WMO SPACE PROGRAMME UPDATE

Heikki Pohjola
WMO Space Programme Office

ITSC 2019
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:

- Weather Climate Water
- Observations
- Modelling
- Forecasting
- Service delivery
- Processing & data management
- Research & development

(WMO-No. 1153, 2015)

WMO`s role is to:
- Set standards
- Build capacity
- Influence requirements

WMO Space Programme:
To cover all satellite related aspects

5 November 2019
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:

<table>
<thead>
<tr>
<th>The space-based Observing System</th>
<th>Access to Satellite Data and Products</th>
<th>Awareness and Training</th>
<th>Space Weather Coordination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global Planning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satellite Status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency Coordination</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
WMO Space Programme value Chain

- Satellites & sensors
  - CGMS
  - OSCAR
- Calibrated data sets
- Quality-controlled products
- Dissemination & access
- Awareness & training
- Users

**Initiative to improve quality of observations**

- To ensure sustained and continuous provision of Satellite Data
- To ensure efficient delivery of data and products to a global user community
- Global network of specialised training centres and meteorological satellite operators
WMO Integrated Global Observing System

- International coordination and planning
  -> Gap analysis of the observation systems
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 Capabilities
- Surface based Capabilities

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 editors
- 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)
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**
- **Payload status**
- **Instruments**

### 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

Long-term WIGOS Vision 2040

“Statement of Guidance” Implementation Plan (Actions, Recom)

Members agencies and programmes

The global observing system

OSCAR/ Surface

OSCAR/ Space

Requirements

Gap Analysis

Requirements

Requirements

Requirements

Requirements
# Gap Analysis - Measurement timeline for Radio Occultation Sounding missions

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>TRG (COSMIC-2)</td>
<td>No</td>
<td></td>
<td>COSMIC-2a</td>
<td>24°</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRG (COSMIC-2)</td>
<td>No</td>
<td></td>
<td>COSMIC-1</td>
<td>72°</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GNOS</td>
<td>Yes</td>
<td></td>
<td>FY-3M-1</td>
<td>50°</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GNOS</td>
<td></td>
<td></td>
<td>FY-3M-2</td>
<td>50°</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TGL (JASON-CS)</td>
<td>No</td>
<td></td>
<td>JASON-CS-A</td>
<td>66°</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TGL (JASON-CS)</td>
<td>No</td>
<td></td>
<td>JASON-CS-B</td>
<td>66°</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AOPOD</td>
<td>Yes</td>
<td></td>
<td>KOMPSAT-5</td>
<td>06:00 asc</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radiomet</td>
<td>Yes</td>
<td></td>
<td>Meteor-M NJ</td>
<td>12:00 asc</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RO</td>
<td>Yes</td>
<td></td>
<td>EPS-SG-A1</td>
<td>09:30 desc</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RO</td>
<td>Yes</td>
<td></td>
<td>EPS-SG-A2</td>
<td>09:30 desc</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RO</td>
<td>Yes</td>
<td></td>
<td>EPS-SG-A3</td>
<td>09:30 desc</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RO</td>
<td>Yes</td>
<td></td>
<td>EPS-SG-B1</td>
<td>09:30 desc</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RO</td>
<td>Yes</td>
<td></td>
<td>EPS-SG-D3</td>
<td>09:30 desc</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RO</td>
<td>Yes</td>
<td></td>
<td>FY-3E</td>
<td>06:00 desc</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GRAS</td>
<td>Yes</td>
<td></td>
<td>SAC-D</td>
<td>09:30 asc</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GRAS</td>
<td>Yes</td>
<td></td>
<td>SAC-C</td>
<td>10:20 asc</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CORISS</td>
<td>Yes</td>
<td></td>
<td>GNOLS</td>
<td>13°</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GPS/SLF</td>
<td>Yes</td>
<td></td>
<td>OrbitView-1</td>
<td>70°</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BlackJack (CHAMP)</td>
<td>No</td>
<td></td>
<td>CHAMP</td>
<td>87°</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BlackJack (GRACE)</td>
<td>No</td>
<td></td>
<td>GRACE (1 sat)</td>
<td>85°</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TGL (GRACE-EO)</td>
<td>No</td>
<td></td>
<td>GRACE-FO (2 sat)</td>
<td>85°</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRSR (Distributed)</td>
<td>Yes</td>
<td></td>
<td>Ørsted</td>
<td>96.5°</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROHPP</td>
<td>Yes</td>
<td></td>
<td>SFOSAR/Paz</td>
<td>06:00 desc</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IGOR (TanDEM)</td>
<td>Yes</td>
<td></td>
<td>TanDEM-X</td>
<td>06:00 desc</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IGOR (TanDEM)</td>
<td>Yes</td>
<td></td>
<td>TanDEM-X</td>
<td>06:00 desc</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IGOR (TerraSAR)</td>
<td>Yes</td>
<td></td>
<td>TerraSAR-X</td>
<td>06:00 desc</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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

BY PAUL WILLIS ON SEPTEMBER 17, 2019

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.

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
Thank you

http://www.wmo.int/sat
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

- 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

Increase value for society

Agile and responsive to new challenges

Engagement of Members and Partners

5 November 2019
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**
   - Better serve societal needs

2. **Infrastructures**
   - Enhance Earth system observations and predictions

3. **Science & Innovations**
   - Advance targeted research

4. **Member Services**
   - Close the capacity gap

5. **Smart Organization**
   - Strategic realignment of structure and programmes

**STRATEGIC OBJECTIVES**

**FOCUSED ON 2020-23**

- **Services**
  - Strengthen national multi-hazard early warning/alert systems
  - Broaden provision of policy- and decision-supporting climate, water and weather services

- **Infrastructures**
  - 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

- **Science & Innovations**
  - Advance scientific knowledge of the Earth system
  - Enhance science-for-service value chain to improve predictive capabilities
  - Advance policy-relevant science

- **Member Services**
  - 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

- **Smart Organization**
  - Optimize WMO constituent body structure
  - Streamline WMO programmes
  - Advance equal, effective and inclusive participation

5 November 2019
### WMO Application Areas – Earth System Approach

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Global numerical weather prediction</td>
</tr>
<tr>
<td>2</td>
<td>High-resolution numerical weather prediction</td>
</tr>
<tr>
<td>3</td>
<td>Nowcasting and very short range forecasting</td>
</tr>
<tr>
<td>4</td>
<td>Sub-seasonal to longer predictions</td>
</tr>
<tr>
<td>5</td>
<td>Aeronautical meteorology</td>
</tr>
<tr>
<td>6</td>
<td>Forecasting atmospheric composition</td>
</tr>
<tr>
<td>7</td>
<td>Monitoring atmospheric composition</td>
</tr>
<tr>
<td>8</td>
<td>Atmospheric composition for urban applications</td>
</tr>
<tr>
<td>9</td>
<td>Ocean applications</td>
</tr>
<tr>
<td>10</td>
<td>Agricultural meteorology</td>
</tr>
<tr>
<td>11</td>
<td>Hydrology</td>
</tr>
<tr>
<td>12</td>
<td>Climate monitoring (GCOS)</td>
</tr>
<tr>
<td>13</td>
<td>Space weather</td>
</tr>
<tr>
<td>14</td>
<td>Climate science</td>
</tr>
</tbody>
</table>

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
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. Altitude scanned OR 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. Altitude scanned OR 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. Altitude scanned OR 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 OR not.
5. Receiver hosted on single satellites to track 1 GNSS system by 1 directional antenna for either fore- or aft- occultation. OR receiver equipped with directional antenna. Altitude scanned up to the ionosphere OR not.
Other Key Cg-18 Outcomes (Relevant to Observations)
## Selected Cg-18 Outcomes

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>34</strong></td>
<td>Global Basic Observing Network (GBON)</td>
</tr>
<tr>
<td><strong>35</strong></td>
<td>WMO Integrated Global Observing System station identifiers</td>
</tr>
<tr>
<td><strong>37</strong></td>
<td>The WMO Integrated Global Observing System transition to operational status commencing in 2020</td>
</tr>
<tr>
<td><strong>38</strong></td>
<td>Vision for the WMO Integrated Global Observing System in 2040</td>
</tr>
<tr>
<td><strong>40</strong></td>
<td>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</td>
</tr>
<tr>
<td><strong>42</strong></td>
<td>Radio frequencies for meteorological and related environmental activities</td>
</tr>
<tr>
<td><strong>46</strong></td>
<td>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</td>
</tr>
</tbody>
</table>

Selected Cg-18 Outcomes

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>47</td>
<td>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)</td>
</tr>
<tr>
<td>49</td>
<td>Antarctic Observing Network</td>
</tr>
<tr>
<td>50</td>
<td>Pre-operational phase of the Global Cryosphere Watch</td>
</tr>
<tr>
<td>51</td>
<td>Implementation of the architecture for climate monitoring from space</td>
</tr>
<tr>
<td>52</td>
<td>Strategy for the Virtual Laboratory for Education and Training in Satellite Meteorology 2020–2024</td>
</tr>
<tr>
<td>53</td>
<td>Four-year plan for WMO activities related to space weather 2020–2023</td>
</tr>
<tr>
<td>54</td>
<td>Implementation plan of the regional operational subproject for space-based monitoring of weather and climate extremes in East Asia and the Western Pacific</td>
</tr>
<tr>
<td>55</td>
<td>Emerging data issues</td>
</tr>
<tr>
<td>56</td>
<td>Data policies and practices</td>
</tr>
</tbody>
</table>

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