WEATHER CLIMATE WATER
TEMPS CLIMAT EAU

The WMO Vision for the Space-based Global Observing System in 2040 and the WMO Unified Data Policy

WMO OMM

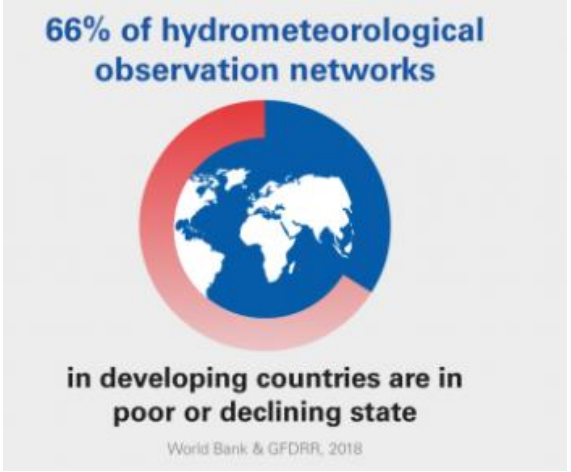
World Meteorological Organization
Organisation météorologique mondiale

Content

- Precipitation measurements and the meteorological value chain
- WMO Space Programme
- WMO Integrated Global Observing System (WIGOS)
- WIGOS Vision 2040
- New WMO Data Policy

Why space-based precipitation measurements are important ?

- Water is a key prerequisite for human development, yet only 0.5% of water on Earth is useable and available as freshwater
- Worldwide, 44% of disasters and 31% of economic losses have been associated with floods, with the majority of all flood-related losses occurring in Asia
- Drought, on the other hand, claimed lives of 34% of disaster related deaths from 1970 to 2019, with the majority of deaths recorded in Africa
- On average, 60% of WMO Members lack the full capacity needed to provide observations or climate services for water



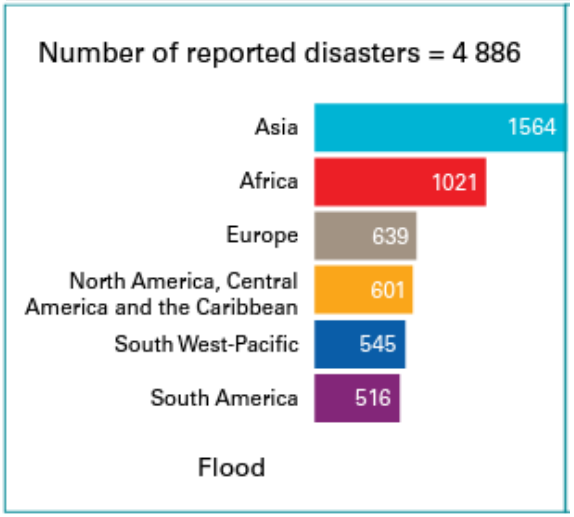
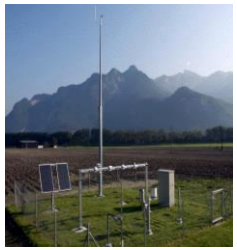


Figure 3: Distributions of flood-related disasters

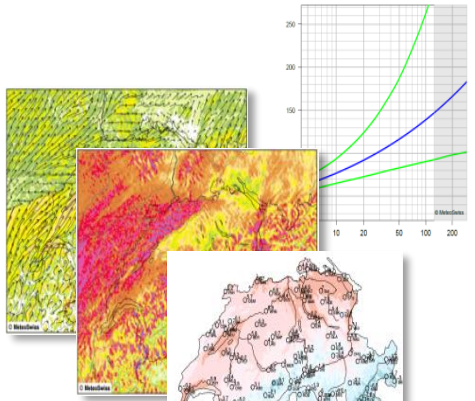
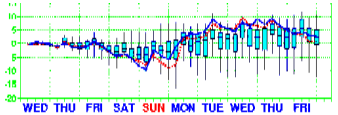
WMO OMM

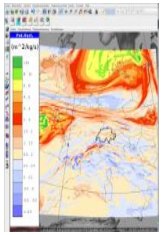
Ref. 2021 edition of the WMO State of Climate Services





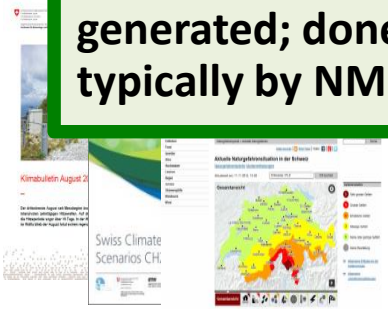


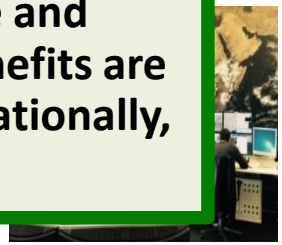
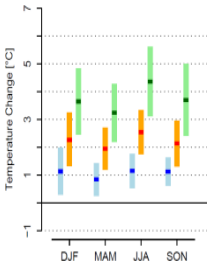











This needs to be done globally

Data collection and analysis

Modelling for prediction

Post-processing and automatic production

The Meteorological Value Chain

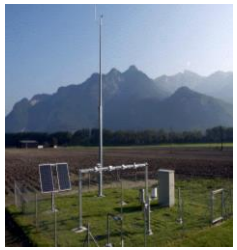
Forecast interpretation and decision

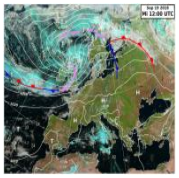
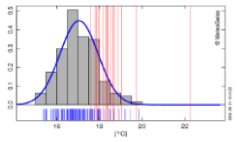
Dissemination of products and services

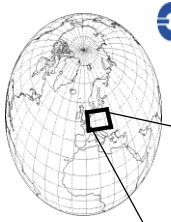
Understanding and use of forecasts

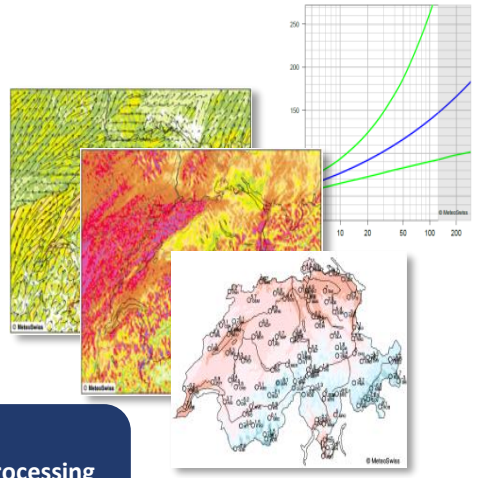
This is where value and socioeconomic benefits are generated; done nationally, typically by NMHS

WMO OMM







Data collection and analysis

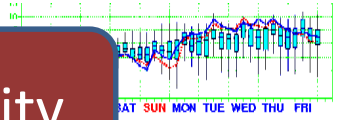
Modelling for prediction

Post-processing and automatic

WMO‘s role is to:

Set standards

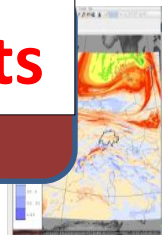
Build capacity



WMO Space Programme:
To cover all satellite related aspects

influence

requirements



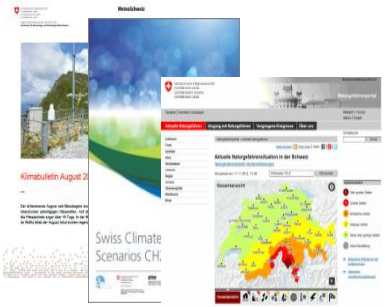

Understanding and use of forecasts

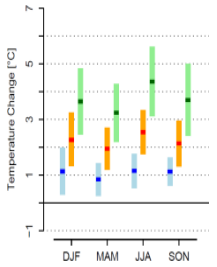
Dissemination of products and services to users

and decision







OMM

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:

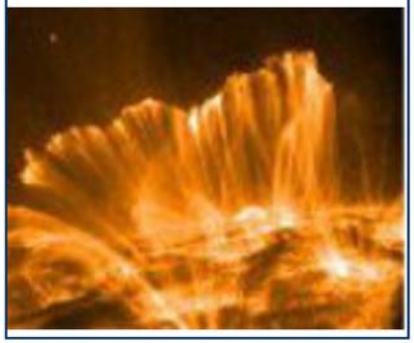
The space-based Observing System

- Global Planning
- Satellite Status
- GSICS
- Frequency Coordination

Access to Satellite Data and Products

Awareness and Training

Space Weather Coordination



WMO OMM

WMO Integrated Global Observing System

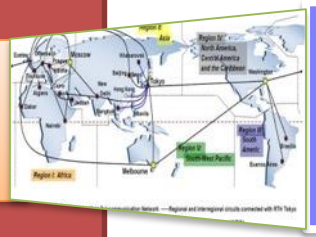
Operational from 1 January 2020, includes space weather

World Weather Watch

- GOS
- GDPFS
- GTS

WIGOS

- GAW
- GCW
- WHOS
- GCOS
- Partners
- Co-sponsors

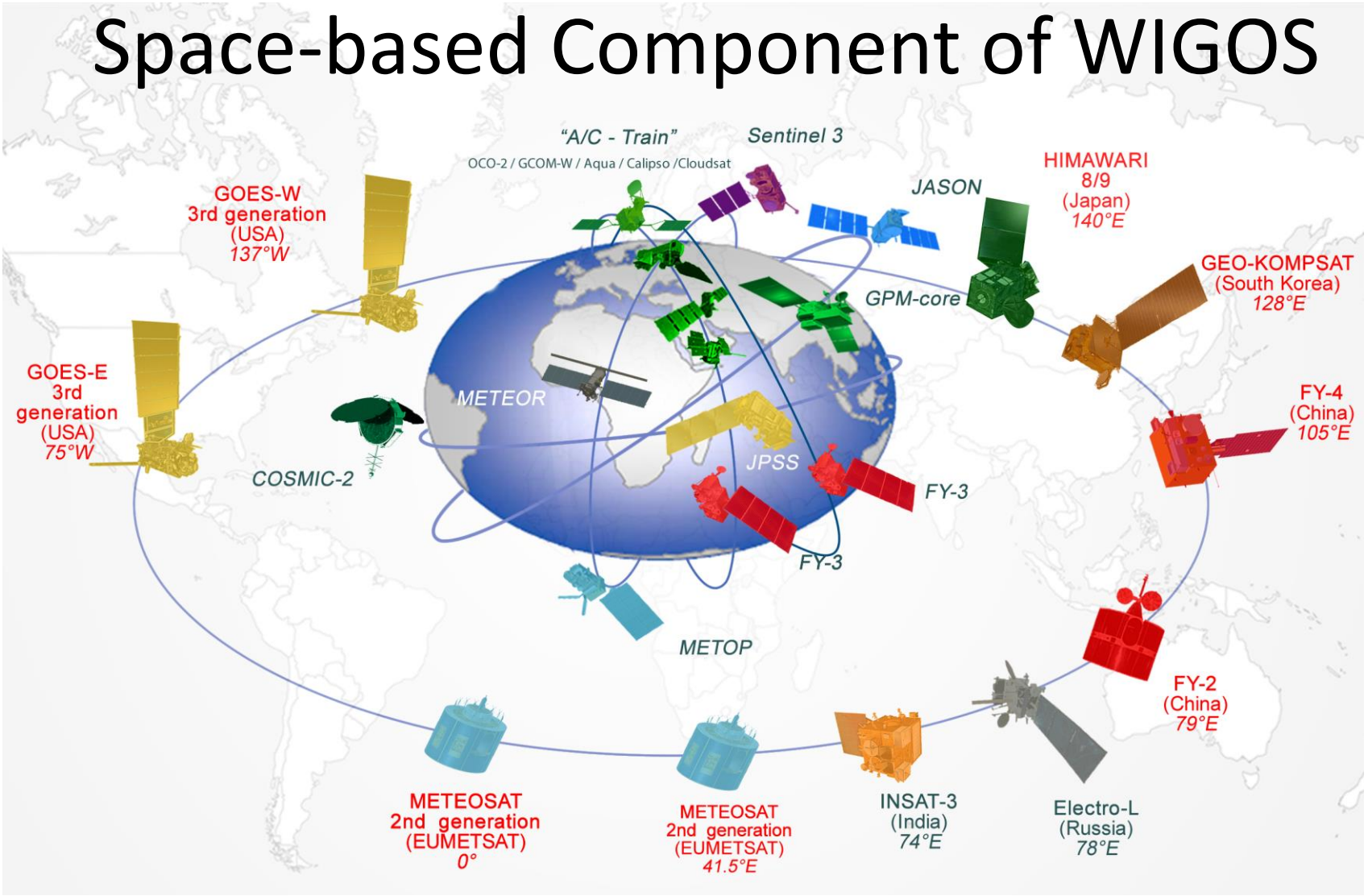


WMO Information System (WIS)

Global Atmosphere Watch (GAW), Global Cryosphere Watch (GCW), Hydro Observing System, Global Climate Observing System (GCOS)

WMO OMM

Space-based Component of WIGOS



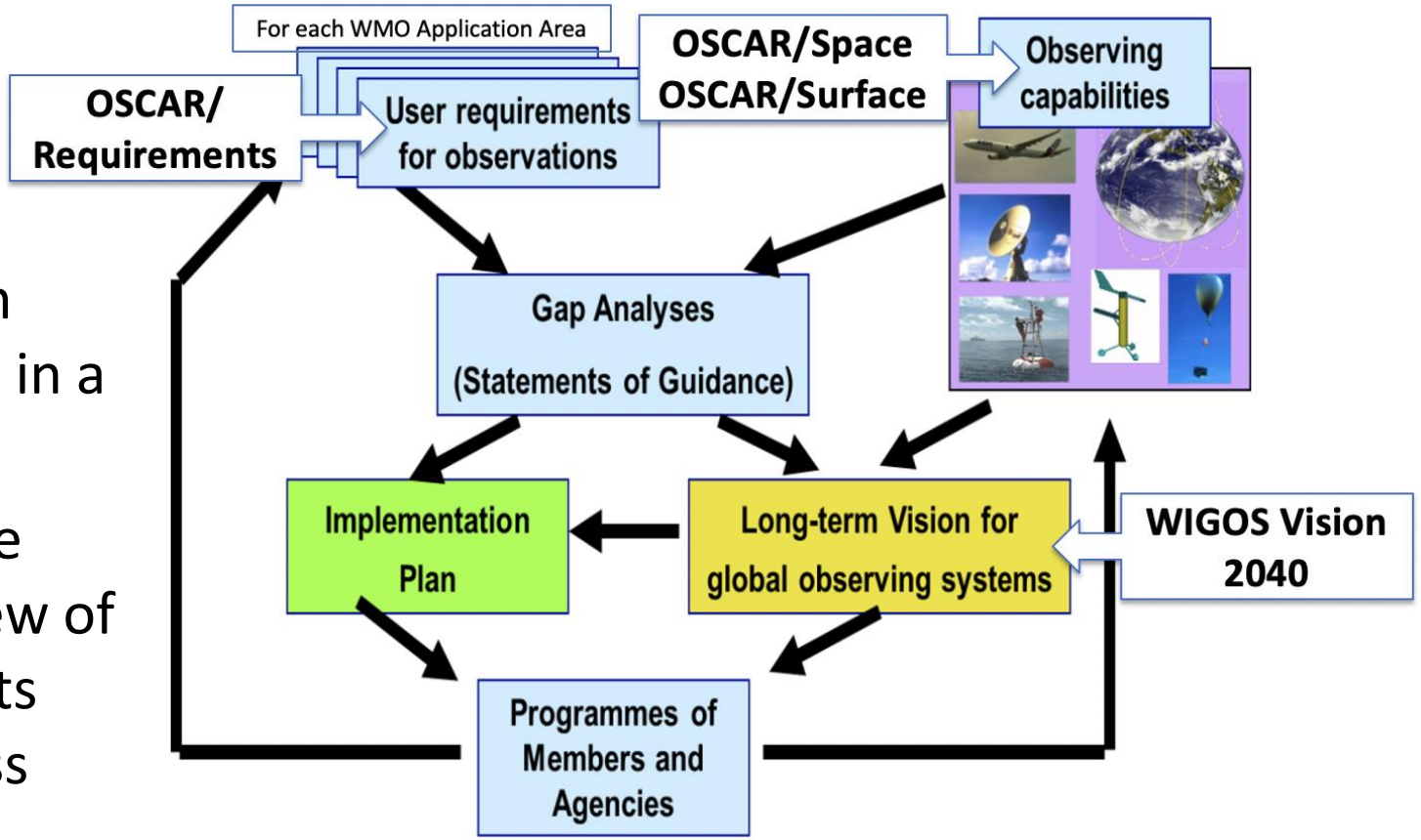
As of December 2021 approx. 200 operational satellites

See https://www.wmo-sat.info/oscar/spacecapabilities

WMO OMM

Design and Evolution of WIGOS

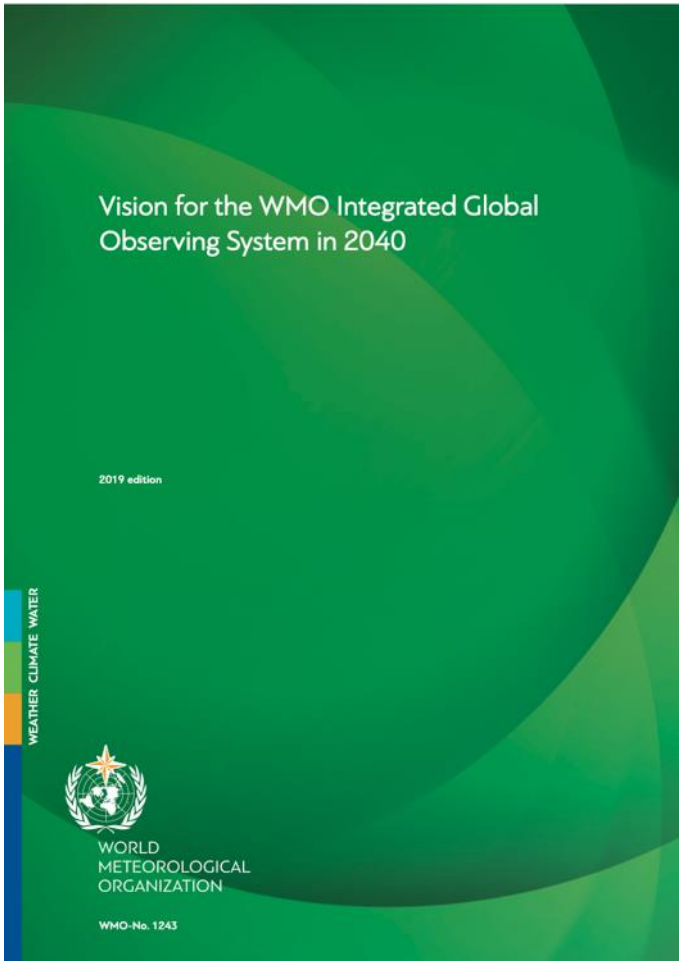
- Earth System modelling is in a key role
- Driven by the Rolling Review of Requirements (RRR) process



See https://community.wmo.int/rolling-review-requirements-process

WMO OMM

WIGOS Vision 2040



- Describes the space- and surface based observing networks we desire to operate by 2040
- The space-based component consists of four subcomponents:

1. Backbone system with specified orbital configuration and measurement approaches
   - Basis for Members' commitments and responds to the vital data needs
   - Baseline of Coordination Group of Meteorological Satellites (CGMS)
2. Backbone system with open orbit configuration and flexibility to optimize the implementation
   - Basis for open contributions of WMO Members, to optimize and enhance the backbone
   - Leaving room for further system optimization
3. Operational pathfinders, and technology and science demonstrators
   - Responding to R&D needs and exploratory data for applications
4. Additional capabilities (e.g. contributions by commercial operators)

WMO OMM

See https://community.wmo.int/vision2040

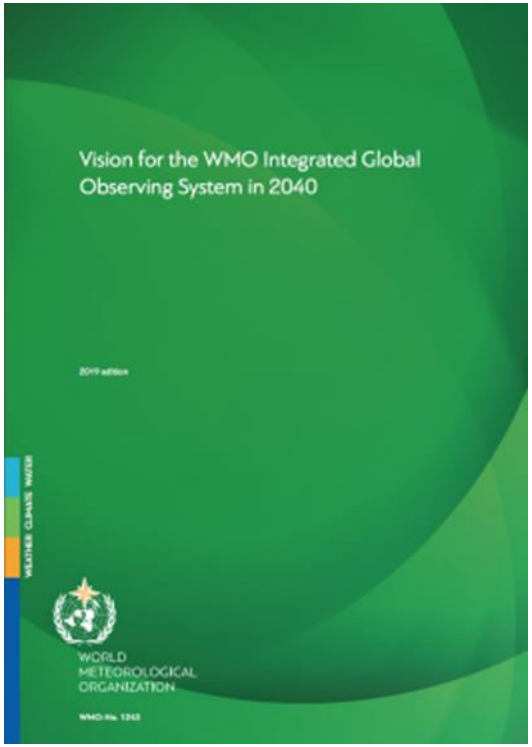
Example: Backbone system with specified orbital configuration and measurement approaches (Subcomponent 1)

Instruments	*Geophysical variables and phenomena*
Geostationary core constellation with a minimum of five satellites providing complete Earth coverage	
Multi-spectral VIS/IR imagery with rapid repeat cycles	Cloud amount, type, top height/temperature; wind (by tracking cloud and water vapour features); sea/land surface temperature; precipitation; aerosol content and physical properties; snow cover; vegetation cover; albedo; atmospheric stability; fire properties; volcanic ash; sand and dust storms; convective initiation (combining multispectral imagery with IR sounders data)
IR hyperspectral sounders	Atmospheric temperature, humidity; wind (by tracking cloud and water vapour features); rapidly evolving mesoscale features; sea/land surface temperature; cloud amount and top height/temperature; atmospheric composition (aerosols, ozone, greenhouse gases, trace gases)
Lightning mappers	Total lightning (in particular, cloud to cloud), convective initiation and intensity, life cycle of convective systems, NOx production
UV/VIS/NIR sounders	Ozone, trace gases, aerosol, humidity, cloud top height
Sun-synchronous core constellation satellites in three orbital planes (morning, afternoon, early morning)	
IR hyperspectral sounders	Atmospheric temperature and humidity; sea/land surface temperature; cloud amount, water content and top height/temperature; precipitation; atmospheric composition (aerosols, ozone, greenhouse gases, trace gases)
MW sounders	
VIS/IR imagery, realization of a day/night band	Cloud amount, type, top height/temperature; wind (high latitudes, by tracking cloud and water vapour features); sea/land surface temperature; precipitation; aerosol properties; snow and (sea-) ice cover; ice-flow distribution; vegetation cover; albedo; atmospheric stability; volcanic ash; sand and dust storm; convective initiation
MW imagery	Sea-ice extent and concentration and derived parameters, such as ice motion; total column water vapour; water vapour profile; precipitation; sea-surface wind speed and direction; cloud liquid water; sea/land surface temperature; soil moisture; terrestrial snow
Scatterometers	Sea-surface wind speed and direction; surface stress; sea ice; soil moisture; snow cover extent and snow water equivalent (SWE)
Sun-synchronous satellites at three additional equatorial crossing times for improved robustness and improved time sampling, particularly for monitoring precipitation	
Instruments on other satellites in low-Earth orbit	
Wide-swath radar altimeters and high-altitude, inclined, high-precision orbit altimeters	Ocean surface topography; sea level; ocean wave height; lake levels; sea- and land-ice characteristics; snow over sea ice
IR dual-angle view imagers	Sea-surface temperature (of climate monitoring quality); aerosols; cloud properties
MW imagery for surface temperature	Sea-surface temperature (all weather)
Low-frequency MW imagery	Soil moisture; ocean salinity; sea-surface wind; sea-ice thickness; snow cover extent and SWE
MW cross-track upper stratospheric and mesospheric sounders	Atmospheric temperature profiles in the stratosphere and mesosphere

See the details https://community.wmo.int/vision2040

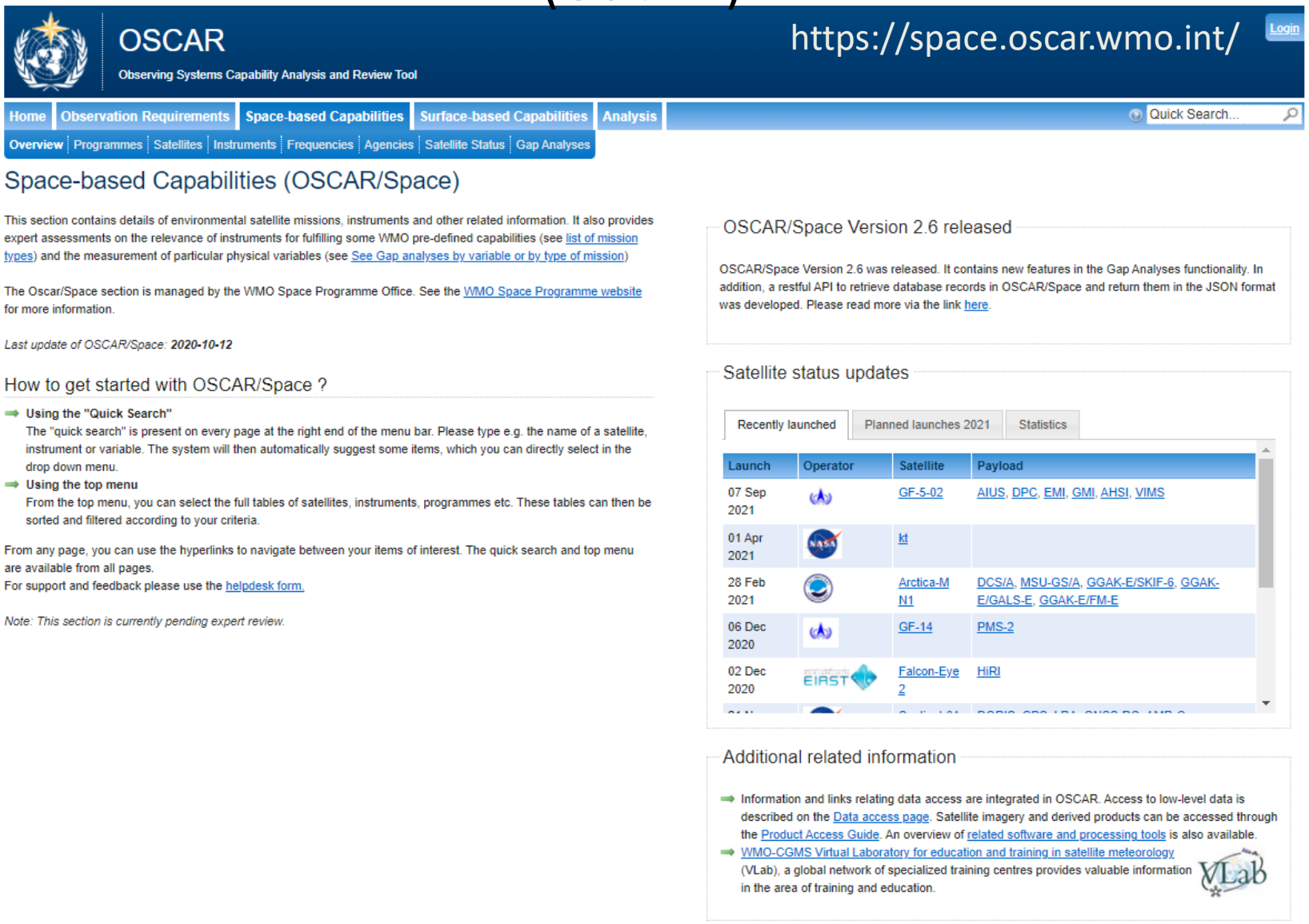
WIGOS Vision 2040 Implementation

- For the space-based component the partnership with CGMS is a key (CGMS baseline)
  - However, this does not cover all the aspects for comprehensive Earth-System modelling, hence Coordination Group of Earth Observation Satellites (CEOS) support is also essential
- WMO new data policy
  - consultation on WMO *Core* satellite data
- WMO requests a consultancy via open consultative platforms
  - Guidance on the development of a national implementation strategy
  - Capacity development opportunities
  - Guidance based on Systematic Observations Financial Facility (SOFF) and Country Support Initiative (CSI)



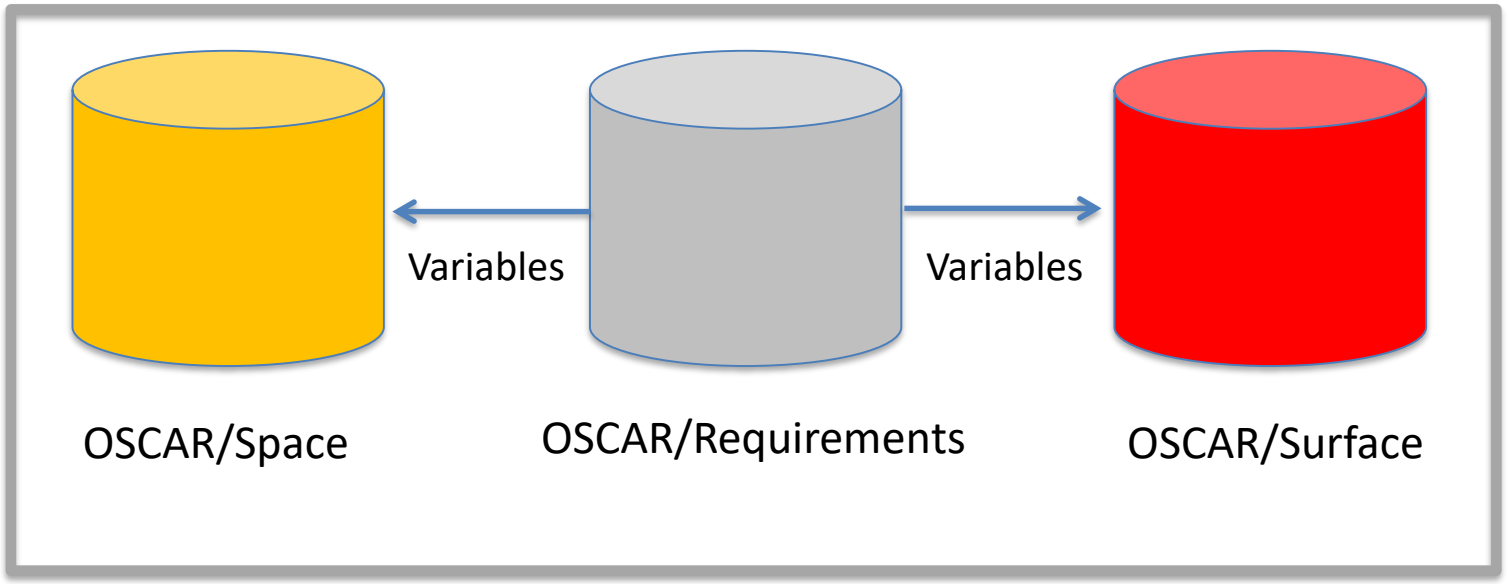
WMO OMM

WMO Observing System Capability Analysis and Review tool (OSCAR)



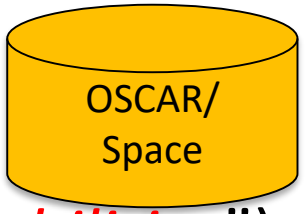
WMO Observing System Capability Analysis and Review tool (OSCAR)

- 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 (CGMS and CEOS)
   - Over 800 satellites
   - Over 1000 instruments
   - Weather and climate
   - Environmental monitoring
   - Space weather, 355 instruments

2. Assessment of instruments ("*analysis and review*")

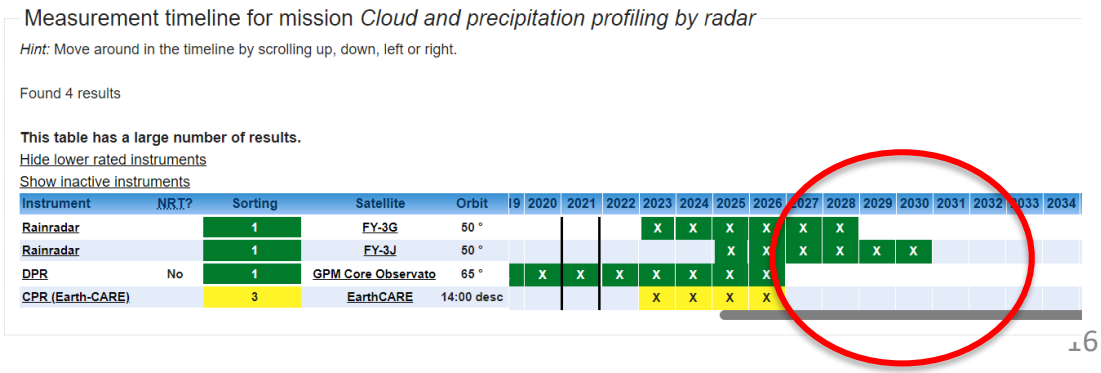
   - Mapping instruments to measured variables
   - "Gap analysis" by measured variable, or by the type of the mission
   - Mapping instruments by WIGOS Subcomponents (e.g. CGMS Baseline)

WMO OMM

OSCAR/Space assessment: Gap Analysis

- Gap analysis by instrument type or technology
  - Tables are provided for each of the following 28 technologies (22 for Earth observation, 6 for Space weather):
- Does not consider Data Policy

VIS/IR imagery from LEO	MW sounding from GEO	Cloud and precipitation radar	VIS/IR imagery from GEO	Mm-submm sounding	Measurements from L1	Measurements from the Ecliptic
Lightning imagery	IR sounding from LEO	Limb sounding (mech. or electr. scanning)	Broadband radiometry	IR sounding from GEO	Measurements from solar orbits	Measurements from GEO and Molniya orbits
Limb sounding (by occultation)	SAR imagery	SW spectroscopy from LEO	Radio occultation sounding	Space geodesy systems	Measurements from HEO through MAG	Measurements from LEO
SW spectroscopy from GEO	Radar scatterometry	Earth's gravity systems	MW imagery	Radar altimetry		
MW sounding from LEO	Space lidar					



CGMS Risk Assessment

- Risk vs CGMS commitment to WIGOS 2040

WMO OMM

New WMO Data Policy

WMO OMM

WMO data policy for the international exchange of earth system data

International data exchange is a major purpose of WMO, WMO Convention, Art. 2b

- WMO Unified Data Policy (Res. 1) approved by WMO members
- Replacing the old Res 40 (weather), 25(hydrology) and 60 (climate)
- Adopts the following policy on the international exchange of Earth system data:
  - *As a fundamental principle of WMO and in consonance with the expanding requirements for its scientific and technical expertise,* ***WMO commits itself to broadening and enhancing the free and unrestricted international exchange of Earth system data;***
- Single, overarching data policy resolution emphasis on the Earth System: Observations, Monitoring, Prediction and Services

New WMO Unified Data Policy Resolution (Ext Congress 2021)

Key changes with respect to Resolution 40 (Cg-XI, 1995)

Resolution 40; 1995

1. Covers weather data only;
2. Two main categories of data:
   - *Essential* (*shall* be exchanged);
   - *Additional* (*should* be exchanged);
3. Specific "*essential*" datasets listed directly in Annex I to the resolution (with some reference also to RBSN);
4. "*Free and unrestricted*" exchange (term not defined in the Resolution);
5. Covers exchange of data between NMHSs

Resolution 1; 2021

1. Covers all WMO Earth system data: weather, climate, hydrology, ...
2. Two main categories of data:
   - *Core* (*shall* be exchanged);
   - *Recommended;* (*should* be exchanged);
3. Specifics on ***core*** **and** ***recommended*** data referred to Technical Regulations, primarily Manuals on WIGOS, GDPFS;
4. "*Free and unrestricted*" exchange (term defined directly in the Resolution, literal interpretation);
5. Addressed to Members, but covers exchange of data between all partners, including private sector, academia, etc.

For some of the data types listed in Annex I to the draft data policy resolution, detailed Technical Regulations already exist, but for many data types these still need to be developed as requirements and agreements mature.

Specifically on satellite data in new Data Policy Resolution

- Vital importance of satellite data now clearly recognized. The concept of ***core satellite data*** is framed primarily in terms of importance to global NWP.

- No specific satellite datasets are listed as neither *core* nor *recommended* in current draft of policy. This is referred to the Manual on WIGOS.
  - Work to be done in collaboration with satellite operators on a bilateral basis

- No particular position regarding provision of observational data by private sector
  - The policy is addressed to national governments of WMO Members and cannot dictate what private sector entities should or should not do

- Reflecting guidance provided by the WMO Data Conference, exchange of ***core data is*** considered mandatory, irrespective of data origin;

  - Relevant for commercial data

Summary

- Space-based (and other remote sensing) precipitation measurement are highly import to fill the gap in the lacking observation capabilities especially in the developing countries

- A key WIGOS principle is to design and implement observing systems in response to specific requirements coming from the WMO Rolling Review of Requirements (RRR) gathering the observational requirements for all WMO application areas.

- WIGOS Vision 2040 document describes the high-level targets to guide the evolution of WMO Integrated Global Observing System (WIGOS) in the coming decades including the space-based component.

- WMO Unified Data Policy was recently approved by WMO members. It is replacing the old Res 40 (weather), 25(hydrology) and 60 (climate).

- Vital importance of satellite data now clearly recognized. The concept of *core satellite data* is framed primarily in terms of importance to global NWP.

WEATHER CLIMATE WATER
TEMPS CLIMAT EAU

Thank you
Merci

WMO OMM

World Meteorological Organization
Organisation météorologique mondiale