WORLD METEOROLOGICAL ORGANIZATION

WMO INTEGRATED GLOBAL OBSERVING SYSTEM (WIGOS)

FUNCTIONAL REQUIREMENTS OF THE WIGOS OPERATIONAL INFORMATION RESOURCE (WIR)

*(**Draft** **version** 0.15, 8/1/2013)*

NOTES

DISCLAIMER

Regulation 42

Recommendations of working groups shall have no status within the Organization until they have been approved by the responsible constituent body. In the case of joint working groups the recommendations must be concurred with by the presidents of the constituent bodies concerned before being submitted to the designated constituent body.

Regulation 43

In the case of a recommendation made by a working group between sessions of the responsible constituent body, either in a session of a working group or by correspondence, the president of the body may, as an exceptional measure, approve the recommendation on behalf of the constituent body when the matter is, in his opinion, urgent, and does not appear to imply new obligations for Members. He may then submit this recommendation for adoption by the Executive Council or to the President of the Organization for action in accordance with Regulation 9(5).

Chairperson, Publications Board
World Meteorological Organization (WMO)
7 bis, avenue de la Paix
P.O. Box No. 2300
CH-1211 Geneva 2, Switzerland

Tel. : +41 (0)22 730 84 03
Fax: +41 (0)22 730 80 40
E-mail: Publications@wmo.int

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FUNCTIONAL REQUIREMENTS OF THE WIGOS OPERATIONAL INFORMATION RESOURCE (WIR)

INTRODUCTION

The document describes the functional requirements of the WIR to be developed as specified by the WIGOS framework Implementation Plan to be operational from 2016 onwards.

1. PURPOSE AND SCOPE OF THE WIR

The WMO Integrated Global Observing System (WIGOS) Operational Information Resource (WIR) is a network platform[1] and tool designed to provide WIGOS stakeholders[2] with all relevant information on the operational status and evolution of WIGOS and its observing components, the operational requirements of WIGOS, including standards and recommended practices and procedures used in the WIGOS framework, and their capabilities to meet observational user requirements of all WMO Application Areas[3].

The WIR is to serve a number of purposes:

(i) To provide general information on WIGOS, its benefits to Members, and the impacts on Members of addressing WIGOS requirements;
(ii) To provide an overall description of the WIGOS component observing systems that are currently in place (list of observing networks / stations[4], their characteristics/metadata including information on observational products they deliver);
(iii) To monitor the evolution of the observing systems and compare this with the plans, to ascertain progress;
(iv) To outline existing national and regional plans for evolution of WIGOS component observing systems;
(v) To assist Members and those in charge of observing network design and implementation to understand the requirements for the relevant observing systems, including standards and recommended practices and procedures, and observational user requirements, in order for them to make appropriate decisions;
(vi) To assist Members to identify observational gaps[5] through critical review and to conduct network design studies, in order for them to address those gaps;
(vii) To assist Members to understand the full potential of the current observing systems with regard to the WMO Application Areas, including those systems operated by partner organizations, to enhance (a) the scope and availability of observations made by specific observing stations, (b) collaborations, (c) data sharing, and (d) data exchange;
(viii) To provide data users with immediate access to the list of WIGOS component observing systems, with a basic set of observational metadata for each (specified by WMO Technical Regulations), and with links to the appropriate national databases where more detailed information is available in those cases where such databases exist;
(ix) To provide developing countries with guidance on observing network implementation, and tools they can readily use to document their own observing systems (e.g. by using the OSCAR[6] tool of the WIR, they could avoid the need to develop a database nationally);

1 Accessible through a WMO web portal
2 Members (including observing network decision makers / managers / supervisors, observational data users), Technical Commissions (e.g. implementation coordination groups) and Regional Associations
3 The 12 WMO Application Areas are: global NWP, high-resolution NWP, nowcasting and very short-range forecasting, seasonal to inter-annual forecasting, aeronautical meteorology, ocean applications (including marine meteorology), atmospheric chemistry, agricultural meteorology, hydrology, climate monitoring, climate applications, and space weather
4 In this document, observing stations refer to all types of observing sites, stations, and platforms relevant to WIGOS, whether they are surface-based, or space-based, on land, at sea/lake/river, or in the air, fixed, or mobile (incl. in the air), and making in-situ or remote observations.
5 Gaps are expressed in terms of required space/time resolution, observing cycle, timeliness, and uncertainty for the WMO Application Areas
6 Observing Systems Capabilities Analysis and Review tool (OSCAR); see paragraph 2.3 for details.

(x) To provide a mechanism for matching specific needs (capacity building, gaps, etc) with resources (via knowledge sharing, donor contributions etc).

Based on feedback from Members and other users of the WIR, the need for additional functionality and/or information to be accessible from the WIR will be considered by the relevant expert team(s), once implemented.

2. FUNCTIONAL COMPONENTS OF THE WIR

The WIGOS Operational Information Resource shall be accessible via a centralized point (web portal), and shall provide seamless access to the following information components:

- **The Portal**: A portal with access to general information and to the other components;
- **The "Standardization of Observations" Reference Tool (SORT)**: A tool linking to information on WIGOS standards and recommended practices and procedures;
- **The Observing Systems Capabilities Analysis and Review tool (OSCAR)**: A tool for Rolling Review of Requirements (RRR) process, network design and planning, providing information on observational user requirements and observing systems capabilities, including description of WIGOS component observing systems (i.e. observational metadata), and linkages to existing databases (e.g. WMO Country Profile database, when applicable).

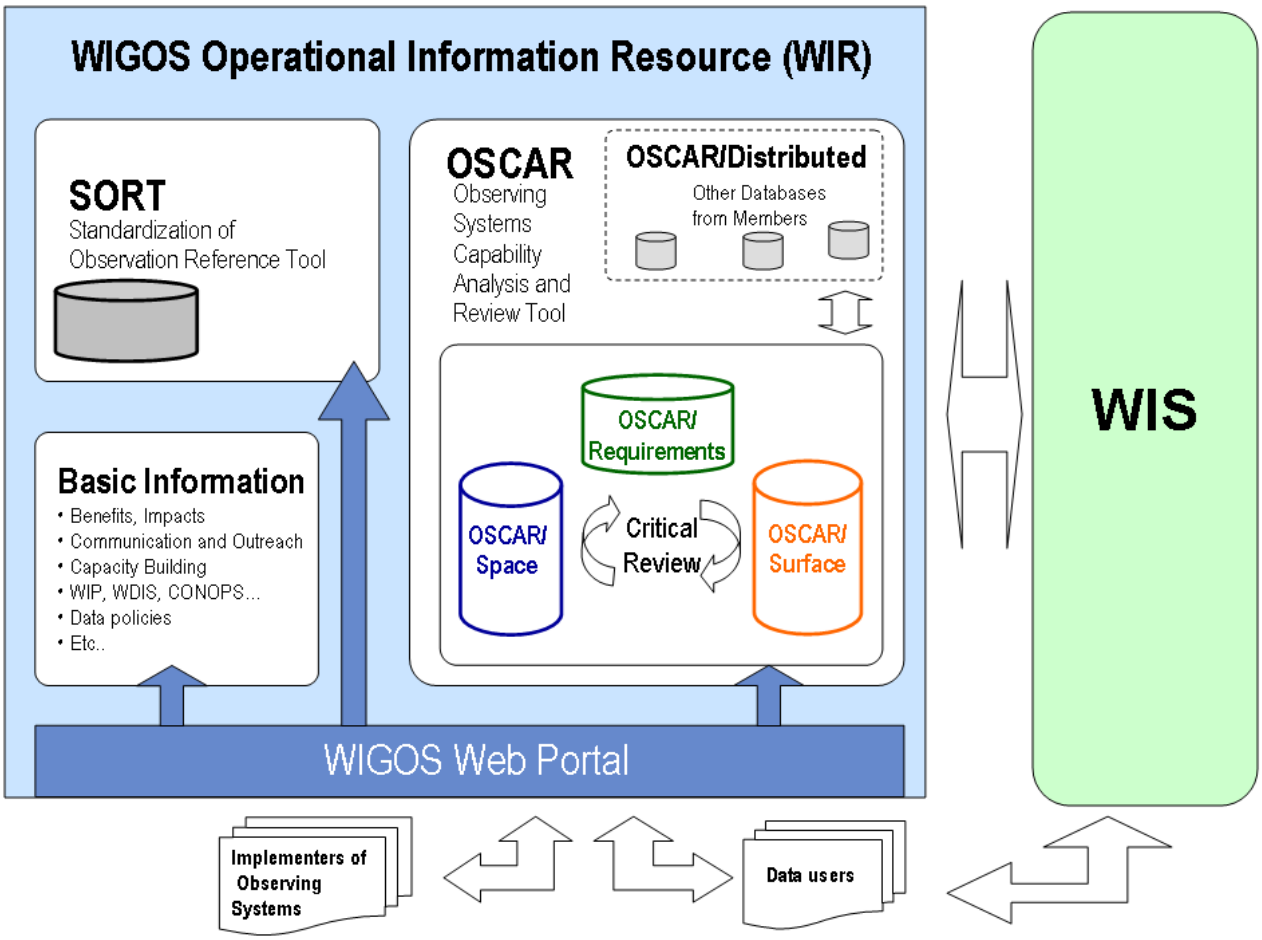


Figure 1: The WIGOS Operational Information Resource and its three components

All information should preferably be accessible through one coherent dynamic user-friendly interface. A single Content Management System (CMS) could be used for recording, managing, updating, and making accessible the content of the three components.

While the WIR is not designed to provide direct access to the observations, the WIR will provide a link to the WMO Information System (WIS), which is the effective mechanism for accessing observational data, as well as data flow monitoring information. WIR and WIS are therefore complementary and do not overlap.

The information provided to the different stakeholders who use (draw information from) the WIR, is summarized in Table 1 below, for each of the three WIR components. Similarly, the information that needs to be contributed to the WIR by the different stakeholders is summarized in Table 2 for each WIR component.

Components / Actors	**Web Portal**	**SORT**	**OSCAR**
WMO Members; Regional Associations; Obs. Network managers (incl. implementers of WIGOS component observing systems, and implementation and coordination groups)	Rationale and scope of observing networks; Information on benefits and impacts; Information on national and regional WIGOS plans (plans, status, gaps etc), as well as associated templates	Understanding and access to required standards; Recommended practices	Monitoring of observing systems status; Understanding existing networks, and their potential Gap analysis; Network design and evolution; Monitoring progress
Data users	Portal to information on data policies and data access (WIS)	Understanding data, and data interpretation (at concept level)	Understanding data, and data interpretation (at observing station level)
Technical Commissions	Rationale and scope of observing networks	Information on existing standards and recommended practices and procedures to facilitate the review of regulatory materials	Monitoring of observing systems status; Identification of strengths and weaknesses and derived recommendations Gap analysis
Partners	Understand WIGOS, data policies, and how to access WIGOS data	Data providers: understand WIGOS requirements and procedures; Data users: understand data and how to interpret them	Collaboration: bringing new data-sets to WIGOS; or using existing WIGOS data Understanding observational user requirements and how they can contribute data to WIGOS

Table 1: Information provided by the WIR components to WIR users.

Components / Actors	**Web Portal**	**SORT**	**OSCAR**
WMO Members; Regional Associations; Obs. Network managers (incl. implementers of WIGOS component observing systems, and implementation and coordination groups)	Feedback on portal usefulness, strengths and weaknesses	Provide information on national standards and practices that may be relevant to add into SORT	Provide information on observing systems capabilities, including metadata Provide information on network design and evolution being undertaken plus regular status reports on progress.
Data users	Feedback on portal usefulness, strengths and weaknesses in terms of available information on data policies and access	Provide feedback on information provided regarding data understanding, and data interpretation	Points of Contact in each Application Area: provide information on observational user requirements; Data users: provide feedback on accuracy/relevance of the observational user requirements
Technical Commissions	Propose changes to the portal structure and content	Evolution of standards and recommended practices and procedures Review and update regulatory materials	Provide comments on the accuracy/relevance of the observational user requirements
Partners	Feedback on portal usefulness, strengths and weaknesses	Contribute to the evolution of standards and recommended practices and procedures, as well as the review of regulatory materials	Provide feedback on the capabilities of their observing systems, including metadata Provide comments on the accuracy/relevance of the observational user requirements

Table 2: Information provided to the WIR components by WIR contributors.

2.1. The Web Portal (general information)

This web-based component of the WIR (wir.wmo.int) shall provide access to the other components and support tools of the WIR. It shall also provide general information on WIGOS, including the concept, benefits and impacts on Members, applicable data policies, etc. It will provide generic information on the core WIGOS component observing systems (GOS[7], GAW[8], WHYCOS[9], GCW[10]), and co-sponsored ones (GOOS[11], GCOS[12], GTOS), and on how to access WIGOS data, including link(s) to the WMO Information System (WIS), and data monitoring information as provided through WIS. The link(s) to the WIS will in particular allow identification of and access to the observation data-sets, and observational products from WIGOS observing systems.

7 World Weather Watch (WWW) Global Observing Systems (GOS)
8 Global Atmosphere Watch (GAW)
9 World Hydrological Cycle Observing System (WHYCOS)
10 Global Cryosphere Watch
11 WMO-IOC-UNEP-ICSU Global Ocean Observing System (GOOS)
12 WMO-IOC-UNEP-ICSU Global Climate Observing System (GCOS)

It is also to provide access to basic communication and outreach WIGOS documents, including:

- WIGOS Development and Implementation Strategy (WDIS, WMO 2010/1)
- WIGOS Framework Implementation Plan (WIP, WMO 2012/1)
- WIGOS Concept of Operations (CONOPS, WMO 2010/2)
- WIGOS Imperative document (WMO 2010/3)
- WIGOS Functional Architecture (to be developed by ICG-WIGOS)
- Implementation Plan for the Evolution of Global Observing Systems (WMO 2012/2)
- The WIGOS communication and outreach strategy (to be developed by ICG-WIGOS)
- Information on WIGOS for developing countries (to be developed by ICG-WIGOS)

The Portal will provide information on national and regional WIGOS plans (plans, status, gaps etc), as well as associated templates. At some later stage, the portal will provide a mechanism for matching specific needs (capacity building, gaps, etc) with resources (via knowledge sharing, donor contributions etc).

2.2. The "Standardization of Observations" Reference Tool (SORT)

SORT shall provide the network supervisors, managers and operators with an easy access to the information they must consider when installing, configuring and operating their observing systems according to WIGOS Regulatory Material. It will also help the data users to understand the standards and recommended practices and procedures used for generating specific observations needed for their applications. The information provided on standards will support the production of more coherent data sets for the development of unbiased, homogenous, long-term time-series with known and documented quality.

The SORT component of the WIR is meant to deliver a modernized, standardized access to the up-to-date standards and recommended practices and procedures and relevant technical guidelines to be used by the user community.

In a first step, the implementation of a modern tool providing easy access to the relevant documents will help the users to gather an overview on what information is available to support meeting both their and WMO requirements, at a National, Regional and Global scale.

This should be followed by further steps to merge all the relevant information into a vital information system providing user-friendly access to all observations relevant WMO standard and recommended practices and procedures; guidelines, etc., that should be clear, consistent, plain and unambiguous. Table 3 provides an example of how different entities of the WIR should be linked to specific standards[13]:

13 Note: this linkage may evolve depending on the development and future content of the WIGOS sections in Technical Regulations and Guide on WIGOS.

Standard types / Entities	**Network management**	**Instrument standards and methods of observation**	**Instrument & Station metadata**	**Data exchange**	**Quality Management**
Surface station types, and observing stations	WMO 544 WMO 488, Part III WMO 471	WMO 8, part I WMO 544 WMO 488, Part III WMO 471 (for VOS ships)	WIGOS Regulatory Material (TBD) Expanded WMO 9, Vol A WMO 47	WMO-No. 306 (relevant BUFR tables) WMO 471 (delayed mode for VOS ships)	WMO-No. 8, part III WMO 544, part V WMO 488, parts VI & VIII
Observed variables, and surface station instruments	n/a	WMO 8, part II	WIGOS Regulatory Material (TBD) WMO 9, Vol A WMO 47	WMO-No. 306 (relevant BUFR tables)	WMO-No. 8, part III WMO 544, part V WMO 488, parts VI & VIII
Satellites	WMO 488, Part IV WMO 544, Part IV	WMO 8, part II	WIGOS Regulatory Material (TBD)	WMO-No. 306 (relevant BUFR tables)	WMO-No. 8, part III WMO 544, part V WMO 488, parts VI & VIII
Satellite instruments		WMO 8, part II	WIGOS Regulatory Material (TBD)	WMO-No. 306 (relevant BUFR tables)	WMO-No. 8, part III WMO 544, part V WMO 488, parts VI & VIII

Table 3: Linkage between specific entities of the WIR with specific standards (linkage to be made with the relevant sections of the indicated publications).

The resulting product will help to integrate all the existing and future standards and recommended practices and procedures and guidelines, promote their harmonization, guarantee the interoperability of the observing systems, optimize operational costs and development as much as possible and, last but not least, improve the quality and measurement uncertainty of the final meteorological products and information.

Details about the requirements for this component are provided in the document describing the Framework for WIGOS standardization of the surface-based components (Heimo A., 2009).

2.3. The "Observing Systems Capabilities" Analysis and Review tool (OSCAR)

The "Observing Systems Capabilities" Analysis and Review tool (OSCAR) of the WIR shall provide:

(i) access to a description of all WIGOS component observing systems and their relevant metadata (i.e. information about the stations and their instruments, see ***Annex I*** for information on user requirements for metadata), and

(ii) a tool for conducting the Rolling Review of Requirements (RRR) process.

It shall consist of the following parts[14]:

14 They are specified in more details below

(iii) (OSCAR/Requirements): Observational user requirements for the 12 WMO Application Areas (see footnote 3) (for each variable, the requirements are expressed quantitatively in terms of threshold, breakthrough, and goal for each of the space/time resolution, uncertainty, timeliness, observing cycle, and stability criteria);

(iv) OSCAR/Space: Space-based observing capabilities, and critical review and analysis tools;

(v) OSCAR/Surface: Surface-based observing capabilities, and critical review and analysis tools;

(vi) OSCAR/Distributed: Descriptions of the WIGOS component observing systems per information directly provided by Members and partners through their own systems.

OSCAR is essentially a distributed system with a core component hosted at the WMO Secretariat. The core component provides quantitative observational user requirements, as well as basic information about the observing stations capabilities operated in the WIGOS framework.

The distributed operational component (OSCAR/Distributed) is made of distributed databases provided by Members, plus some specific global or regional programmes elements (e.g. GAWSIS [15], JCOMMOPS [16], EUMETNET [17], and possible future systems such as the cryosphere observing network (Cryonet) of the GCW[18]). All these are stand-alone information systems providing detailed information about their respective observing networks, and observational products that are made available.

OSCAR can also readily and directly be used by Members to record metadata about the observing systems/networks, stations and instruments they operate. Hence, they would avoid having to develop/maintain their own metadata management tools and make savings.

A link between the WMO Country Profile database (CPDB)[19] and OSCAR will be established so that all relevant information in both, the CPDB and the OSCAR are available, but not duplicated and consistent.

Finally, OSCAR is also a tool for conducting the Rolling Review of Requirements as it contains quantitative information on observational user requirements in all WMO Application Areas[3], and observing systems capabilities. It allows the user to perform the critical review by comparing the capabilities with requirements; supporting gap analysis and network evaluation, redesign and optimization.

OSCAR will provide a certain level of standardization for the metadata (formal standardization for the core component of OSCAR hosted at the WMO Secretariat and standardization of the interfaces for the distributed operational component – OSCAR/Distributed).

2.3.1. The Satellite component of OSCAR (OSCAR/Space)

An inventory of factual information on satellites, including space-based capabilities (e.g. instruments, satellites, programmes and agencies, with related details) is provided through the Satellite component of OSCAR (OSCAR/Space[20])

Most factual information is organized in tables, e.g. satellites, instruments and observed variables, agencies. These tables can be sorted and filtered with advanced criteria. It is

15 Global Atmosphere Watch (GAW) Station Information System (GAWSIS) – http://gaw.empa.ch/gawsis
16 JCOMM in situ Observations Programme Support Centre (JCOMMOPS) – http://www.jcommops.org
17 The Network of European Meteorological Services (EUMETNET) – http://www.eumetnet.eu
18 Global Cryosphere Watch (GCW)
19 http://www.wmo.int/cpdb/
20 www.wmo-sat.info/db2

therefore possible to make queries such as "*Show all satellites planned in the year 2020-2040, flying in geostationary orbit and operated by NASA or ROSCOSMOS*" (Figure 2). All tables can also be exported in spreadsheet format for offline use.

Every data item also has a detailed page which displays additional information. Links enable the user to quickly navigate from a satellite to its associated instruments, and to the type they belong to, for example.

A search field enables direct access of these detailed pages, very useful when interested in a specific satellite/instrument/agency/type etc. The tool returns suggestions while typing (Figure 3)

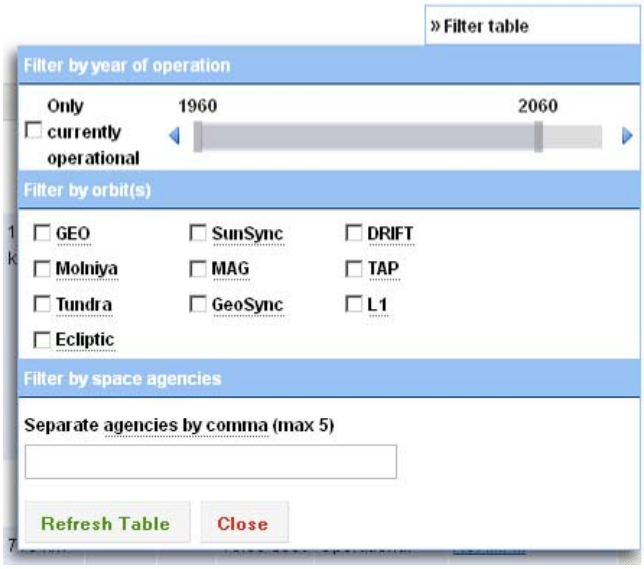


Figure 2: Detailed filter of the satellite table

Figure 3: Free Text Search

2.3.2. The surface-based observing system component of OSCAR (OSCAR/Surface)

The surface-based observing system component of OSCAR (OSCAR/Surface) shall provide basic metadata and information on capabilities of surface-based observing stations contributing to WIGOS, and will feed from existing sources[21] of metadata such as:

- WMO Publication No. 9, Volume A[22], "Observing Stations" contains a complete list of all the surface and upper-air stations in operation, which are used for synoptic purposes;
- The "*WMO Catalogue of Radiosondes and Upper-air wind Systems*" complements the information included in Volume A for upper-air stations, and provides information on the type of radiosonde, windfinding equipment, ground systems, radiation corrections applied to temperature observations and other local practices for the radio-sondes and upper-air systems in use by Members
- The list of stations of the Regional Basic Synoptic Network (RBSN) has now been included in WMO-No. 9, Volume A with specific flag but there are a few stations without proper identification numbers which are managed separately by the WMO Secretariat;
- The list of stations of the Regional Basic Climatological Network (RBCN) has now been included in WMO-No. 9, Volume A with specific flag;
- The list of stations of the Antarctic Observing Network (AntON) has now been included in WMO-No. 9, Volume A with specific flag but there are a few stations without proper identification numbers which are managed separately by the WMO Secretariat;

21 a transition might be proposed to make the current relevant WMO databases (e.g. WMO-No. 9, Volume A, WMO-No. 47) evolve into OSCAR/Surface

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

- WMO-No. 47, International List of Selected, Supplementary, and Auxiliary Observing Ships.
- The Global Atmosphere Watch (GAW) Station Information System (GAWSIS[15])
- The JCOMM in situ Observations Programme Support Centre (JCOMMOPS[16])

Observing stations will be referenced in the system using a unique universal station identification scheme (details of the scheme and its management yet to be defined), and will include the following basic metadata[23] categorized as following:

- Metadata on the observation network:
  - Country operating the station
  - Programme in which the observing station is participating (e.g. GOS, GAW, GOOS, etc.)
- Metadata on the observing stations:
  - Unique station identification number
  - Station name (optional)
  - Observing station type
  - Whether the station is mobile of fixed
  - Station position (latest position in case of mobile station)
  - Station elevation
  - Implementation date
- Metadata on the equipment used on these stations:
  - List of operating instruments with basic characteristics such as variable measured, height, uncertainty, vertical resolution, observing cycle, timeliness, stability, and operational status[24]
  - When required list of observation products[25]
- Operational status:
  - Operational status of the observing station
  - Operational status of the instruments of the station

Detailed functional requirements for basic metadata and capabilities of surface-based observing stations contributing to WIGOS, and details about the required metadata to be recorded are provided in the document describing the requirements for the surface-based observing systems capabilities part of the WMO Rolling Review of Requirements (RRR) database (WMO 2012/4).

Members will be responsible for providing the required metadata and information on capabilities of the observing stations they operate. This is described in section 3.3.2. They will also be invited to consistently record the basic metadata through WIS within the WMO core profile of related observational platform datasets.

OSCAR/Surface shall provide the possibility to query the system in order to obtain the following information:

See ***Annex I*** for information on user requirements for metadata.

23 This list is a sub-set of the metadata required for AWS as described in the Guide to the Global Observing System (WMO-No. 488), Appendix III.3. The provision of a full set of metadata is under the responsibility of the Members to record them in their own databases as a contribution to OSCAR/Distributed (see section 2.3.3 below).

24 This information will also be used to derive the generic capabilities as described in section 2.3.4.3

25 In the case of remote sensing observing stations generating 2D or 3D products (e.g. surface radars), the capabilities are provided for the observational product in addition to the instrument itself.

List of observing stations generated using different selection criteria. Optionally, the list could also be limited to a programme (i.e. stations belonging to a particular WMO programme or network), an application area (i.e. stations contributing to a particular application area), or to stations making specific measurements (1D, 2D, by variable) and/or conforming to specific criteria (observing cycle, timeliness, uncertainty of measurements, vertical resolution).

Region	Country	Station ID	Station Name	Latitude	Longitude	Link
RA-I	ALGERIA	60351	JIJEL-ACHOUAT	36 48N	05 53E	url
RA-I	ALGERIA	60353	JIJEL-PORT	36 49N	05 53E	url
RA-I	ALGERIA	60355	SKIKDA	36 53N	06 54E	url
RA-I	ALGERIA	60360	ANNABA	36 50N	07 49E	url

Table 4: Example of list of stations obtained from querying OSCAR. The link column provides access (url) to specific information about the station as provided by the host country through their information system (see section 2.3.3).

Maps of observing stations meeting specific selection criteria. Similar criteria could be used as for selecting lists of stations above. The maps could also be interactive in order to select a region of interest (i.e. a Lat/Lon box, or a Regional Association).

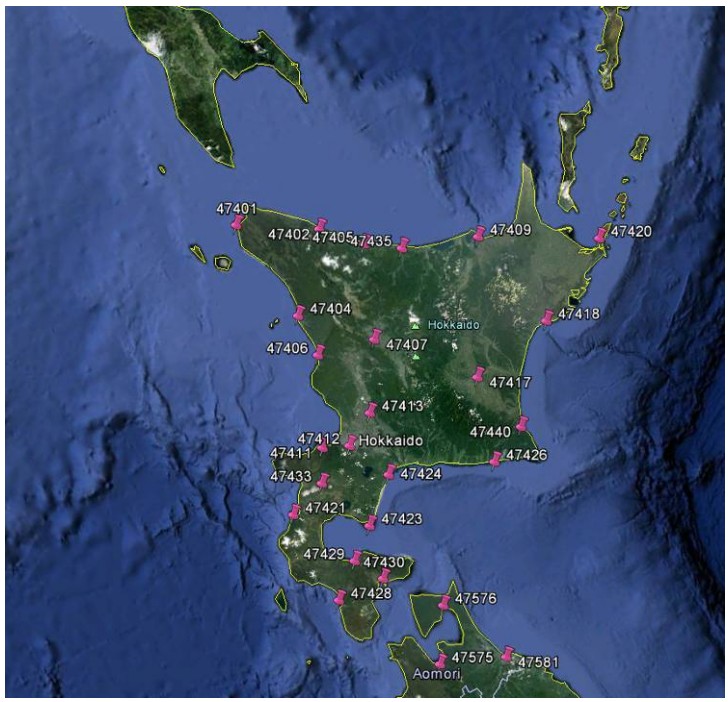


Figure 4: Example of map returned (here weather stations operated by JMA in Hokkaido, Japan) from querying OSCAR. Clicking on a particular station provides access to specific information about the station as provided by the host country through their information system (see section 2.3.3).

Statistics on the number of stations meeting specific criteria. Similar criteria could be used as for selecting lists of stations above (e.g. how many stations are reporting sea level pressure from West Africa with observing cycle better than 1 observation per day, and uncertainty better than 1 hPa?).

Summary reports the selected area (e.g. the world, Regional Associations, countries, etc.). The statistics could also be provided in a summary form for the world, a Regional Association, a country:

- Total number of stations
- Total number of stations belonging to particular networks
- Total number of stations contributing to particular application areas
- And in each of the categories above, providing the number of stations making specific measurements
- For each level, the report should include the global statistics, and all the statistics for the level below (i.e. word statistics plus statistics of all Regional Associations; or Regional Association statistics plus statistics of all the countries in that Regional Association; or a country statistics).

2.3.3. The Distributed operational component of OSCAR (OSCAR/Distributed)

The distributed operational component of OSCAR (OSCAR/Distributed) relies on information systems provided by Members (e.g. see figure 5) and specific global (e.g. World Weather Radar database[26] as shown on figure 6 below) and regional (e.g. EUCOS[27]) programmes contributing to WIGOS. Through this component, the operators (Members, specific programmes, Regional Associations, etc.) of the observing networks make detailed metadata available about the sites/observing stations they operate, and their instruments. Network owners and data custodians, in the case of 'external' data sources, are responsible for providing correct and update metadata as specified in the WMO Technical Regulations related to all parts of their observing systems and networks. These metadata are provided through specific websites (or web services). Access (e.g. interfaces through web service) to this information is standardized internationally (see section 3.3.3), but the content and/or representation of the information returned is not necessarily completely standardized internationally (e.g. it can be a national or regional standard). Supplementary information on space-based observing systems can also be provided through distributed databases by the Space Agencies and Members as appropriate (see section 2.3.1).

Basic information as described in section 2.3.2 shall be provided. In addition, metadata available through OSCAR/Distributed should provide detailed information about the observing stations in line with Technical Regulations as currently described in the WMO Manual on the Global Observing System (WMO-No. 544), and the Guide to the Global Observing System (WMO-No. 488) (see Appendix III.3 of WMO-No. 488 in particular)[28] respectively, i.e.:

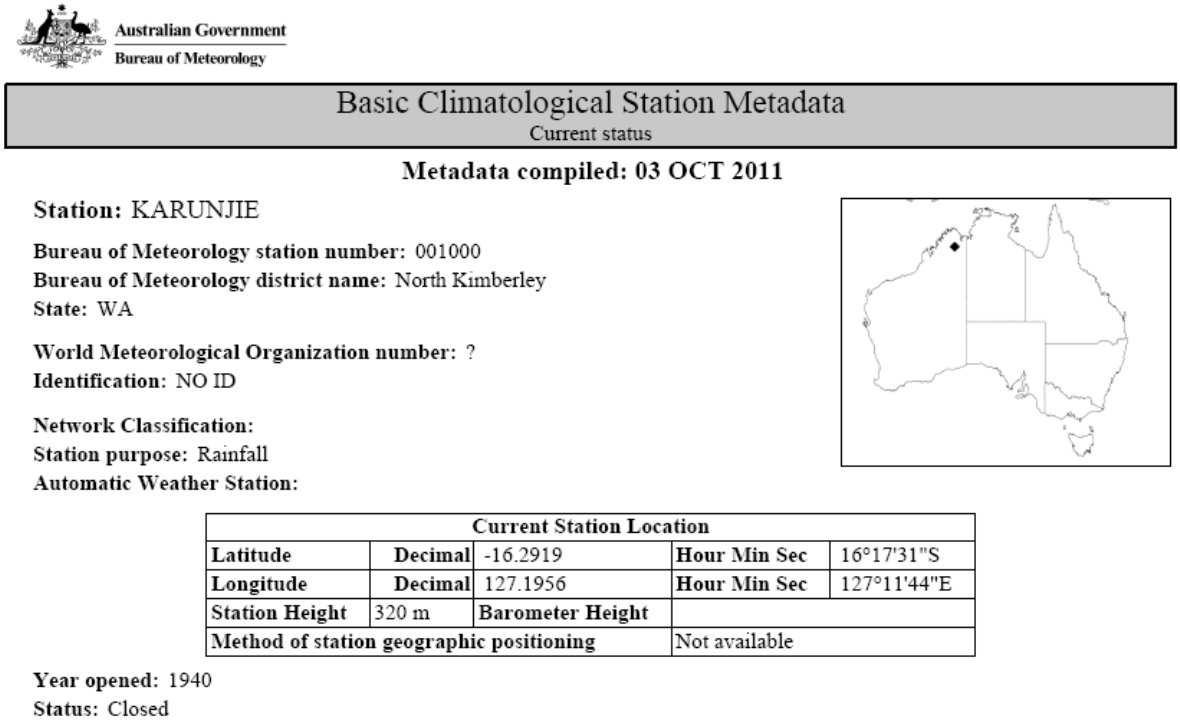
- Observing station configuration (e.g. map, pictures);
- Principle of operation; and maintenance information;
- Instrument siting, and exposure;
- Sensor types, and models;
- Instrument calibration information;
- Instrument performance;
- Information on observational products produced (in the case of remote sensing);
- Information on data-processing (sampling, averaging, etc.), handling, transmission;
- Historical information (e.g. change of instruments and siting conditions);
- Information on quality assurance;
- Etc.

Basic information on the programmes under which the observing stations operate shall also be provided:

- Owner of the station (institution);
- Programme(s) under which the station is operating, including contact details;
- Standards compliance information;
- Data policy(ies) that is(are) applicable;

26 http://wwr.dmi.gov.tr/
27 EUCOS: EUMETNET Composite Observing System
28 Later on in the WIGOS Regulatory material

- Planning.



Australian Government
Bureau of Meteorology

Basic Climatological Station Metadata
Current status

Metadata compiled: 03 OCT 2011

Station: KARUNJIE

Bureau of Meteorology station number: 001000
Bureau of Meteorology district name: North Kimberley
State: WA

World Meteorological Organization number: ?
Identification: NO ID

Network Classification:
Station purpose: Rainfall
Automatic Weather Station:

Current Station Location				
Latitude	**Decimal**	-16.2919	**Hour Min Sec**	16°17'31"S
Longitude	**Decimal**	127.1956	**Hour Min Sec**	127°11'44"E
Station Height	320 m	**Barometer Height**		
Method of station geographic positioning			Not available	

Year opened: 1940
Status: Closed

Station summary

Figure 5: Example (excerpt) of national product showing station metadata as accessible through OSCAR/Distributed (here station Karunjie of Australia as obtained through the BOM website).

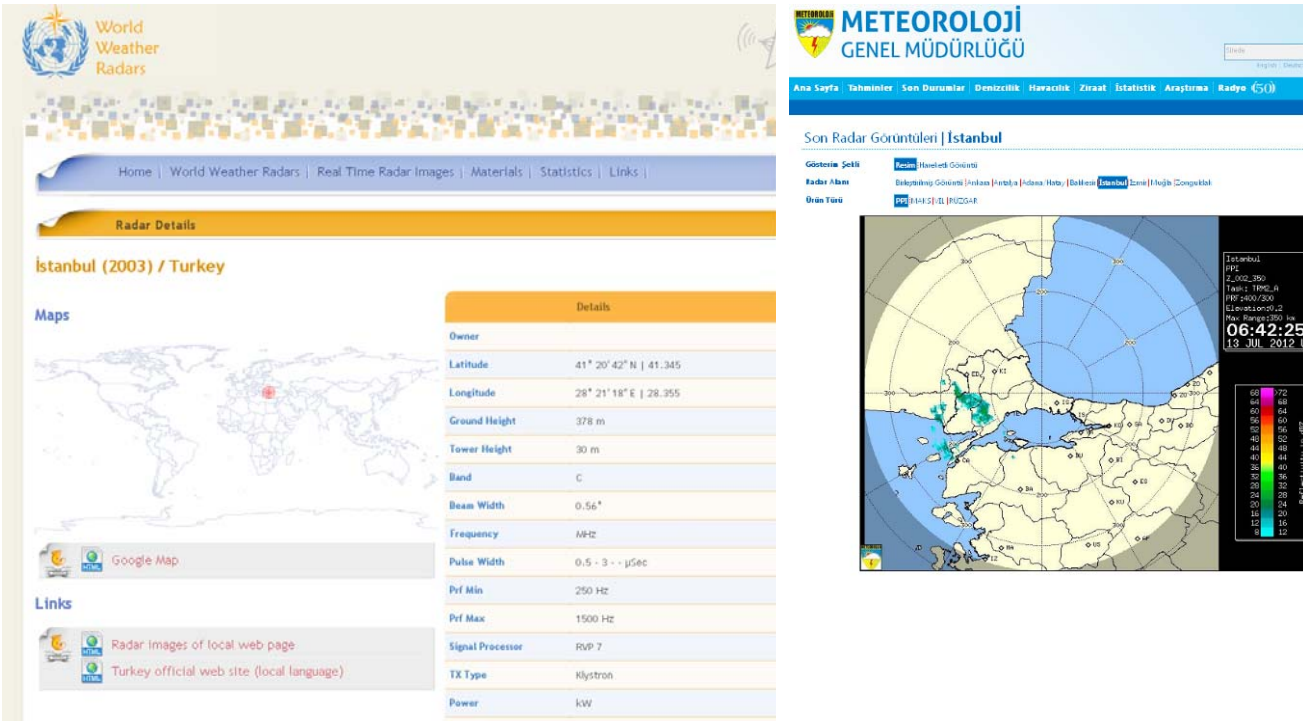


Figure 6: Snapshot from the WMO global World Weather Radar database maintained by the government of Turkey (here metadata about the Istanbul weather radar) – http://wwr.dmi.gov.tr/

Current and past observational data may also be provided through this component although the main purpose of the WIR is not to distribute data to end users (this must be done through WIS, not WIGOS). That function could for example be realized by linking to Geographical Information Systems provided by Members and specific global and regional programmes contributing to WIGOS.

At the same time, the metadata about observational data sets provided to WIS through the WMO Core Profile (ISO 19115) should be consistent with the WIGOS metadata provided through the WIR.

2.3.4. OSCAR, a tool for the Rolling Review of Requirements (RRR) component

As part of the Rolling Review of Requirements (RRR[29]) process, the WMO is routinely providing guidance to its Members regarding the evolution of the global observing systems addressing a wide range of WMO applications[3]. Concerned observing systems include surface and space based observing systems, as well as those owned by WMO and others managed by partner Organizations.

To realize appropriate guidance, WMO has been maintaining a database[30] of user requirements which is now integrated as OSCAR/Requirements. Its content is regularly reviewed by community experts. Critical review and gap analysis are then performed by the community experts in each application area, and in close cooperation with the appropriate partner Organizations, to ascertain the extent to which the capabilities meet the requirements. Impact studies, and results from Observing System Experiments (OSE) and Observing System Simulation Experiments (OSSEs) are also used in some cases to refine knowledge about the gaps. The key deliverables of the critical review are Statements of Guidance (SoG) regarding how well satellite- and surface- based observing system capabilities meet the WMO user requirements in each application area. The Statements of Guidance particularly include key recommendations on how to address those gaps, which are then considered for the Implementation Plan for the Evolution of Global Observing Systems (EGOS-IP[31]).

OSCAR shall provide a tool for conducting the RRR process, as well as helping observing programme managers to evaluate the status and capabilities of the observing networks in comparison with the observational user requirements, and identify gaps (i.e. to do the critical review).

To achieve this, OSCAR shall offer customized critical review tools for both the surface and space segments, but in the aim of WIGOS to integrate observing systems, the objective is also to provide a first-level analysis that is system-agnostic, i.e. a specific requirement for an observation is directly compared with capabilities of both space and surface based systems.

It is therefore contributing useful information for observing network redesign and optimization studies with the goal to make the observing system cost-effective. It is useful for Members and those in charge of observing network design and implementation to understand the requirements for the relevant observing systems, including standards, and observational user requirements, in order for them to make appropriate decisions.

It has to be understood that such automatic critical review tools will always only give a rough, first level-overview of possible gaps, and that expertise in instruments and measurements is needed to draw conclusions from the generated output.

Details about the RRR process can be found in *WMO 2012/3*.

29 http://www.wmo.int/egos
30 http://www.wmo.int/pages/prog/www/OSY/RRR-DB.html
31 http://www.wmo.int/pages/prog/www/OSY/gos-vision.html#egos-ip

2.3.4.1. Observational User Requirements component of OSCAR (OSCAR/Requirements)

The Observational User Requirements component of OSCAR (OSCAR/Requirements) allows the recording, in a quantitative way, of the observational user requirements of each WMO Application Area. These are addressing WMO programmes and co-sponsored programmes.

For each application area, and for each observed variable, the technology free requirements for observations are stated quantitatively in terms of required horizontal and vertical resolution, frequency (observation cycle), timeliness (delay in availability), and uncertainty, and stability. For each of these criteria, three values determined by experts are provided:

- the “threshold” which is the minimum requirement to be met to ensure that data are useful;
- the “goal” which is an ideal requirement above which further improvements are not necessary; and
- the “breakthrough” which is an intermediate level between “threshold” and “goal“ which, if achieved, would result in a significant improvement for the targeted application.

Id	Variable	Layer	App Area	Uncert Goal	Uncert Thresh	HR Goal	HR Thresh	VR Goal	VR Thresh	OC Goal	OC Thresh	Avail Goal	Avail Thresh
244	Accumulated precipitation (over 24 h)	2D	Global NWP	0.5 mm	5 mm	10 km	100 km	N/A	N/A	60 min	12 h	24 h	30 d
245	Aerosol column burden	TC	Global NWP	10 %	50 %	15 km	250 km	N/A	N/A	60 min	24 h	6 min	6 h
246	Aerosol mass mixing ratio	HS&M	Global NWP	10 %	50 %	15 km	250 km	km	km	60 min	24 h	6 min	6 h
247	Aerosol mass mixing ratio	HT	Global NWP	10 %	50 %	15 km	250 km	km	km	60 min	24 h	6 min	6 h
248	Aerosol mass mixing ratio	LS	Global NWP	10 %	50 %	15 km	250 km	0.2 km	3 km	60 min	24 h	6 min	6 h
249	Aerosol mass mixing ratio	LT	Global NWP	10 %	50 %	15 km	250 km	0.2 km	3 km	60 min	24 h	6 min	6 h
250	Air pressure (at surface)	Over land	Global NWP	0.5 hPa	1 hPa	15 km	500 km	N/A	N/A	60 min	12 h	6 min	6 h
251	Air pressure (at surface)	Over sea	Global NWP	0.5 hPa	1 hPa	15 km	500 km	N/A	N/A	60 min	12 h	6 min	6 h
252	Air specific humidity (at surface)	Surface	Global NWP	2 %	10 %	15 km	250 km	N/A	N/A	60 min	12 h	6 min	6 h
253	Air temperature (at surface)	Surface	Global NWP	0.5 K	2 K	15 km	250 km	N/A	N/A	60 min	12 h	6 min	6 h
254	Atmospheric temperature	HS&M	Global NWP	0.5 K	5 K	50 km	500 km	km	km	60 min	24 h	6 min	6 h
255	Atmospheric temperature	HT	Global NWP	0.5 K	3 K	15 km	500 km	km	km	60 min	24 h	6 min	6 h
256	Atmospheric temperature	LS	Global NWP	0.5 K	3 K	15 km	500 km	km	km	60 min	24 h	6 min	6 h

Table 5: Example of observation user requirements extracted from the current observational user requirements database (here excerpt of Global NWP requirements)

2.3.4.2. Satellite gap analysis and capability review

Besides providing an inventory on factual information on satellite capabilities (see section 2.3.1 above), the Satellite component of OSCAR (OSCAR/Space) also offers a tool providing **expert assessments** on the relevance of instruments for fulfilling pre-defined capabilities and the measurement of particular geophysical variables.

OSCAR/Space provides two kinds of expert assessments:

a) Gap Analyses by Variables

The Gap Analysis by Variable is based on an expert assessment of the relevance and limitation of instruments for the measurement of particular geophysical variables.

b) Capability review

The "Capability review" is an internal tool for WMO Members. It refers to the list of capabilities identified either in the WMO Vision of Global Observing Systems for 2025, or to the Implementation Plan for Evolution of Global Observing Systems. A simplified index is used to identify which instruments are most suitable to provide the capability identified in WMO plans.

Each expert assessment tool automatically generates timelines of the instruments and satellites involved (Figure 7).

Timeline for: *Earth radiation budget from LEO*

Timeline of current and planned Instruments contributing to this capability.

Table data can be sorted for analysis by clicking on the header columns (e.g. instrument, rating, orbit, year). Filtering by satellite or instrument is als

Note: Instruments to fly on satellites which are not firmly planned are shaded with stripes in the table

Filter:

Instrument	Rating	Satellite	Orbit	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
ScaRaB	2	Megha-Tropiques	20 °		X	X	X	X	X	X								
CERES	1	TRMM	35 °	X	X	X	X											
SIM	4	SORCE	40 °	X	X	X												
TIM	4	SORCE	40 °	X	X	X												
CERES	1	Suomi-NPP	13:25 asc		X	X	X	X	X	X								
CERES	1	EOS-Aqua	13:30 asc	X	X	X												
CERES	1	JPSS-1	13:30 asc							X	X	X	X	X	X	X	X	
ERM-1	3	FY-3B	13:40 asc	X	X	X	X											
SIM-1	4	FY-3B	13:40 asc	X	X	X	X											
ERM-2	1	FY-3E	10:00 desc								X	X	X	X				
ERM-2	1	FY-3G	10:00 desc												X	X	X	X
ERM-1	3	FY-3C	10:00 desc				X	X	X	X								
SIM-1	4	FY-3C	10:00 desc				X	X	X	X								
SIM-2	4	FY-3E	10:00 desc								X	X	X	X				
SIM-2	4	FY-3G	10:00 desc												X	X	X	X

Figure 7: Capability review timeline

Future functionalities

In addition to the **qualitative** analysis of instrument capabilities to measure specific **variables**, it is planned to include a direct **quantitative** analysis of instrument performances, which would allow a comparison with **requirements** (quantified by uncertainty, resolution, observing cycle and timeliness).

2.3.4.3. Critical review for surface-based observing systems

Generic capabilities (i.e. horizontal resolution, vertical resolution, observing cycle, timeliness, uncertainty, and stability) in predefined regions (e.g. countries, ocean basins, geographic boxes) for a component observing system (i.e. a station type) and a specific variable shall be derived and computed on the basis of the basic metadata and capabilities of surface-based observing stations as described in section 2.3.2. Details on the algorithms proposed are provided in *WMO 2012/4.*

Besides critical review tools for satellite observations (the OSCAR/Space, see section 2.3.4.2), there will be similar tools for estimating how surface-based observing systems capabilities meet the observational user requirements.

The critical review shall be performed according to the following options:

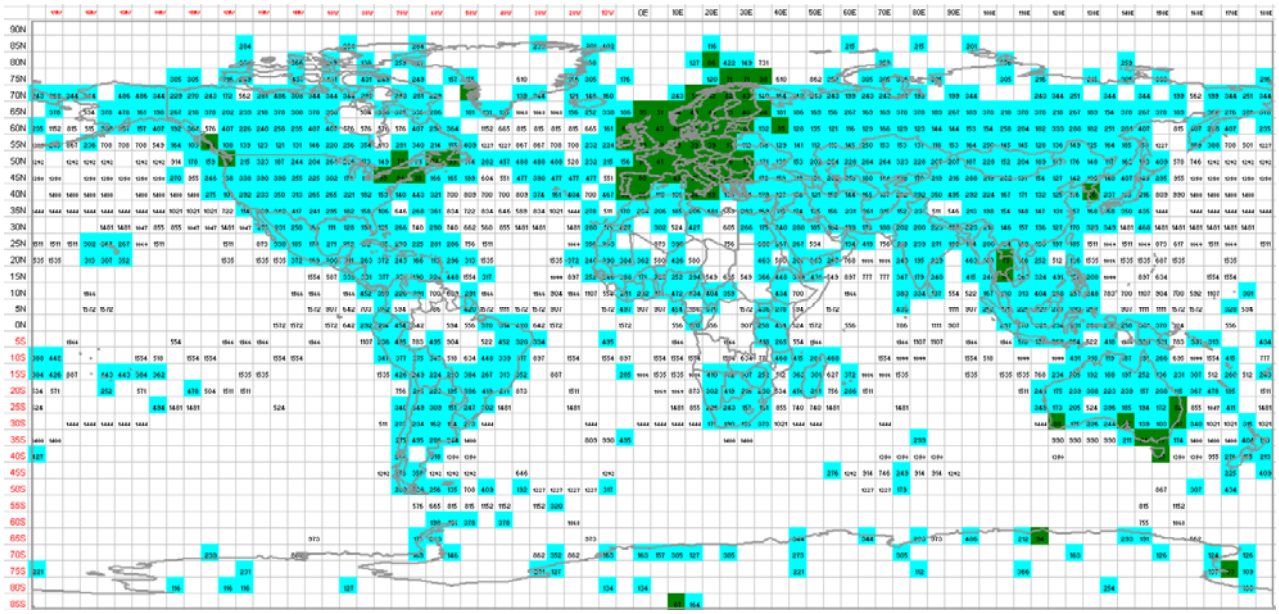
- Maps for a given application area, domain, layer, variable, and capability;
- Table(s) for a given region and application area;
- Table(s) for a given region and variable.

Appropriate computation on the basis of (i) actual station capabilities as described in section 2.3.2, and (ii) the observational user requirements, shall be made in order to deduce the capabilities.

Colour codes shall be used to indicate whether the obtained capabilities comply with the threshold, optimal, or goal values of the observational user requirements for the considered application area, domain, layer, variable, and capability (see legend of figure 8 below).

Maps for a given application area, domain, layer, variable, and capability

For a given application area, and selected region(s) (global, Regional Associations, countries, or specific areas), domain(s), layer(s), variables, and capability criteria, the query shall return for each variable, domain, and layer (i.e. as many maps as there are selected variables, domains, and layers), a map displaying the capabilities (i.e. either horizontal resolution, vertical resolution, observing cycle, timelines, or uncertainty depending on the selection) in specific pre-selected regions. See example of a global map in figure 8 below (the map shows capabilities in 5° x 5° boxes, but in reality the predefined regions will rather be for example countries, or climatologically consistent areas).



Colour codes:

Value range	*Colour*	*Comment*
Value > Threshold	White	No impact
Optimum < Value ≤ Threshold	Blue	Significant impact
Goal < Value ≤ Optimum :	Green	Optimal

Value range	*Colour*	*Comment*
Value ≤ Goal :	Red	Oversampled
No requirements value	Gray	n/a

Figure 8: Example of Critical Review global map for Global NWP, surface layer, Air pressure[32]

32 Map extrapolated from ECMWF monitoring statistics, February 2012

Table(s) for a given region and application area

For a given region (Lat/Lon box, Region, or a Regional Association), and selected application area(s), domain(s) (all domains if not specified), layer(s) (all layers if not specified), and variables (all variables if not specified), the query shall return for each application area (i.e. as many tables as there are selected application areas), a table listing the results. For each row (domain, variable, layer) the table shall provide the following information for the capabilities:

- Horizontal resolution (km)
- Vertical resolution (km)
- Observing Cycle (min)
- Timelines (min)
- Uncertainty (variable units)

Same colour codes as in figure 8 above shall be used to indicate whether the obtained capabilities comply with the threshold, optimal, or goal values of the observational user requirements for the considered application area, domain, layer, variable, and capability.

An example of required output is given below:

Capabilities compared to requirements for Global NWP in <region>							
Domain	***Variable***	***Layer***	***HR***	***VR***	***OC***	***Timeliness***	***Uncertainty***
Atmosphere	Air pressure (at surface)	Surface	400km	n/a	70min	25min	0.4hPa
Atmosphere	Air temperature (at surface)	Surface	240km	n/a	3h	25min	2.5K
Atmosphere	Air pressure (at surface)	Over sea	1200 km	n/a	70min	25min	0.4hPa

Table 6: Example of critical review for Global NWP in a given region; the colour codes are the same as those used in figure 8 above.

Table(s) for a given region and variable

For a given region (Lat/Lon box, Region, or a Regional Association), and selected variable(s) (all variables if not specified), application areas (all application areas if not specified), domain(s) (all domains if not specified), and layer(s) (all layers if not specified), the query shall return for each variable (i.e. as many tables as there are selected variables) a table listing the results. For each row (domain, application area, layer), the table shall provide the following information for the capabilities:

- Horizontal resolution (km)
- Vertical resolution (km)
- Observing Cycle (min)
- Timelines (min)
- Uncertainty (variable units)

Same colour codes as above shall be used to indicate whether the obtained capabilities comply with the threshold, optimal, or goal values of the observational user requirements for the considered application area, domain, layer, variable, and capability.

An example of required output is given below:

Capabilities compared to requirements for Air Temperature (at surface) in <region>							
Domain	***Application Area***	***Layer***	***HR***	***VR***	***OC***	***Timeliness***	***Uncertainty***
Atmosphere	Global NWP	Surface	240km	n/a	3h	25min	2.5K
Atmosphere	High Resolution NWP	Surface	240km	n/a	3h	25min	2.5K

Table 7: Example of critical review for Air Temperature (at surface) in a given region; the colour codes are the same as those used in figure 8 above.

3. MANAGEMENT OF THE WIR

3.1. Management of the Portal (basic information)

The management of the information accessible through the WIR Portal is provided by the WMO Secretariat in liaison with relevant expert groups and bodies.

3.2. Management of SORT

The management of the information accessible through SORT is provided by the WMO Secretariat in liaison with relevant expert groups and bodies, in accordance with the WIGOS agreed upon standards and procedures.

3.3. Management of OSCAR

Overall coordination for the management of OSCAR is provided by the WMO Secretariat in liaison with relevant expert groups and bodies.

OSCAR is managed by the WMO Secretariat with assistance from designated experts and focal points that are given specific access rights for editing the content.

OSCAR provides for a comprehensive user management; this makes it possible to define user-rights on a detailed basis. All administration, adding, updating or deleting information is done via the web-based interface.

3.3.1. Management of OSCAR/Space

Overall coordination for the management is provided by the WMO Secretariat.

3.3.2. Management of OSCAR/Surface

Overall coordination for the management OSCAR/Surface is provided by the WMO Secretariat.

The system shall be organized in such a way to permit authorized focal points designated by Members to enter information directly in the WIR database through password protected access. Information should be entered for individual stations. The following focal points should be nominated as appropriate:

- National focal points nominated by their Permanent Representatives; access shall be restricted only to the stations operated by the respective WMO Member.
- Nominated focal points for a particular programme; access shall be restricted only to the stations operated in the framework of the respective programme.

- Nominated focal points for specific station types; access shall be restricted only the specific station types for which the nominated person is responsible for.
- The WMO Secretariat staff responsible for a management of WIR with full access to the system.

There shall also be the possibility to allow a bulk upload of station characteristics and capabilities into the WIR database. The format to be used of the current ASCII files will be discussed at some later stage, once the developments have actually started.

Through online editing, it shall be possible to update any piece of information of OSCAR/Surface whenever needed (e.g. when the status of a particular station is changed). Regular maintenance of OSCAR/Surface shall be done periodically (e.g. once per six month) by the users of the WIR database authorized to manage such content. That's particularly the case for the bulk updates.

Mechanisms shall be put in place to avoid duplicate information to be entered in the WIR database (e.g. a station to be listed twice in the database).

The generic surface-based capabilities are in principle computed automatically on the basis of the basic metadata (see section 2.3.2).. Some manual adjustments may be made by the WMO Secretariat in consultation with appropriate experts to address gaps, duplication, and inconsistencies that may appear from the automatic process.

3.3.3. Management of the distributed operational component of OSCAR (OSCAR/Distributed)

The distributed operational component of OSCAR (OSCAR/Distributed) is managed directly by Members or centres or individuals in charge of specific programme components (e.g. GAWSIS[15]). Minimal requirements on WIGOS observational metadata provided by Members will be specified by the ICG-WIGOS Task Team on Metadata (TT-WMD), and documented in the WIGOS sections of the WMO Technical Regulations and Guide on WIGOS.

The interfaces between the core components of OSCAR hosted at the WMO Secretariat and OSCAR/Distributed will have to be regulated through standard URL or web services on the basis of universal and unique station identifiers, which scheme will be agreed upon through the CBS. This will require updating the WMO Technical Regulations.

Some coordination will be required between the centres making instrument and station metadata available and the Secretariat to inform the Secretariat about changes in content and procedures.

3.3.4. Management of observational user requirements (OSCAR/Requirements)

The management of the observational user requirements is provided by designated experts for each of the WMO Application Area[3]. Such an expert (a focal point) is authorized to modify a content related to the application area under his responsibility, based on the consensus achieved in the relevant community for all variables and criteria for the considered application. Specific access rights are given to the focal point for direct editing of the content.

ANNEX I

USER REQUIREMENTS FOR METADATA

User requirements for observational metadata

The proper management of instrument/station (observational) metadata is an important component of the WIGOS as an operational system. Observational metadata are required for data users and observing programme managers/supervisors. Instrument/station metadata shall also be consistently recorded through WIS within the WMO core profile for the observational data sets of the corresponding stations.

Instrument/Station metadata are categorized as following:

- Metadata on the observation network:
- Metadata on the observing stations:
- Metadata on the equipment used on these stations:
- Operational status:

Metadata requirements for data users

Instrument/Station metadata are required by operational users [33], climate applications [34], research, and quality assurance activities serving those applications.

They allow data users to identify observational data and products of interest to them. End users also require instrument/station metadata in order to understand the observations better and make a better use of them. Metadata provide detailed information about the instrumentation and methods of observation used (e.g. accuracy, resolution, sampling, averaging) and the conditions under which they are made (e.g. siting and exposure) and therefore permit to estimate uncertainties, and weight the observations accordingly when using them (e.g. in data assimilation). The metadata also include some technical specifications, photos, location (position for fixed station, or main operating area for mobile stations) etc. Instrument and station metadata permit bias correction, and the black listing of stations which are reporting systematic errors. They are useful for the validation of products, including models and satellite products, for the reanalysis of historical data, and for quality monitoring of the observations, including feedback to station operators. High quality climatic researches also rely largely on metadata to judge the applicability of certain data.

Metadata requirements for observational programme management

Instrument/Station metadata are also required for observational programme management, including:

- Programme coordination, planning and implementation at both the international national levels,
- Observing Station monitoring, diagnostic & follow up (feedback and remedial/corrective actions), and
- Understanding the full potential of the current observing systems with regard to the WMO Application Areas, including those systems operated by partner organizations, in the view to enhance (a) collaborations and coordination, (b) the scope of observations made by specific observing stations, (c) data sharing, and (d) data exchange. For

33 e.g. data assimilation and field analysis for Numerical Weather Prediction (NWP), ocean modelling; weather forecasters, seasonal to inter-annual climate forecasting, disaster response, satellite applications (e.g. virtual constellations & mixed products, space-based inter-calibration)

34 e.g. climate monitoring and change, seasonal to inter-annual climate variability, and climate services

example, they allow to identify areas where synergies between countries can be developed thanks to the identification of observing station operated by other countries; hence allowing to develop cross-border synergies and save costs (similar principle can be used between institutions within a country to develop cross-application synergies).

Moreover, standardization is necessary for all data and associated metadata so that the measurements from individual systems can be integrated into accurate and coherent data sets that allow for the development of unbiased, homogeneous long-term time-series.

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Heimo A., 2009: Framework for WIGOS standardization of the surface-based components

WMO-No. 8: Guide to Meteorological Instruments and Methods of Observation

WMO-No. 9, Volume A, *Observing Stations*

WMO-No. 47: International List of Selected, Supplementary, and Auxiliary Observing Ships

WMO-No. 488: Guide to the Global Observing System

WMO-No. 544: Manual on the Global Observing System

ACRONYMS

AntON	Antarctic Observing Network
CBS	Commission for Basic Systems
CMS	Content Management System
CONOPS	Concept of Operations
EGOS-IP	Implementation Plan for the Evolution of Global Observing Systems
EUCOS	EUMETNET Composite Observing System
EUMETNET	Network of European Meteorological Services
GAW	Global Atmosphere Watch
GAWSIS	GAW Station Information System
GCOS	WMO-IOC-UNEP-ICSU Global Climate Observing System
GCW	Global Cryosphere Watch
GOOS	IOC-WMO-UNEP-ICSU Global Ocean Observing System
GOS	Global Observing System
ICG-WIGOS	Inter-Commission Coordination Group on WIGOS
ICSU	International Council for Science
IOC	Intergovernmental Oceanographic Commission of UNESCO
ISO	International Organization for Standardization
JCOMM	Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology
JCOMMOPS	JCOMM *in situ* Observations Programme Support Centre
JMA	Japan Meteorological Agency
LEO	Low Earth Orbit
NASA	National Aeronautics and Space Administration (USA)
NWP	Numerical Weather Prediction
OSCAR	Observing Systems Capabilities Analysis and Review tool
OSE	Observing System Experiment
OSSE	Observing System Simulation Experiment
RA	Regional Association
RBCN	Regional Basic Climatological Network
RBSN	Regional Basic Synoptic Network
ROSCOSMOS	Russian Federal Space Agency
RRR	Rolling Review of Requirements
SoG	Statement of Guidance
SORT	“Standardization of Observations” Reference Tool
TBD	To be defined
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational Scientific and Cultural Organization
URL	Universal Resource Locator
WHYCOS	World Hydrological Cycle Observing System
WIGOS	WMO Integrated Global Observing System
WIR	WIGOS Operational Information Resource
WIS	WMO Information System
WMO	World Meteorological Organization