WMO SPACE PROGRAMME AND CLIMATE MONITORING FROM SPACE

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WMO Space Programme Office

CM SAF 5th User Workshop
3-5 June 2019

WORLD METEOROLOGICAL ORGANIZATION

WEATHER CLIMATE WATER

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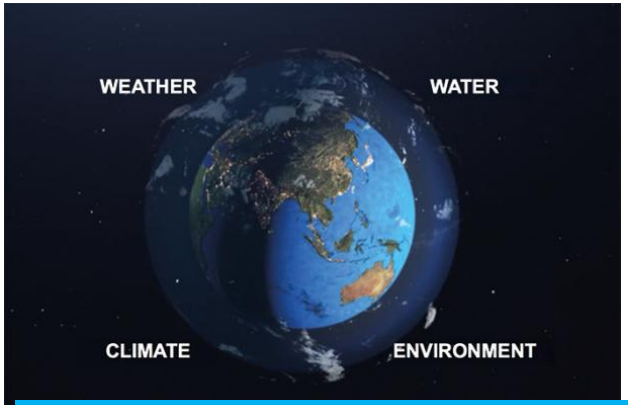
I. WMO and Global Development Agendas

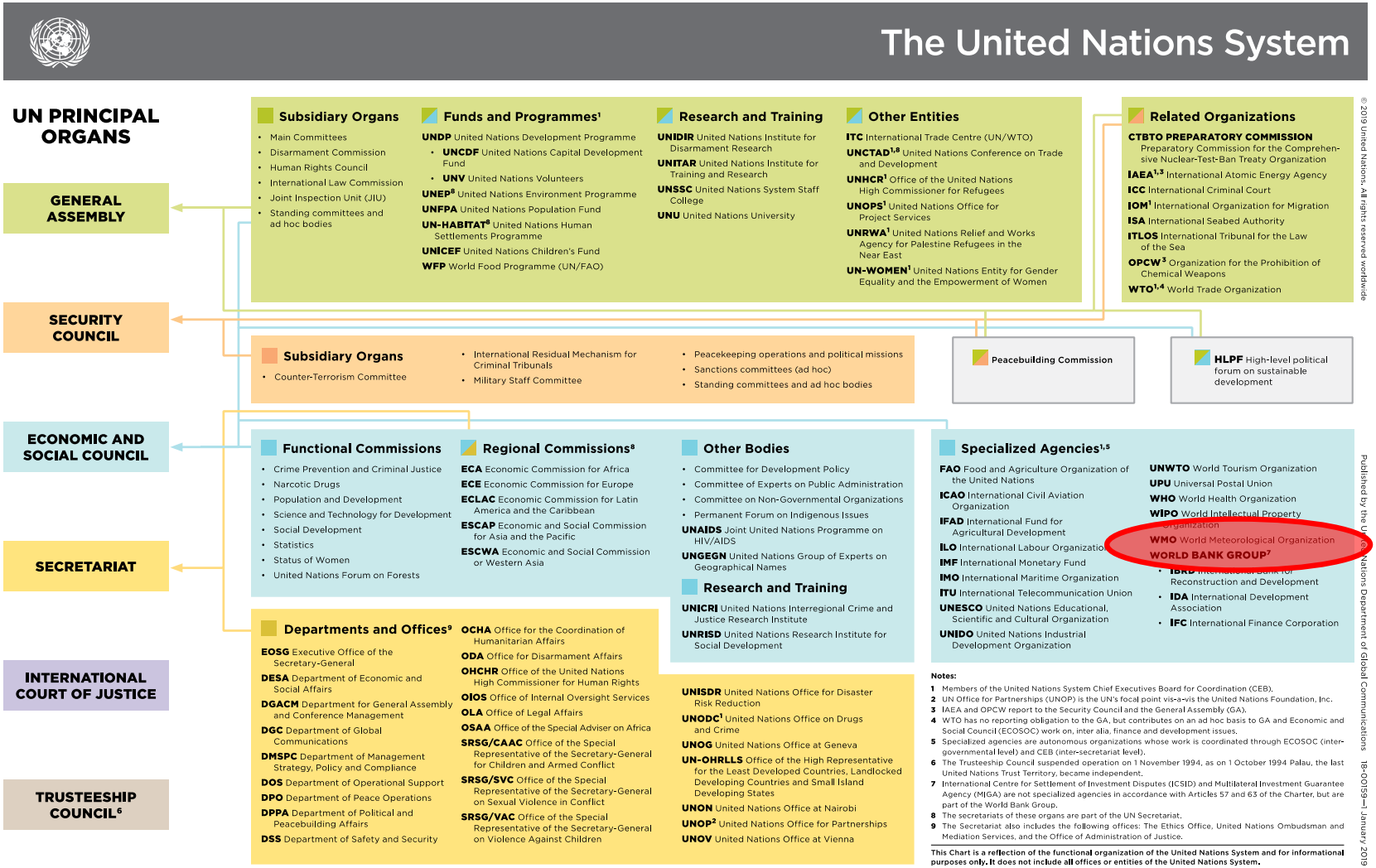
World Meteorological Organization



- Founded as International Meteorological Organization (IMO) in 1873
- Established in 1950 as World Meteorological Organization (WMO)
- UN specialized agency and UN authoritative voice for weather, climate, water and environmental services, since 1951
- 193 Member States
- Represented by Directors of National Meteorological and Hydrological Services (NMHSs)

See https://public.wmo.int/en/about-us/who-we-are

WMO: A UN Specialized Agency

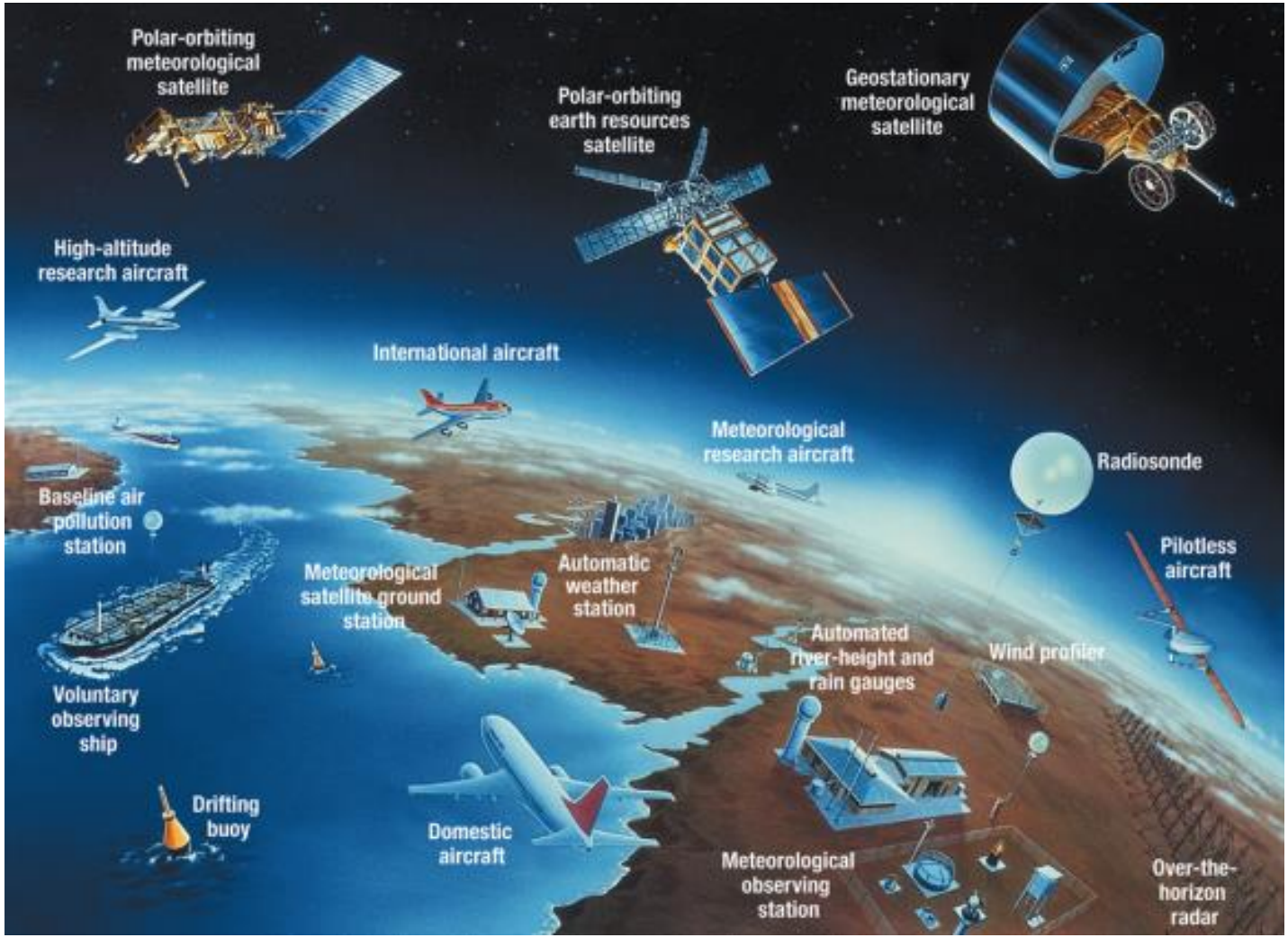


2030 Agenda for Sustainable Development

- WMO contributes to 12 of the 17 SDGs and is the co-custodian of SDG 13 on Climate Action

See https://public.wmo.int/en/our-mandate/what-we-do/wmo-contributing-sustainable-development-goals-sdgs

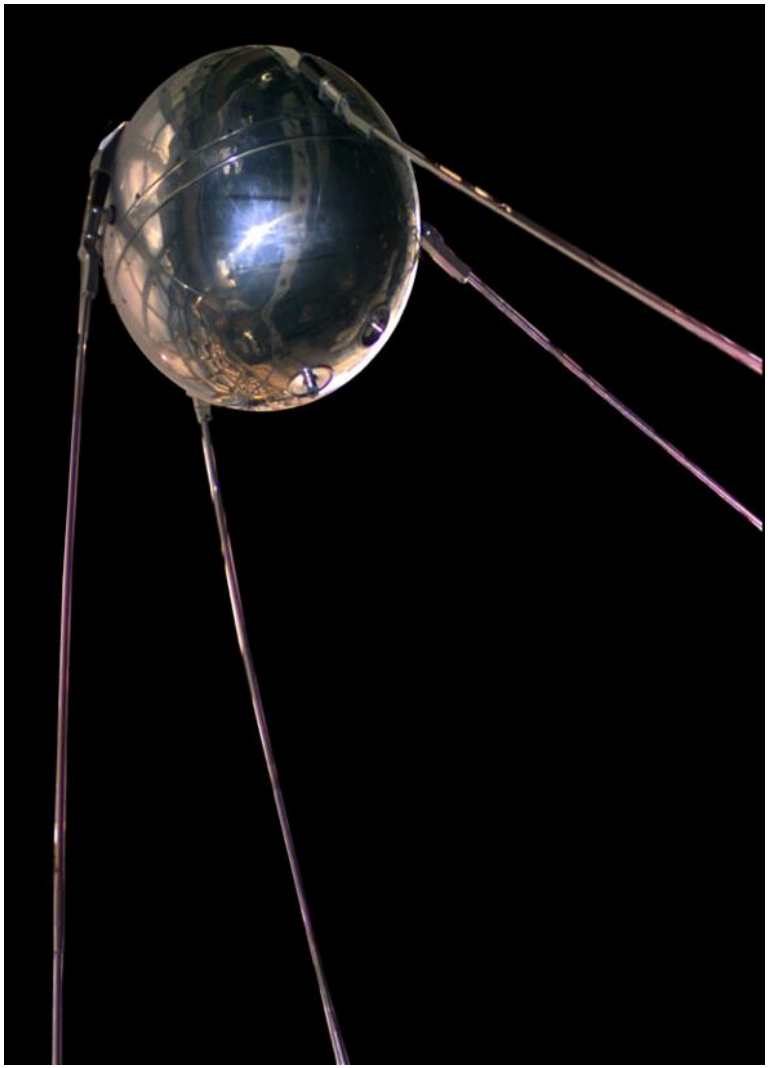
WMO Integrated Global Observing System



II. WMO Space Programme

United Nations and Outer Space

- Launch of Sputnik in 1957 - the beginning of space activities
- Raised many questions:
  - How to prevent weaponization of outer space?
  - What rule-set for outer space activities?
  - Sharing of space benefits?
- UN Member States decide to establish the ***Committee on the Peaceful Uses of Outer Space (UNCOPUOS)***
- WMO, as a specialized UN agency, joins UNCOPUOS



COPUOS and the Origin of the World Weather Watch

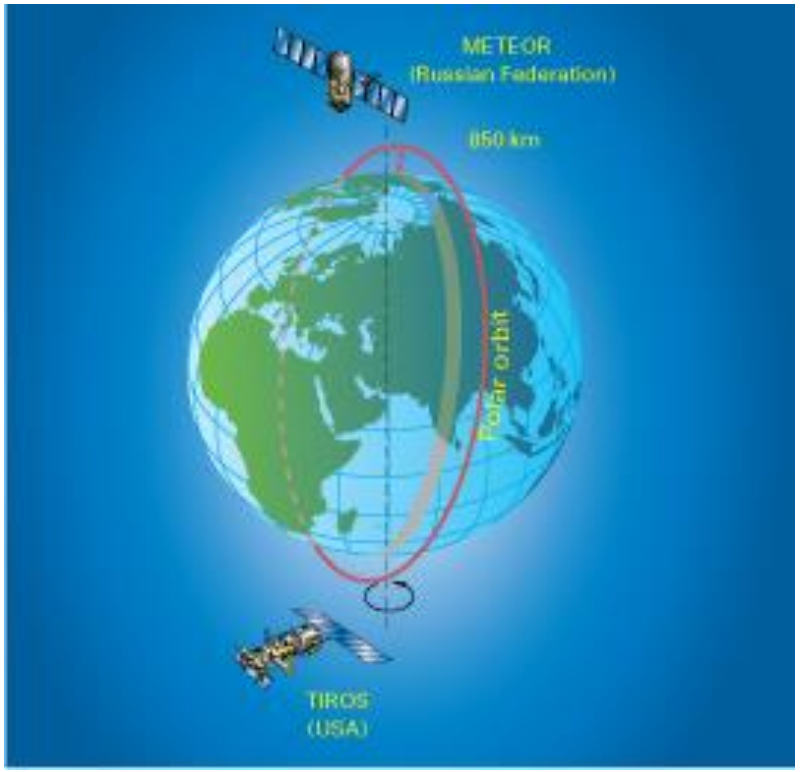
- In 1961, UN General Assembly requests WMO to report to COPUOS on how it would utilize space technology in its work
- US President John F. Kennedy proposes to launch "cooperative efforts between all the nations in weather prediction *and eventually in weather control*" making use of space-based observations from satellites
- In response, WMO prepares the proposal for the **World Weather Watch (WWW)**
- Subsequently endorsed by the UN General Assembly and implemented from 1967

See https://public.wmo.int/en/bulletin/global-satellite-observing-system-success-story

Global Observing System (GOS) - 1961

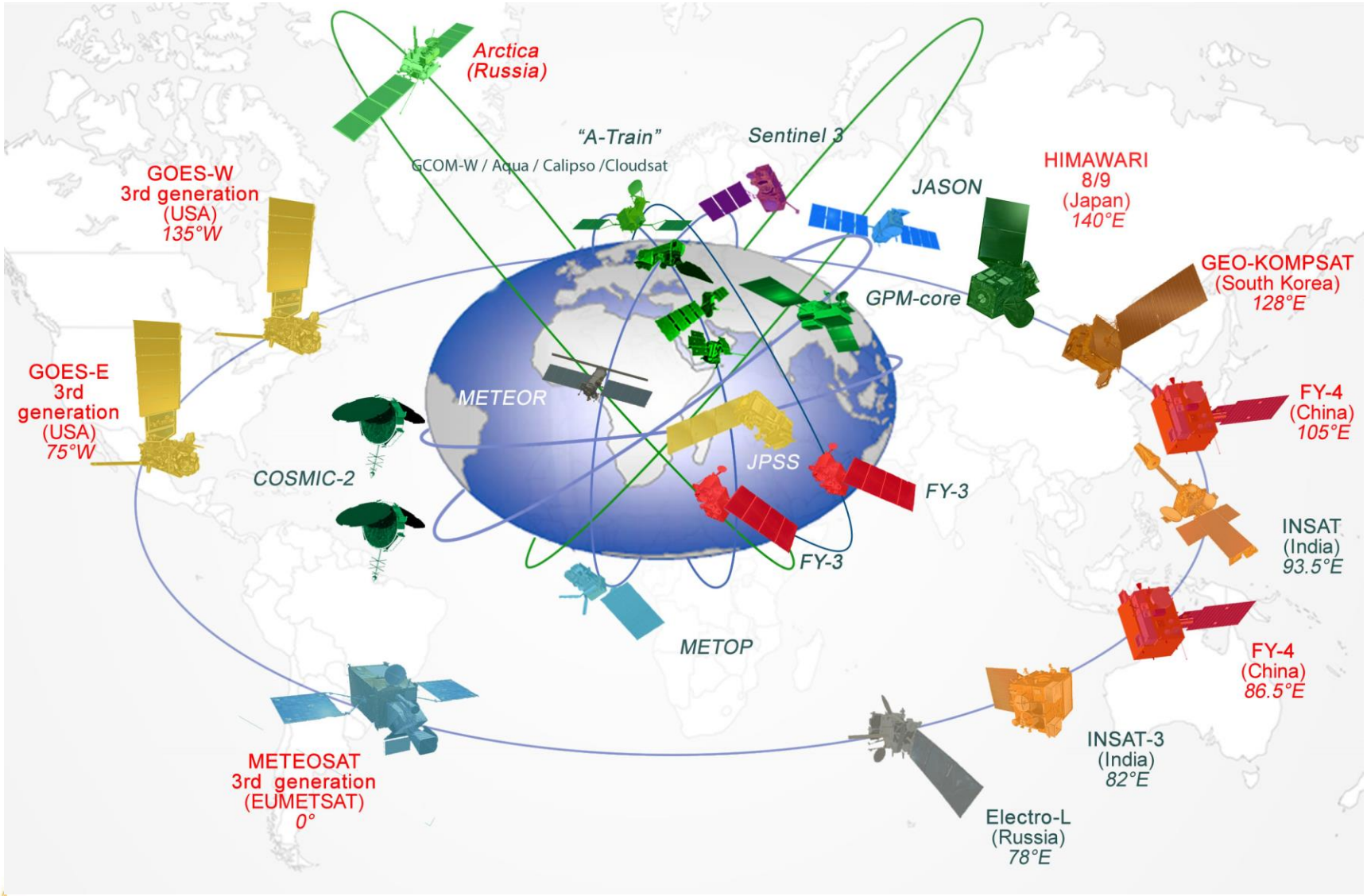
- GOS is the Observing System Element of WWW

TIROS-I – First weather satellite image (April 1960)



Space-based Global Observing System (GOS) in 1961

Global Observing System (GOS) - 2021



WMO Space Programme

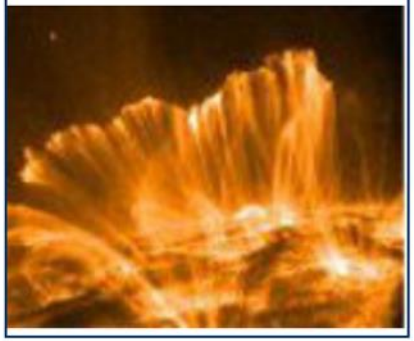
- Established by Resolution 5 (Cg-XIV) of the 14th WMO Congress in 2003
- Promote availability and utilization of satellite data and products for weather, climate, water and related applications.
- Coordinate environmental satellite matters and activities throughout all WMO Programmes.
- 16th WMO Congress in 2011 confirmed four main components:

The space-based Observing System

Access to Satellite Data and Products

Awareness and Training

Space Weather Coordination



See http://www.wmo.int/sat

WMO Space Programme Value Chain

Satellite Operators → Calibrated data sets → Quality-controlled products → Data collection, Dissemination & Access → Awareness & training → **Users**

CGMS

CEOS

GSICS Global Space-based Inter-Calibration System

SCOPE•CM

SCOPE•NWC

WIS

DBNet

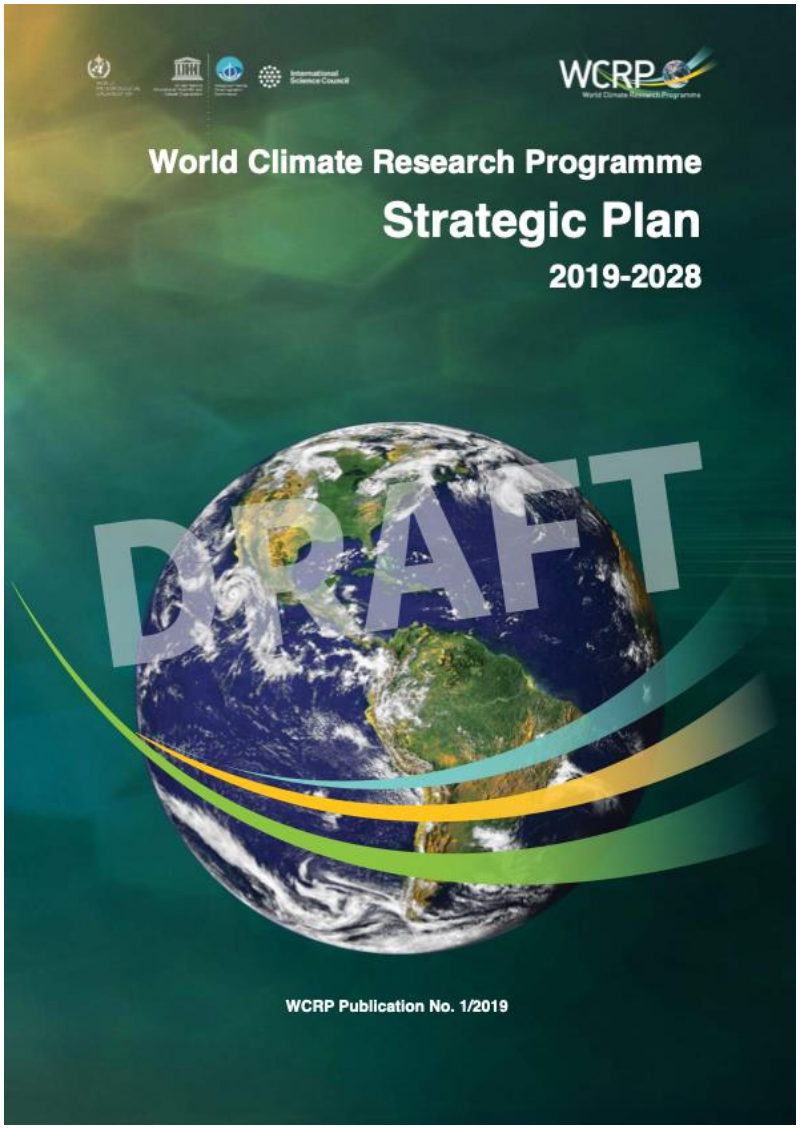
VLab

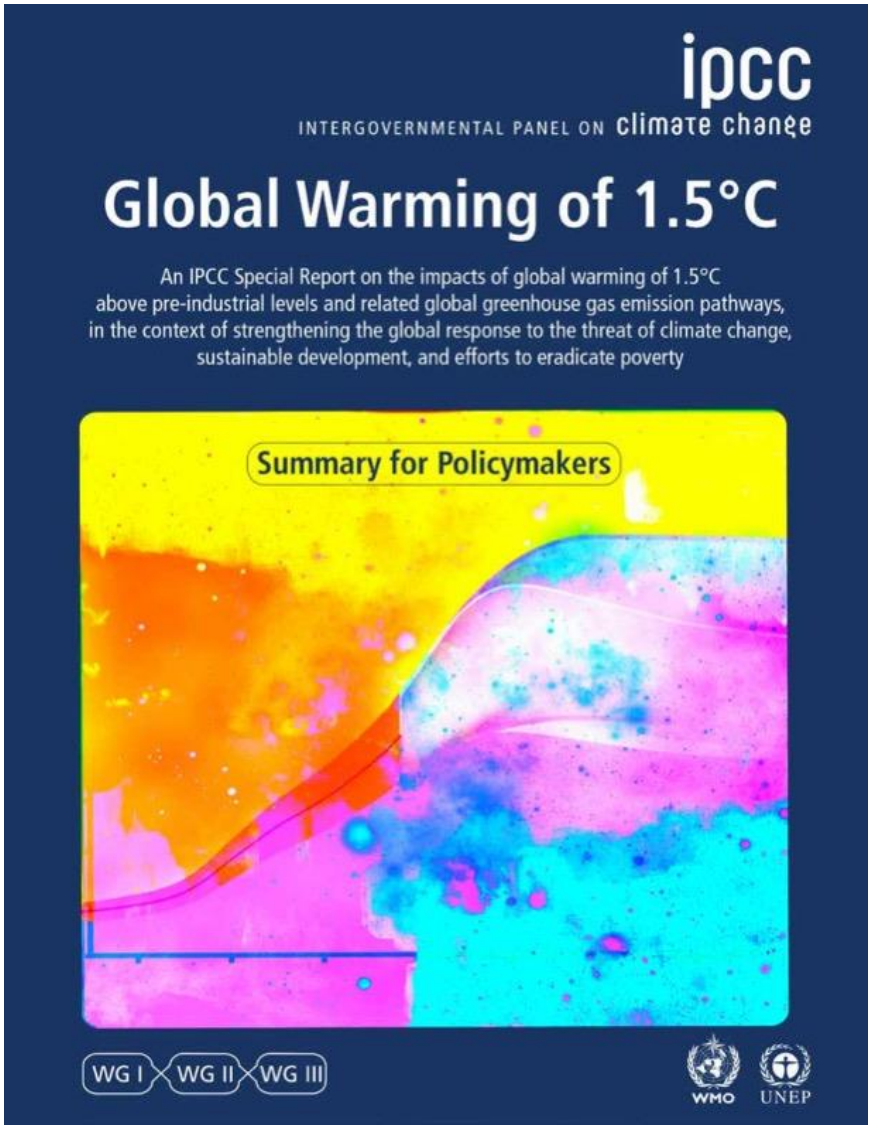
III. Climate Monitoring from Space

Role of World Climate Conferences

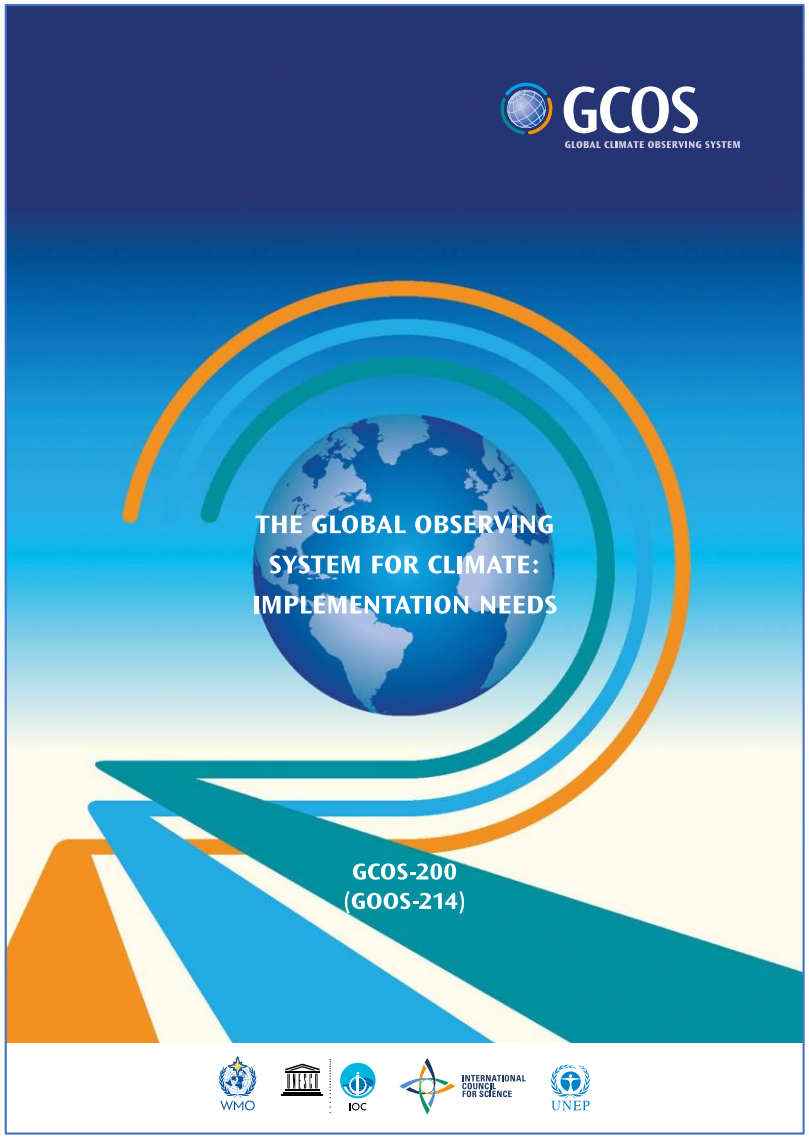
- First World Climate Conference (1979)
  - World Climate Research Programme (WCRP)
  - Intergovernmental Panel on Climate Change (IPCC)
- Second World Climate Conference (1990)
  - United Nations Framework Convention on Climate Change (UNFCCC)
  - Global Climate Observing System (GCOS)
- Third World Climate Conference (2009)
  - Global Framework for Climate Services (GFCS)

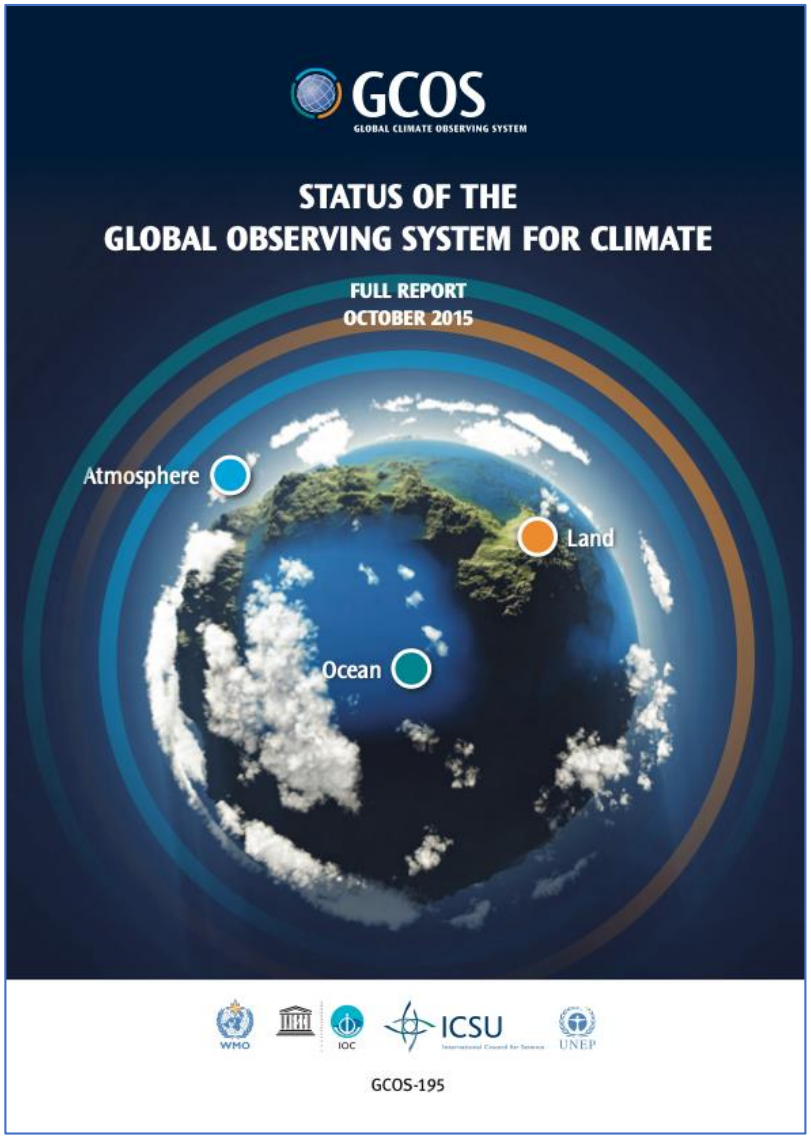
WCRP and IPCC



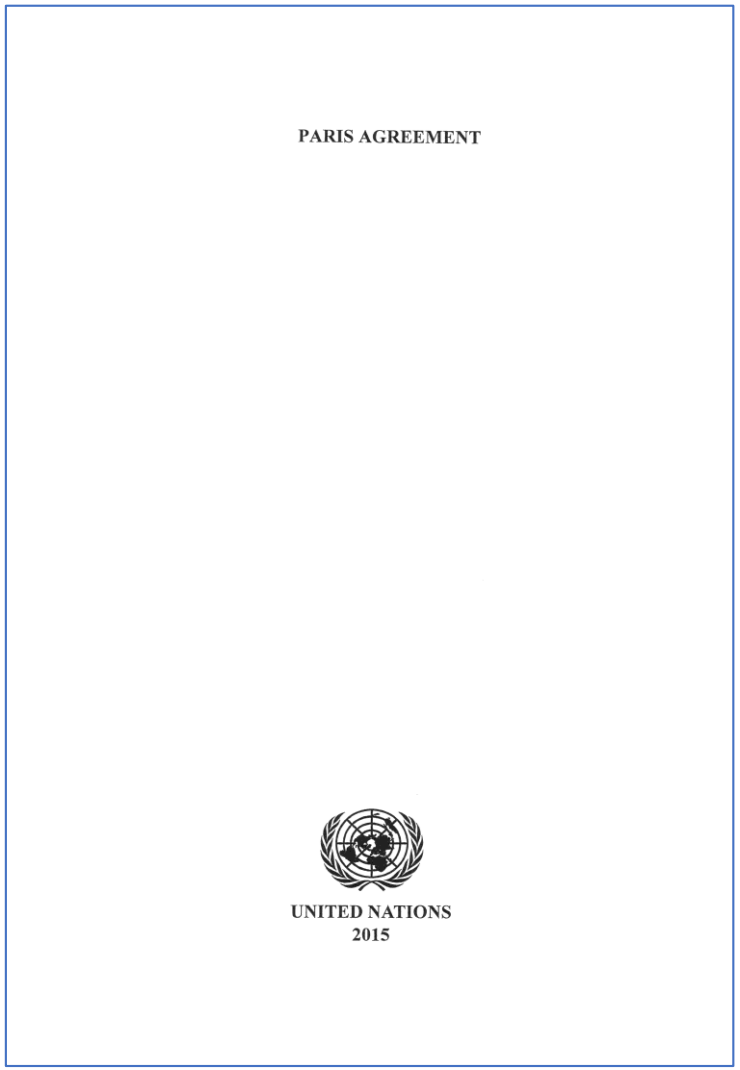


GCOS


GCOS
GLOBAL CLIMATE OBSERVING SYSTEM
THE GLOBAL OBSERVING SYSTEM FOR CLIMATE: IMPLEMENTATION NEEDS
GCOS-200
(GOOS-214)
WMO
IOC
INTERNATIONAL COUNCIL FOR SCIENCE
UNEP


GCOS
GLOBAL CLIMATE OBSERVING SYSTEM
STATUS OF THE GLOBAL OBSERVING SYSTEM FOR CLIMATE
FULL REPORT
OCTOBER 2015
Atmosphere
Land
Ocean
WMO
IOC
ICSU
UNEP
GCOS-195

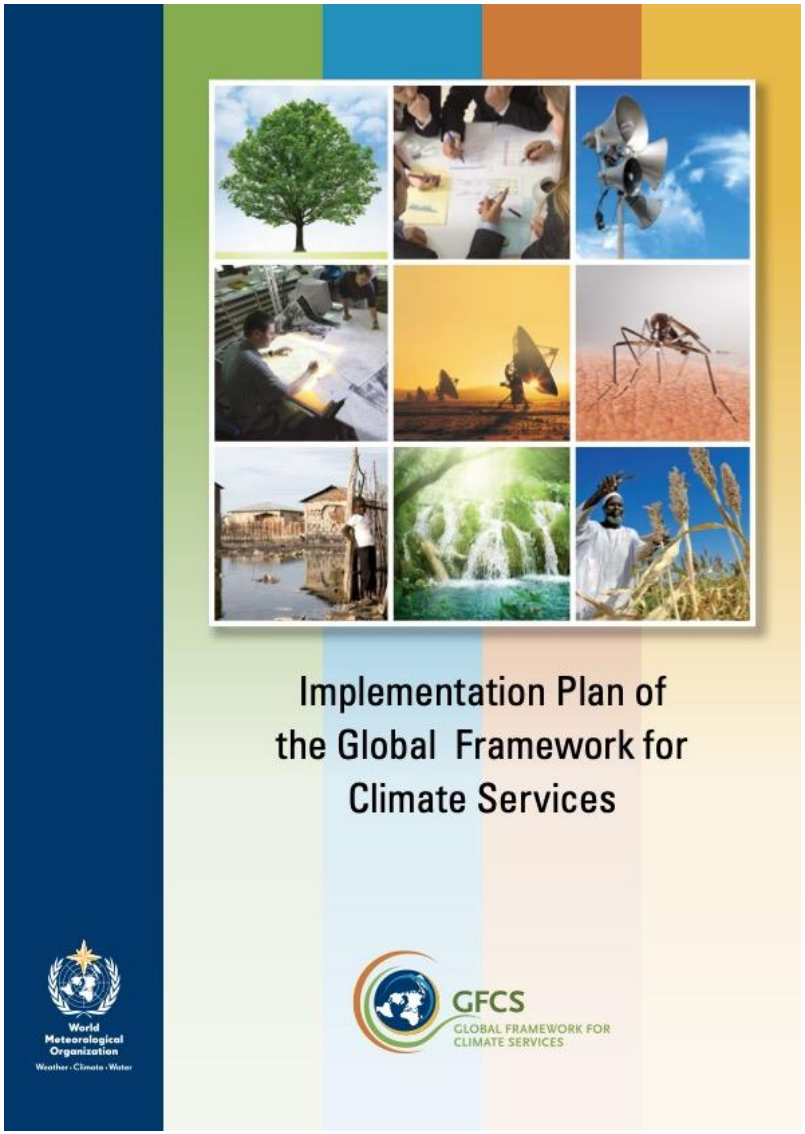
UNFCC and IG3IS

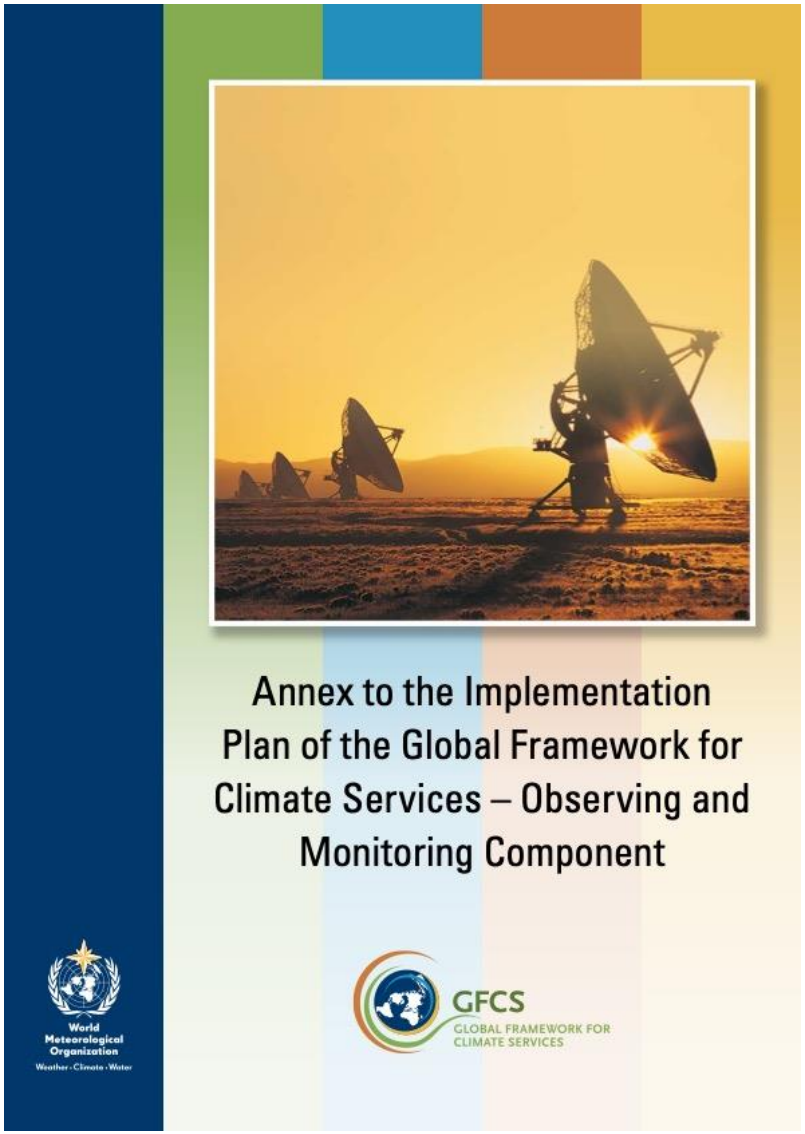


Integrated Global Greenhouse Gas Information System (IG3IS)

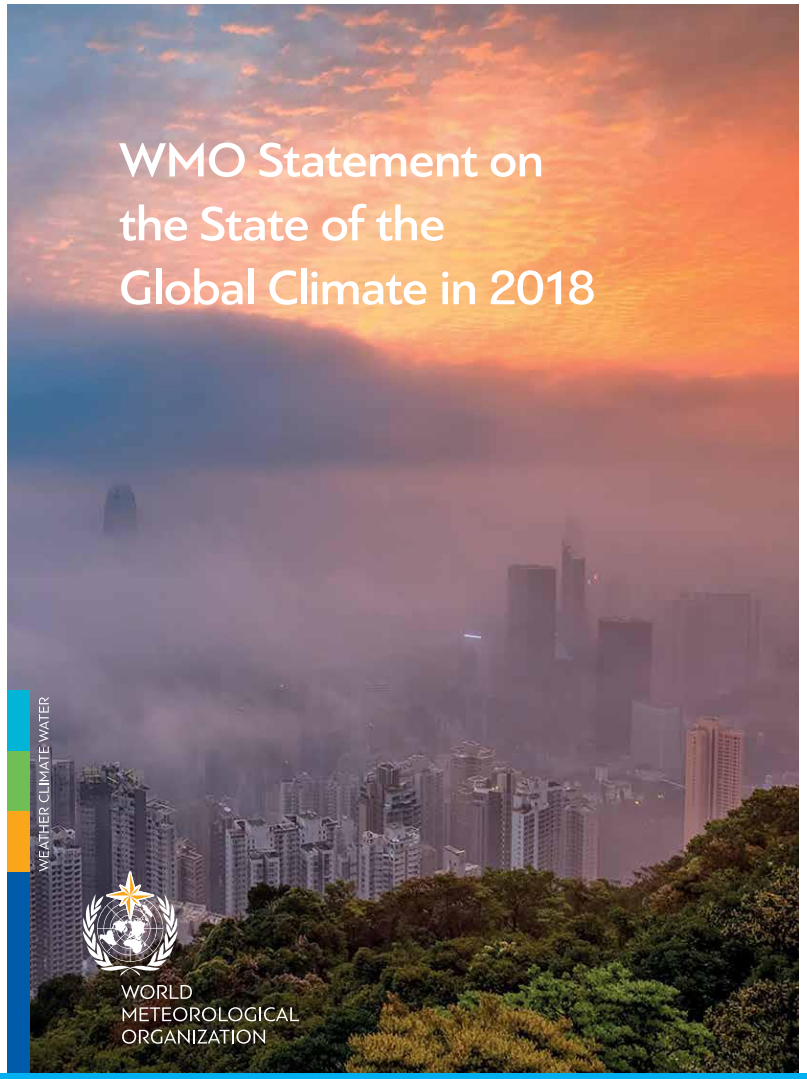
1. Improve knowledge and reduce uncertainty of national emission inventory reporting to UNFCCC;
2. Locate and quantify previously unknown emission reduction opportunities such as fugitive methane emissions from industrial sources; and,
3. Provide subnational entities such as large urban source regions (megacities) with timely and quantified information on the amounts, trends and attribution by sector of their GHG emissions to evaluate and guide progress towards emission reduction goals.
4. Support of global stock taking

Global Framework for Climate Services





WMO Statement on State of the Climate



- Issued annually since 1993
- 2018 Statement shows that the past four years have been the warmest on record, with many high impact weather events which bear the hallmarks of climate change.
- Increasingly the preparation of the annual Statement is informed by data from the space-based observing system.
- Some of its findings would not be possible without the data gathered by Earth Observation satellites.
- It is now beginning to pay off that we have collected space-based climate data for the past two to three decades and we are starting to see certain climate trends in that data.

See https://public.wmo.int/en/our-mandate/climate/wmo-statement-state-of-global-climate

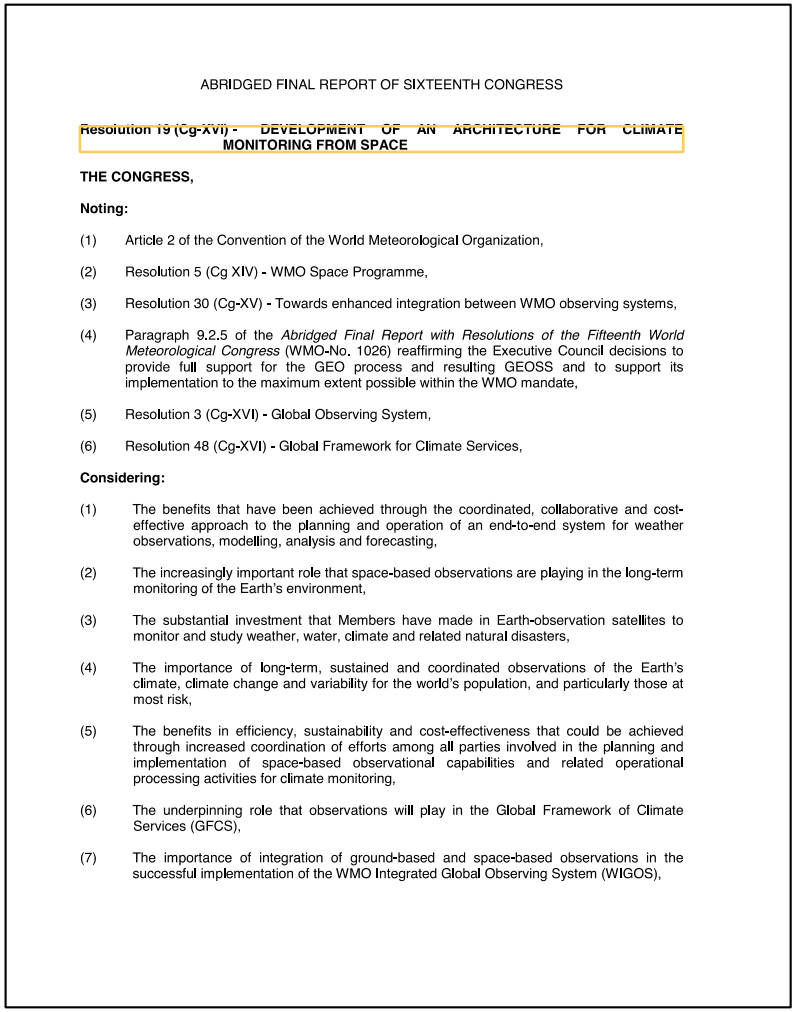
WMO Briefing to UN Security Council

- In January 2019, WMO, for the first time briefed the UN Security Council on impacts of climate-related disasters on international peace and security
- Global average greenhouse gas concentrations of CO2 reached 405.5 parts per million (ppm) in 2017 and continued to rise to record levels in 2018-2019.
- The last time the Earth experienced a comparable concentration of CO2 was 3 to 5 million years ago, when the temperature was 2 to 3 degrees C warmer and sea level was 10-20 m higher than now.
- Climate change has a multitude of security impacts – rolling back the gains in nutrition and access to food; heightening the risk of wildfires and exacerbating air quality challenges; increasing the potential for water conflict; leading to more internal displacement and migration.
- It is increasingly regarded as a national security threat.

The Need for Space-based Observations

- Discussions on the development of an "Architecture for Climate Monitoring from Space" began around 2005-2009
- Building on the success of the World Weather Watch
- To engage "R&D space agencies" in the same way that operational space agencies are engaged in weather monitoring
- Led to Resolution 19 (Cg-XVI) of World Meteorological Congress in 2011

Resolution 19 (Cg-XVI)



ABRIDGED FINAL REPORT OF SIXTEENTH CONGRESS

Resolution 19 (Cg-XVI) - DEVELOPMENT OF AN ARCHITECTURE FOR CLIMATE MONITORING FROM SPACE

THE CONGRESS,

Noting:

(1) Article 2 of the Convention of the World Meteorological Organization,

(2) Resolution 5 (Cg XIV) - WMO Space Programme,

(3) Resolution 30 (Cg-XV) - Towards enhanced integration between WMO observing systems,

(4) Paragraph 9.2.5 of the *Abridged Final Report with Resolutions of the Fifteenth World Meteorological Congress* (WMO-No. 1026) reaffirming the Executive Council decisions to provide full support for the GEO process and resulting GEOSS and to support its implementation to the maximum extent possible within the WMO mandate,

(5) Resolution 3 (Cg-XVI) - Global Observing System,

(6) Resolution 48 (Cg-XVI) - Global Framework for Climate Services,

Considering:

(1) The benefits that have been achieved through the coordinated, collaborative and cost-effective approach to the planning and operation of an end-to-end system for weather observations, modelling, analysis and forecasting,

(2) The increasingly important role that space-based observations are playing in the long-term monitoring of the Earth's environment,

(3) The substantial investment that Members have made in Earth-observation satellites to monitor and study weather, water, climate and related natural disasters,

(4) The importance of long-term, sustained and coordinated observations of the Earth's climate, climate change and variability for the world's population, and particularly those at most risk,

(5) The benefits in efficiency, sustainability and cost-effectiveness that could be achieved through increased coordination of efforts among all parties involved in the planning and implementation of space-based observational capabilities and related operational processing activities for climate monitoring,

(6) The underpinning role that observations will play in the Global Framework of Climate Services (GFCS),

(7) The importance of integration of ground-based and space-based observations in the successful implementation of the WMO Integrated Global Observing System (WIGOS),

Requested WMO to

- "to develop an architecture ... for climate monitoring as a component of the future WIGOS and GFCS, for consideration by Congress",
- as a "major initiative of the WMO Space Programme", and
- "in coordination with satellite operators, CEOS, CGMS, GCOS, GEO and WCRP".

See https://library.wmo.int/doc_num.php?explnum_id=3429#page=220

Architecture for Climate Monitoring

- Strategy Towards an Architecture for Climate Monitoring from Space (2013)
  - Terminology
  - Logical View
  - Implementation Roadmap

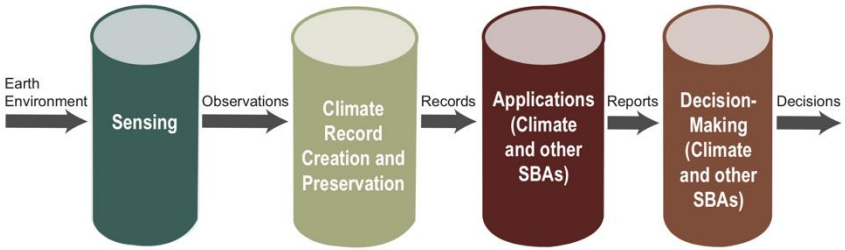
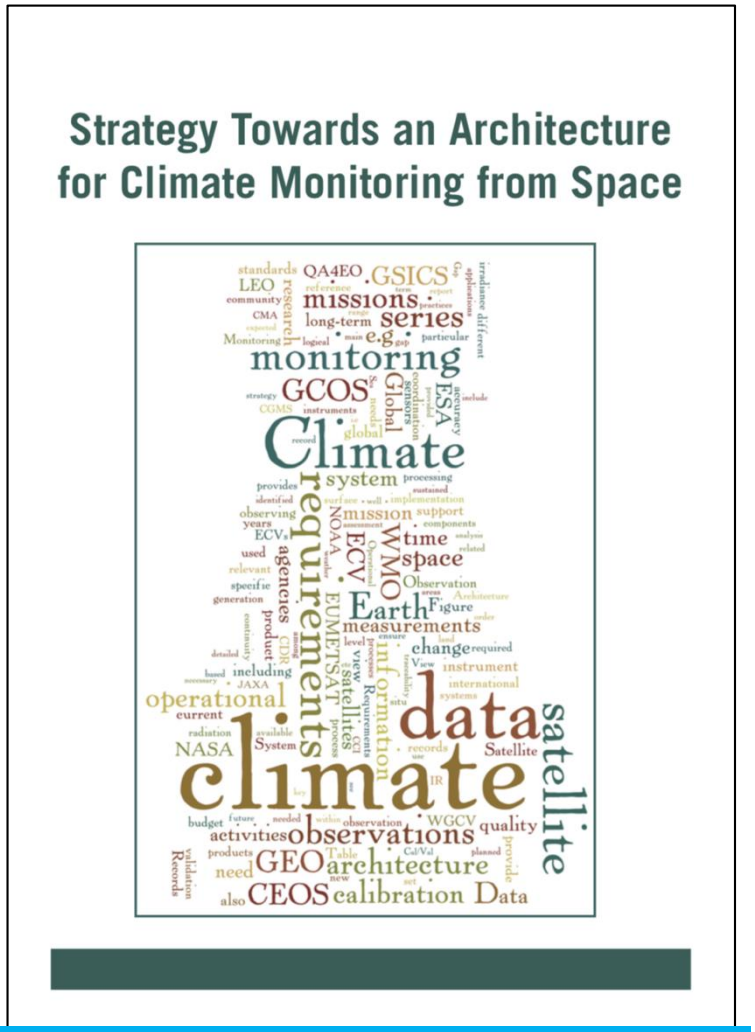
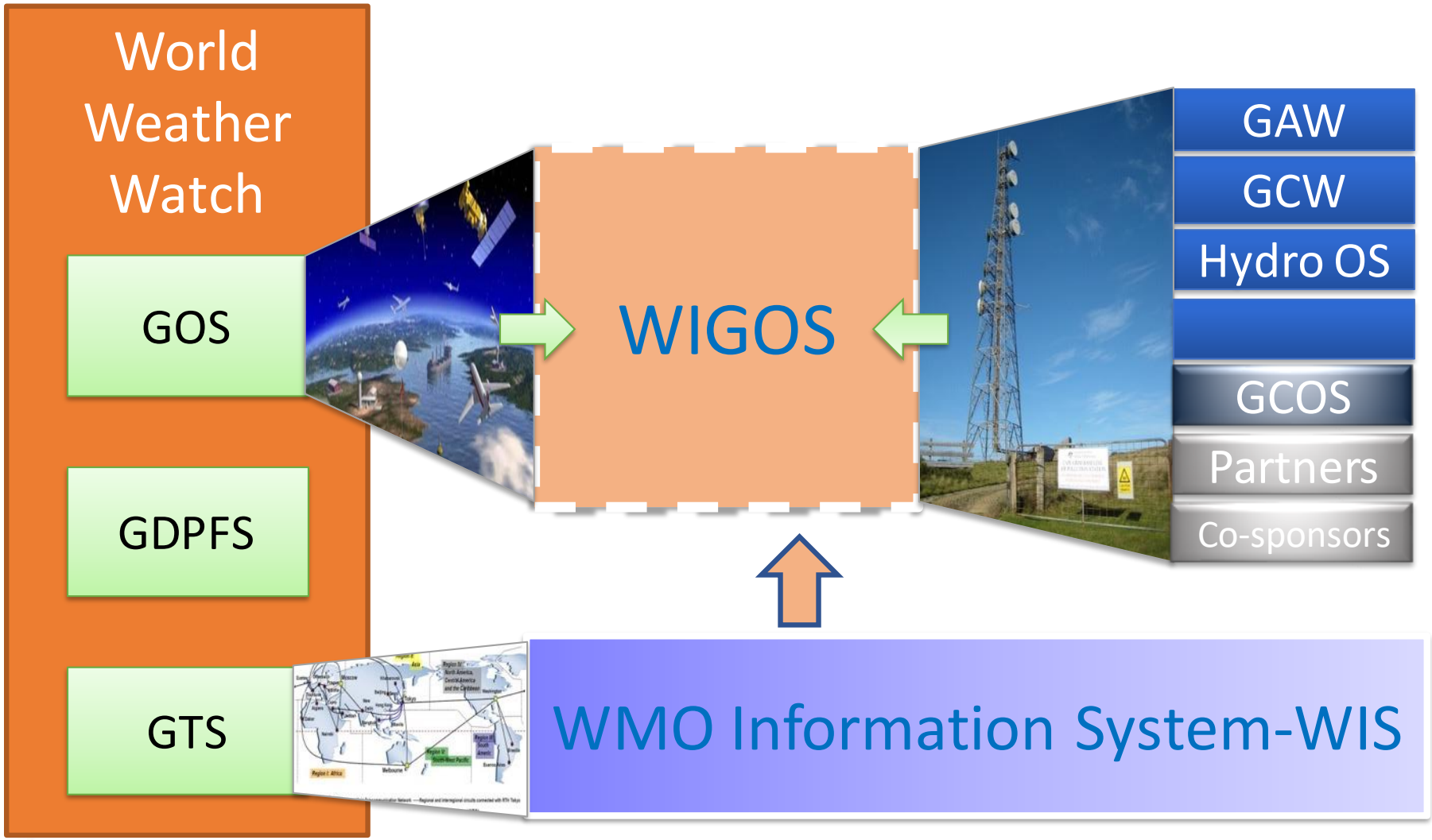


Figure 6.1: Main Components of a logical view



See http://www.wmo.int/pages/prog/sat/documents/ARCH_strategy-climate-architecture-space.pdf

Space-based Observations

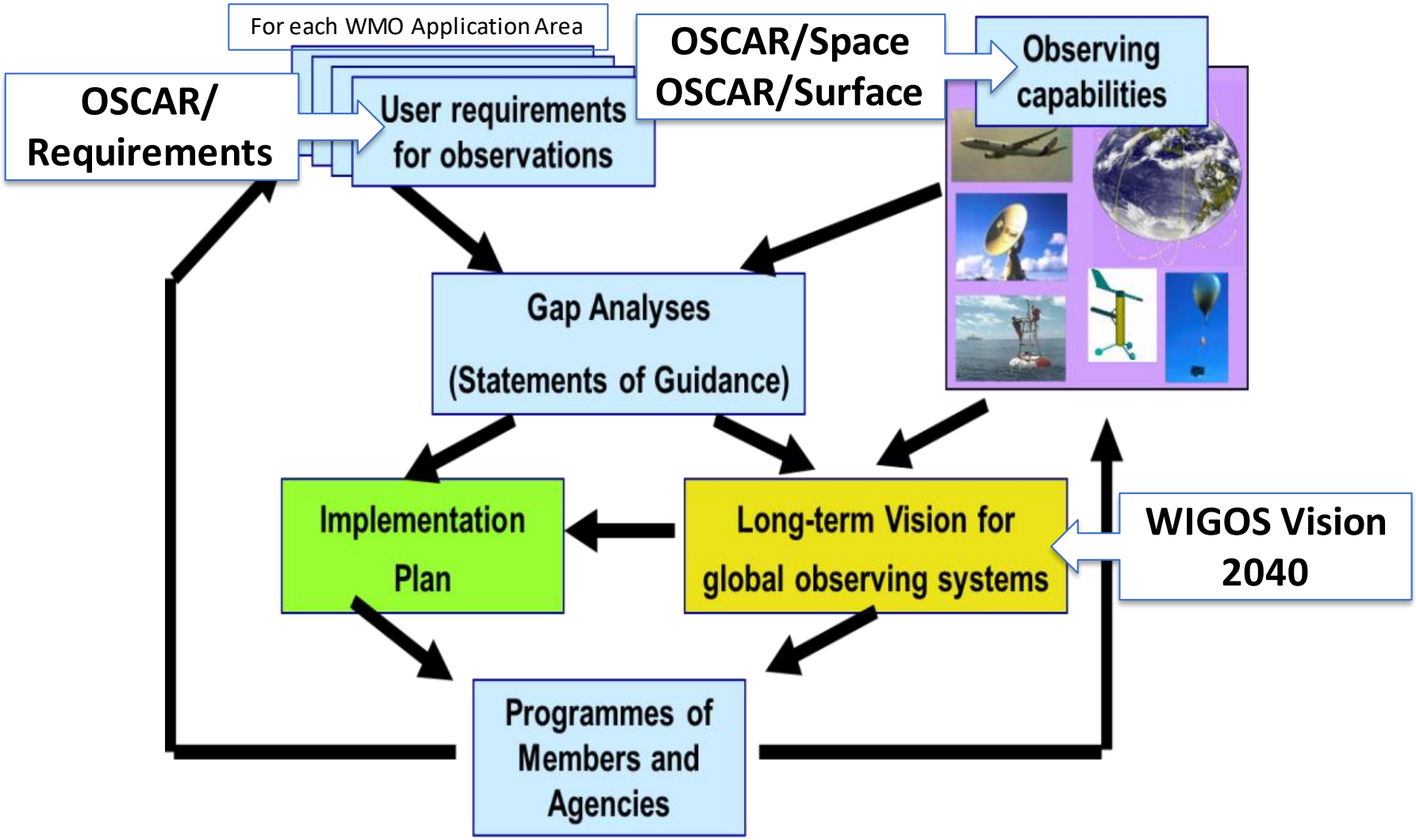


WMO Application Areas

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

Rolling Review of (Observing) Requirements



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

Vision for WIGOS in 2040

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

See CGMS-47-WMO-WP-02

Observing System Capability Analysis and Review Tool

OSCAR

Observing Systems Capability Analysis and Review Tool

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 Capabilities**
- **Surface based Capabilities**

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

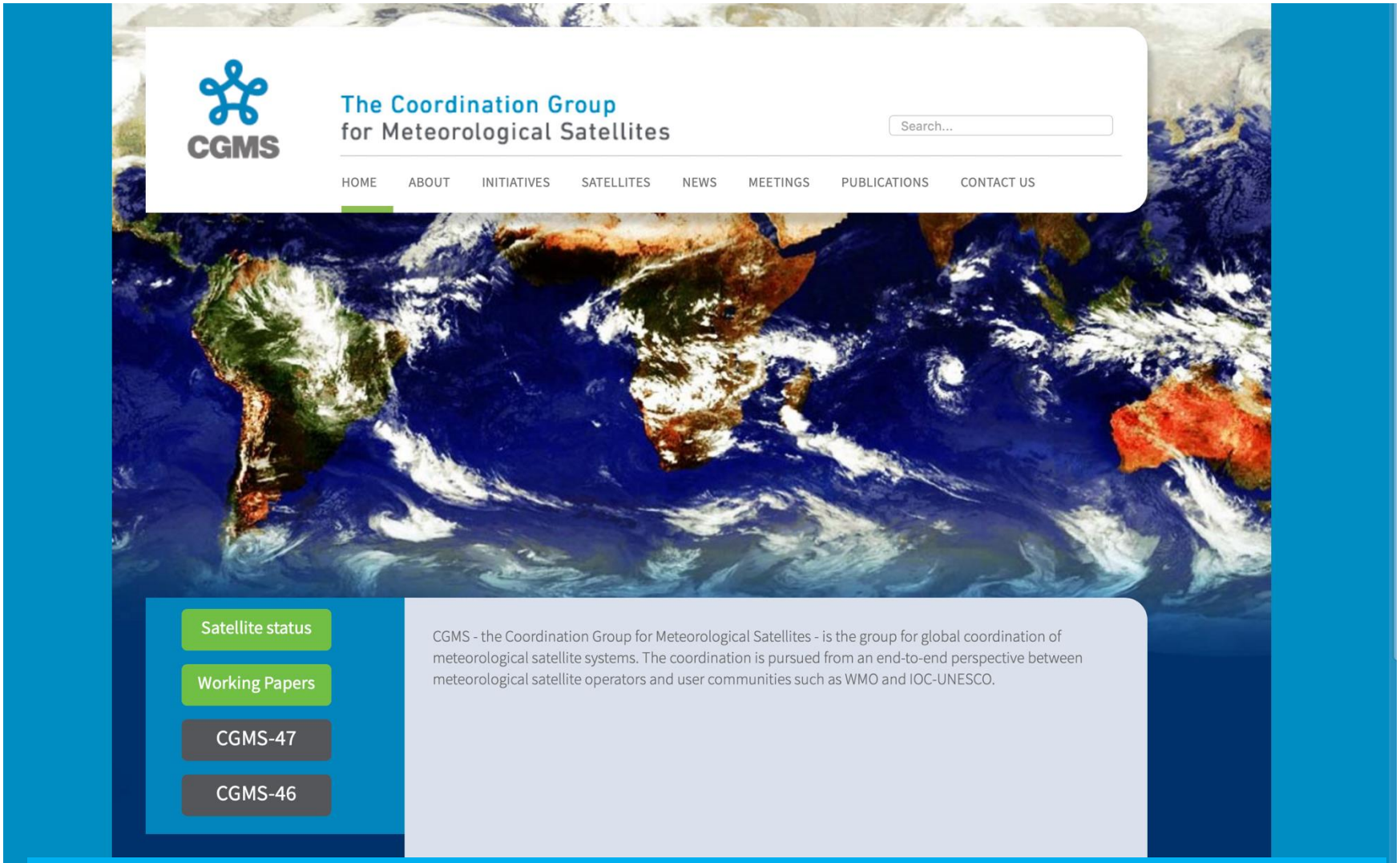
- Watch the 10 minute OSCAR screen-cast to get an overview of the application and learn how to use its functionalities
- Documents available for download
  - OSCAR/Space and OSCAR/Requirements User manual (413 kbyte)
  - OSCAR/Requirements Focal Point manual (200 kbyte) for user requirements ediors
  - 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.

See http://oscar.wmo.int

Coordination Group for Meteorological Satellites



See https://www.cgms-info.org/index_.php/cgms/index

Resolution for Cg-18

- WMO EXTRANET -

WORLD METEOROLOGICAL ORGANIZATION
WEATHER CLIMATE WATER

Please visit our public website:
http://public.wmo.int

Home

Architecture for Climate Monitoring from Space

PROGRAMMES > Space > Architecture for Climate Monitoring from Space

Commission for Basic Systems / OPAG on Integrated Observing Systems

Workshop on the WMO Role in the Architecture for Climate Monitoring from Space

Date: 6 February 2019, 9:00 - 17:00

Venue: WMO HQ, Geneva, Room "8 Jura " (8th floor)

ALL DOCUMENTS AND PRESENTATIONS

Agenda Item	Related Working Documents for Discussion
1	Welcome and Organization of the Session [Provisional Agenda, Invitation Letter]
2	WMO Role in the Architecture for Climate Monitoring from Space (WMO)
3	WGClimate and Architecture for Climate Monitoring from Space (Chair WGClimate)
4	SCOPE-CM and Architecture for Climate Monitoring from Space (Chair SCOPE-CM)
5	Discussion of Draft Consensus Paper on the Architecture for Climate Monitoring from Space (Paper, Presentation) (All)
6	Preparation of Climate Event at the 18th World Meteorological Congress (Cg-18)
7	Closing

Information Documents

I.1 Cg Resolutions and EC Decisions related to the Architecture for Climate Monitoring from Space

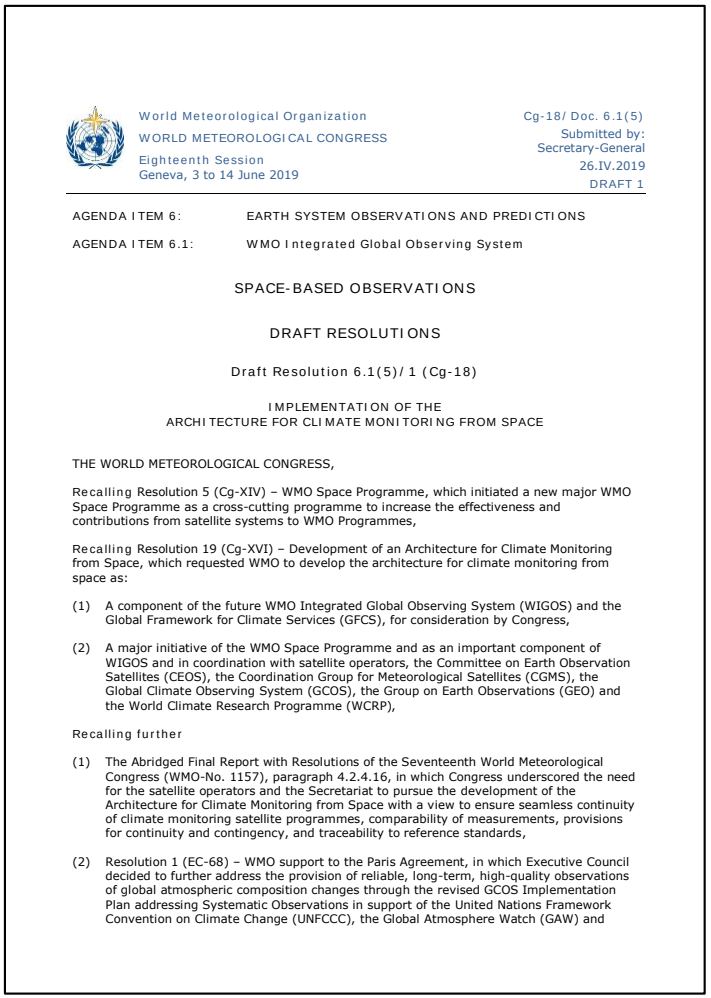
Programme Overview
⇒ Space-based GOS
⇒ Data Access & Use
⇒Awareness & Training
⇒ Space Weather
Regional Activities
Information Resources
Partners

CGMS
GOS
WIGOS
WIS
OSCAR Database

- Discussions at CGMS-46 in 2018 (CGMS-46-WMO-WP-06)
- Workshop organized at WMO on 6 February 2019
- Participation by the major stakeholders
- Agreed on purpose, title, scope and elements of a Draft Resolution for Cg-18, responding to Resolution 19 (Cg-XVI)

See http://www.wmo.int/pages/prog/sat/meetings/Climate-architecture-workshop.php

Draft Resolution 6.1(5)/1



World Meteorological Organization
WORLD METEOROLOGICAL CONGRESS
Eighteenth Session
Geneva, 3 to 14 June 2019

Cg-18/ Doc. 6.1(5)
Submitted by:
Secretary-General
26.IV.2019
DRAFT 1

AGENDA ITEM 6: EARTH SYSTEM OBSERVATIONS AND PREDICTIONS

AGENDA ITEM 6.1: WMO Integrated Global Observing System

SPACE-BASED OBSERVATIONS

DRAFT RESOLUTIONS

Draft Resolution 6.1(5)/1 (Cg-18)

IMPLEMENTATION OF THE
ARCHITECTURE FOR CLIMATE MONITORING FROM SPACE

THE WORLD METEOROLOGICAL CONGRESS,

Recalling Resolution 5 (Cg-XIV) – WMO Space Programme, which initiated a new major WMO Space Programme as a cross-cutting programme to increase the effectiveness and contributions from satellite systems to WMO Programmes,

Recalling Resolution 19 (Cg-XVI) – Development of an Architecture for Climate Monitoring from Space, which requested WMO to develop the architecture for climate monitoring from space as:

(1) A component of the future WMO Integrated Global Observing System (WIGOS) and the Global Framework for Climate Services (GFCS), for consideration by Congress,

(2) A major initiative of the WMO Space Programme and as an important component of WIGOS and in coordination with satellite operators, the Committee on Earth Observation Satellites (CEOS), the Coordination Group for Meteorological Satellites (CGMS), the Global Climate Observing System (GCOS), the Group on Earth Observations (GEO) and the World Climate Research Programme (WCRP),

Recalling further

(1) The Abridged Final Report with Resolutions of the Seventeenth World Meteorological Congress (WMO-No. 1157), paragraph 4.2.4.16, in which Congress underscored the need for the satellite operators and the Secretariat to pursue the development of the Architecture for Climate Monitoring from Space with a view to ensure seamless continuity of climate monitoring satellite programmes, comparability of measurements, provisions for continuity and contingency, and traceability to reference standards,

(2) Resolution 1 (EC-68) – WMO support to the Paris Agreement, in which Executive Council decided to further address the provision of reliable, long-term, high-quality observations of global atmospheric composition changes through the revised GCOS Implementation Plan addressing Systematic Observations in support of the United Nations Framework Convention on Climate Change (UNFCCC), the Global Atmosphere Watch (GAW) and

- Recalls background and history
- Confirms importance of the architecture
- Describes the architecture and its status
- Recognizes contributions of all stakeholders
- Reflects, acknowledges and expresses appreciation for achievements
- Endorses its continued implementation
- Requests continued support of space agencies

See https://www.cgms-info.org/Agendas/WP/CGMS-47-WMO-WP-04

IV. Conclusions

How Well Are We Achieving the SDGs?

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

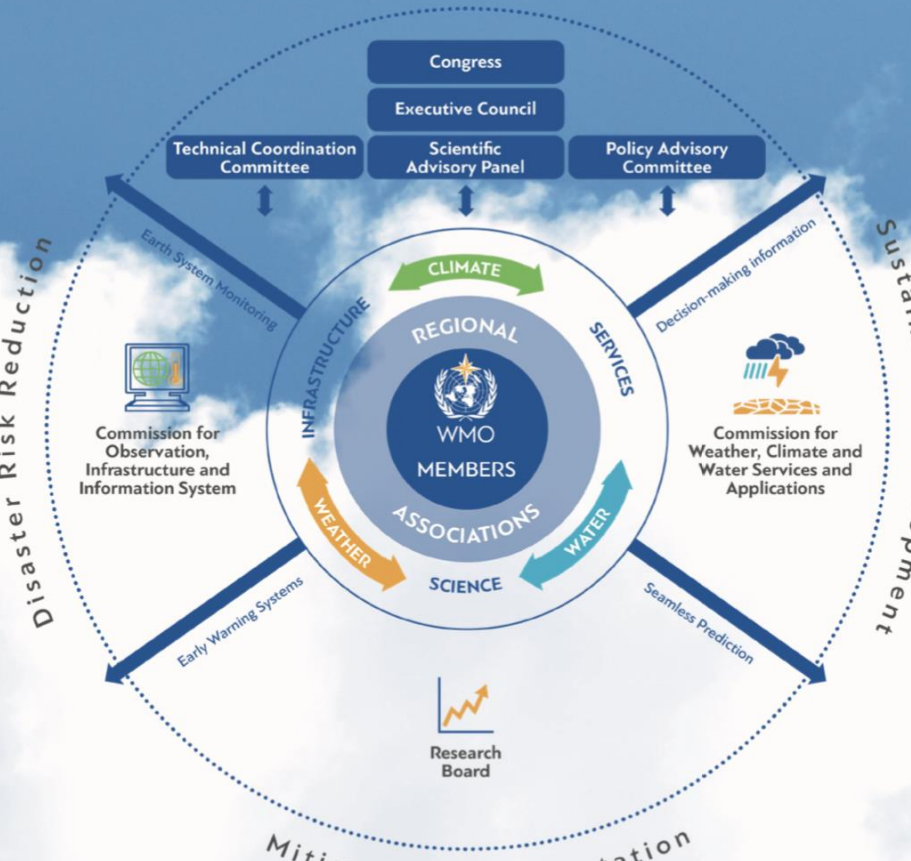
1 Services	2 Infrastructures	3 Science & Innovations	4 Member Services	5 Smart Organization
Better serve societal needs	**Enhance Earth system observations and predictions**	**Advance targeted research**	**Close the capacity gap**	**Strategic realignment of structure and programmes**

STRATEGIC OBJECTIVES

FOCUSED ON 2020-23

• 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**

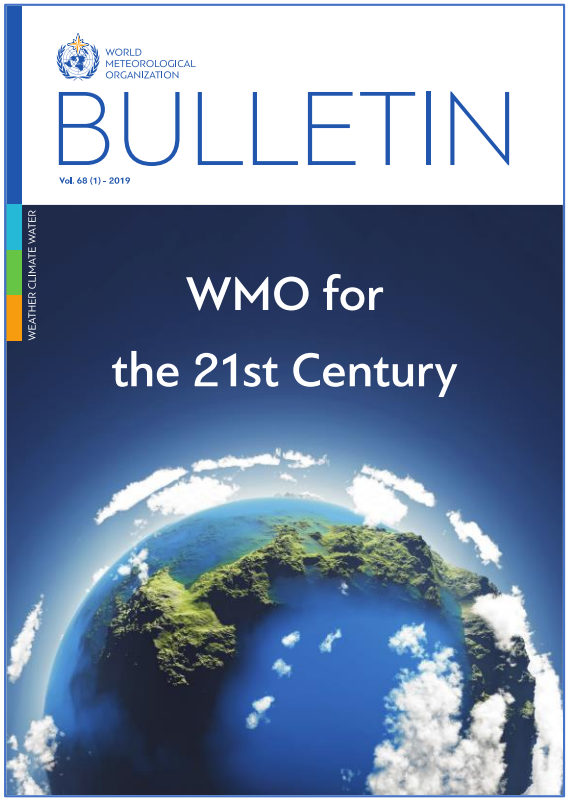
WMO for the 21st Century



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

Conclusions

- Space-based observing systems are essential for achieving global development agendas and for addressing climate change
- All actors (space agencies, satellite operators, NMHSs, governments, UN ...) must work together to realize the full potential of space technology and its applications!



See https://library.wmo.int/doc_num.php?explnum_id=5843

WEATHER CLIMATE WATER

Thank you

WMO Space Programme
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