1.1)

Another metadata element (6-03 Sampling strategy) of the Standard has optional status during phase I (2016).

All other elements of the Standard are to be implemented in phase II (2017–2018) or III (2019–2020); however, a Member may make these elements available before then.

In OSCAR/Surface, metadata are assembled under the following five headings.

Notes:

1. Each time the number in format x-yy appears in this Guide, it refers to the number of the metadata element in the WIGOS Metadata Standard. Where a metadata element is mentioned without this number, it means it is not part of the Standard.

2. Users of OSCAR/Surface may or may not see certain fields when navigating the various stations in the database depending on whether the field was filled out when the station was created/edited.

3.2.1 Station characteristics

This heading contains the basic information of the station/platform. The following fields are mandatory for phase I: station name (3‑03 Station/platform name), date established (1‑03 Temporal extent ), WMO Region (3‑01 Region of origin of data), the station’s country/territory (3‑02 Territory of origin of data), its coordinates, i.e. the latitude, longitude, elevation and geopositioning method (3‑07 Geospatial location), its unique WIGOS identifier number (3‑06 Station/platform unique identifier), labelled as the WMO index number in OSCAR/Surface, and the official programme/network affiliations (2‑02) for the station, including status (3‑09 Station operating status).

The heading also includes some elements that are not mandatory for phase I, such as those describing the relevant environmental characteristics of the station/platform and its surroundings, which should refer to the station/platform geospatial location: climate zone (4‑07), predominant surface cover (4‑01 Surface cover), surface roughness (4‑06), topography or bathymetry (4‑03) and site information (4‑05) with possible images (photos) of the station/platform. The station type (3‑04 Station/platform type), supervising organization (9‑01) and any human or natural events at the station/platform that may have influenced the observations (4‑04 Events at observing facility) are also metadata elements that can be included under this heading.

Complementary information listed under station characteristics that does not correspond to any metadata elements of the Standard includes: station alias, station class(es), time zone, station URL (a reference/address to a resource on the Internet), other link (URL), and population in 10 km/50 km (in thousands).

### 3.2.1.1 Station coordinates

The method to specify station coordinates (3‑07 Geospatial location) is described in the Guide to Meteorological Instruments and Methods of Observation (WMO‑No. 8), Part I, Chapter 1, 1.3.3.2. The figure in this section shows the various metadata elements related to the station’s geospatial location (3‑07) versus the instrument’s geospatial location (5‑12), and their references for the height.

Metadata elements for station location and instrument location, including height references

3.2.2 Observations/measurements

Under this heading, each observation or measurement is described succinctly in terms of the following elements that are mandatory for phase I: variable (1‑01 Observed variable – measurand), variable unit (1‑02 Measurement unit), method of observation (5‑02 Measurement/observing method ), programme/network affiliation (2‑02), application area(s) (2‑01), source of observation (5‑01), geometry (1‑04 Spatial extent) and data policy/use constraints (9‑02).

For each variable, there is a subset of metadata elements that are also required in phase I, such as reference datum (7‑11). Under each deployment that may be present, the information is structured into two groups of metadata elements: “schedule” and “instruments”. Under “schedule” the following elements can be listed: temporal reporting interval (7‑03 Temporal reporting period), diurnal base time (6‑07), and schedule (6‑08 Schedule of observation) which includes month (from–to), day (from–to), and hour (from–to). Under “instruments” the instrument specifications (5‑03) can be listed as well as the distance from the reference surface (5‑05 Vertical distance of sensor).

Many other metadata elements can be listed under this heading that are not required for phase I, including: latency (7‑13 Latency (of reporting)), sampling procedure (6‑01), representativeness (1‑05), instrument and serial number (5‑09 Instrument model and serial number), configuration (5‑06 Configuration of instrumentation), quality assurance/quality control schedule (5‑07 Instrument control schedule), firmware version (5‑09), coordinates, i.e. latitude, longitude and elevation of the instrument (5‑12 Geospatial location), data centre (7‑02 processing/analysis centre), status (5‑14 Status of observation), status from, to, and maintenance periods: description (5‑13 Maintenance activity), party (5‑11 Maintenance party) and date (5‑08 Instrument control result).

Also included is other complementary information that is not part of the Standard, such as near real time, near real time URL, measurement leader/principal investigator, and last updated.

Often, multiple observations are associated with a single station/platform. Observations at a station/platform are listed in alphabetical order. A future requirement is that the observations can be grouped according to observing domain or subdomain.

Certain metadata elements covering site characteristics may only be relevant to specific types of observations. For example, surface cover (4‑01) is generally most applicable to observations such as surface air temperature, humidity, irradiance and precipitation. Surface roughness (4‑06) is not applicable to lake/river observations.

### 3.2.2.1 Instrument coordinates

A method similar to the one referred to in section 3.2.1.1 should be followed for the coordinates of individual instruments (5‑12 Geospatial location). If the instruments are located at a single observing point, the station/platform coordinates may be used as an approximation. Where necessary, the actual geospatial location of the instrument (sensing component) is recorded according to the Guide to Meteorological Instruments and Methods of Observation (WMO-No. 8), Part I, Chapter 1, 1.3.3.2. Additionally the height or depth of the instrument above or below its reference surface is recorded where appropriate.

3.2.3 Station contacts

The details of the station contacts (10‑01 Contact (nominated focal point)) are recorded. This may include someone with a relevant function, such as the station or network manager, or the data or metadata holder, or the organization responsible for the data policy.

3.2.4 Bibliographic references

Where the data series or deployment, or methods relating to the data series or deployment, have been previously published or referenced, for example nationally or on the Internet, the references are recorded in this section. OSCAR/Surface allows for the upload of documents. There is no direct correspondence between this section and any particular metadata element of the Standard.

3.2.5 Documents

This section provides access to documents concerning the station/platform or the observed variables. These may include correspondence, instrument calibration certificates, network descriptions and so on. This section may be related with element 4‑05 Site information and can be regarded as a historic archive of complementary documentation on the changes in the station/platform, its instruments and conditions of observation.

3.3 Specific guidance for different types of stations/platforms

While the guidance in section 3.2 is intended to be useful for Members managing metadata of any type of station/platform, the following section is intended to provide additional guidance relevant to specific types of stations/platforms.

As mentioned above, the geospatial location of the station/platform should identify the reference location of that station/platform, while the geographic coordinates of the instruments are specified separately for each instrument of the station/platform. A change of coordinates should always reflect a physical relocation of the station/platform and/or instrument. The historical coordinate values of the station/platform location should be retained.

3.3.1 Stations/platforms on land

This section describes the metadata aspects of the main types of observations made on land. It is structured according to the geometry (1‑04 Spatial extent), i.e. a point, profile or volume, and to the technology (in situ or remote-sensing) used for the observations.

The geospatial location (3‑07) of the station/platform may refer to the observation which has existed for the longest period of time, it may be related to the administrative point, or to the primary application area(s) (2‑01). The coordinates should be centred over the instrument and the ground elevation should be the natural (undisturbed) surface of the ground.

Stations/platforms on land include observations which are made at a fixed position in relation to the land surface, a mobile observation on land or those which transfer their data to a facility on land. These facilities may be close to land (such as a wharf or on a pylon grounded in the earth). A mobile station may remain in a fixed location during a period of observations or may be mobile during the observation.

### 3.3.1.1 Surface in situ observations

The observations of the variables at a surface in situ observing station, such as wind speed/direction, air temperature, relative humidity, atmospheric pressure, precipitation, present weather, or cloud, made by the instruments/observer located at this station, are described individually. Although such observations are made in situ, they should represent an area surrounding the station, depending on the environmental exposure conditions of the instrument.

Some instruments may measure more than one observed variable at the same time. Each observed variable should be described and the common instrument may be identified through a common serial number. Examples of such instruments include some humidity probes (reporting humidity and temperature), some sonic anemometers (may report wind speed, wind direction, virtual air temperature) and so-called “all-in-one” instruments (for example, reporting temperature, humidity, wind speed, wind direction and pressure).

Surface in situ refers to observations made near the surface of the Earth, over land, for example at automatic weather stations and manual weather stations. The simplest station may make only one observation (for example, rainfall), while others may include observations of several variables, such as air temperature, humidity, wind, soil temperature, rainfall intensity and amount.

The following conditional elements of the WIGOS Metadata Standard are mandatory for fixed stations, for the first phase of the implementation of the Standard:

3-01 Region of origin of data

3-02 Territory of origin of data

5-05 Vertical distance of the sensor from a (specified) reference level, such as local ground, the deck of a marine platform at the point where the sensor is located, or sea surface

7-11 Reference datum: mandatory for derived observations that depend on a local datum

### 3.3.1.2 Upper-air in situ observations

Upper-air in situ observations primarily include observations made using instrumentation attached to meteorological balloons (radiosondes), or unmanned aerial vehicles (also called drones). The balloon tracking for the calculation of winds (that is, by radar or radio-theodolite) is also regarded as an upper-air in situ observation. The radiosonde measurement, often referred to as a sounding, delivers a complete profile from the launch point to balloon burst. To ensure timely availability for the data users the sounding is often split into several messages, but the same metadata are included in all parts of the transmitted messages. Observations such as those made by dropsondes, rockets and kites are also included in this category, but specific guidance for these systems will be included in a later release of the metadata standard.

The majority of the metadata for these systems are also incorporated within the WMO-defined BUFR message and are reported along with the data for each sounding. Because the observations are meaningless without these metadata, the station/platform metadata maintainer and the network metadata manager must ensure that the transmitted metadata are valid and accurate for each reported sounding. To prevent any confusion the metadata reported in BUFR messages must be fully consistent with the WIGOS Metadata Standard elements and with the information inserted into OSCAR.

It is common that the launch point of the balloon has different geospatial coordinates than the station/platform and this can have a significant impact for the data users. It is important that both sets of geospatial coordinates are included in the station/platform metadata database, and that the coordinates incorporated in the BUFR messages are for the balloon launch location. Element 5‑12 Geospatial location of the instrument, is related to this, while element 3‑07 Geospatial location of the station, refers to the main facility. Note that element 5‑12 is an element for phase II of implementation.

Many radiosonde systems no longer include a pressure sensor, and thus the pressure and geopotential height are derived from the Global Navigation Satellite System (GNSS) altitude. The atmospheric pressure can be derived artificially from an estimate of the status of the atmosphere based on WMO-recommended calculus or by using the static predefined International Standard Atmosphere. The metadata defining the source of the pressure and geopotential height measurements are mandatory and must be included in every BUFR message. This relates to element 7‑01 Data-processing methods and algorithms, which is optional during phase III of implementation of the Standard.

### 3.3.1.3 Weather radar observations

Weather radars are active remote-sensing observing systems used to make real-time and high-resolution observations from a large-scale area (up to a radius of 250 km). Weather radar observations have been made particularly for the detection of precipitation, hydrometeor classification and quantitative precipitation estimation. Doppler wind speed and direction can also be reported from some weather radars. Radar station/platform coordinates, height of the location, tower height, frequency, polarization, scanning parameters and other characteristics of weather radar observations are metadata elements contained in the WMO Radar Database (<http://wrd.mgm.gov.tr/default.aspx?l=en>). Members should continue to collect and supply/update the metadata about their weather radars to the WMO Radar Database (managed by the Turkish State Meteorological Service). The metadata regarding weather radars are transferred from the WMO Radar Database to the OSCAR/Surface by machine-to-machine procedures. Radar metadata cannot be edited manually in OSCAR/Surface.

### 3.3.1.4 Other surface-based remote-sensing observations

Other surface-based remote-sensing observations include all observations, excluding from weather radars, made using remote-sensing instrumentation located at a fixed station. These systems are wide ranging in their methods of observation, but primarily result in a measurement profile representative of the atmosphere above the sites. Examples of systems in this category are wind profiling radars, lidars, sodars, radiometers, ground-based GNSS receivers, and high-frequency radars. So, both active and passive remote-sensing technologies are considered here.

The majority of the metadata regarding these systems are incorporated within the WMO-defined BUFR message and thus are only reported along with the data for each sounding. The station/platform metadata maintainer and the network metadata manager must ensure that the transmitted metadata are valid and accurate for each reported sounding.

These systems often use advanced flagging techniques to identify measurements that do not meet the data quality criteria, and it is mandatory to include this information within the metadata that are transmitted with each message. This relates to elements 8‑01 to 8‑05 of the Standard (Category 8: Data quality), which are mandatory/conditional for phase II.

3.3.2 Stations/platforms on the sea surface

Sea-surface observations are taken from a variety of stations/platforms. These include moored buoys, drifting buoys, ships and off-shore installations. Also terrestrial-based (on shore) high-frequency radars (measuring surface current direction and speed) can be considered as such. Variables most commonly measured are air temperature, atmospheric pressure, humidity, wind direction and speed, sea-surface temperature, wave height, wave period, wave direction, sea-level altitude, current speed and direction, and salinity.

Ship observations typically include air and seawater temperature, atmospheric pressure, humidity, and wind direction and speed. These are commonly measured automatically. Manual ship observations also include wave height, wave period, wave direction, ceiling (cloud cover) and visibility.

Sea-surface observations are also being made from autonomous surface vehicles. These are propelled by wind and/or wave action and measure air temperature, atmospheric pressure, humidity, wind direction, wind speed, sea-surface temperature and sea-surface salinity.

Buoy positions are reported at the time of observation by the organization that operates the platform. Ship positions are also reported at the time of observation; however, many vessels do not report their actual identity due to economic considerations. Autonomous vehicles report their position obtained at the time of observation. The observations are reported under the ownership of the organization that is remotely controlling the vehicle(s).

3.3.3 Airborne stations/platforms

Airborne observations, involving measurements of one or more meteorological variables, are made at particular pre-scheduled intervals in space and time, so at a series of locations (in three-dimensional space). In practice these observations are carried out on board of aircraft called aircraft-based observation stations/platforms. These series of observations deliver profiles near aerodromes or are composed of a series of equidistant observations at constant altitude.

In general, data are reported by three categories of aircraft-based observation stations/platforms using different data relay systems. Examples are:

(a) WMO Aircraft Meteorological Data Relay (AMDAR): aircraft providing meteorological data according to WMO standards and specifications;

(b) ICAO Automatic Dependent Surveillance – Contract: aircraft providing data under regulations and cooperative arrangements with ICAO;

(c) Other aircraft-based observation stations/platforms: data derived from observing systems on aircraft not controlled by WMO or ICAO (called third-party data). Data availability is dependent on arrangements between National Meteorological and Hydrological Services and the data provider as to whether data can be ingested into WIS, taking into account requirements stated in the Technical Regulations.

The data from aircraft-based observation stations/platforms require that network metadata managers maintain a database of metadata relating to aircraft models and types, and information on sensors and software for processing the data. There will also be a requirement for airport positional metadata with regards to the initiation and termination of profiles.

Source: Manual on the WMO Integrated Global Observing System (WMO-No. 1160), and the Aircraft Meteorological Data Relay (AMDAR) Reference Manual (WMO-No. 958) to be replaced by the Guide to Aircraft-based Observations

3.3.4 Stations/platforms underwater

Underwater observations can be obtained in a number of ways. These include thermistor strings and devices attached to inductive cabling, expendable bathythermographs, acoustic doppler current profilers, Argo floats, and conductivity, temperature and depth devices. Bottom-mounted water pressure sensors are used to measure variations in the water column, which are indicative of a low-amplitude wave (tsunami) generated by an underwater disturbance (seismic activity). A new technology, profiling gliders, which are unmanned underwater vehicles, is becoming more widespread. The variables observed by these devices include water temperature, water pressure, salinity, current direction and speed, fluorescence and dissolved oxygen. All of these variables are measured at depth – as deep as the sensors or gliders are located.

The underwater observations obtained from moored buoys use the position of the buoy itself and are reported by the organization that operates the buoy. Expendable bathythermograph positions are taken at the point of launch and are reported by the launch vehicle (ship or aircraft). Acoustic doppler current profilers and conductivity, temperature and depth devices are usually moored at a specific location, which is reported at the time of observation by the organization operating the device. Argo float positions are reported at the time of observation by the organization operating the device. Unmanned underwater vehicle observations are reported using the position of the vehicle when it begins its subsurface excursion and are reported by the organization piloting the vehicle.

3.3.5 Stations/platforms on ice

Note: Specific guidance for stations/platforms on ice is under development.

3.3.6 Stations/platforms on lakes/rivers

Records of lake/river gauge height or stage and river discharge are fundamental to the management of water resources, the understanding of streamflow variability in time and space and the calibration of hydrological models used in streamflow and flood forecasting. Gauge heights can be measured in various ways, such as direct observation of a staff gauge or by automatic sensing through the use of floats, transducers, gas-bubbler manometers and acoustic methods. River flows are generally computed through conversion of a record of stage to discharge using an empirically derived rating conversion curve or other hydraulic model. General stream-gauging procedures are recommended in the Manual on Stream Gauging (WMO-No. 1044), Volumes I and II.

3.3.7 Satellites

Satellite observations provide information from all areas of the world. These observations deliver information on surface characteristics, as well as atmospheric conditions depending on the instrument type. Essential information about satellites are orbit and type of orbit (geostationary or polar orbiting), height of the satellite, local observation intervals, types of technologies applied (active/passive, optical/microwave, imager/sounder) and instrument characteristics (bands measured, footprint, measurement approach like scanning versus push broom or similar, swath size if applicable, return period, etc.).

Meteorological satellites usually transport a variety of instruments, each mounted for specific applications required by a diverse user community. In fact, due to this variety of instruments and the specific observation programme chosen, the related metadata have a different nature than with the classic surface-based observations (see the Guide to Instruments and Methods of Observation (WMO-No. 8)). As a consequence, metadata for satellite observations are collected as a separate database, [OSCAR/Space](https://www.wmo-sat.info/oscar/spacecapabilities).

4. Making WIGOS metadata available to WMO using OSCAR/Surface

4.1 Introduction

Part I contains guidance on finding stations and observations in OSCAR/Surface. Part I is useful for both registered and anonymous users.

Part II contains information on how to manage stations in the system. Part II is mainly relevant for registered users, such as station contacts and national focal points.

The annex to the present chapter will provide a list of all the fields in OSCAR/Surface in a future version.

4.2 Finding information in OSCAR/Surface

4.2.1 How to navigate the portal

The homepage of OSCAR/Surface in Figure 4.1 has been labelled with large red numbers, 1–6, for the purpose of describing the various functionalities of the website. Each number corresponds to a different functionality as follows:

Figure 4.1. OSCAR/Surface homepage

The Home, Search, and Critical review tabs (1)

The Home tab allows for navigation to the OSCAR/Surface homepage at all times. This functionality can be replicated by clicking on the OSCAR logo at the top centre of the page.

Figure 4.2. Search tab

The Search tab opens the search functionality page (Figure 4.2) that allows the user to search for information stored in OSCAR/Surface in a variety of ways:

(a) Search for stations: search by observing-station attributes;

(b) Search for instruments: search by the instrument attributes within an observing station;

(c) Search for contacts (Figure 4.15): search an address book of observing system owners or points of contact;

(d) Search for bibliographic references (Figure 4.17): search the records of peer-reviewed articles that were published.

The Critical review tab is currently not activated as the critical review functionality will be implemented at a later stage.

This section (2) in the upper-right corner of the webpage in Figure 4.1 houses the links to pages for:

(a) About OSCAR/Surface: information about the development and history of OSCAR/Surface;

(b) News: archive of the latest news updates related to OSCAR/Surface;

(c) Glossary: list of commonly used terms in WIGOS and OSCAR/Surface;

(d) Frequently asked questions (FAQs): list of useful questions for the users of OSCAR/Surface;

(e) Links: list of useful links relating to WIGOS and observing systems;

(f) Support: a form requesting contact information from the user and a comments section to capture the user’s request to be submitted to the OSCAR/Surface support and operations team;

(g) Feedback: a form for submitting feedback to the OSCAR/Surface development team;

(h) Login: the permissions-controlled access to edit the data contained in OSCAR/Surface.

The Search box (3) allows for a quick text search of a description, title, name or address

The results are returned in a drop-down menu, as shown in Figure 4.3, arranged by categories:

(a) Search for Station

(b) Search for Contacts

The user may access all the search results by clicking on the View all >> link in the upper-right corner of each category.

Figure 4.3. Quick Search results

Quick access (4)

The Quick access section allows for searches in different categories: under Generate station report by:, search for the station name or WMO ID to retrieve/view the station’s detailed information. Under Generate station lists by:, a list can be generated of all stations (named a “report” in OSCAR/Surface) within a particular country or for a station type. Under Find people by:, there is a quick search for contact names that generates a report with the full contact information stored within OSCAR/Surface.

Filter map (5)

The Filter map functionality allows for the display of worldwide stations on the map. By default, all WIGOS component observing systems and other components/networks are selected; however, the user is able to remove check marks from components to view only those stations affiliated with the selected programmes.

Map interface and download (6)

Figure 4.4 shows the map plotting the observing stations in OSCAR/Surface coloured by the categories: air, land or ocean surface, subsurface, and lake or river. The map interface allows for the selection of individual stations by clicking on a station on the map. The user is able to zoom in/out using the +/- buttons on the upper-left section of the map, or double click on any open spaces in the map. The mouse can also be used to move the map to the appropriate location of interest. Once the desired area is displayed, the user has the option to click on an individual station to generate a report of that station’s information or choose to download the map in various formats for offline display purposes. The download functionality is accessible via the icon in the upper-right section above the map. It allows for an image export as a PNG, JPG, GIF, and EPS, and also allows for the station location information to be downloaded in the KML format for use in Google Earth.

Figure 4.4. Map interface

4.2.2 How to search for stations

Figure 4.5. Search for stations page

The Search for stations page as shown in Figure 4.5, accessible via the Search tab (see Figure 4.2 above), is available for users with prior knowledge of the station. The station name can be found by clicking on the drop-down menu next to Station name: (under the option Browse by station name). Alternatively, other search criteria may be used to narrow the results to probable stations meeting those attributes. These criteria are available under the option Search using advanced criteria:

(a) Search term: to be entered when the user has a partial recall of the station’s name;

(b) Checking the box for near-real-time only allows only stations with data available in near real time to be listed;

(c) Station type: a categorization of the type of station at which an observation is made;

(d) Station class: corresponds to the most frequently used attributes of the Volume A code list for observations and remarks (from Weather Reporting (WMO-No. 9));

(e) Programme/network affiliation: a menu of WMO Programmes is provided by clicking on the list icon. The X button removes the selections from the search criteria;

(f) WMO Region/Country: a list of the various WMO regional associations and the Members within each association;

(g) Organization: a comprehensive list of supervising organizations for all stations in OSCAR/Surface;

(h) Variable: clicking on the list icon allows the user to select one or more variables from the following domains:

(i) Atmosphere

(ii) Earth

(iii) Ocean

(iv) Outer space

(v) Terrestrial

Each variable has its own subcategories to further refine the search to the level of detail of the actual physical variable being measured;

(i) Climate zone: a climate zone can be selected from a drop-down menu with a list of the Köppen classification types;

(j) Geographic coordinates: there are text boxes that allow the selection of a geographic range including “Longitude from” and “Longitude to”, as well as “Latitude from” and “Latitude to”. It is possible to insert only a single value here. For example, inserting 66 into “Latitude from” will show stations roughly above the polar circle. Only numerical entries are valid for these boxes. Attempts to enter text and submit the search will result in the error message: “The submitted data was invalid. Please look for red widgets in each section for more details”. Also noteworthy is the pin icon in the middle of the text boxes (see Figure 4.6), which allows the user to manually draw a box around the region of interest (Figure 4.7);

Figure 4.6. Geographic coordinates search

Figure 4.7. Drag and draw selection

(k) Elevation: the elevation range of the stations can be entered in metres in the text boxes.

At the bottom of the page, there are two buttons: Search to submit the search criteria and Reset to clear all prior entries.

### 4.2.2.1 How to find specific observing systems, such as radars, wind profilers or radiosondes

One way to find stations based on observation technology is to search by network affiliation. Another way is to use the station class. As with all information in OSCAR/Surface, the accuracy of the search results depends heavily on the quality of the metadata inserted into the system. Table 4.1 lists how to find commonly searched observing technologies.

Table 4.1. Examples of how to search specific observing technologies

|  |  |
| --- | --- |
| Technology | Search by |
| Radars | Network affiliation “WRO” (under WIGOS/GOS/GOS Other elements) or  Station class “RADAR” |
| Wind profilers | Station class “WP” |
| Radiosondes | Network affiliation “RBSN(T)” or “RBSN(ST)” (under WIGOS/GOS/GOS Surface networks/RBSN) or  Station class “WN” or “R” |

### 4.2.2.2 Station report details

This is the result of a station search (or “report” as named in OSCAR/Surface) which displays all station details (Figure 4.8), including the history of changes as documented in OSCAR/Surface. The station report is organized into the following five sections: Station characteristics, Observations/measurements, Station contacts, Bibliographic references and Documents, all of which can be expanded by clicking on the respective buttons.

Figure 4.8. The main sections of the station report

#### 4.2.2.2.1 Station characteristics

The Station characteristics section (Figure 4.9) gives an overview of the general situation of the station, such as the country it is located in, coordinates, WMO identifiers and terrain properties. All changes that are inserted in OSCAR/Surface are recorded and can be shown here, together with the date of the change, when expanding the field in question, as shown in Figure 4.10.

Note: A standard text was added to the station description when the station was initially created. This text explains that the station was created based on the information in Weather Reporting (WMO-No. 9), Volume A. The text should be removed once the station has been reviewed by the responsible station contact.

Figure 4.9. Station characteristics

Figure 4.10. Record of the station coordinates in the Station characteristics section  
(here only one position is recorded)

#### 4.2.2.2.2 WIGOS station identifier

Stations are identified by the WIGOS station identifier (WIGOS ID) in OSCAR/Surface (labelled as WMO index No.). WIGOS IDs are the official WMO identifiers and have to be used for all WMO stations from July 2016 on. An example of a WIGOS identifier is reproduced in Figure 4.11. Please see Chapter 2 of this Guide for more details.

An initial WIGOS identifier was created for each station and initially imported into OSCAR/Surface. For stations in Weather Reporting (WMO-No. 9), Volume A, the WIGOS ID is based on the station identifier allocated to the station by the country in Volume A. In the case of radar, Global Atmosphere Watch, or JCOMM In Situ Observations Programme Support Centre (JCOMMOPS) stations, it is based on the identifier used in these systems. This identifier should not be changed as it provides a historic reference. The administrator should be contacted if the identifier needs to be changed nevertheless.

Figure 4.11. WIGOS station identifier (The identifier 0-20000-0-12497 is based on the index number 12497 allocated to the station in Weather Reporting (WMO-No. 9), Volume A. The first “0” indicates that the identifier represents a station, “20000” is an issuer range allocated to WMO Programmes or networks, and the second “0” is the issue number.)

Multiple identifiers can be attached to a station to reflect affiliation with different networks or programmes. For this, the section Programmes/network affiliation can be edited (Figure 4.12). The programme or network to which the identifier is affiliated must also be specified.

Figure 4.12. Additional identifiers can be added under Programmes/network affiliation

#### 4.2.2.2.3 Observations/measurements

This section shows all observations, past and present, that are/were taken at the station, together with details about the instrument used, data processing applied and the observation schedule. If the observations are made under a programme/network, this affiliation and the identifier are also displayed here.

Observations are structured as data series and deployments, where a data series consists of one or more deployments. Attributes are thus recorded either under the data series or under a specific deployment. For example, the observed variable or data centre are recorded at the level of the data series, while the observing schedule and instrument information are stored in data deployments nested within the series. Note that both data series and deployments have a start and end date. See the box below for an explanation of the difference between a data series and a deployment. An example of a data series and a deployment can be seen in Figure 4.13.

Figure 4.13. Observations/measurements section – deployments expanded

Major changes to the properties of a data series or deployment may warrant closing the current one and adding a new one. This is the case when the characteristics of the series or deployment were changed to such an extent that it is no longer continuous. The user may then decide to create a new data series or deployment based on the following concept and example:

|  |
| --- |
| What is the difference between a data series and a deployment?  A data series represents the entirety of observations of the same variable taken at this station.  A deployment is a subset of these observations, and represents those that were taken without major interruption and under roughly the same conditions.  Example: The sampling method and observing schedule of a pressure observation are changed from 30 and 60 minutes to 10 and 30 minutes, respectively, on 1 January 2016. The current deployment is closed (end date is 31 December 2015) and a new one with the new observing schedule created. The deployment remains part of the same pressure data-series. |

#### 4.2.2.2.4 Station contacts, Bibliographic references and Documents

These three sections list station contacts, references and available documents containing further information on the station. Station contacts include various roles, such as operators, national focal points or maintenance technicians.

4.2.3 How to search for instruments

OSCAR/Surface stores the instrument metadata according to the WIGOS Metadata Standard. A user is thus able to query the data for manufacturer, model, serial number and period of observation. Figure 4.14 shows the further search options available by clicking on the More search options button, which reveals criteria for the variable, method, programme/network affiliation, organization, WMO Region or country of the instrument’s location, climate zone, geographic coordinates, and elevation.

Figure 4.14. Search for instruments – expanded

4.2.4 How to search for contacts

The Search for contacts functions as a searchable directory of station owners or points of contact. Figure 4.15 shows the options to search by name, either by entering the text or using the drop-down menu to browse the entries, and the more advanced search using the contact’s country, his or her role within various programmes or regarding the use of the data, and the variables being measured at the station.

Figure 4.15. Search for contacts

### 4.2.4.1 How to identify the national focal point for OSCAR/Surface of a country

To find the national OSCAR/Surface focal point, in the Search for contacts page open the drop-down menu next to the heading User role/programme function and select National Focal Point. This opens various new fields where the user can specify the national focal point’s Country of responsibility or Programme/network affiliation (see Figure 4.16).

Figure 4.16. Search for a national focal point

4.2.5 How to search for bibliographical references

Another function in OSCAR/Surface is the ability to locate any bibliographic reference inputted for the station (see Figure 4.17). If the user knows the author’s name or the year of publication, the search can return the stored references (in BibTex) corresponding to the matches. A keyword search allows for a wider search of the text of the references.

Figure 4.17. Search for bibliographic references

4.3 Changing information in OSCAR/Surface

The following section is addressed to national focal points and station contacts to explain how to access and edit observing stations metadata in OSCAR/Surface.

4.3.1 The authorization and access control module in OSCAR/Surface

Only authorized users can change information in OSCAR/Surface. The administrator, working at the WMO Secretariat, creates the login for the national focal point upon receipt of a nomination from the Permanent Representative. The national focal points can in turn create additional users and associate them with stations within their country. The national focal points have the right to edit all stations in their country, whereas other users can only edit stations they are directly associated with. However, both can create new stations in their country and add additional contacts to a particular station, granting them editing rights to this station.

A focal point for a network, such as the focal point for the Antarctic Observing Network, has the authority to make changes to all stations affiliated with the respective WMO observing system or network. These network focal points are designated by the WMO governing body of the programme or network in question. This means that the approval workflow for affiliating a new station to the programme/network is not implemented in OSCAR/Surface, but it is nevertheless left to the network focal point to make sure the process of adding the station has been followed before approving it in OSCAR/Surface. For details on how to affiliate a station with a programme/network, see section 4.3.6.

Table 4.2 details the access rights of the different types of users. Figure 4.18 shows the hierarchy of roles in OSCAR/Surface.

Table 4.2 User roles and access rights

|  |  |  |  |
| --- | --- | --- | --- |
| Role | Create station | Edit station | Create user |
| Administrator | Everywhere | Everywhere | Everywhere |
| National focal point | For their country | All stations in their country | For their country |
| Station contact | For their country | Only own stations | For their country |
| Network focal point | Everywhere | Only in own network | For their country |

Figure 4.18. Access and roles in OSCAR/Surface

4.3.2 How to log on to OSCAR/Surface and register a new user

Users need to be registered to be able to update information in OSCAR/Surface. The registration only has to be completed once. In this process the authorized e-mail of a national focal point or station contact is synchronized with the electronic identity and access management system used by OSCAR/Surface. To complete this initial procedure, click on the Login button in the top right corner of the page (Figure 4.19) and then on Register user (Figure 4.20).

Figure 4.19. Login and registration of a new user

Figure 4.20. User registration

Registration consists of the following six steps:

Note: Step 3 allows the user to enter a mobile phone number and step 4 to confirm the number. Both steps should be skipped, as supplying a mobile phone number does not work in all countries.

After having successfully registered, the following message is triggered with directions and further steps.

After having completed this procedure, enter the username and password to log on to OSCAR/Surface.

4.3.3 How to create a new station

Once logged on to OSCAR/Surface, the Management console appears in the main menu. The Register new station page can be reached from there (Figure 4.21).

Figure 4.21. New station registration page

The page is separated into the same five sections as the station report page, each of which allows the user to edit the elements corresponding to that category. Some elements, such as the name of the station, are mandatory, and the station cannot be submitted unless all mandatory elements have been provided. Should the information be incomplete, an error message is shown upon submission indicating that some elements are missing, as seen in Figure 4.22. The missing fields and section headers are coloured in red. However, it is possible to save the station as a draft to keep the information so far supplied for later editing.

Figure 4.22. Error message indicating missing fields

### 4.3.3.1 Input of a new WMO index no. (WIGOS ID)

As described in Chapter 2, the WIGOS identifier consists of four blocks:

(a) The WIGOS identifier series (a number, equal to “0” for stations/platforms);

(b) The issuer of identifier (a number);

(c) The issue number (a number);

(d) The local identifier (a set of characters, maximum of 16).

Observing stations that had been allocated WMO station identifiers before the introduction of WIGOS station identifiers (that is, before 1 July 2016) may continue to use those identifiers. With the launch of OSCAR/Surface, these stations were uploaded in the system incorporating the new WIGOS ID structure using “20000” as the value for the issuer of identifier. For example, station Incheon is recorded as “0-20000-0-47112”.

If any of the stations already have a World Weather Watch IIiii identifier, then an additional identifier should not be created. (The WIGOS identifier would be 0-20000-0-IIiii with sub-index number (SI) = 0, or 0-020001-0-IIiii if SI = 1, unless IIiii had been issued to more than one station in the past, in which case the most recent would have issue number 0, and the others would be assigned other issue numbers so that the metadata can be distinguished.)

Please see Chapter 2 of this Guide for more details.

### 4.3.3.2 Saving a station as a draft for further editing

When saving a station as a draft, it is neither publicly visible nor can it be found via the search function. To continue editing, find the station in the list of My stations. To locate the draft, open My stations, select the affiliated programme/network (for example, GOS), and click on Status, as shown in Figure 4.23.

Figure 4.23. Locating a station that was previously saved as a draft in My stations

Note that once a station is published, it can still be edited (see section 4.3.7), but it can no longer be saved as a draft as the station is already public.

4.3.4 Recording changes

Changes to almost all information in OSCAR/Surface are stored to be able to better understand the station history and development of capabilities over time. That is why all relevant fields have two date input fields, called Use since and Use till, in addition to the actual field capturing the information. When completing such fields, the date at which the change actually occurred should be indicated. For example, a change of instrument in a station may only be documented in OSCAR/Surface after the technician in the field has completed the work. In this case, the date when the instrument was changed should be indicated in the field Use till, not the date when the information is input into the system. The field Use till should be left blank if the information is currently still correct and should be set to the appropriate date when the information is no longer valid (Figure 4.24).

Figure 4.24. Recording changes

4.3.5 Multi-purpose station concept/duplicate stations

OSCAR/Surface is observation-centric, meaning that it focuses on documenting the observations made at the station. The concept of a station in OSCAR/Surface is mainly used for describing the physical environment in which the observations take place. Therefore, it is possible that multiple traditional stations that report with different identifiers to various observing programmes be grouped together in OSCAR/Surface as a single station. Each observation is then affiliated to an observing programme with its own identifier. At the same time, physically identical stations may have initially been imported as separate stations into OSCAR/Surface. It is the responsibility of the station operator to decide whether stations should be represented as separate entities in the system.

4.3.6 Programme/network affiliations and approval

In order to indicate that a station is related to a specific observing programme or network, the corresponding data series must be affiliated with such a programme/network. This must be done in two steps: first, the programme/network in question needs to be selected under the Programmes/network affiliation heading in the Station characteristics section; second, the programme/network must be linked to at least one observed variable. This can be done in the corresponding data series under the Observations/measurements section. If the second step is omitted, the original affiliation in Station characteristics will not be recorded when submitting the station (see Figure 4.25).

In some cases, joining the programme/network may be subject to approval. In this case, the programme focal point will receive an automatic e-mail asking for approval of the request. While the approval process is not completed, the affiliation will show as “pending”.

Figure 4.25. Affiliating a data series with a programme/network

4.3.7 Editing an existing station

The edit menu can be reached by clicking on the Edit button, which is shown on the station report when the user has editing rights to the station (Figure 4.26). To get to the station report any of the quick access, search or map filter methods can be used.

Figure 4.26. Edit button

Editing the station is then done using the same form as the Register new station, where most of the fields have been already populated. It is important to remember that the date of such a change must be documented in OSCAR/Surface too, as described in section 4.3.4.

### 4.3.7.1 Change of elevation of station or instruments

When the elevation of the station is changed, the elevation of the installed instruments must be also updated if needed. This means that the instrument coordinates for each deployment must be changed. If the coordinates of the station and instrument are the same, the Fill in from station coordinates button can be used to copy the values from the station level to the deployment. Note that all current deployments in all data series must be updated accordingly.

### 4.3.7.2 When the edits cannot be saved

In case of missing information, the system refuses to save the change. This is especially likely with stations that are being edited for the first time, as the station may have been created with incomplete information when the system was first populated.

Another reason why the edits cannot be saved is an internal error in the system. When this happens, a red notification is shown, and the station will remain in editing mode. In such a case, it is worthwhile checking whether the changes have been applied to the database or not. This can be done by opening the station report in another window while keeping the current one open. If the latest changes can be seen in the new window, it means that they have been saved by the system, and the current windows can be closed. Otherwise, the changes need to be saved again to make sure they are permanently stored in OSCAR/Surface.

### 4.3.7.3 Session timeout

The session is closed after one hour of inactivity. A message is displayed three minutes before the end asking the user whether the session should be prolonged. If no action is taken, the system tries to save any unsaved changes and ends the session. If the station was never submitted, it is automatically saved in draft form. Note that the system can only perform an automatic save if no mandatory fields are missing. If making changes with long pauses between edits, it is recommended to save the edits as a draft station before the long pause.

### 4.3.7.4 Editing radars or JCOMMOPS stations

OSCAR/Surface also contains information that is regularly imported from external portals. This is the case for stations maintained by JCOMMOPS and the WMO Radar Database operated by the Turkish State Meteorological Service. Therefore, changes to these stations cannot be applied in OSCAR/Surface but have to be made in the respective portals.

4.3.8 How to delete a station

Normal users cannot delete stations in OSCAR/Surface. This is because the purpose of OSCAR/Surface is to document current and past stations in order to see historic trends. Deleting a station removes all traces of it from the system, even for the period during which the station was active. Therefore, rather than deleting the station, it is in most cases more appropriate to set an end date for the data series and set the reporting status of the station to closed (see section 4.3.8.1). Stations created for testing purposes can be removed by the administrator. The contact form can be used to request the removal of a station.

### 4.3.8.1 Closure of a station

In order to close a station, the following procedure should be followed for all networks/programmes the station is affiliated with:

(a) Set the To date to one day before the station closure date;

(b) Add a new affiliation for the same network/programmme with status Closed. Enter the closure date in the From field and leave the To field blank.

(c) Add the new affiliation to all the existing observations affiliated with the network and set the To date for the corresponding data deployment.

This procedure is necessary to keep a record of the station, the variables observed by the station and the networks/programmes it was affiliated with; otherwise, this information would be lost.

4.3.9 How to copy a station

Instead of creating a station from scratch, it is often easier to create a station by using an existing one as a template. To do this, locate the existing station in the My stations screen, as can be seen in Figure 4.27. From there it is possible to copy the station using the copy icon on the right. The new station will be opened as the edit screen. Only relevant attributes are copied.

Figure 4.27. The copy action in the My stations screen

4.3.10 How to get help and report bugs

There is a contact form (accessed via the Support button) in OSCAR/Surface that can be used to ask for help and also report bugs. Requests submitted through this form are tracked and responded to by the OSCAR/Surface operating team and the WMO Secretariat.

4.3.11 Development of a machine-to-machine interface

OSCAR/Surface will provide a machine-to-machine application program interface that has been under development and will be available in the next release. Future versions of this Guide will discuss how to make mass changes and how to synchronize an existing database with OSCAR/Surface using such tools.

Annex. List of fields in OSCAR/Surface

A list of fields will be provided in the next version of this Guide.

In order to get an overview of the information fields needed to complete a station, try creating a dummy station, which is saved as a draft or not saved at all, using the Register new station function. This gives the possibility to browse through all forms and fields required for creating a new station.

5. Observing network design

5.1 Introduction

The observing network design principles are provided in the Manual on the WMO Integrated Global Observing System (WMO-No. 1160), Appendix 2.1. The 12 principles are short and therefore abstract. National Meteorological and Hydrological Services (NMHSs) designing and evolving their observing system networks need more concrete guidance on how to respond to these principles. This chapter thus provides for each principle a set of more specific guidelines or recommendations on their interpretation and implementation.

Some recommendations apply across several principles. For ease of interpretation, these points are repeated wherever applicable.

In some cases in this chapter, rather abstract terms are used. These terms sometimes have their origin in a specific area of meteorological observation, such as in ground-based observation. The terms “network design” and “observing networks”, for example, are regularly used and accepted when describing the process of creating a network of ground-based observing sites in a country, and thus when considering aspects like appropriate distance between stations, other siting conditions or the frequency of observations. The term “network design” can and is already being used in the area of space-based observations. However, this additional application has not yet been adopted generally. Therefore, it is important to recognize that many guidelines and recommendations in this chapter – when referring to, for example “network design” or “observing networks” – are not necessarily restricted to ground-based observations but should be applied to all observing systems.

Abstract or conceptual terms and definitions, for example “integrated station network”, are also sometimes used for the purpose of making certain guidelines and recommendations more generally applicable. Explanations of such abstract terms can be found in the annex to the present chapter.

5.2 Guidance on the observing network design principles

Note: For convenience, the observing network design principle is reproduced in parentheses and italic under the name of each principle.

Principle 1. Serving many application areas

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

Note: A WMO application area is an activity involving the direct use of observations in a chain of activities that allow National Meteorological Services or other organizations to render services contributing to public safety and socioeconomic 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[[1]](#footnote-1) and describes a homogeneous field of activity for which it is possible to compile a consistent set of observational user requirements agreed by community experts working operationally in this area.

(a) When designing observing networks, the needs of WMO application areas, as regulated in the Manual on the WMO Integrated Global Observing System (WMO-No. 1160), should be taken into account. In particular, see the [WMO Rolling Review of Requirements](http://www.wmo.int/pages/prog/www/OSY/GOS-RRR.html) process, the WIGOS database of user requirements for observations ([OSCAR/Requirements](https://www.wmo-sat.info/oscar/observingrequirements)) and the [Statements of Guidance](http://www.wmo.int/pages/prog/www/OSY/GOS-RRR.html#SOG) for all applications areas. As an example, the design of observing networks implemented primarily in support of operational weather forecasting should also take into account the requirements of other applications areas, such as climate monitoring.

(b) Where practicable, observing networks should be designed and operated in such a way that the needs of multiple applications are addressed. It is acknowledged that different applications have different, and sometimes conflicting, requirements; when an observing network is implemented primarily to serve the needs of one application, compromises may be needed in its ability to serve others. Nevertheless, the requirements of other applications should be actively considered during network design.

(c) As part of the management of an observing network, a user consultation procedure should be implemented through which the requirements of different application areas can be ascertained, considered and analysed simultaneously. (See also principle 2.)

(d) In order to respond to the needs of its Programmes, WMO engages in partnerships with other bodies responsible for observations through co-sponsored programmes (see the preamble to the [Implementation Plan for the Evolution of Global Observing Systems (EGOS-IP)](http://www.wmo.int/pages/prog/www/OSY/gos-vision.html#egos-ip) (WIGOS Technical Report No. 2013-4). These partnerships should be taken into account when designing observing networks.

(e) Partnerships with other organizations (such as those involved in road transportation or electric power generation), including partner organizations responsible for observations, should be exploited through the integrated and multi-purpose design of observing networks in order to achieve synergies between networks and/or domains and improve cost-effectiveness.

Principle 2. Responding to user requirements

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

Note: User requirements for observations are documented and quantified in the Observing Systems Capability Analysis and Review tool ([OSCAR/Requirements](https://www.wmo-sat.info/oscar/observingrequirements)). The user requirements as stated in OSCAR are high-level in the sense that they are not intended to capture all the detailed requirements that must be considered when designing a specific observing system. The requirements in OSCAR/Requirements should therefore be taken into account, but they are not sufficient to provide a full description of the observing system requirements.

(a) User communities should be involved in the observing network design. To ensure that observing networks respond to the key needs of the user communities, specific decisions about observing network design should include a consultation stage with appropriate application area representatives. A procedure should be implemented to allow a documented collection and synthesis of detailed user requirements.

(b) When designing their observing networks, Members should take into account the actions listed in the [Implementation Plan for the Evolution of Global Observing Systems (EGOS-IP)](http://www.wmo.int/pages/prog/www/OSY/gos-vision.html#egos-ip) (WIGOS Technical Report No. 2013-4), as well as the gap analyses from the [Statements of Guidance](http://www.wmo.int/pages/prog/www/OSY/GOS-RRR.html#SOG) for all application areas.

(c) Members should conduct further studies to assess the feasibility of addressing with existing technology the observational user requirements specified in OSCAR, as well as the additional regional requirements that may not be specified in OSCAR and national requirements, taking resources and cost-effectiveness into account. (See also principle 5.)

(d) Observational data should be processed to a level to be established in consultation with users (for example, raw instrument data, calibrated instrument data or retrieved geophysical variable). This should include an agreement on quality control, formats, etc. The appropriate level of processing will vary according to the user communities’ needs and to the intended applications. Appropriate resources should be allocated to these data-processing requirements. Also, where supported by user requirements, appropriate resources should be allocated to archiving the raw data and metadata, such that data can be reprocessed at a later date.

Principle 3. Meeting national, regional and global requirements

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

(a) National observing networks are designed and established by Members primarily to respond to their own national needs/requirements, in many cases in agreement with other Members and in accordance with WMO regulatory and guidance material. However, when implementing these national networks, Members should also take into account the requirements for global and regional applications. For example, Members should consider small additional commitments or adjustments (for instance, in terms of data storage, data policy, availability, exchange and documentation) to make data useful to other Members.

(b) WIGOS regulations should be adopted for observing networks that are implemented primarily to respond to national needs.

(c) Procedures through which national user requirements are collected and assessed (see principle 2, paragraph (a)) should be designed in such a way that regional and global requirements can be addressed simultaneously.

(d) For each national network/site, a network/site definition document should be maintained containing information on:

(i) Planned observing capabilities of the network/site;

(ii) Target performances;

(iii) User requirements to which the network/site responds.

Principle 4. Designing appropriately spaced networks

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

(a) In general, the composite observing network should be designed in such a way that it delivers basic observations that are quasi-uniform in space for observed variables and resulting from an analysis of the 3D-resolution requirements provided in [OSCAR](https://www.wmo-sat.info/oscar/observingrequirements). Gaps should be assessed in accordance with the Manual on the WMO Integrated Global Observing System (WMO-No. 1160). (See also principle 5 for guidance on composite network design.)

(b) However, for some application areas, the representativeness of observations may be a more important design driver than spatial and temporal homogeneity. In such cases, the density of an observing network should be adjusted according to the variability of the observed phenomena in a given region, for example to address the need for greater density of some observations in mountainous and coastal areas where steep gradients in geophysical variables exist. Also, observing networks should be designed with spatial and temporal spacing such that severe, extreme and high-impact events, often of short duration, are captured, and such that climate-relevant changes (for example, diurnal, seasonal and long-term interannual) can be resolved.

(c) When considering priorities for additional observations, attention should be given to: data-sparse regions and domains, poorly observed variables, regions sensitive to change and regions which experience environmental phenomena that place populations at risk. As these are not always located within the territory of the country needing the observations, this creates a need to acquire observations in areas outside the territory of the funding nation or group of nations (for example, the Network of European Meteorological Services funding of the EUMETNET Automated Shipboard Aerological Programme, or the Global Climate Observing System (GCOS) Cooperation Mechanism).

(d) Observing networks should be designed taking into account measurements and gaps of other systems in the vicinity, such as measurements using the same technology in neighbouring countries or measurements from networks using different technologies, both surface-based and space-based.

(e) Surface-based observations have to be representative for specific applications. Sites representative of local features should be generally avoided (for example, on steep slopes, in hollows, in proximity to pronounced features such as buildings, topographical influences or ridges) unless sited for a specific purpose and application.

(f) Non-NMHS observations can provide valuable measurements for filling in observational gaps. In many areas these may be the only available observations, particularly for elements requiring higher density measurements such as precipitation, and extreme events such as hail or windstorms. NMHSs should investigate collaborations with others within their country in order to complement existing networks, share resources and address gaps. For observations of this type, special attention should be given to possible data-policy issues, and the guidance given under principle 3, paragraph (a), should be followed.

(g) Where possible, objective tools should be used to assess the impact and benefit of observations, including to demonstrate the impact of observation density. Such tools (for example, Observing System Experiments, Observing System Simulation Experiments or forecast sensitivities to observations) exist in numerical weather prediction and are well-proven. The development of equivalent tools for other application areas is encouraged.

Principle 5. Designing cost-effective networks

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

(a) Observing networks should be designed using the most appropriate and cost-effective technologies or combinations of technologies. Guidance documents from the Commission for Instruments and Methods of Observation and other technical commissions on existing technology should be consulted. For example, reference can be made to the Guide to Climatological Practices (WMO-No. 100), Chapter 2, 2.5; the Guide to Agricultural Meteorological Practices (WMO-No. 134), Chapter 2, 2.2.4 and 2.4.1.11.3; and the Guide to the Global Observing System (WMO-No. 488), Part III, 3.1.

(b) Developments to observing networks should, where possible, build on and lead to the consolidation of existing subnetworks, capitalizing on both existing and new technology and integrating new networks into existing WIGOS capabilities.

(c) The observing network should evolve in response to changing user requirements. Designs should be sufficiently flexible to allow for incremental expansion, or contraction, without the need for complete network redesign.

(d) Partnerships with other organizations responsible for observations should be established or maintained in order to build on potential synergies, share costs and provide more cost-effective multi-purpose networks. Other organizations may include WMO partners (see the preamble to the [Implementation Plan for the Evolution of Global Observing Systems (EGOS-IP)](http://www.wmo.int/pages/prog/www/OSY/gos-vision.html#egos-ip) (WIGOS Technical Report No. 2013-4)) or national governmental and non-governmental organizations.

(e) Observing network design should, where possible, be based on the results from scientific studies which assess the impact, importance and value of the observations for the applications to which they contribute. Complementary impact-per-cost studies should also be conducted in order to address the cost-effectiveness of various possible observing systems when designing networks.

(f) Spaced-based and surface-based observing networks should be designed and operated in such a way that they are complementary, with appropriate activities and cooperation between the communities responsible for these networks, to ensure that observations from each network are used to enhance the impact and effectiveness of the other.

(g) Observing networks should be designed taking into account measurements available from other networks in the vicinity, including in neighbouring countries, or measurements from networks using different technologies.

(h) To optimize benefits within a Member’s own territory, an effective observing network may require investment outside the Member’s territory. This may be realized through, for example, regional collaboration.

(i) Network design may include the need for visual/manual observations and observations of phenomena not necessarily well detected/identified by automated systems or that are more cost-effective detected manually.

For space-based observing systems

(j) Space-based observing systems that continue to meet calibration and stability requirements may remain cost-effective for longer than their expected lifetime. Operators should consider continuing to operate such systems at a lower level of maintenance after the designed lifetime.

Principle 6. Achieving homogeneity in observational data

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

(a) Only observing technologies with adequately characterized performance should be deployed to ensure that levels of observational quality consistent with user requirements are attained.

(b) Observing networks should be operated to meet agreed performance targets.

(c) Observing networks and stations should be assessed regularly using objective criteria to ensure that the desired performance standards are being met.

(d) As part of routine operations, the quality and homogeneity of data should be regularly assessed through an ongoing programme to monitor performance of the network. This may include both automated and manual checks.

(e) A comprehensive monitoring of data availability, timeliness and quality should be implemented. For appropriate observation types, this should include monitoring of short-range numerical weather prediction. Monitoring should also be implemented to help detect various types of errors, for example, non-timely or missing data, improperly coded observations and grossly erroneous measurements.

(f) Monitoring results may be made available in different ways, for example, via web portals, regular reports (review of overall performance statistics) or fault reports (focus on detected errors at specific sites).

(g) When station relocations or instrument upgrades are made, a sufficient period of overlap between the old and new systems, considering the targeted application areas, should be made whenever practicable. (See also principle 12.)

(h) The availability of complete metadata is essential to assess the homogeneity of observations. (See also principle 10.)

(i) For many applications including climate monitoring, it is important that calibration, calibration monitoring and intercalibration be designed as part of the observing network. For applications in (near) real time, it is important that calibration information be made available in (near) real time. It is also important that raw data be archived so that they can be reprocessed at a later date to improve their homogeneity.

(j) Intercomparisons and validation of observations made using different technologies should be undertaken in order to improve understanding of observational uncertainty or relative performances (bias, standard deviation, gross errors).

(k) Whilst some non-NMHS observations may be collected using non-standard formats, where possible all observations should be disseminated using standard quality rules, standard formats and according to standard dissemination procedures.

(l) Observations should be disseminated in such a way that the quality and provenance of the original measurement are retained.

(m) Members should give a high priority to maintaining the operations of observing stations/sites/systems that have long-term data series, especially for climate applications.

(n) For climate monitoring applications, surface-based stations should be sited in locations that are least likely to be impacted by changes through time in the natural or man-made environment.

Principle 7. Designing through a tiered approach

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

Note: In addition to improving the quality and utility of observations, this approach will also lead to improvements in the understanding of the quality of the observations.

(a) The tiered approach should include, as a minimum, a sparse network of reference stations (for example, the GCOS Reference Upper-air Network) from which other stations can be benchmarked. Reference stations should be calibrated to the International System of Units or community-accepted traceable standards with fully quantified uncertainties, have the highest level of robustness (for example, duplicate or triplicate sensors of key variables such as temperature and precipitation), be well sited in locations least affected by urbanization and other non-climatic influences, have regular maintenance and replacement cycling of instruments, have the highest standard of metadata collection including photo documentation, and have continuous monitoring of system performance to resolve instrument and environmental issues as they arise.

(b) Stations such as the baseline networks of the Global Climate Observing System (the GCOS Surface Network and GCOS Upper-air Network) can form an intermediate data layer, with quality between that of reference stations and the larger comprehensive network of observing stations.[[2]](#footnote-2)

(c) In the field of space-based observing, satellite redundancy should be used whenever appropriate to ensure the reliability of data provision from certain orbits. With regards to ground-based observations, even at non-reference stations, instrument redundancy should be used whenever appropriate to ensure the reliability of the observation and measurement accuracy.

(d) In addition to geostationary and low-Earth orbit Sun-synchronous constellations, space-based observing networks should include high-eccentricity orbits to permanently cover the polar regions, low- or high-inclination low-Earth orbiting satellites for comprehensive sampling of the global atmosphere, and lower-flying platforms, such as short-life nanosatellites, as gap fillers.

(e) A network of other NMHS or non-NMHS stations can be interspersed with a subset of high-quality stations for more complete coverage.

(f) Network design should include consideration of skills and training needed for staff, which is expected to be different at different levels in the tiered structure. Expertise of staff at reference stations should be used to provide guidance to other parts of the network.

Principle 8. Designing reliable and stable networks

(Observing networks should be designed to be reliable and stable.)

(a) The design and implementation of observing networks should ensure that standard operating procedures and practices are followed, including appropriate maintenance and calibration procedures.

(b) Data quality objectives should be defined for each network. Decisions will need to be made regarding the level of quality control to be applied. Fully automatic quality control with no manual assessment may be the most cost-effective but in some cases may result in a lower level of quality.

(c) The criteria for selecting the station site/satellite orbit should be based on the purpose and tier of the network. Criteria associated with the length of time the station/satellite will be operated, available energy sources, data transmission options, and factors associated with homogeneity and the local environment should be considered.

(d) Training should be commensurate with the network tier. A basic network consisting of manual observations should focus on sound observing techniques and methods for data recording and dissemination. For automated networks, training should focus to a greater degree on maintenance and operation of instruments and automatic data collection methods. The operation of reference networks will require the greatest level of training and higher standards for calibration, inspection, maintenance and management.

(e) Observing networks, both ground-based stations and space-based systems, and their telecommunications should be designed to be robust against exposure to severe weather and hydrological, climate and other environmental conditions (such as geomagnetic storms or space debris in case of satellites).

(f) A combination of standard and backup power sources (sustainable sources such as solar, water and wind for ground-based stations and other appropriate sources for satellites) should be used whenever possible to better ensure uninterrupted operation of observing platforms in all environmental conditions.

(g) When possible, data should be made available to global collection centres where data monitoring can be performed and feedback provided in near real time regarding data quality, including the frequency and character of observational errors, reporting percentages, completeness and timeliness.

(h) Monitoring procedures described under principle 6 should also help in assessing the current and long-term reliability and stability of networks.

(i) The functioning of the operations of an observing network and its components should be monitored and supported by incident/fault management in order to improve the reliability and stability of a network.

(j) For climate monitoring, special attention should be given to maintaining stations/satellite orbits with long, historically uninterrupted records and to maintaining their homogeneity in location, instrumentation and observing procedures.

(k) Parallel long-term data storage (for example, on site) should be designed to augment real-time dissemination, which will help ensure that original observations are preserved (for example, on site) to allow for the higher level of quality and completeness required for climate applications.

(l) Station sites/satellite orbits should be selected in areas least likely to be impacted by factors such as new construction that will force station relocations.

Principle 9. Making observational data available

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

(a) Data availability gaps with respect to the stated user requirements must be addressed. Members should: (i) make efforts to collect and disseminate observations that are made but not currently collected centrally; (ii) exchange existing data internationally in accordance with the Manual on the WMO Integrated Global Observing System (WMO-No. 1160); and (iii) improve data timeliness.

(b) Mechanisms should be established to minimize the loss of existing observational data and to promote the recovery of historical records for climate applications.

(c) Multiple and overlapping methods of dissemination (for example, through multiple routes) that comply with the Technical Regulations should be used to improve continuity of data delivery to users.

(d) Cloud concepts and other methods for expanding telecommunication capacities should be considered for managing the rapid growth in data volumes of 2D- and 3D-scanning remote-sensing observing systems (such as satellites and radars).

(e) To facilitate data availability and access, WMO-defined standard data formats should be used for data exchange.

For climate applications

(f) All raw data and agreed subsets of processed data should be collected into a documented and permanent data and metadata record following common standards (see, for example, the Guideline for the Generation of Datasets and Products Meeting GCOS Requirements, GCOS Report No. 143 (WMO/TD-No. 1530)) and archived in a World Data Centre or other recognized data centre.

(g) A sustained operational capability is required to produce and maintain the archived data record throughout and after the life of the observing network.

(h) Resources should be allocated to ensure appropriate reprocessing of observational data to respond to the needs of climate applications.

Principle 10. Providing information so that the observations can be interpreted

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

(a) Metadata practices should adhere to the WIGOS Metadata Standard as specified in the Manual on the WMO Integrated Global Observing System (WMO-No. 1160) and the WIGOS Metadata Standard (WMO-No. 1192).

(b) Members should follow standard procedures to collect, check, share and distribute the WIGOS metadata that are required for international exchange, to ensure appropriate homogeneous use of the observational data and knowledge of their quality and traceability; additional WIGOS metadata should be recorded by Members and made available on request.

(c) Station metadata should be created at the time of network installation and updated regularly to include information such as station location, the surrounding environment, instrumentation type and calibration metrics, observing practices and maintenance. Whenever possible, photographic images of the station and environment should be made and archived annually.

(d) WIGOS metadata should be updated whenever changes occur, including changes in sheltering and exposure, mean calculations, observation hours, land use, instrument types, quality control, homogenization and data recovery procedures.

(e) Wherever possible, users should be given advance notice of changes in instruments and data processing.

Principle 11. Achieving sustainable networks

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

Note: In this context, “sustainable” means that the network can be maintained in the medium to long term. This is desirable for most operational applications and is required for climate monitoring. Requirements for systems to be robust and for their data to be of appropriate quality are discussed under other principles.

(a) Where appropriate, some research-based systems, namely those that are mature and cost-effective, should evolve to a status of secure, long-term funding, while maintaining or improving the availability and quality of the observations.

(b) The transition of research observing systems or new observing technologies to long-term operations requires careful coordination between data providers and users (both research and operational users).

(c) Members should ensure that their funding for the sustained networks remains sufficient in the longer term taking into account the required evolutions and changes (for example, in technology). (See also principle 12.)

(d) The transition of research-based observing systems or new observing technologies to long-term operations should include the design of robust and maintainable systems that assure appropriate data collection, quality control, archive and access.

(e) Members should take steps to make preoperational data available to users on a best efforts basis to facilitate early uptake and adoption of the new data, once operational.

(f) A written agreement for the operational collection and archive of observations should be made with a recognized archive centre.

(g) When selecting sites/stations/satellite orbits, network planners and administrators should consider locations that can be secured through long-term agreements (for example, leases or ownership for ground-based observing sites).

(h) Other useful guidance material is available in the GAIA-CLIM Report/Deliverable D1.3. Gap Analysis for Integrated Atmospheric ECV Climate Monitoring: Report on System of Systems Approach Adopted and Rationale (see footnote 2 for reference information).

Principle 12. Managing change

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

Note: When considering which changes might be consistent with WMO strategy, reference should be made to the [Implementation Plan for the Evolution of Global Observing Systems (EGOS-IP)](http://www.wmo.int/pages/prog/www/OSY/gos-vision.html#egos-ip) (WIGOS Technical Report No. 2013-4).

(a) The impact of new systems or changes to existing systems on user applications should be assessed prior to implementation, taking into account the observational user requirements of all application areas.

(b) A suitable period of overlap between old and new observing systems is required (meaning parallel observations) to maintain the homogeneity and consistency of observations in time.

(c) Test beds and pilot projects are required through which new systems can be tested and evaluated and guidelines for operational transition (including the production and dissemination of the necessary new metadata) developed.

(d) The objective tools assessing the impact and benefit of observations for certain application areas should be used, where possible, to support change management. (See also principle 4.)

For climate applications

(e) To avoid gaps in the long-term record, continuity of key measurements should be ensured through appropriate strategies.

(f) When a period of overlap between old and new systems is not possible, other methods, such as paired observations (co-location of original and new instrumentation), should be used.

(g) When introducing a change, efforts should be made to retain as many similarities as possible between the old and new system (for example, similar site exposure for ground-based systems, similar orbital position for space-based systems, similar procedures, instruments and sensors).

Annex. Explanation of terms related to observing network guidance

Note: Formal definitions of terms are published in the Technical Regulations (WMO-No. 49) rather than in Guides.

An integrated station network consists of multi-purpose stations and/or stations of different types in the same geographical area in which agreed WMO practices are applied.

A tiered network is a network designed in accordance with (or following) an industry standard hierarchical network model.

Third parties are persons or organizations who are not a party to a contract or a transaction but are involved. The third party normally has no legal rights in the matter, unless the contract was made for the third party’s benefit.

1. The WMO Rolling Review of Requirements is described in the Manual on the WMO Integrated Global Observing System (WMO-No. 1160), Appendix 2.3. [↑](#footnote-ref-1)
2. See the GAIA-CLIM Report/Deliverable D1.3. Gap Analysis for Integrated Atmospheric ECV Climate Monitoring: Report on System of Systems Approach Adopted and Rationale  
   (<http://www.gaia-clim.eu/workpackagedocument/d13-report-system-systems-approach-adopted-and-rationale>). [↑](#footnote-ref-2)