
Global Climate Observing System and the role of Satellite Data in Climate Monitoring

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Chairman, GCOS Atmospheric Observation Panel for Climate (AOPC)

United Nations/Germany International Conference on Earth Observation

Bonn, Germany

27 May 2015



Script:

1 - History of the GCOS

**2- Concept of the Global Climate Observing System:
A systems of systems for climate observations**

3 – Rationale for GCOS:

**4 – Next plans: GCOS is assessing the status of the global observing systems
for climate:**

supporting climate services

evolution

status report and new implementation plan

discussing Earth-life cycles

launch of new plane

Script:

1 - History of the GCOS programme (slides 3-7): list of initiatives to coordinate observations on a global scale (slide 8), IPCC First Assessment Report and 2nd World Climate Conference (slides 9 and 10), which called upon and eventually decided on systematic observations for climate and signed Mou for a GCOS (slide 11)

2- Concept of the Global Climate Observing System: a systems of systems for climate observations (slides 8-11)

3 – Rationale for GCOS: Importance of Climate Observations (slide 12), GCOS networks GSN and GUAN (slides 13 – 15); Reasons why climate observations need to be enhanced, and GCOS` mandate (slides 16 – 23)

4 – Next plans: GCOS is assessing the status of the global observing systems for climate: supporting climate services (slides 25-26), evolution (slides 27 – 29), status report and new implementation plan (slides 30-35), discussing Earth-life cycles (slide 36), launch of new plane (slide 37)



Global Climate Observing before GCOS

- Humboldt (1769-1859)
- Maury and the Brussels Conference (1853)
- International Meteorological Organization (1873)
- The National Meteorological Service
- International Polar Years and the IGY (1957)
- The Wexler Vision and Weather Satellites
- World Weather Watch and GARP (1967)
- World Climate Conference (1979) and the World Climate Programme
- Villach (1985), Brundtland (1987) and the IPCC (1988)

credit to: John W. Zillman (GCOS Sc Chairman 2006-2009)

The Origin of GCOS

IPCC FAR

CLIMATE CHANGE
The IPCC Scientific Assessment
August 1990
 Policy Makers' Summary

Chapter 11

“We need...to improve the systematic observation of climate-related variables on a global basis...”

“It is necessary to develop a comprehensive Global Earth Observing System”. Require:

- Improvement of the Global Atmosphere and Land Surfaces Observing System,
- Development of a Global Ocean and Ice Observing System.

WORLD METEOROLOGICAL ORGANIZATION UNITED NATIONS ENVIRONMENT PROGRAMME
 INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

VIEUX BOIS

Gordon Mc Bean (WCRP)
Pierre Morel (WCRP)
John Houghton
Jim Baker
Jim Bruce
John Woods
John Rodda
Andre Lebeau
Angus McEwan
Jim O'Brien
David Axford (WMO)
Gunnar Kullenberg (IOC)

WCC-2 Conference Statement

CLIMATE CHANGE: SCIENCE, IMPACTS AND POLICY

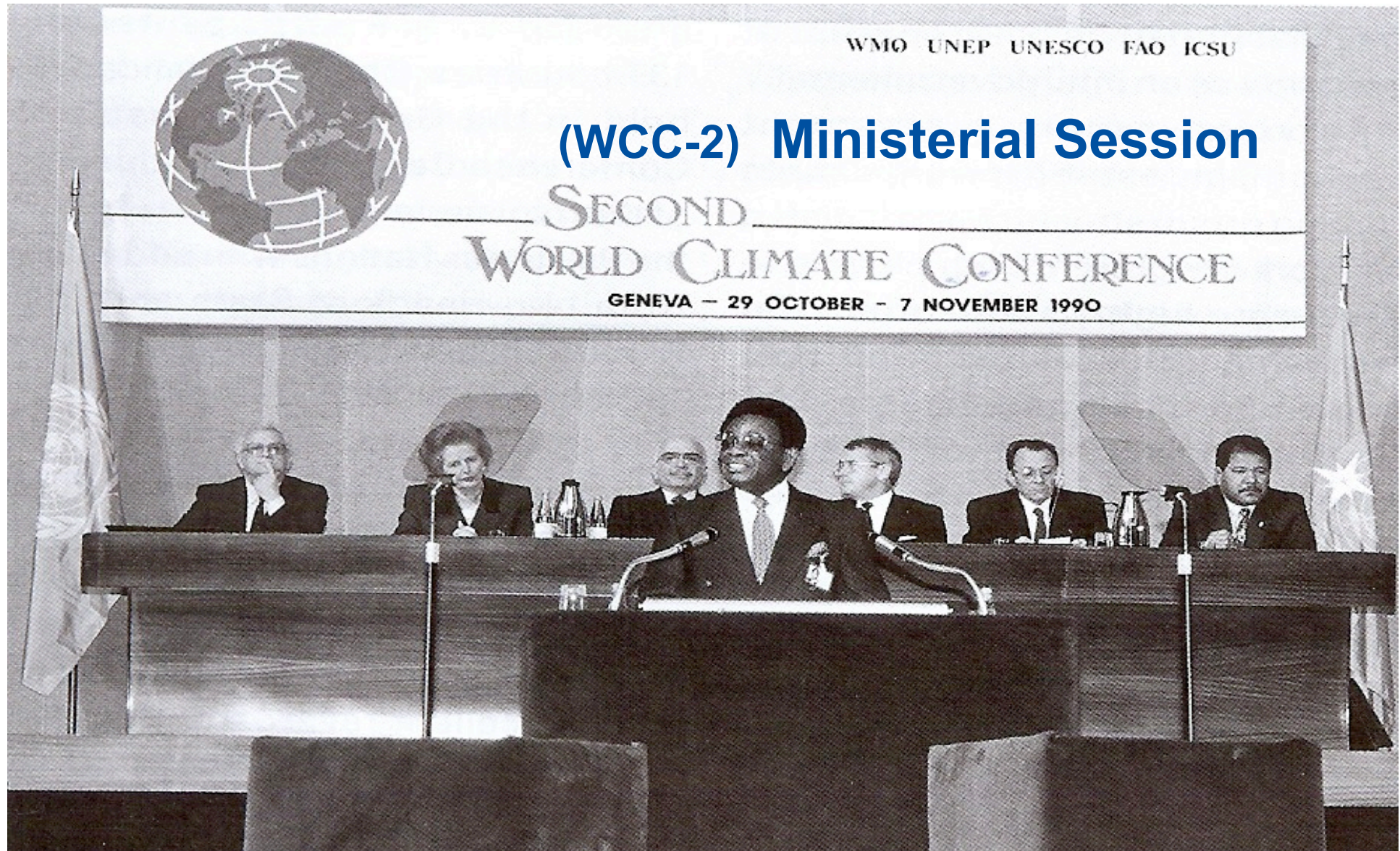
“Present observational systems for monitoring the climate system are inadequate for operational and research purposes. They are deteriorating in both industrialised and developing regions...”

“There is an urgent need to create a Global Climate Observing System (GCOS) built upon the World Weather Watch Global Observing System and the Integrated Global Ocean Service System and including both space-based and surface-based components.....”.

PROCEEDINGS OF THE SECOND WORLD CLIMATE CONFERENCE
 EDITED BY J. JÄGER AND H. L. FERGUSON

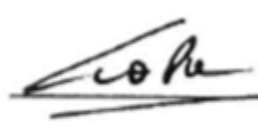

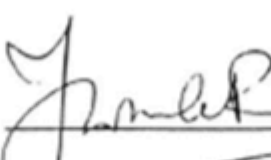

credit to: John W. Zillman (GCOS Sc Chairman 2006-2009)

Second World Climate Conference



GCOS Memorandum of Understanding

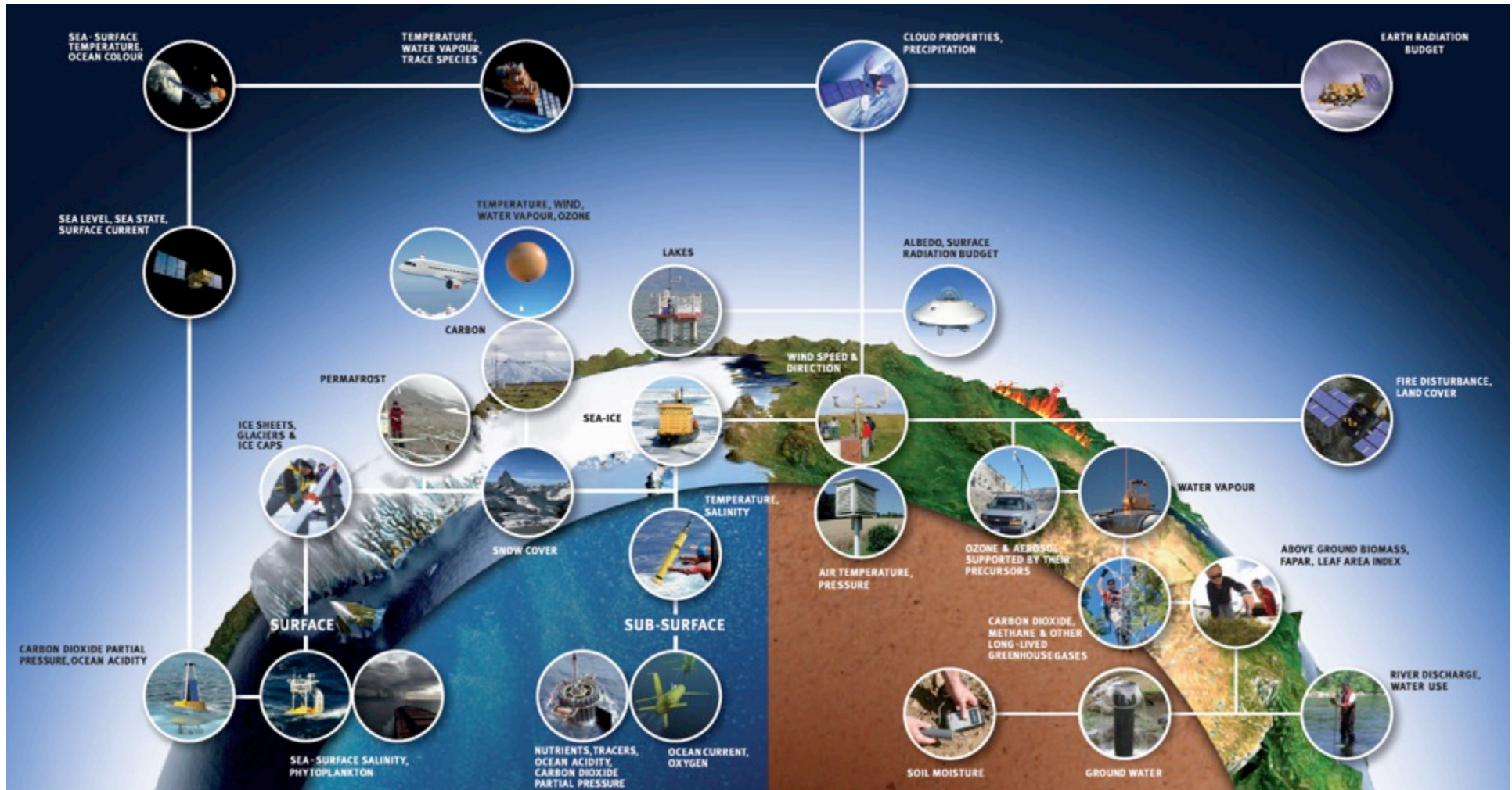
AGREE that this Memorandum of Understanding shall come into force on signature by all four parties.

			
Secretary-General WMO	Secretary IOC	Secretary-General ICSU	Executive Director UNEP
Place: <u>GENEVA</u>	Place: <u>Paris</u>	Place: <u>Paris</u>	Place: <u>Geneva</u>
Date: <u>5/2/92</u>	Date: <u>7/2/92</u>	Date: <u>20/2/92</u>	Date: <u>9/4/1992</u>

This MoU defines the rationale for the establishment of GCOS and its purpose, concept of operation, governance and financial arrangements.

Signed on 9. April 1992 by WMO, IOC, ICSU and UNEP; updated in 1998

Need of Coordination of Climate Observing Systems



Scope of GCOS as a System (of Systems)

GCOS encompasses the climate components of:

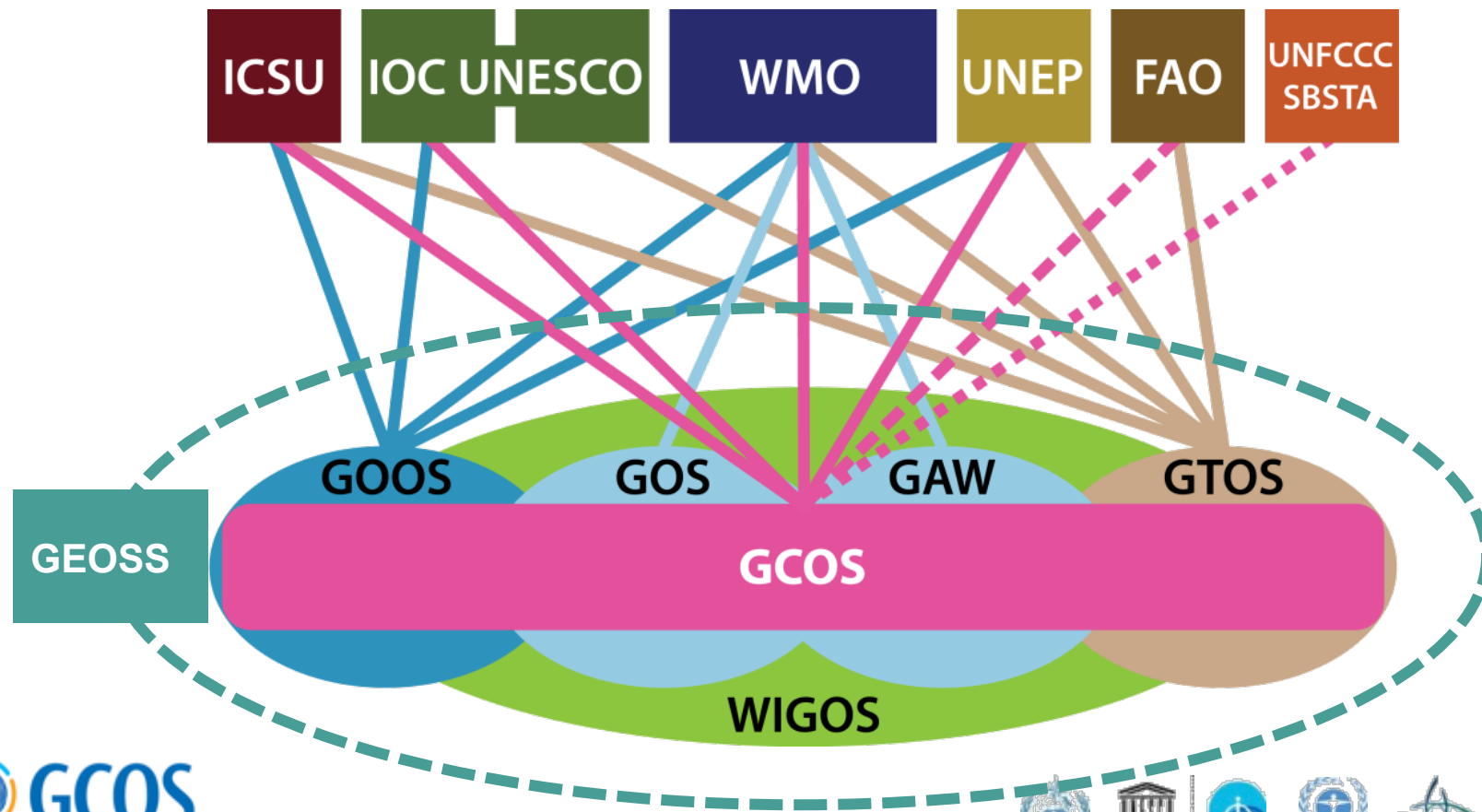
- the **WMO observing systems (WIGOS: GOS, GAW, WHYCOS, ...)**
- the **IOC-led co-sponsored Global Ocean Observing System (GOOS)**
- the **FAO-led co-sponsored Global Terrestrial Observing System (GTOS)**
- observational elements of **research programmes (WCRP, IGBP, ...)**
- other **systems contributing to climate observations, data management or products**

which together form our overall global observing system for climate, and the climate-observing component of the GEO System of Systems



Sponsors and Partners

GCOS assesses progress and requirements, advises on implementation, and reports to UNFCCC on the status of observing systems for climate.



GCOS Expert Panels for Atmosphere, Oceans and Land



Key mandates of **AOPC**:

- Assess the current state of the atmospheric component of the GCOS and identify gaps and inadequacies
- Secure the implementation of designated GCOS networks and promote the establishment and enhancement of systems to provide consistent, long-term data and information for atmospheric Essential Climate Variables (ECVs)
- Liaise with relevant research, operational and end-user bodies in order to identify and maintain the requirements for data to monitor, understand and predict the dynamical, physical and chemical state of the atmosphere and its interfaces on seasonal to multi-decadal time scales



Key mandates of **TOPC**:

- Identify measurable terrestrial (biosphere, cryosphere, and hydrosphere) ECVs, which control the physical, biological and chemical processes affecting climate
- Coordinate activities with other global observing system panels and task groups to ensure the consistency of requirements with overall programmes
- Assess and monitor the adequacy of terrestrial observing networks such as the Global Terrestrial Networks (GTNs), and promote their integration and development in order to measure and exchange climate data and information



Key mandates of **OOPC**:

- Provide scientific requirements to the Joint WMO-IOC Technical Commission on Oceanography and Marine Meteorology (JCOMM) Observations Coordination Group
- Review and prioritise requirements for sustained observations of the ocean ECVs and physical Essential Ocean Variables (EOVs) in support of the Global Ocean Observing System (GOOS), GCOS and WCRP
- Provide technical advice on the development of national coastal and ocean observing requirements and observing system implementation

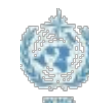


ICSU
International Council for Science

GCOS is strongly supported by the international science community, and the World Climate Research Programme (WCRP) co-sponsors three expert panels for atmospheric, oceanic and terrestrial observations. These panels gather experts from the climate research community and utilize their specific expertise to generate output benefitting the climate observation community.



For more information, please go to: <http://gcos.wmo.int>



ICSU
International Council for Science

Essential Climate Variables (ECVs)

OCEANIC

Surface (10)

- Sea-surface temperature
- Sea-surface salinity
- Sea level
- Sea state
- Sea ice
- Surface current
- Ocean colour
- Carbon dioxide partial pressure
- Ocean acidity
- Phytoplankton

Sub-surface (8)

- Temperature
- Salinity
- Current
- Nutrients
- Carbon dioxide partial pressure
- Ocean acidity
- Oxygen
- Tracers

ATMOSPHERIC

Surface (6)

- Air temperature
- Wind speed and direction
- Water Vapour
- Pressure
- Precipitation
- Surface radiation budget

Upper-air (5)

- Temperature
- Wind speed and direction
- Water Vapour
- Cloud properties
- Earth radiation budget (incl. solar irradiance)

Composition (5)

- Carbon dioxide
- Methane
- Other long-lived greenhouse gases
- Ozone, supported by its precursors
- Aerosol, supported by its precursors

TERRESTRIAL

Biological/Ecological/Other (7)

- Land Cover
- FAPAR
- Leaf area index
- Above ground biomass
- Soil carbon
- Fire disturbance
- Albedo

Hydrological (5)

- River discharge
- Water use
- Ground water
- Lakes
- Soil moisture

Cryospheric (4)

- Snow cover
- Glaciers and ice caps
- Ice sheets
- Permafrost

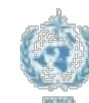


ICSU

International Council for Science

GCOS has defined a list of Essential Climate Variables (ECVs) that are both technically and economically feasible for systematic observation and global implementation, and for which observations are needed to meet important requirements of the UNFCCC and the IPCC. It is these variables for which international exchange is required for both current and historical observations.

For more information, please go to: <http://gcos.wmo.int>



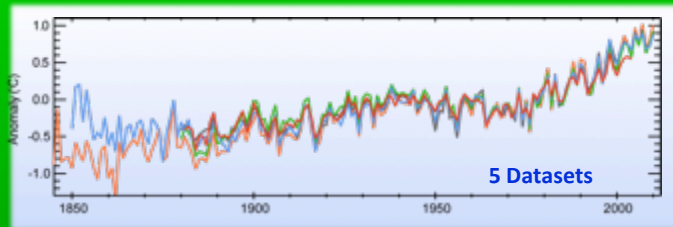
ICSU

International Council for Science

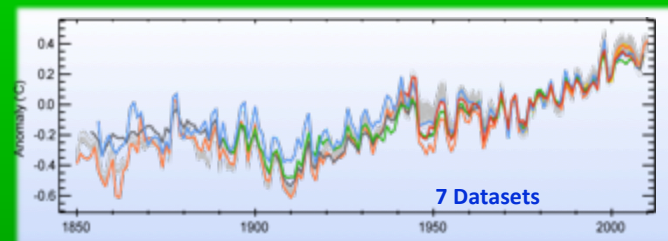
The Importance of Climate Observations

Observations made in the past have unequivocally demonstrated that the climate system is warming.

Land Surface Air Temperature

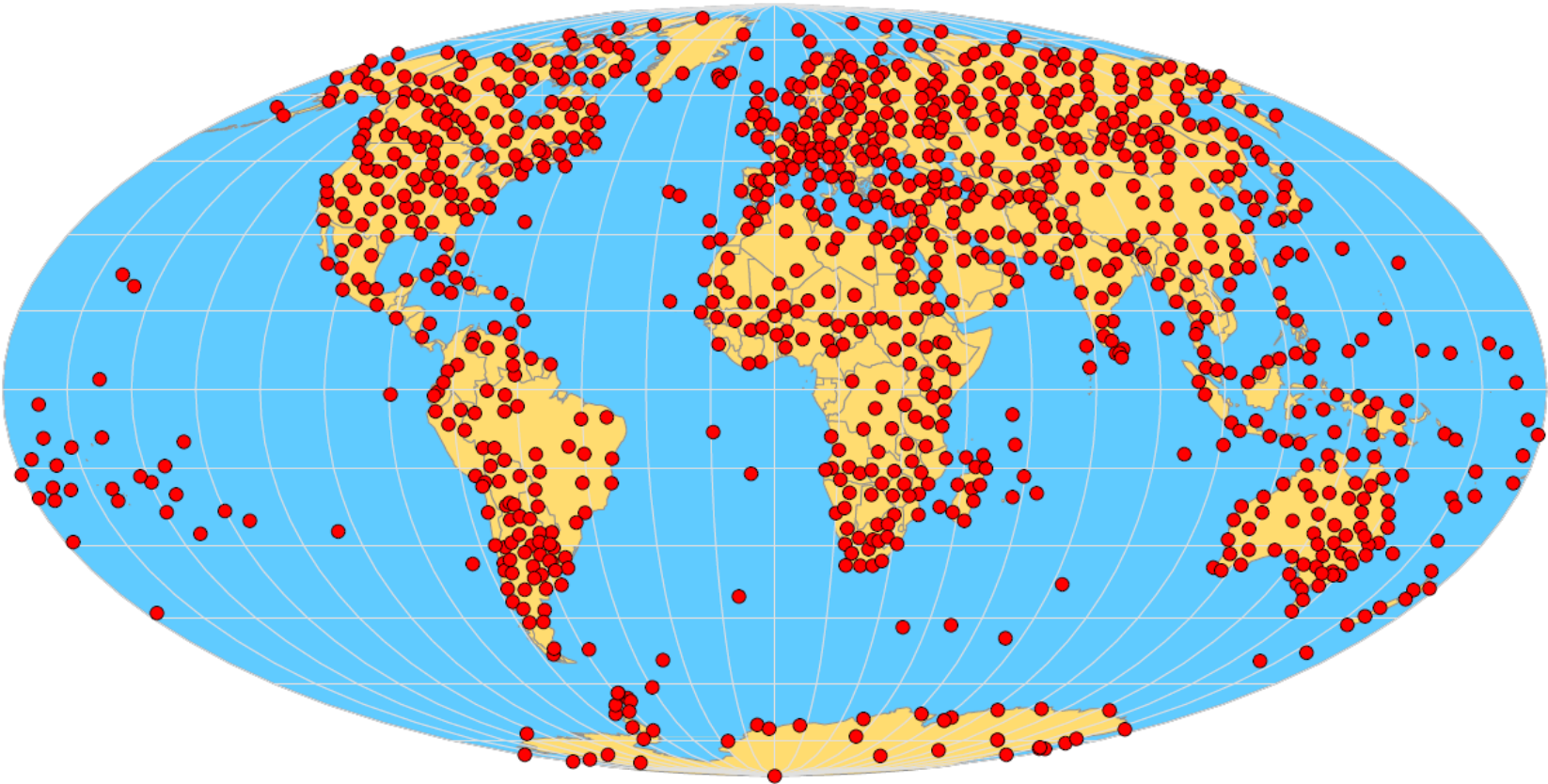


Sea Surface Temperature



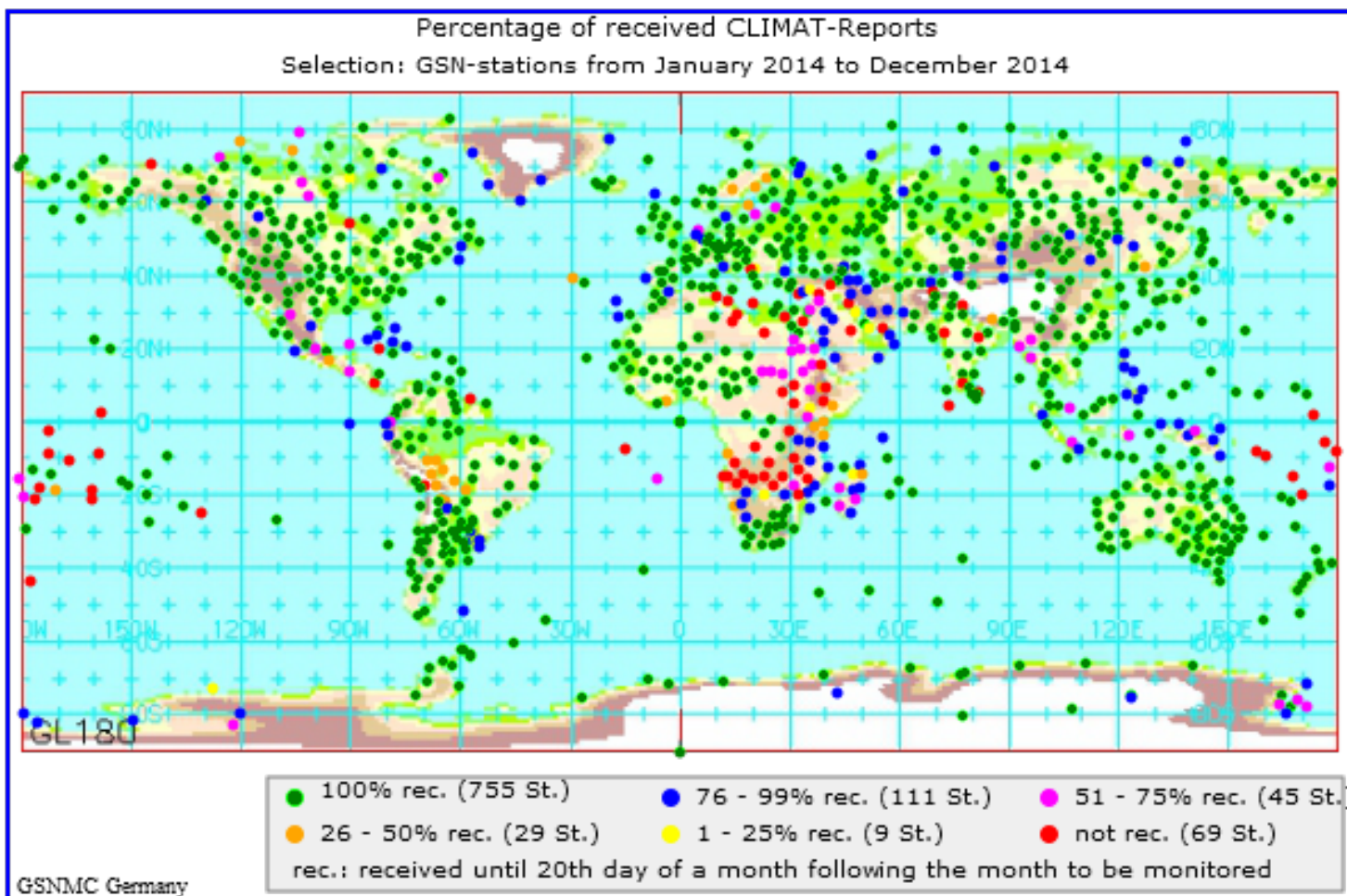
GCOS Surface Network

(1017 Stations)



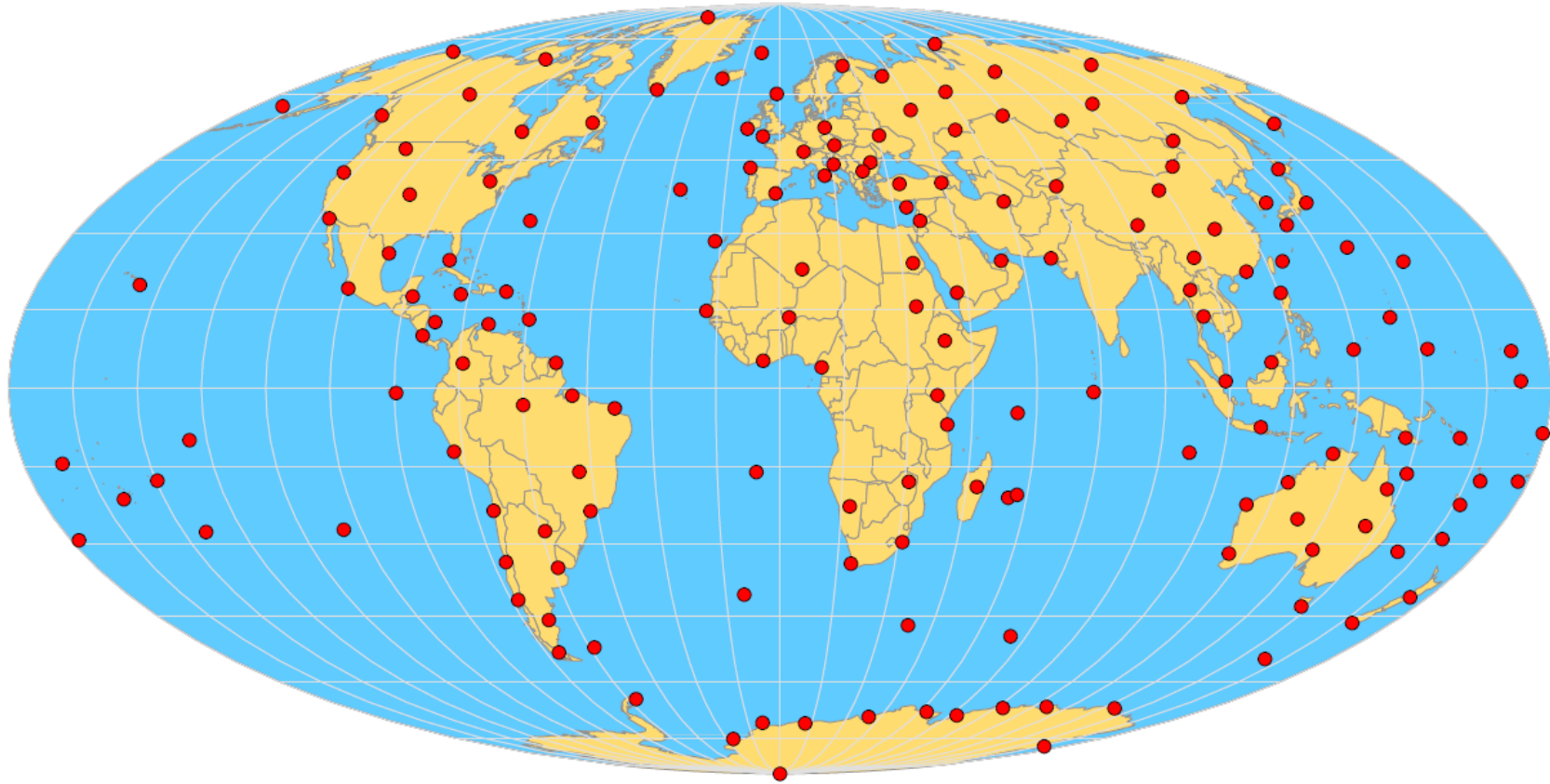
GCOS Secretariat, 1 March 2014

Arrival rate CLIMAT at DWD 2014



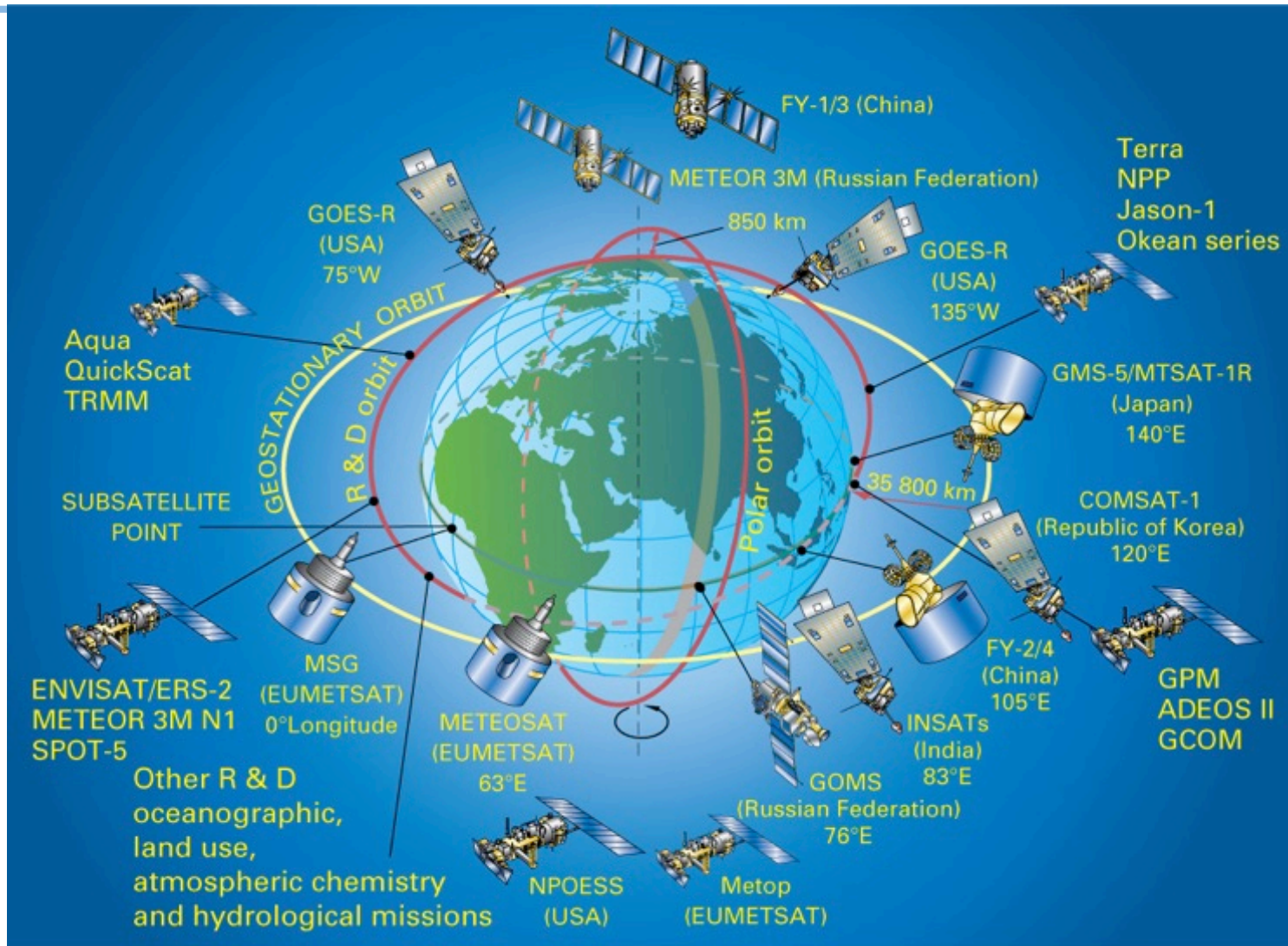
GCOS Upper-Air Network

(171 Stations)

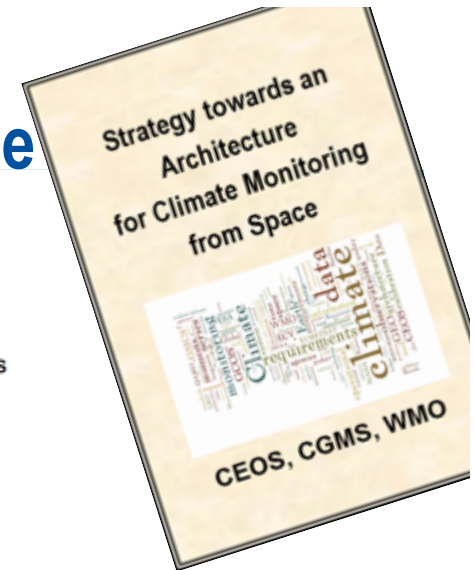
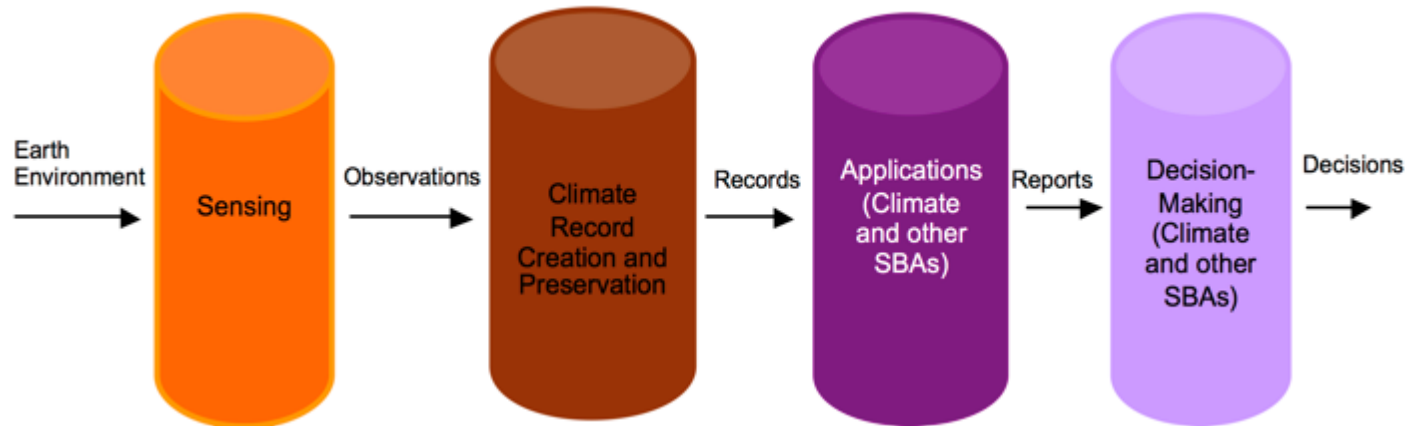


GCOS Secretariat, 1 March 2014

...and the space based observing system



Four Pillars of end-to-end Architecture for Climate Monitoring from Space



- The sensing level (Pillar 1) drives the *potential* to generate ECVs
- The climate record creation (Pillar 2) is the *actual* use of this potential
- The ECV inventory addresses Pillar 2 => helps maximize the use of data
- Calibration activities must be addressed in both Pillars 1 and 2 :
 - 1) Space segment (pre-launch and on-board calibration, space/ground references)
 - 2) Applying inter-calibration corrections, re-calibration of archived data

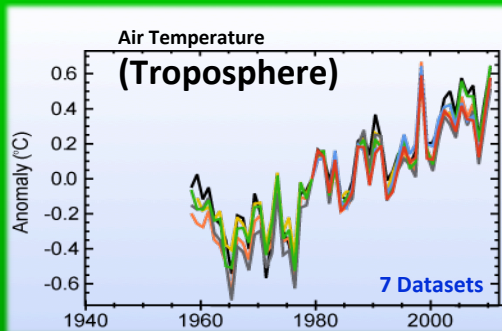
How should calibration be addressed in the Architecture?

- **Calibration infrastructure to be implemented and shared**
 - a) In-orbit references for traceability
 - b) Ground-based calibration sites
 - c) Databases and software tools
 - **Calibration processes to be addressed by operators**
 - a) Best practices for pre-launch calibration
 - b) Procedures for in-orbit calibration with uncertainty estimation
 - c) Procedures for in-orbit comparison and inter-calibration
 - d) Procedures for vicarious calibration with ground targets
 - e) Algorithms/tools for re-calibration of archived data
 - f) Communication and capacity building (incl. QA4EO)
- **These activities are conducted by GSICS together with CEOS/WGCV**

- Space-based observations required for weather and climate applications rely on multiple satellite missions from different agencies around the world
- To be reliable and interoperable, these different sources must be precisely calibrated with similar methods and common references. Poor or inhomogeneous calibration would result in degraded performance
- GSICS members are collaborating to develop and apply “best practices” for state-of-the-art and homogeneous calibration
- GSICS provides references, tools and guidelines, for **prelaunch characterization, instrument performance monitoring, anomaly resolution, comparison of sensors, and correction if necessary.**

Climate observations must be enhanced and continued into the future, to enable users to.....

... detect further climate change and determine its causes.

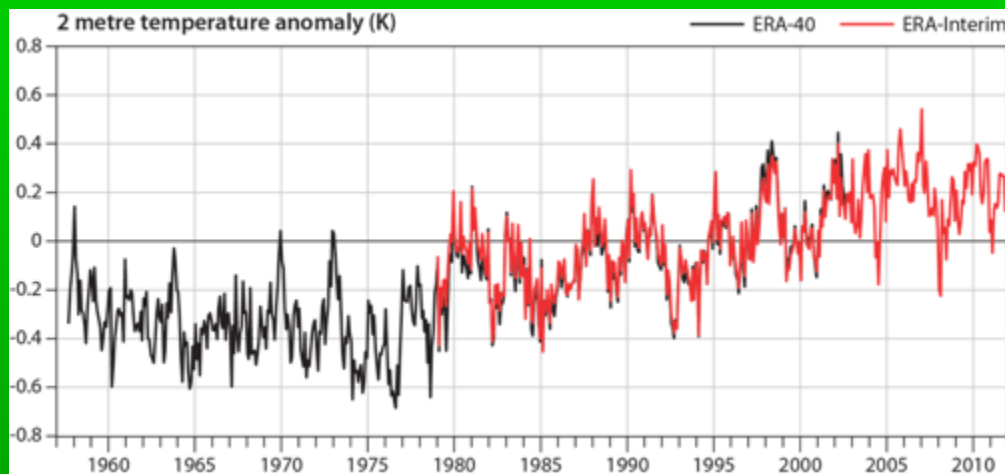


GCOS Reference
Upper-air Network

Climate observations must be enhanced and continued into the future, to enable users to.....

... model and predict the climate system.

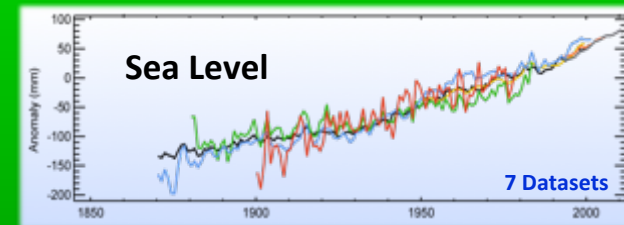
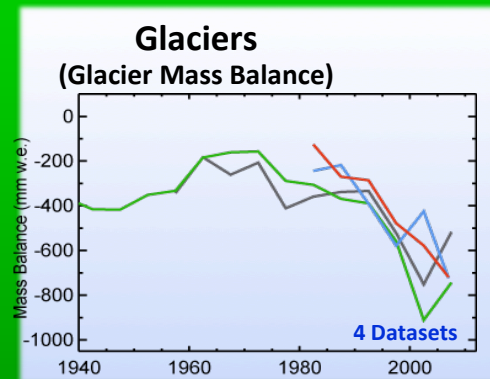
ECMWF



A **climate reanalysis** gives a numerical description of the recent climate, produced by combining models with observations. It contains estimates of atmospheric parameters such as **air temperature, pressure and wind** at different altitudes, and surface parameters such as **rainfall, soil moisture content, and sea-surface temperature**. The estimates are produced for all locations on earth, and they span a long time period that can extend back by decades or more. © **European Centre for Medium-Range Weather Forecasts**

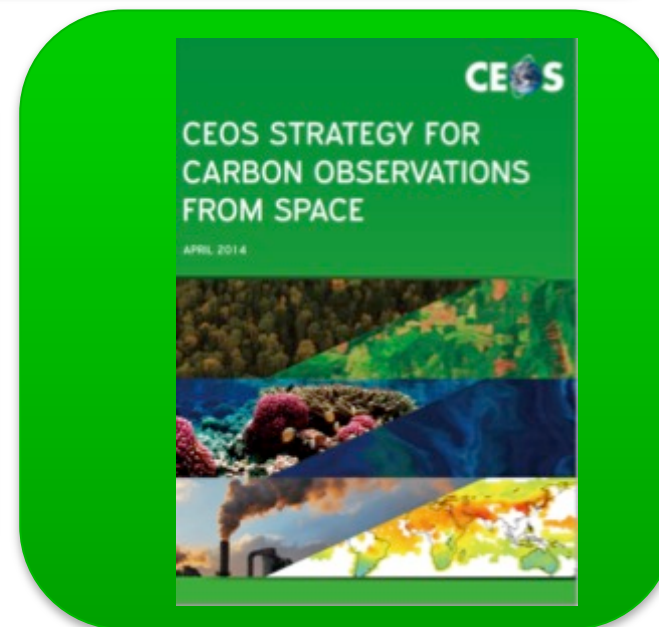
Climate observations must be enhanced and continued into the future, to enable users to.....

... assess impacts of climate variability and change.



Climate observations must be enhanced and continued into the future, to enable users to.....

... monitor the effectiveness of policies for mitigation climate change.



Climate observations must be enhanced and continued into the future, to enable users to.....

... support adaptation to climate change.



Building elevated houses to cope with sea level rise



Left: Sea level rise is one important impact of global temperature increase. Right: Stilt houses can prevent losses due to rising sea levels.

Adaptation Calendar 2014

Building Climate Resilience through Practical Action

United Nations Framework Convention on Climate Change 2014



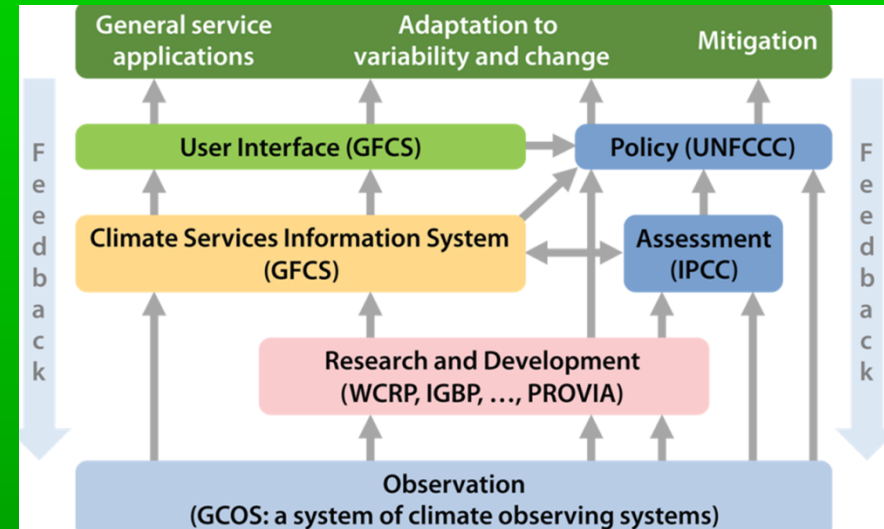
Lowering glacial lakes to prevent flashfloods



Left: Glacial Lake Outburst Floods (GLOFs) pose a great risk in mountainous areas. Right: Lowering of glacial lakes can help prevent GLOFs.

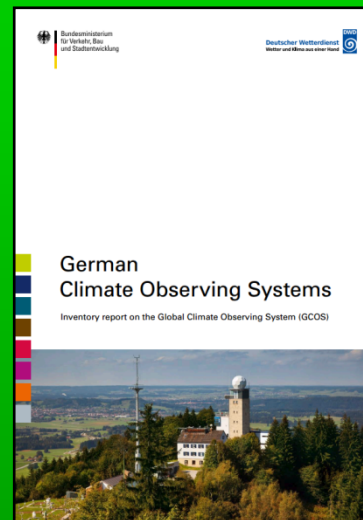
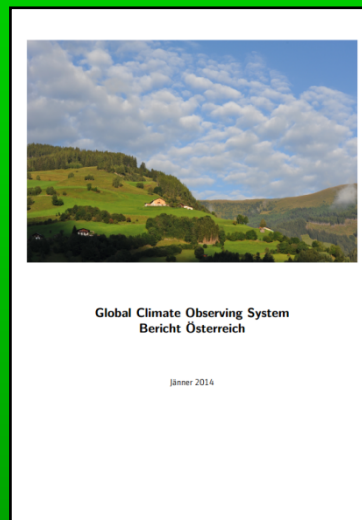
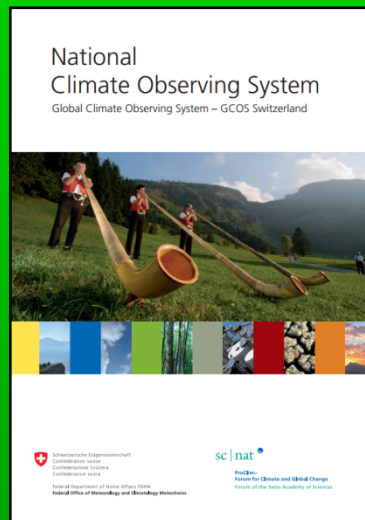
Climate observations must be enhanced and continued into the future, to enable users to.....

... develop climate information services.



Climate observations must be enhanced and continued into the future, to enable users to.....

... promote sustainable national and economic development.



National GCOS reports that present the progress made in the implementation of GCOS on a national level, and give an overview of the observations made according to the list of GCOS ECVs.

- 25 National GCOS Coordinators
- 151 National GCOS Focal Points

Climate observations must be enhanced and continued into the future, to enable users to.....

...meet other requirements of the UNFCCC and other international conventions and agreements.

UNFCCC Convention May 1992

Article 4 Commitments

- All Parties shall: 1(g) Promote and cooperate in scientific, technological, technical, socio-economic and other research, **systematic observation** and development of data archives related to the climate system.....

Article 5 Research and Systematic Observations

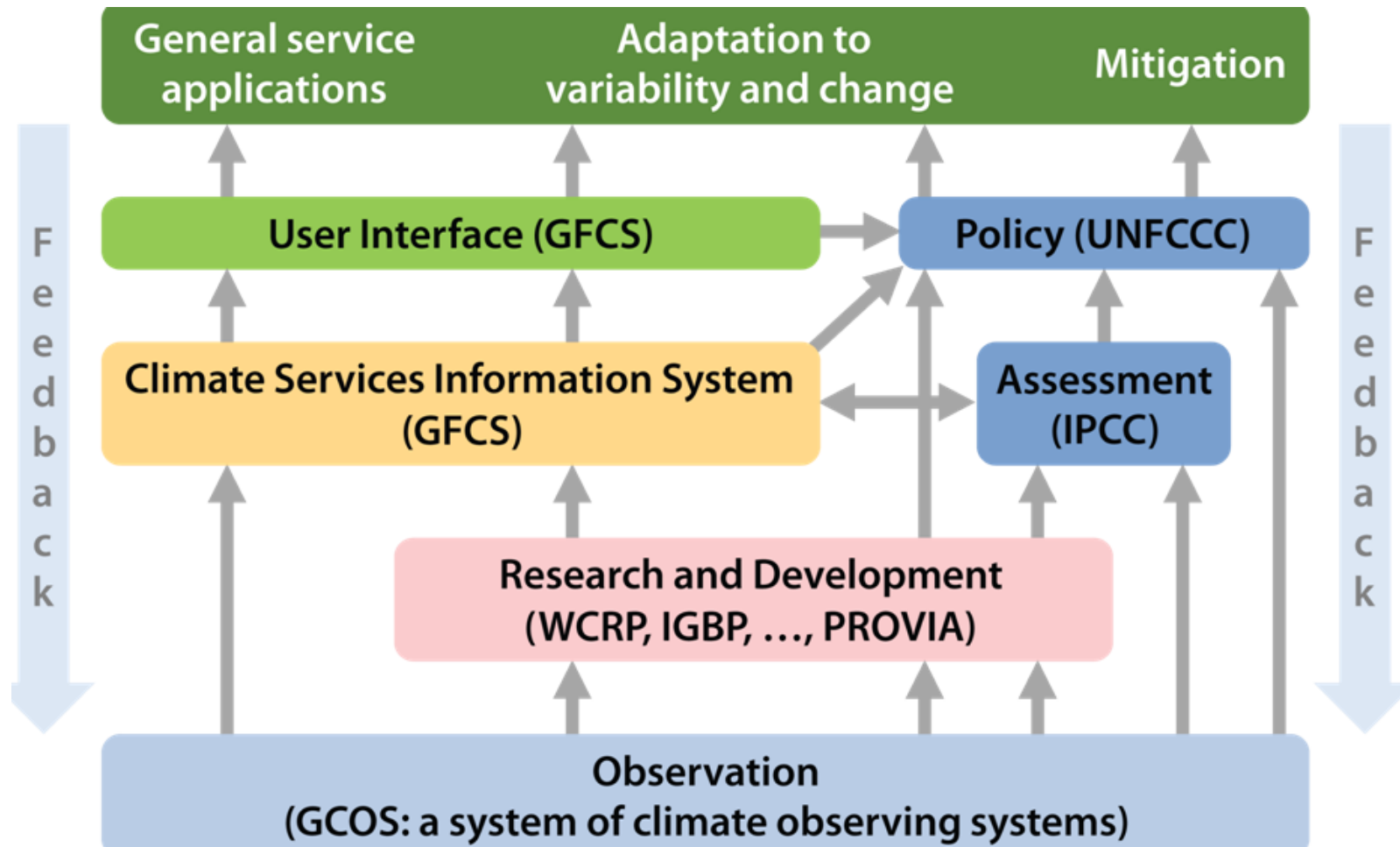
- In carrying out their commitments under Article 4, paragraph 1(g), the Parties shall: (a) Support and further develop... programs and networks or organizations aimed at defining, conducting, assessing and financing research, data collection and **systematic observation**, taking into account the need to minimize duplication of effort; (b) Support international and intergovernmental efforts to strengthen **systematic observation** particularly in developing countries, and to promote access to, and the exchange of, data and analyses thereof.....

Plans 2015 - 2016

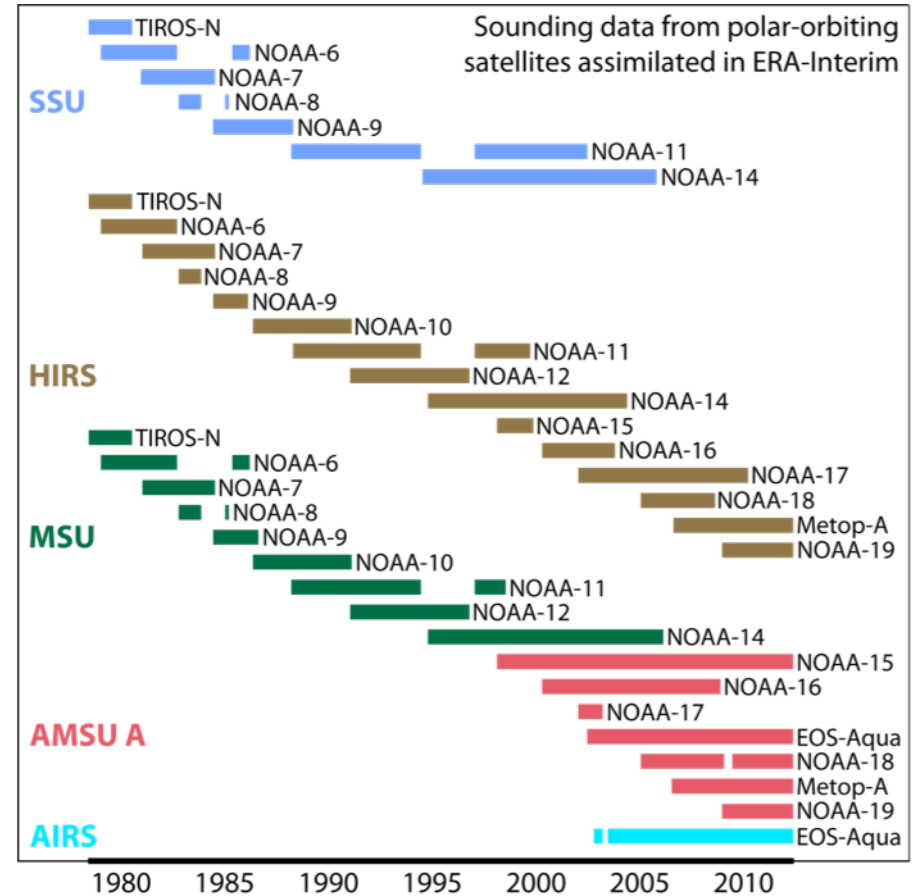
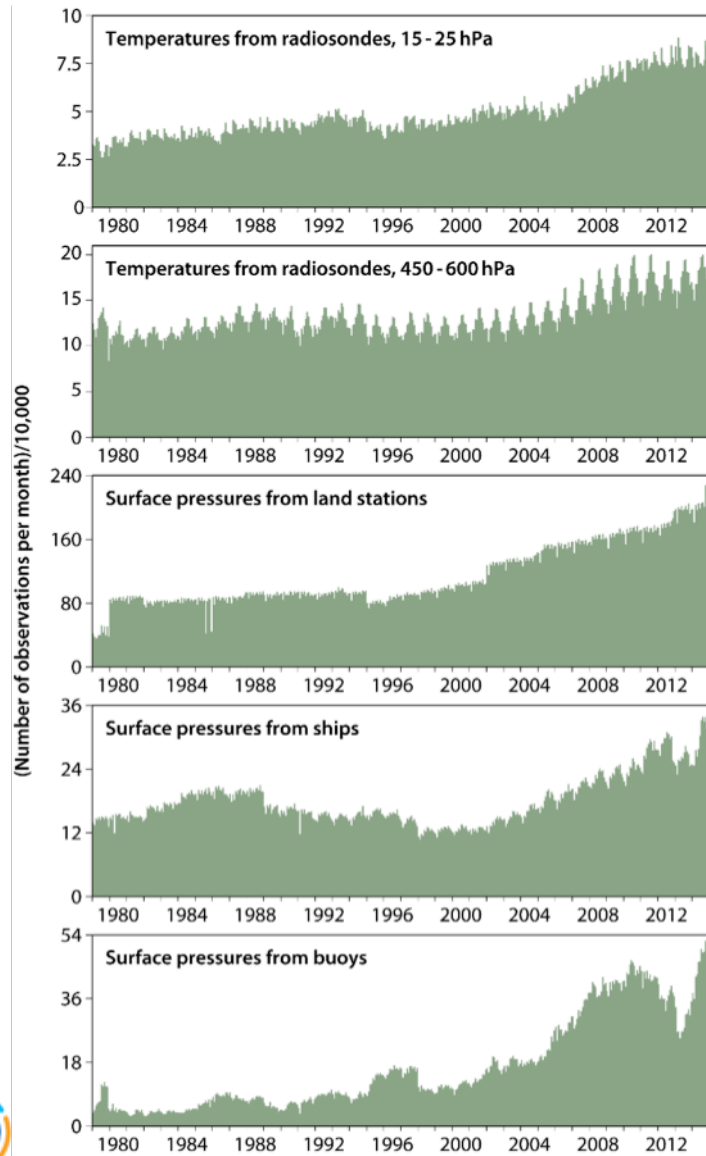
Supporting Climate Services

- **Observations for Adaptation to Climate Variability and Change, February 2013, Offenbach**
- **Enhancing observations to support preparedness and adaptation in a changing climate – Learning from the Fifth IPCC Assessment Report (AR5), February 2015, UNFCCC, Bonn, Germany**
- **Observations for Climate Change Mitigation , May 2014, Geneva, Switzerland**

GCOS supports the Global Framework for Climate Services



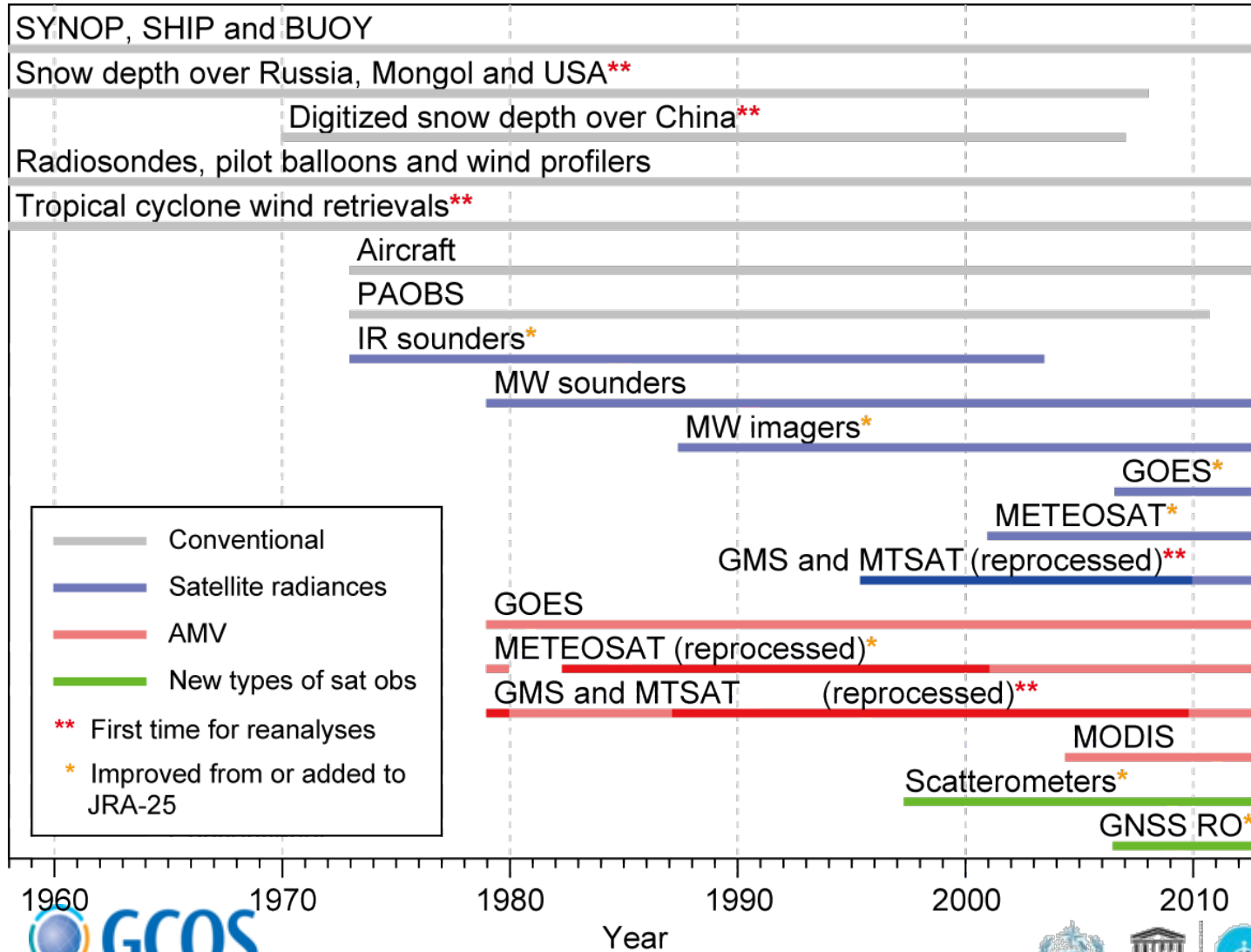
Evolution of the observing system



Data from IASI and NPP could not be used in 2006 version of assimilation system frozen for ERA-Interim. Use of data from Metop-B was not activated in 2012, Data from FY-3 are a candidate for use in future reanalyses, Coverage is for SSU-1, HIRS-2, MSU-4, AMSU-A10, AIRS-40



Evolution of the observing system



Types of data assimilated in JMA's new. JRA-57.25 reanalysis (as of April 2015)

Credit: Adrian Simmons, May 2015 (ECMWF)



Evolution of the observing system

– robust conclusions since 2013

Some continuing concerns, including

- deterioration of some *in situ* networks; lack of progress in filling gaps in others
- limited provision for limb sounding
- little movement on reference measurement from space

but many improvements (that need sustaining) including

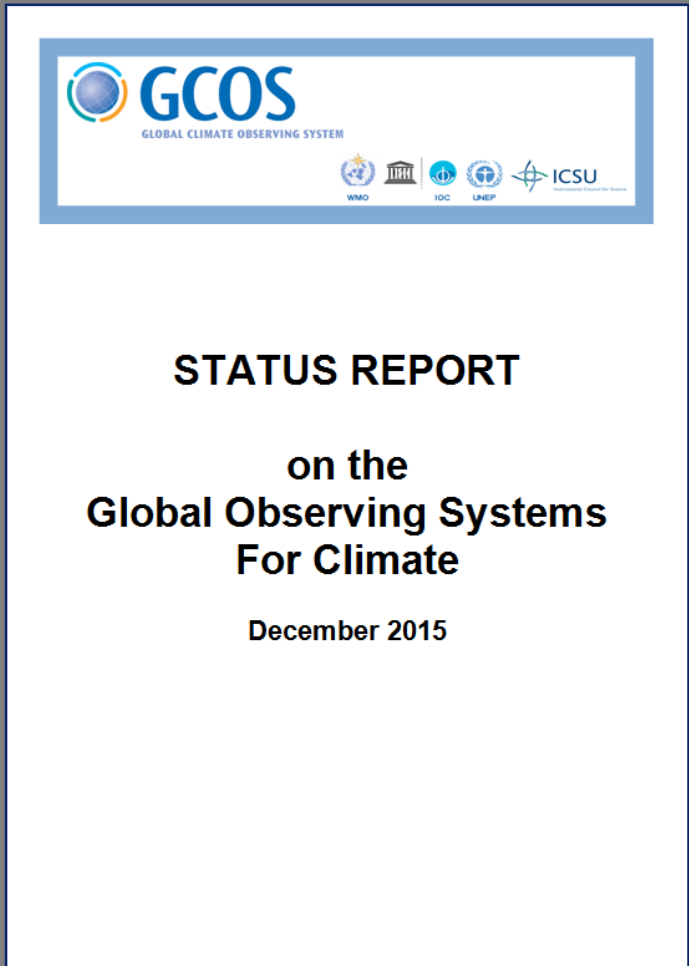
- quantity and quality of data from several *in situ* sources, including radiosondes
- quantity, quality and variety of data from satellites
- New types of satellite observations
- recovery and reprocessing of past data, both *in situ* and remotely sensed
- reanalysis, with coupling of atmosphere to ocean and land, and inclusion of chemistry
- conventional analysis of instrumental records
- converging temperature information from various observational and model datasets

and evolving requirements

- e.g. for global, ground-based, soil-moisture data to complement remote sensing and reanalysis



Next Status Report and New Implementation Plan



GCOS
GLOBAL CLIMATE OBSERVING SYSTEM

WMO IOC UNEP ICSU

STATUS REPORT

on the
**Global Observing Systems
For Climate**

December 2015

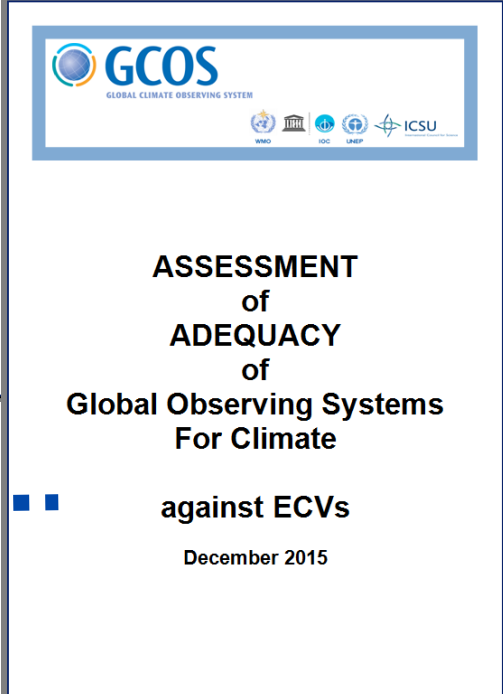


GCOS
GLOBAL CLIMATE OBSERVING SYSTEM

WMO IOC UNEP ICSU

PROGRESS REPORT

December 2015



GCOS
GLOBAL CLIMATE OBSERVING SYSTEM

WMO IOC UNEP ICSU

**ASSESSMENT
of
ADEQUACY
of
Global Observing Systems
For Climate**

against ECVs

December 2015

New Implementation Plan in 2016

Following the Second Adequacy Report in 2003, GCOS produced:

- an Implementation Plan in 2004
- a Supplement to the Plan in 2006 on requirements for satellite-based data products
- a Progress Report in 2009
- an updated Implementation Plan in 2010
- an updated Satellite Supplement in 2011

UNFCCC/SBSTA:

- welcomed the 2010 Plan and urged Parties to work towards implementation
- invited a subsequent progress report and encouraged a review of adequacy
- welcomed the timetable proposed by GCOS for
 - a Status Report in 2015
 - a new Implementation Plan in 2016



March/April: Finish domain sections and work on general ones

May: Complete General Sections and Executive Summary

– will need input from Panel Chairs (or their representatives)

June/July: Make version openly available for review

July/Aug: Respond to review comments and update

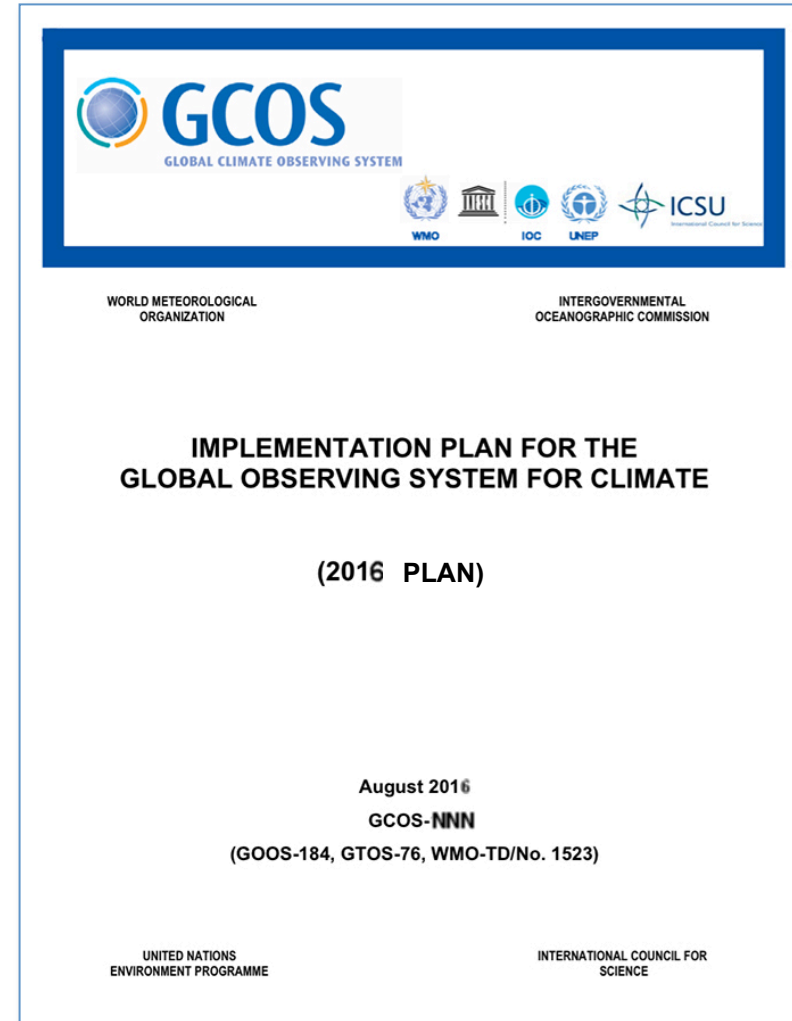
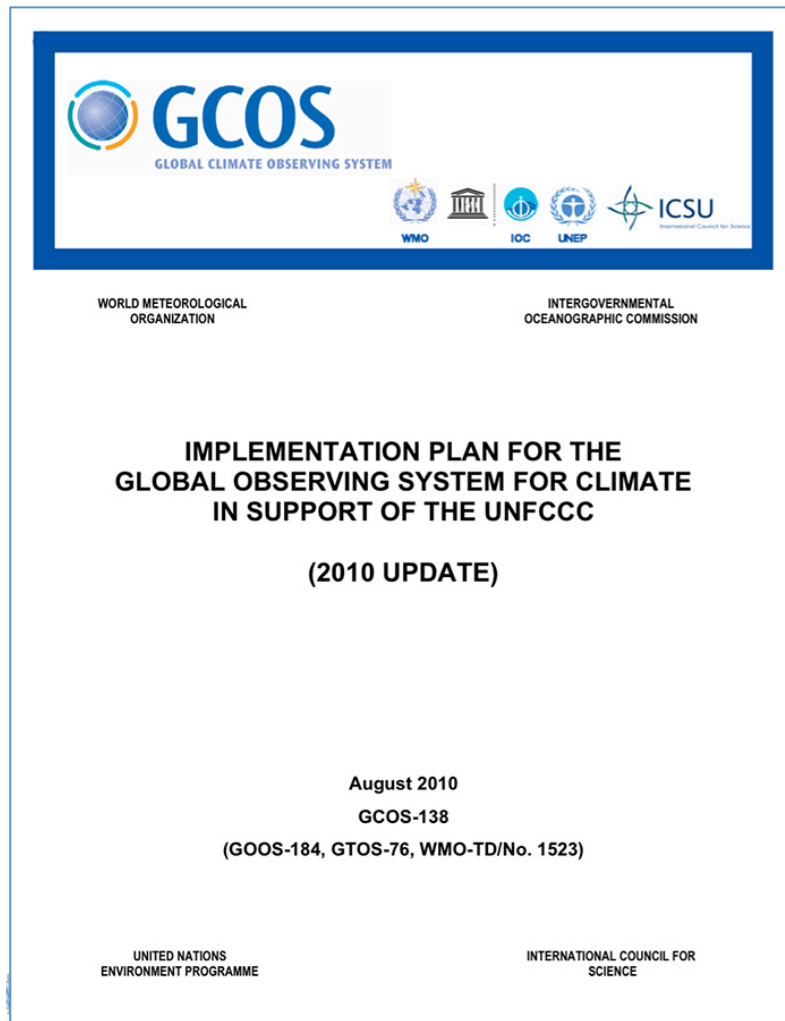
September: Finalise

Obtain Steering Committee approval

Submit to Sponsors and UNFCCC

From

To



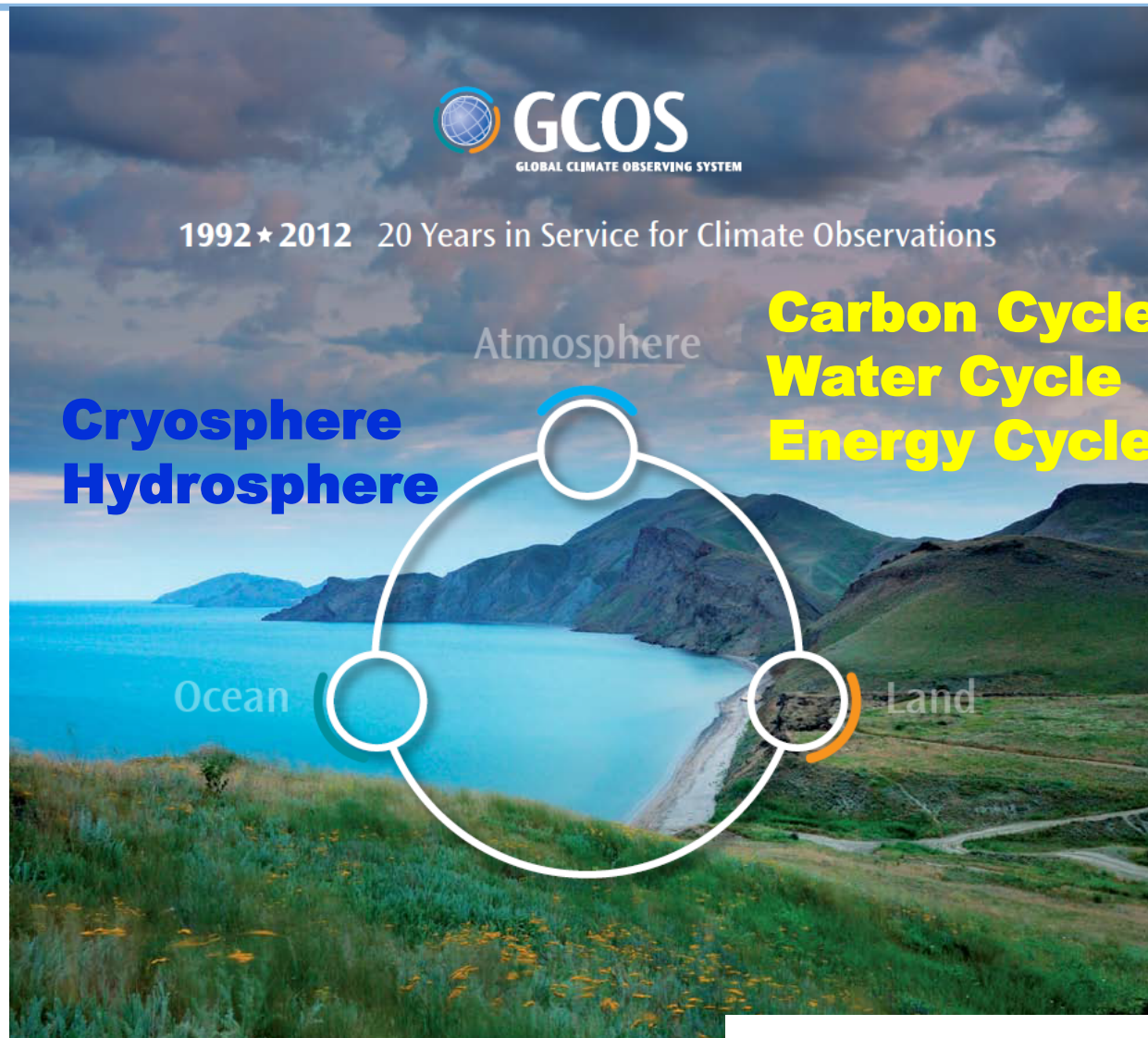
- Overall message: continuity with progress
- Primary purpose (UNFCCC) remains intact
- Broader context of implementation introduced
 - ① Energy, water and carbon cycles reinforced
 - ② Cross-convention use of observations (UNFCCC, CBD, UNCCD) proposed
 - ③ Adaptation + Mitigation framed
 - ④ Climate Services acknowledged
- Supporting observations introduced gravity, DEM, orbit restitution...
 - The list of ECVs may be updated
 - Planning for an updated Sat. Supplement are TBD



- ① Writing team, contents and process submitted to GCOS SC September 2015
- ② IP outline presented to SBSTA November 2015
- ③ First writing team meeting February 2016
- ④ GCOS Open science meeting March 2016
- ⑤ Bring work in progress to the panels' meetings April 2016
- ⑥ Writing team prepares first complete draft May 2016
- ⑦ V0.1 submitted for Community review July 2016
- ⑧ Public review closes end of August 2016
- ⑨ V1.0 prepared in light of comments on V0.1
- ⑩ V1.0 submitted to GCOS SC September 2016 and subsequently to SBSTA




GCOS – Global Climate Observing System



**GCOS International Science
Conference**

2 – 4 March 2016






**Royal Academy of Arts and
Sciences, Amsterdam,
The Netherlands**



**GLOBAL
CLIMATE
OBSERVATIONS**

GCOS
GLOBAL CLIMATE OBSERVING SYSTEM

THE ROAD TO THE FUTURE 2-4 March, 2016
Amsterdam

WMO     **ICSU**
International Council for Science  **UNEP**