WMO SPACE PROGRAMME UPDATE

WEATHER CLIMATE WATER
TEMPS CLIMAT EAU

Heikki Pohjola
WMO Space Programme Office

ITSC 2019

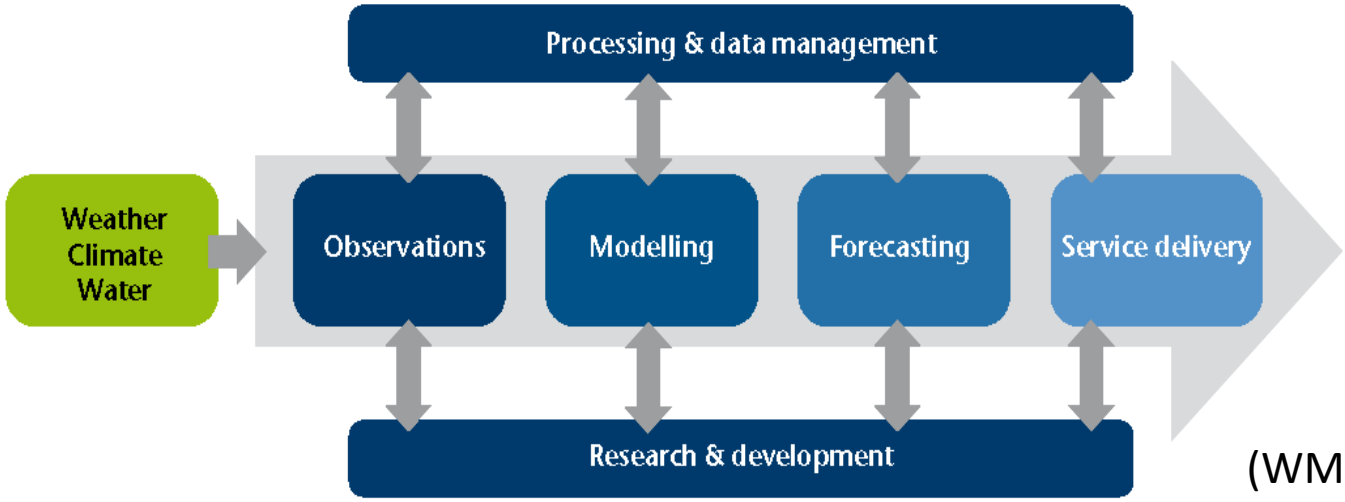
WMO OMM
World Meteorological Organization
Organisation météorologique mondiale

Content

- WMO and Space Programme Office
- WMO Integrated Global Observing System
- Observing System Capability Analysis and Review Tool (OSCAR)
- Conclusion

WMO`s role in general

Value chain of NHMS:



(WMO-No. 1153, 2015)

WMO‘s role is to:

Set standards

Build capacity

WMO Space Programme:
To cover all satellite related aspects

influence

requirements

WMO Space Programme

- WMO started implementation of World Weather Watch in 1967
  - The core of WMO programmes: Combines observing systems, telecommunication facilities as well as data-processing and forecasting centres
- Since that there was growing importance of space-based observing system component
- WMO Space Programme established by the 14th WMO Congress in 2003
- Tasked **to promote availability and utilization of satellite data and products for weather, climate, water and related applications and to coordinate environmental satellite matters and activities** throughout all WMO Programmes. Four main components:

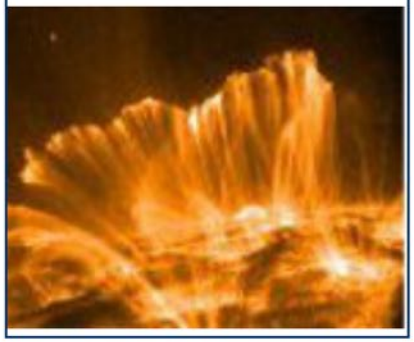
The space-based Observing System

- Global Planning
- Satellite Status
- Frequency Coordination

Access to Satellite Data and Products

Awareness and Training

Space Weather Coordination



WMO Space Programme value Chain

Satellites & sensors

- CGMS
- OSCAR

contingency plan

Calibrated data sets

Initiative to improve quality of observations

Quality-controlled products

To ensure sustained and continious provision of Satellite Data

Dissemination & access

To ensure efficient delivery of data and products to a global user community

Awareness & training

Global network of specialised training centres and meteorological satellite operators

Users

WMO Integrated Global Observing System

- International coordination and planning
  -> **Gap analysis of the observation systems**

World Weather Watch

GOS

GDPFS

GTS

WIGOS

GAW

GCW

Hydro OS

GCOS

Partners

Co-sponsors

WMO Information System -WIS

WMO Observing System Capability Analysis and Review tool

OSCAR

Observing Systems Capability Analysis and Review Tool

oscar.wmo.int/space/

Login

Home | Observation Requirements | Space-based Capabilities | Surface-based Capabilities

Welcome to OSCAR

OSCAR is a resource developed by WMO in support of Earth Observation applications, studies and global coordination.

It contains quantitative user-defined requirements for observation of physical variables in application areas of WMO (i.e. related to weather, water and climate). OSCAR also provides detailed information on all earth observation satellites and instruments, and expert analyses of space-based capabilities.

The tool constitutes a building block of WIGOS and more specifically, the so-called Rolling Requirements Review process. OSCAR targets all users interested in the status and the planning of global observing systems as well as data users looking for instrument specifications at platform level. To continue, please select one of the following modules:

- **Observation Requirements**
- **Satellite Capabilties**
- **Surface based Capabilties**

Each of the modules can be consulted individually, however, the tool is also designed with the goal to integrate user requirements with actual capabilities. This facilitates the Rolling Requirements Review process, comparing "what is required" with "what is, or will be available", in order to identify gaps and support the planning of integrated global observing systems.

OSCAR overview - click to enlarge

The tool is being further developed, and additional functionality and information will be added as appropriate. Please consult the list of open issues for a description of bugs affecting the system. One future objective is to automatically generate first-level analyses of compliance between the quantitative requirements and the actual capabilities (space- or surface-based).

Getting started with OSCAR/Space and OSCAR/Requirements

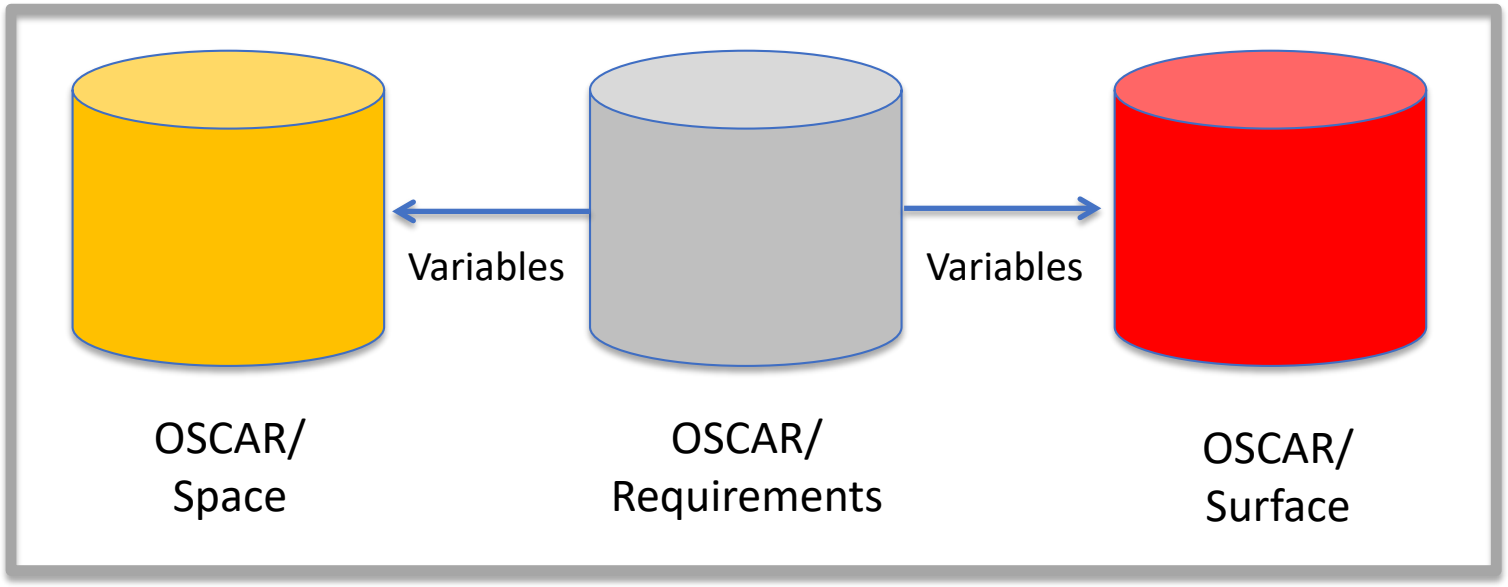
- Watch the 10 minute OSCAR screen-cast to get an overview of the application and learn how to use its functionalities
- Documents available for download
  - OSCAR/Space and OSCAR/Requirements User manual (413 kbyte)
  - OSCAR/Requirements Focal Point manual (200 kbyte) for user requirements ediors
  - OSCAR Flyer (1.4 Mbyte)
- Please provide feedback to the WMO Space Programme Office sat-help-desk@wmo.int

Getting started with OSCAR/Surface

- Read the OSCAR/Surface User manual
- The user support can be contacted via the OSCAR/Surface feedback form.

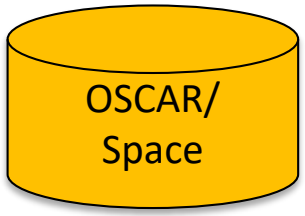
WMO Observing System Capability Analysis and Review tool (OSCAR)

- WMO-maintained online resource with 3 components:
  - satellite programmes, instruments, and the variables they can observe (OSCAR/Space)
  - surface-based stations/platforms under WIGOS (OSCAR/Surface)
  - observation requirements for 14 “application areas” and for all relevant variables (OSCAR/Requirements)



- WIGOS Information Resource
- Basis for WMO Rolling Review of Requirements

OSCAR/Space



1. Information on satellites and instruments (“*capabilities*”)

- 93 agencies
- Over 800 satellites
- Over 900 instruments
- Weather and climate
- Environmental monitoring
- Space weather

2. Assessment of instruments (“*analysis and review*”)

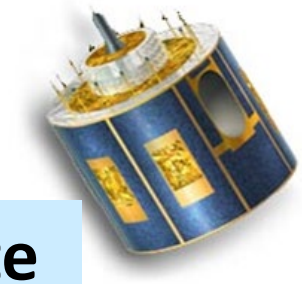
- Mapping instruments to measured variables
- “Gap analysis” by measured variable, or by the type of the mission

Factual information content (Part 1)

Agency

Programme

Satellite

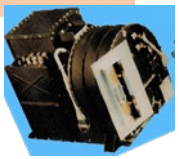


- Name, purpose
- Mass, power
- Orbit (type, alt, ECT, longitude)
- Launch date, end date, status
- Data access, telecom frequencies

Payload status

- Instrument status, dates
- Link to calibration events

Instruments



- Name, purpose
- Mass, power
- Type, description, scan mode
- Resolution, FOV, coverage
- Status
- Spectral characteristics

Assessments: mapping instruments to variables, gap analyses (Part 2)

- Which variables can be measured with a given instrument?
- Which instruments can measure a given variable?

Gap analysis for the global observing system

Requirements
Requirements
Requirements
Requirements

OSCAR/ Requirements

Long-term WIGOS Vision 2040

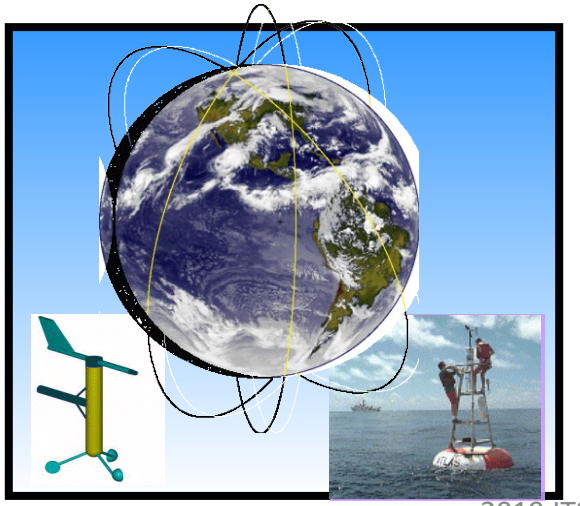
Gap Analysis

"Statement of Guidance"

Implementation Plan
(Actions,Recom)

Members agencies and programmes

The global observing system



OSCAR/ Surface

OSCAR/ Space

Gap Analysis - Measurement timeline for Radio Occultation Sounding missions

Instrument	NRT?	Sorting	Satellite	Orbit	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
TGRS (COSMIC-2)		2	COSMIC-2a	24 °																X	X	X	X	X	X	X	X		
IGOR (COSMIC)	No	2	COSMIC-1	72 °			X	X	X	X	X	X	X	X	X	X	X	X	X	X									
GNOS		3	FY-3RM-1	50 °																	X	X	X	X	X	X			
GNOS		3	FY-3RM-2	50 °																				X	X	X	X	X	X
Tri-G (JASON-CS)		3	JASON-CS-A	66 °																	X	X	X	X	X	X	X	X	
Tri-G (JASON-CS)		3	JASON-CS-B	66 °																						X	X	X	X
AOPOD		3	KOMPSAT-5	06:00 asc											X	X	X	X	X	X									
Radiomet		3	Meteor-M N3	12:00 asc																		X	X	X	X	X	X		
GNOS	Yes	3	FY-3D	14:00 asc															X	X	X	X	X						
GNOS		3	FY-3G	14:00 asc																			X	X	X	X	X	X	
ARMA-MP		3	Meteor-MP N1	15:30 asc																		X	X	X	X	X	X	X	X
GNOS		3	FY-3E	06:00 desc																	X	X	X	X	X	X			
GNOS		3	FY-3H	06:00 desc																					X	X	X	X	X
ARMA-MP		3	Meteor-MP N2	09:30 desc																				X	X	X	X	X	X
RO		3	EPS-SG-A1	09:30 desc																			X	X	X	X	X	X	X
RO		3	EPS-SG-A2	09:30 desc																									
RO		3	EPS-SG-A3	09:30 desc																									
RO		3	EPS-SG-B1	09:30 desc																				X	X	X	X	X	X
RO		3	EPS-SG-B2	09:30 desc																									
RO		3	EPS-SG-B3	09:30 desc																									
GNOS		3	FY-3F	10:00 desc																		X	X	X	X	X	X		
GNOS	Yes	3	FY-3C	10:15 desc											X	X	X	X	X	X									
ROSA		4	Megha-Tropiques	20 °									X	X	X	X	X	X	X	X									
IGOR (TacSat-2)		4	TacSat-2	40 °				X	X																				
ROSA		4	SAC-D	06:00 desc								X	X	X	X	X													
GRAS	Yes	4	Metop-A	09:30 desc			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X							
GRAS	Yes	4	Metop-B	09:30 desc									X	X	X	X	X	X	X	X	X	X	X	X	X				
GRAS		4	Metop-C	09:30 desc															X	X	X	X	X	X	X	X			
GOLPE		4	SAC-C	10:20 desc		X	X	X	X	X	X	X	X	X															
CORISS		5	C/NOFS	13 °					X	X	X	X	X	X	X	X													
GPS/MET		5	OrbView-1/MicroLa	70 °																									
BlackJack (CHAMP)		5	CHAMP	87 °		X	X	X	X	X																			
BlackJack (GRACE)	No	5	GRACE (2 sats)	89 °		X	X	X	X	X	X	X	X	X	X	X	X	X											
Tri-G (GRACE-FO)		5	GRACE-FO (2 sats	89 °															X	X	X	X	X	X					
TRSR (Ørsted)	No	5	Ørsted	96.5 °		X	X	X																					
ROHPP		5	SEOSAR/Paz	06:00 asc															X	X	X	X	X	X					
IGOR (TanDEM)		5	TanDEM-X	06:00 desc							X	X	X	X	X	X	X	X	X	X									
IGOR (TerraSAR)		5	TerraSAR-X	06:00 desc				X	X	X	X	X	X	X	X	X	X	X	X	X									

Remarks on OSCAR/Space Gap Analysis

- OSCAR provides a “short-list” of instruments based on assessment of sensor design and specifications
  - Does not consider actual instrument performance
  - Does not take into account actual data availability
  - Does not consider the synergy between different instruments
- OSCAR/Space provides a basis for expert-based gap analyses
  - E.g., to support mission advisory groups

Coordination is needed!

ESA weather satellite's near miss warns of dangers to come

0

BY PAUL WILLIS ON SEPTEMBER 17, 2019 SATELLITES

A weather satellite belonging to the European Space Agency (ESA) was forced into a last-minute maneuver to avoid colliding with another satellite in a large constellation, in a first for the agency.

The ESA performed what it called a "collision avoidance maneuver", firing the thrusters of its Aelous observation satellite to move it off a course from a potential direct hit with a SpaceX satellite in the Starlink constellation.

ESA Operations
@esaoperations

Follow

For the first time ever, ESA has performed a 'collision avoidance manoeuvre' to protect one of its satellites from colliding with a 'mega constellation'
#SpaceTraffic

Conclusion

- WMO Space Programme:
  - Promotes availability and utilization of satellite data and products for weather, climate, water and related applications
  - Coordinates weather and environmental satellite matters and activities

- Space-based component is an essential part of WMO Integrated observing system, which needs international coordination and planning
  - Gap analysis of the observation systems

- OSCAR/Space is a reference community resource on satellite programmes, instruments, and the variables they can observe

WEATHER CLIMATE WATER
TEMPS CLIMAT EAU

Thank you

http://www.wmo.int/sat

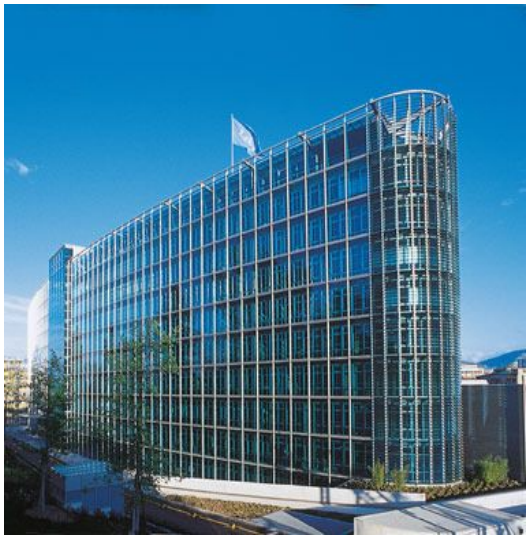
WMO OMM

World Meteorological Organization
Organisation météorologique mondiale

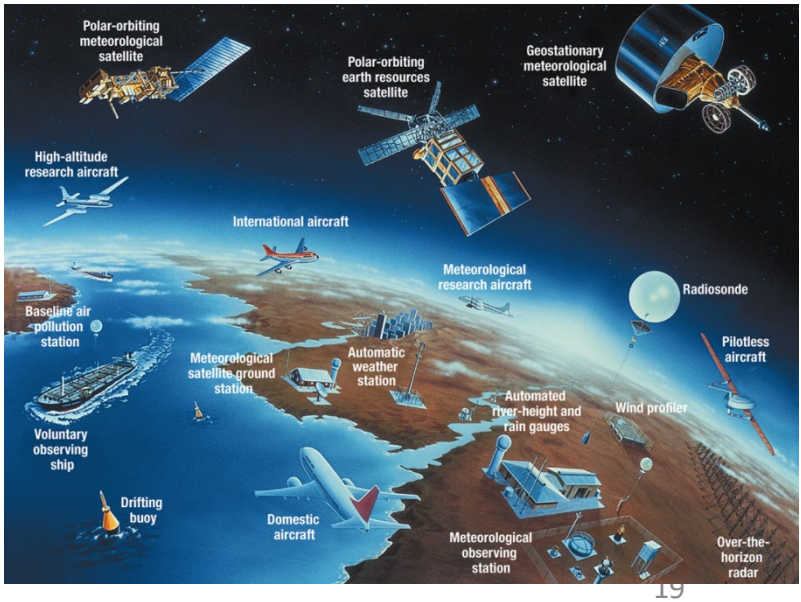
Back up slides

World Meteorological Organization

- UN Specialized Agency on weather, climate & water
- 193 Members, HQ in Geneva
- 2nd oldest UN Agency, 1873-
- Coordinates work of ~3000 national experts serving on WMO technical committees from meteorological and hydrological services, academia and private sector
  - Secretariat with ~290 staff (~80 technical and scientific) in Geneva, Switzerland
  - Space Programme Office: 3 staff



WMO HQ in Geneva



- Co-Founder and host agency of IPCC (1st World Climate Conference)
- Co-Founder of UNFCCC (2nd World Climate Conference)

IV. Vision for WIGOS in 2040

Why a Vision for WIGOS in 2040?

- To serve as reference for WMO Members and other observing system operators
  - providing context and expected boundary conditions relevant for observing system developments

- To inform long-term planning of satellite agencies about expected evolution of WMO user requirements
  - This drives the 2040 timeline

- To inform planning efforts of users (NHMSs, NWP centers, ...) regarding systems development and required computing and communication capabilities

See: https://www.cgms-info.org/Agendas/WP/CGMS-47-WMO-WP-02

Space-based Component - Four Groups

- Backbone system with specified orbital configuration and measurement approaches (Group 1).
  - MetOp, …
- Backbone system with open orbit configuration and flexibility to optimize the implementation (Group 2).
  - Cosmiq, …
- Operational pathfinders, and technology and science demonstrators (Group 3).
  - Future needs
- Additional capabilities (Group 4).
  - Commercial data providers, …

V. WMO Governance Reform

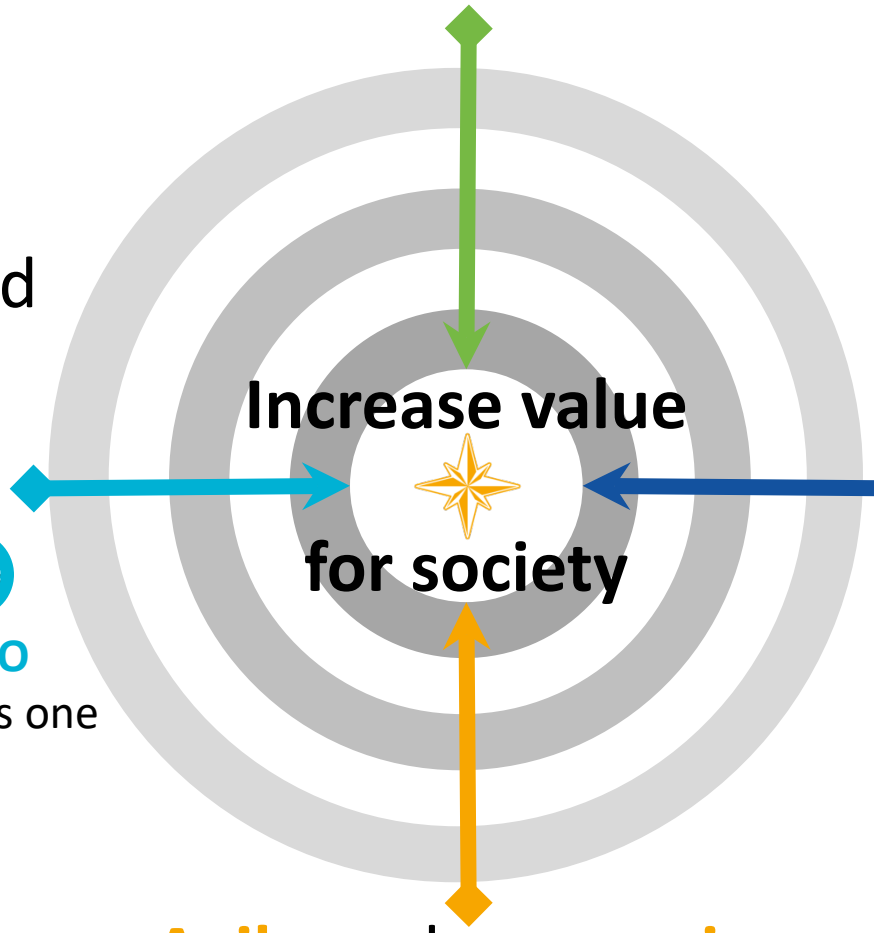
Reform Objectives

Effectiveness and **efficiency**

Seamless and **integrated** approach

Earth System approach

WMO acting as one

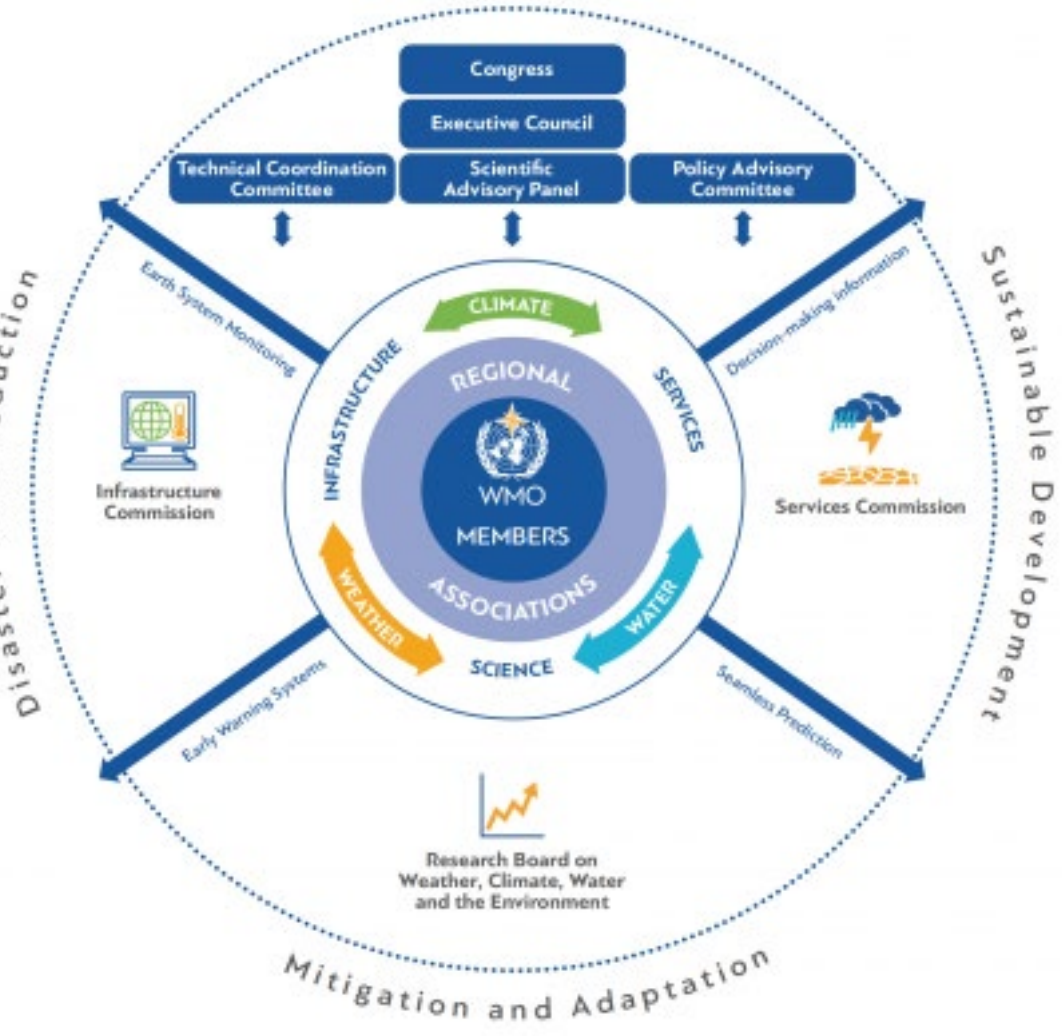


Engagement of Members and Partners

Agile and **responsive** to **new challenges**

Cg-18 Adopted New WMO Structure

- Global development agenda



See https://public.wmo.int/en/governance-reform

WMO Strategic Plan 2020-2030

VISION 2030

A world where **all nations**, especially the **most vulnerable**, are **more resilient** to the **socioeconomic impact** of **extreme weather, climate, water** and other **environmental events**, and **empowered** to boost their **sustainable development** through the **best possible weather, climate and water services**

OVERARCHING PRIORITIES

- Preparedness for, and reducing losses from hydrometeorological extremes
- Climate-smart decision-making to build resilience and adaptation to climate risk
- Socioeconomic value of weather, climate, hydrological and related environmental services

CORE VALUES

Accountability for Results and **Transparency** | **Collaboration** and **Partnership** | **Inclusiveness** and **Diversity**

LONG-TERM GOALS

1 Services	2 Infrastructures	3 Science & Innovations	4 Member Services	5 Smart Organization
Better serve societal needs	**Enhance Earth system observations and predictions**	**Advance targeted research**	**Close the capacity gap**	**Strategic realignment of structure and programmes**

STRATEGIC OBJECTIVES

FOCUSED ON 2020-23

1 Services	2 Infrastructures	3 Science & Innovations	4 Member Services	5 Smart Organization
• Strengthen **national multi-hazard early warning/alert systems** • Broaden provision of **policy- and decision-supporting climate, water** and **weather services**	• Optimize **observation data acquisition** • Improve access to, exchange and management of **Earth system observation data and products** • Enable access and use of **numerical analysis and prediction products**	• Advance **scientific knowledge of the Earth system** • Enhance **science-for-service value chain** to improve predictive capabilities • Advance **policy-relevant science**	• Enable developing countries to **provide** and **utilize essential weather, climate, hydrological** and related **environmental services** • Develop and sustain **core competencies** and **expertise** • Scale up **partnerships**	• Optimize WMO **constituent body structure** • Streamline WMO **programmes** • Advance **equal, effective** and **inclusive participation**

WMO Application Areas – Earth System Approach

1)	Global numerical weather prediction
2)	High-resolution numerical weather prediction
3)	Nowcasting and very short range forecasting
4)	Sub-seasonal to longer predictions
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 (GCOS)
13)	Space weather
14)	Climate science

See http://www.wmo.int/pages/prog/www/OSY/GOS-RRR.html

WMO Space Programme Expert Teams

ET-SAT	IPET-SUP	IPT-SWeISS
Expert Team on Satellite Systems	**Inter-Programme Expert Team on Satellite Utilization and Products**	**Inter-Programme Team on Space Weather Information, Systems and Services**

- Established under the Open Programme Area Group on Integrated Observing Systems (OPAG-IOS) of the Commission for Basic Systems (CBS)
- The OPAG-IOS makes recommendations to CBS biennially.
  - CBS reports annually to the WMO Executive Council through the report of the president of CBS.
- Members nominated by Permanent Representatives

Sorting criteria – OSCAR/Space Gap Analysis

Relevant instruments and their contribution

The sorting column describes how the instruments, by design, have the potential to contribute to certain pre-determined capabilities, assuming ground segments. For this particular capability, instrument performance is considered to be driven by:

- the number of occultations per day, determined by:
  - how many GNSS systems are exploited (GPS, GLONASS, Galileo, Beidou)
  - whether occultations are exploited with the GNSS satellite rising and/or setting (viewing fore- and/or aft-);
  - whether the instrument is launched and operated as a constellation or an individual system ;
- the capability to scan the ionosphere (this requires GNSS signal sampling for altitudes above 100 km.

Sorting criteria and colour code:

1. Receivers flown on dedicated satellite clusters to track >=3 GNSS systems by 2 directional antennas for both fore- and aft- occultations. Alt ionosphere OR not.
2. Receivers flown on dedicated satellite clusters to track >=1 GNSS systems by 2 directional antennas for both fore- and aft- occultations. Alt ionosphere OR not.
3. Receiver hosted on single satellites, to track >=3 OR >=2 GNSS systems by 2 directional antennas for both fore- and aft- occultations. Altitu ionosphere OR not.
4. Receiver hosted on single satellites to track 1 GNSS system by 2 directional antennas for both fore- and aft- occultations. Altitude scanned not.
5. Receiver hosted on single satellites to track 1 GNSS system by 1 directional antenna for either fore- or aft- occultation. OR receiver equippe directional antenna. Altitude scanned up to the ionosphere OR not.

Other Key Cg-18 Outcomes (Relevant to Observations)

Selected Cg-18 Outcomes

34	Global Basic Observing Network (GBON)
35	WMO Integrated Global Observing System station identifiers
36	Amendments to the Technical Regulations (WMO-No. 49), Volume I, Part I – WMO Integrated Global Observing System, and to the Manual on the WMO Integrated Global Observing System (WMO-No. 1160)
37	The WMO Integrated Global Observing System transition to operational status commencing in 2020
38	Vision for the WMO Integrated Global Observing System in 2040
40	Members' contribution to the actions specified in the Implementation Plan for the Evolution of Global Observing Systems, in the context of the future WMO Integrated Global Observing System Implementation Plan
42	Radio frequencies for meteorological and related environmental activities
46	Future collaboration between WMO and the Intergovernmental Oceanographic Commission on facilitating oceanographic observations in coastal regions in support of Earth system prediction and climate services

See https://library.wmo.int/index.php?lvl=notice_display&id=15822 (WMO No.508)

Selected Cg-18 Outcomes

47	Ocean observations in support of Earth system prediction, and WMO support to the Global Ocean Observing System Strategy 2030 (including Tropical Pacific Observing System 2020)
49	Antarctic Observing Network
50	Pre-operational phase of the Global Cryosphere Watch
51	Implementation of the architecture for climate monitoring from space
52	Strategy for the Virtual Laboratory for Education and Training in Satellite Meteorology 2020–2024
53	Four-year plan for WMO activities related to space weather 2020–2023
54	Implementation plan of the regional operational subproject for space-based monitoring of weather and climate extremes in East Asia and the Western Pacific
55	Emerging data issues
56	Data policies and practices

See https://library.wmo.int/index.php?lvl=notice_display&id=15822 (WMO No.508)

37(Cg-18) – WIGOS Operational

1. National WIGOS implementation:
2. Implementation of the Global Basic Observing Network and the Regional Basic Observing Networks;
3. Operational deployment of the WIGOS Data Quality Monitoring System;
4. Operational deployment of Regional WIGOS Centres;
5. Further development of the OSCAR databases and integration with other system elements;
6. Fostering a culture of compliance with the WIGOS technical regulations;

See https://www.wmo.int/pages/prog/www/wigos/documents/WIGOS_Newsletter_Vol5_N3_July2019_v1.0.pdf