WEATHER CLIMATE WATER
TEMPS CLIMAT EAU

Introduction to the WMO Integrated Global Observing System (WIGOS);

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Outline

- Introduction to WIGOS
- The WIGOS Pre-operational Phase (2016-19)
- The Rolling Review of Requirements (RRR)
- The Observing Systems Capabilities and Review tool (OSCAR)
- The WIGOS Data Quality Monitoring System (WDQMS)
- Regional WIGOS Centers
- Summary and conclusions

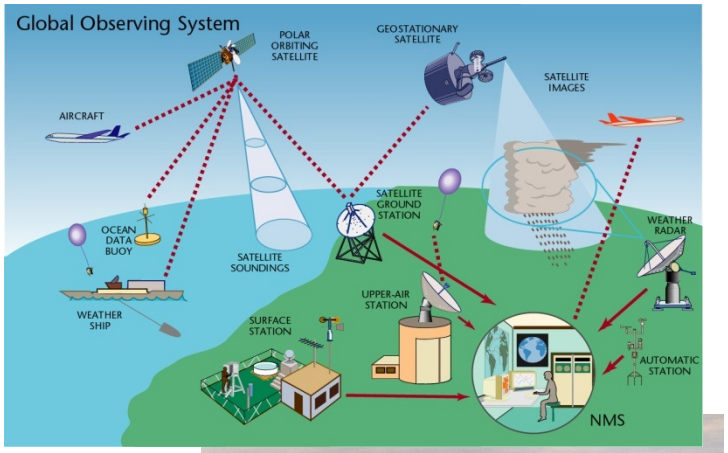
What is the WMO Integrated Global Observing System (WIGOS)?

- WMO foundational activity addressing the observing needs of the weather, climate, water and environmental services of its Members
- A framework for integrating all WMO observing systems and WMO contributions to co-sponsored observing systems under a common regulatory and management framework
- WIGOS is not:
  - Replacing or taking over existing observing systems, which will continue to be owned and operated by a diverse array of organizations and programmes, national as well as international.

WIGOS homepage

WIGOS Component Systems

- Global Observing System (WWW/**GOS**)
- Observing component of Global Atmospheric Watch (**GAW**)
- WMO Hydrological Observations (including **WHYCOS**)
- Observing component of Global Cryosphere Watch (**GCW**)



Why do we need WIGOS?

- **I. NMHS mandate typically broader now than when the World Weather Watch and the GOS were created, including e.g.**
  - Climate monitoring, climate change, mitigation
  - Air quality, atmospheric composition from urban to planetary scales
  - Oceans
  - Cryosphere
  - Water resources
- **II. Technical and scientific advances:**
  - Observing technology
  - Telecommunications
  - Numerical modeling and data assimilation
  - Increased user demand to access and use observations in decision making

Why do we need WIGOS?

- **III. Economic realities**
  - Budgetary pressure on many NMHS, in spite of expanding mandates and increasing demand for services
  - Efficiency by exploiting synergies
    - Integration of observing networks across disciplines (e.g. weather and climate)
    - Integration across organizational boundaries, e.g. between different national ministries/departments operating observing systems
    - Integration across technological boundaries, e.g. between surface- and space-based systems

A few key WIGOS principles

- **Design observing systems to meet specific requirements**
  - Requires structured inventory of requirements and existing and planned capabilities
- **Design observing systems with a view toward synergies between different application areas**
  - Do not install separate systems for weather and climate measuring of e.g. atmospheric temperature
  - One observation, many applications, many users
- **Space- and surface-based observing networks seen together as one integrated system**
  - Complementary capabilities, designed based on information about what the other component can/will provide

What do we mean by Integration?

I. **Integrated network design, e.g. across national borders:**
   - Radar and lightning detection networks
   - Radiosonde networks designed together with those of neighboring countries

II. **Integration across disciplines: Multi-purpose networks**
   - No separate networks for application areas that rely on measurements of the same variables, e.g. weather and climate

III. **Integration across organizational boundaries:**
   - Take advantage of other organizations outside the NMHS that operated observing systems; partner with them where possible

What do we mean by Integration? (II)

IV. Integration across technological boundaries; space- and surface-based observing system as one

- Space-based components provide excellent spatial and temporal coverage
- Ground-based components provide fine-scaled structure, in situ validation and can provide measurements not possible from space

V. Integration across different levels of performance; concept of tiered networks can include e.g.

- Crowd-sourced data, IoT observations (massive amounts of data, poor or unknown quality)
- Standard networks; routine, operational quality data
- Reference networks with data traceable to SI standards (fewer data, very high quality)

WIGOS Network Design Principles

(from WMO 1160 « Manual on WIGOS »)

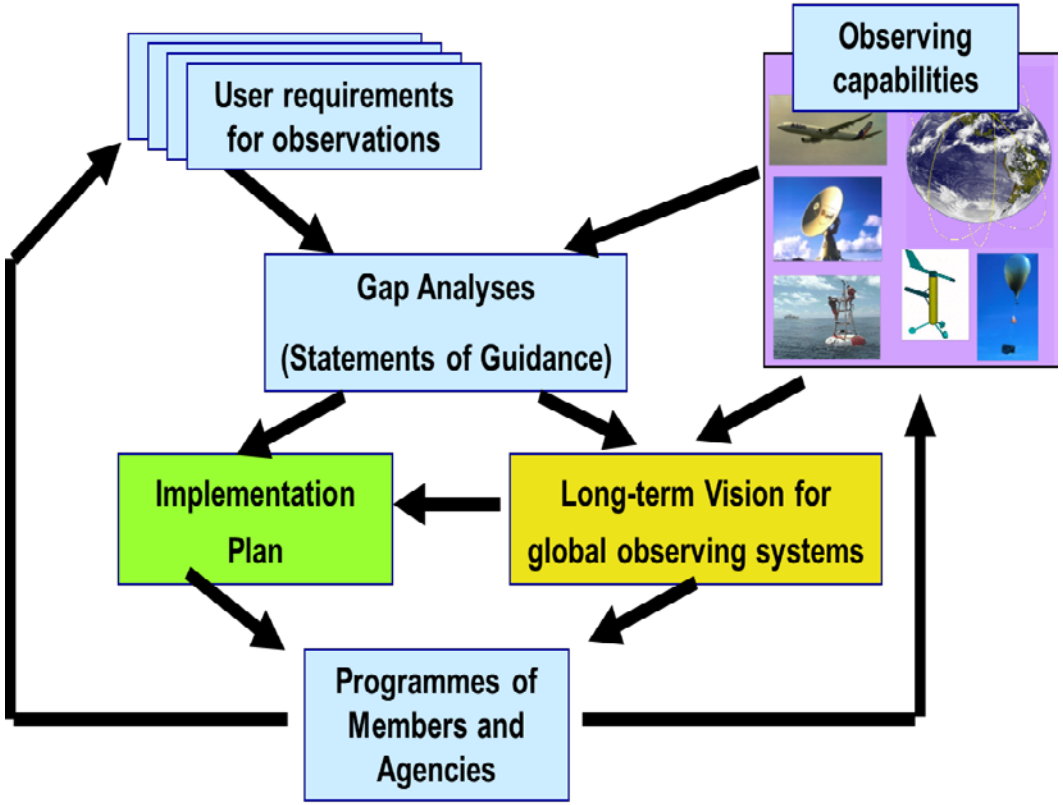
According to the Manual on WIGOS, networks should be designed with a view toward:

1. Serving many application areas
2. Responding to user requirements
3. Meeting national, regional and global requirements
4. Designing appropriately spaced networks
5. Designing cost-effective networks
6. Achieving homogeneity in observational data
7. Designing through a tiered approach
8. Designing reliable and stable networks
9. Making observational data available
10. Providing information so that the observations can be interpreted
11. Achieving sustainable networks
12. Managing change

Rolling Review of Requirements (RRR)

- WMO Congress: All WMO and WMO co-sponsored observing systems shall use the RRR to design networks, plan evolution and assess performance.

- The RRR is the process used by WMO to collect, vet and record user requirements for all WMO application areas and match them against observational capabilities



Rolling Review of Requirements

WMO Application Areas listed in the RRR

(January 2017)

1. Global numerical weather prediction
2. High-resolution numerical weather prediction
3. Nowcasting and very short range forecasting
4. Seasonal and inter-annual forecasting
5. Aeronautical meteorology
6. Forecasting atmospheric composition
7. Monitoring atmospheric composition
8. Atmospheric composition for urban applications
9. Ocean applications
10. Agricultural meteorology
11. Hydrology
12. Climate monitoring *(currently under revision by GCOS and WCRP)*
13. Climate applications *(currently under revision by GCOS and WCRP)*
14. Space weather

OSCAR

- The RRR is supported by three key databases of **OSCAR**, the *Observation Systems Capabilities and Review* tool :
  - **OSCAR/Requirements**, in which “technology free” requirements are provided for each application area, expressed in units of geophysical variables (260 in total currently), not measurands; not just atmosphere, also terrestrial, ocean, cryosphere, …
  - **OSCAR/Space,** listing the capabilities of all satellite sensors, whether historical, operational or planned
  - **OSCAR/Surface,** list surface-based capabilities; developed by MeteoSwiss for WMO, operational since May 2016

OSCAR homepage

OSCAR/Requirements

- The following requirements are listed for each of the (currently 14 application) areas and for all relevant geophysical variables (currently more than 200):
  - Spatial (horizontal and vertical) and temporal resolution, uncertainty, data latency, required coverage area, source, and level of confidence
- Each requirement is expressed in terms of three separate values:
  - Threshold (observations not useful unless this is met)
  - Break-through (optimum cost-benefit ratio)
  - Goal (exceeding this provides no additional benefit)
- OSCAR/Requirements information content is assembled by CBS and other WMO Inter-Program Expert Teams and Task Teams and is informed by the broader scientific community

OSCAR

Observing Systems Capability Analysis and Review Tool

Variable: Wind (horizontal)

Definition

Full name	Wind (horizontal)		
Definition	3D field of the horizontal vector component (2D) of the 3D wind vector. The acuracy is meant as vector error, i.e. the module of the vector difference between the observed vector and the true vector.		
Measuring Units	$m.s^{-1}$	**Uncertainty Units**	$m.s^{-1}$
Horizontal Res Units	km	**Vertical Res Units**	km
Stability Units	$m.s^{-1}$ (Stability /decade)		

Comment:	
Last modified:	

Classification

- **Domain:** Atmosphere
  - **Sub-domain:** Basic atmospheric
    - **Variable:** Wind (horizontal)
      - **Measured in Layers:**
        - HS&M
        - LS
        - HT
        - LT
        - LoThermo
        - HiThermo
- **Cross-cutting themes:**
- **Used in Application Areas:**
  - Aeronautical Meteorology
  - Climate-AOPC
  - Climate Modelling
  - Research
  - Global NWP
  - High Res NWP
  - Nowcasting / VSRF
  - Ocean Applications
  - SPARC
  - Space Weather

Requirements defined for *Wind (horizontal)* (25)

This tables shows all related requirements. For more operations/filtering, please consult the full list of Requirements

Note: In reading the values, goal is marked blue, breakthrough green and threshold orange

Id	Variable	Layer	App	Uncertainty	Stability	Hor	Ver	Obs	Timeliness	Coverage	Conf	Val	Source

			Area		/ decade	Res	Res	Cyc			Level	Date	
119	Wind (horizontal)	HS&M	Climate-AOPC	2 m.s^{-1} 3 m.s^{-1} 7 m.s^{-1}		100 km 200 km 500 km		3 h 4 h 6 h	3 h 6 h 12 h	Global	firm	2007-07-19	AOPC
120	Wind (horizontal)	HT	Climate-AOPC	2 m.s^{-1} 3 m.s^{-1} 5 m.s^{-1}		100 km 200 km 500 km		3 h 4 h 6 h	3 h 6 h 12 h	Global	firm	2007-07-19	AOPC
121	Wind (horizontal)	LS	Climate-AOPC	2 m.s^{-1} 3 m.s^{-1} 5 m.s^{-1}		100 km 200 km 500 km	0.5 km 0.65 km 1 km	3 h 4 h 6 h	3 h 6 h 12 h	Global	firm	2007-07-19	AOPC
122	Wind (horizontal)	LT	Climate-AOPC	2 m.s^{-1} 3 m.s^{-1} 5 m.s^{-1}		100 km 200 km 500 km		3 h 4 h 6 h	3 h 6 h 12 h	Global	firm	2007-07-19	AOPC
22	Wind (horizontal)	HT	Aeronautical Meteorology	2 m.s^{-1} 2.7 m.s^{-1} 5 m.s^{-1}		50 km 63 km 100 km	0.15 km 0.238 km 0.6 km	5 min 6 min 10 min	60 min 84 min 3 h	Global	firm	2000-06-23	ET ODRRGO
23	Wind (horizontal)	LS LT	Aeronautical Meteorology	2 m.s^{-1} 3 m.s^{-1} 5 m.s^{-1}		50 km 70 km 100 km	0.15 km 0.3 km 0.6 km	5 min 7 min 10 min	60 min 90 min 3 h	Global	firm	2000-06-23	ET ODRRGO
239	Wind (horizontal)	HS&M	Climate Modelling Research	3 m.s^{-1} 4 m.s^{-1} 5 m.s^{-1}		50 km 100 km 500 km	2 km 3 km 5 km	3 h 6 h 12 h	30 d 45 d 60 d	Global	reasonable	1998-10-29	WCRP
240	Wind (horizontal)	LS HT LT	Climate Modelling Research	1 m.s^{-1} 2 m.s^{-1} 4 m.s^{-1}		10 km 50 km 250 km	0.2 km 1 km 3 km	60 min 3 h 6 h	30 d 45 d 60 d	Global	reasonable	2012-12-01	WCRP
310	Wind (horizontal)	HS&M	Global NWP	1 m.s^{-1} 5 m.s^{-1} 10 m.s^{-1}		50 km 100 km 500 km	1 km 2 km 3 km	60 min 6 h 12 h	6 min 30 min 6 h	Global	firm	2009-02-10	John Eyre
311	Wind (horizontal)	HT	Global NWP	1 m.s^{-1} 3 m.s^{-1} 8 m.s^{-1}		15 km 100 km 500 km	0.5 km 1 km 3 km	60 min 6 h 12 h	6 min 30 min 6 h	Global	firm	2009-02-10	John Eyre
312	Wind (horizontal)	LS	Global NWP	1 m.s^{-1} 3 m.s^{-1}		15 km 100 km	0.5 km 1 km	60 min 6 h	6 min 30 min	Global	firm	2009-02-10	John Eyre

OSCAR/Space

- Repository of metadata about *all satellite sensors (past, present and future) relevant to WMO Programs and Application Areas*
  - Instrument type, measurement technique, high-level characteristics (mass, power, data rate)
  - Programmatic information, e.g. agency, measurement program, operating period, heritage, etc.
  - Orbit, coverage, repeat frequency, resolution
  - ***Capabilities, expressed in terms of geophysical variables that can be derived from the measurements provided by the sensor, listed in order of decreasing fidelity***
- OSCAR/Space 2.0 released in June 2016
  - Objective, rule-based assessment of capabilities

Unique to OSCAR/Space

OSCAR

Observing Systems Capability Analysis and Revi

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Overview | Programmes | Satellites | **Instruments** | Frequencies | Ag

Instrument: AIRS

Instrument details

Acronym	AIRS			
Full name	Atmospheric Infra-Red Sounder			
Purpose	Temperature/humidity sounding, ozone pro green-house gases			
Short description	Grating spectrometer, 2378 channels, reso supporting channels in VIS/NIR [see detail below]			
Background	New development			
Scanning Technique	Cross-track: 90 samples scanned, swath 1 one 13.5-km line each 2.67 s			
Resolution	13.5 km IFOV for the spectrometer; 2.3 km channels			
Coverage / Cycle	Global coverage once/day			
Mass	177 kg	**Power**	220 W	**Data**

Providing Agency	NASA
Instrument Maturity	Flown on an R&D satell
Utilization Period:	2002-09-01 to ≥2016
Last update:	2012-09-05

Variable	Relevance for measuring this variable	Operational limitations	Explanation
Cloud top height	1 - primary	Discontinuous coverage.	MWIR and TIR spectrometry in window and water vapour band (for emissivity) to estimate cloud top height from its temperature
Cloud top temperature	1 - primary	Discontinuous coverage.	TIR spectrometry in window and water vapour band (for emissivity)
Sea surface temperature	1 - primary	Cloud sensitive.	MWIR and TIR spectrometry (inclusive of several narrow-bandwidth windows and absorption bands for atmospheric corrections)
Atmospheric temperature	2 - very high	Cloud sensitive.	MWIR spectrometry in the CO2 4.3 micrometer band; TIR in the CO2 15 micrometer band
Cloud cover	2 - very high	Discontinuous coverage.	MWIR and TIR spectrometry
Land surface temperature	2 - very high	Cloud sensitive. Coarse spatial resolution.	MWIR and TIR spectrometry (inclusive of several narrow-bandwidth windows and absorption bands for atmospheric corrections)
Specific humidity	2 - very high	Cloud sensitive.	TIR spectrometry in the water vapour band around 6.3 micrometers
Integrated Water Vapour (IWV)	2 - very high	Cloud sensitive.	TIR spectrometry in the bands around 6.3 and above 11 micrometers
Upward long-wave irradiance at	2 - very high	Spectral interpolation needed	MWIR and TIR spectrometry in the windows regions around 3.7 and 11 micrometers, and in water vapour and CO2 bands around 4.3, 6.3 and

Showing 1 to 30 of 33 entries

OSCAR/Surface
("What is WIGOS?")

- Implementation layer of the *WIGOS Metadata Standard*: **Modern, electronic, searchable inventory of metadata for all observing stations/platforms under WIGOS**
  - OSCAR/Surface will replace *WMO Pub. 9, Volume A*, but will also include information from similar inventories for other (non-GOS) components of WIGOS
  - Developed jointly by WMO and MeteoSwiss, with the Swiss government providing the major part of the funding
  - Operational since May 2016
  - Education and training Members in populating, editing and using OSCAR/Surface is a major priority for 2016-2019 financial period

Regional WIGOS Centers (RWC)

- Why?
  - Many WMO Members requesting support from Secretariat for national implementation efforts
  - Can be addressed more efficiently and effectively at regional level
- What?
  - Initial role or RWC will be to support national WIGOS Implementation efforts, in particular as concerns
    - OSCAR/Surface; ensuring metadata input and QC
    - WDQMS; especially fault management component
- How?
  - To be decided by individual WMO Regions - will likely take place primarily at the sub-Regional level, aligned with existing cultural, linguistic and/or political groupings of countries
    - Pilot RA-VI (Europe) RWC implemented in pilot mode around existing EUMETNET activities; approved by EUMETNET STAC/PFAC in March 2016
    - This covers primarily Western Europe; the purpose of this meeting is to discuss how to implement RWC for Russian speaking parts of RA-II and RA-VI

Summary and Conclusions

- WIGOS is a global framework for integrating all WMO and co-sponsored observing systems under a common regulatory and management umbrella
- Purpose is to help WMO Members provide and gain access to more observational data at reduced cost by taking an integrated approach
- Regulatory material and technical systems to facilitate has been implemented by WMO and is still undergoing further development
- Strong involvement from Members is necessary
- Regional WIGOS Centers to provide important support functions for Members
    - This Workshop will discuss how RWC(s) can be implemented among participating Members