
GCOS perspective on observation requirements

Carolyn Richter Director, GCOS Secretariat

Copernicus Climate Observations Requirements Workshop

29 June – 2 July 2015

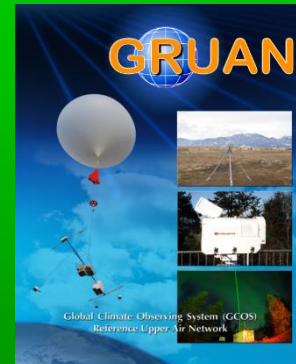
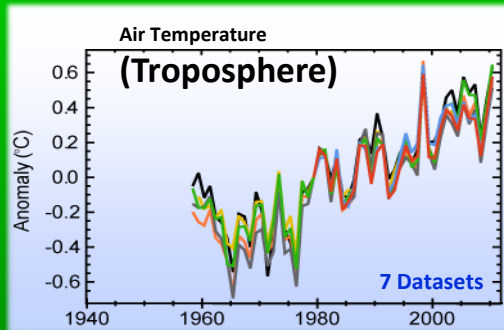
ECMWF, Reading, UK



(1) General requirements:

Eight reasons why Climate observations must be enhanced and continued into the future.

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

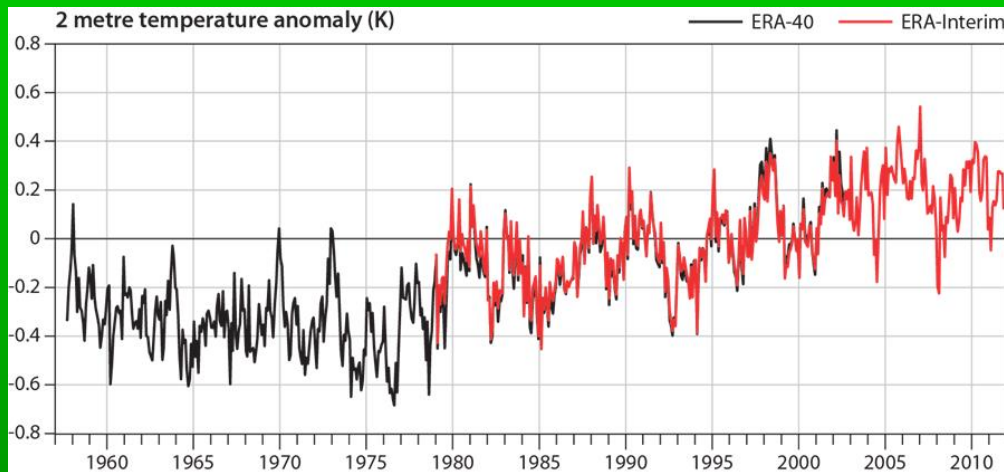


GCOS Reference Upper-air Network

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

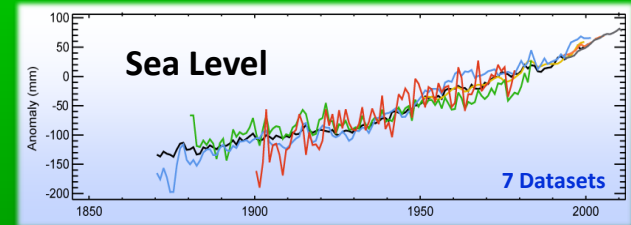
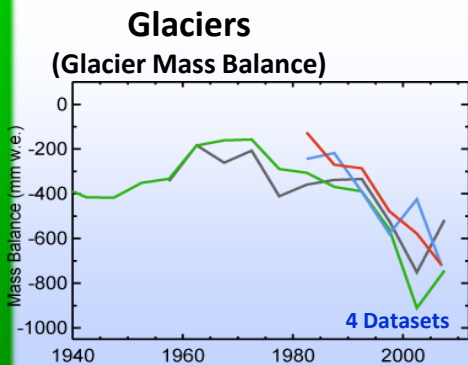
... model and predict the climate system.

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**

... assess impacts of climate variability and change.



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



... 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

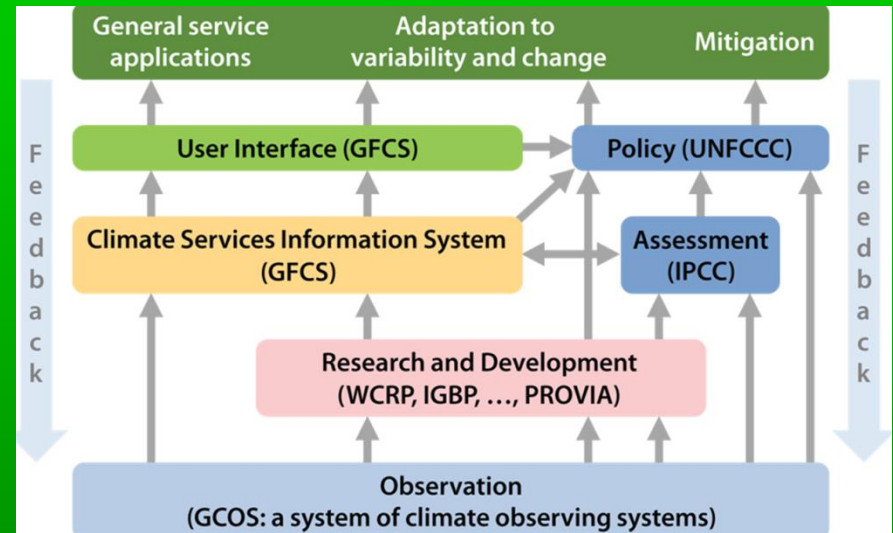
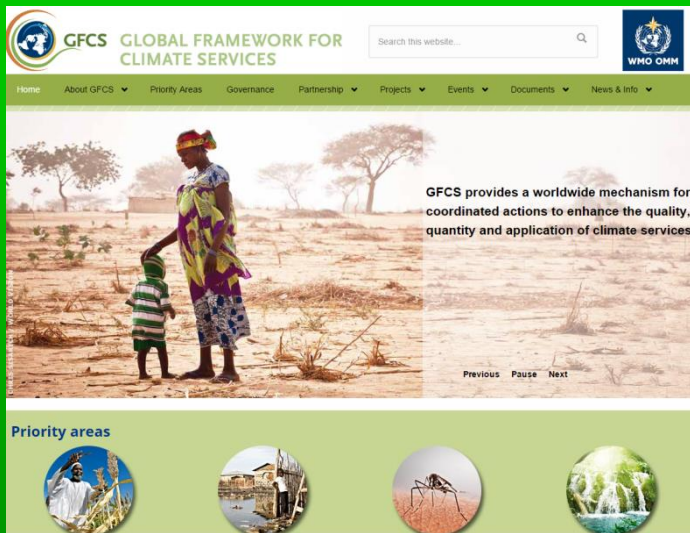


Lowering glacial lakes to prevent flashfloods

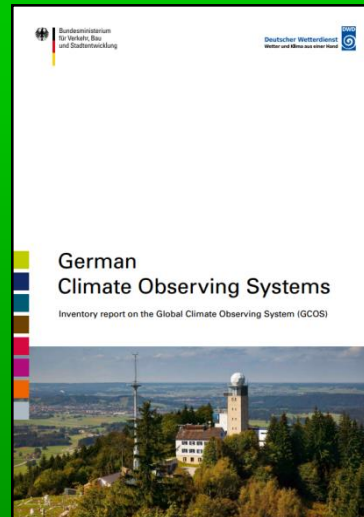
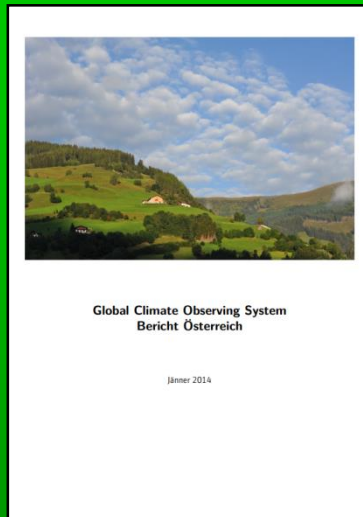
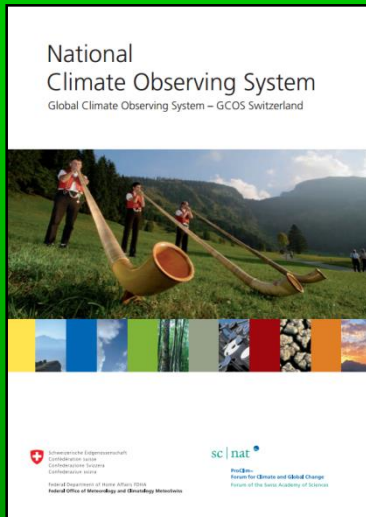


Left: Glacial Lake Outburst Floods (GLOFs) pose a great risk in mountainous areas. Right: Lowering of glacial lakes can help prevent GLOFs.

... develop climate information services.



... 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

- 25 National GCOS Coordinators
- 151 National GCOS Focal Points

...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.....

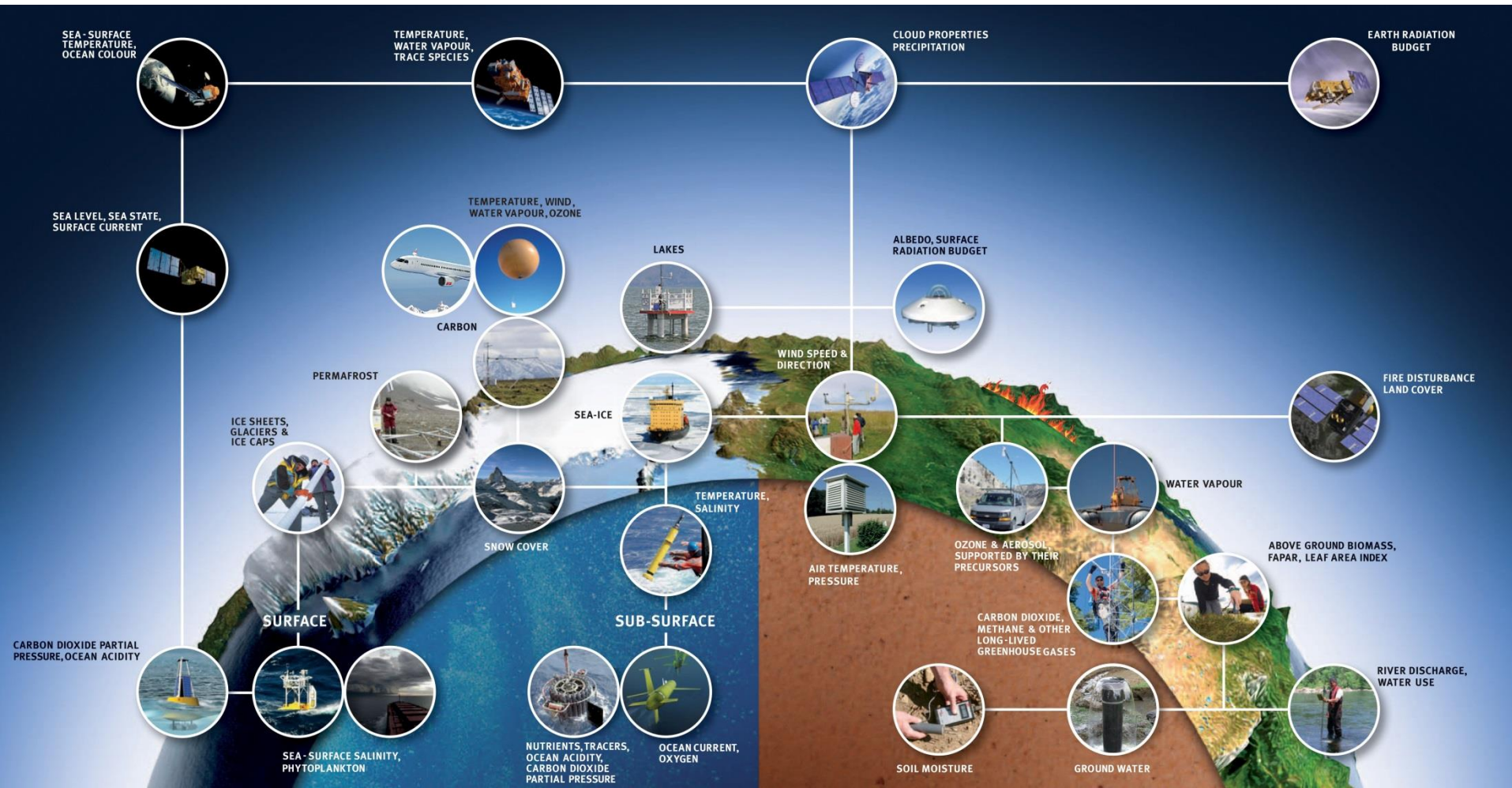
Article 5 Research and Systematic Observations

- 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.....

(2) Global requirements:

How to assess from the global perspective?

Concept: Global Observations for Climate & ECVs



The GCOS includes surface-based, air-borne, and space-based components and constitutes, in aggregate, the climate observing component of the Global Earth Observation System of Systems (GEOSS).

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 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



THE CONCEPT OF ESSENTIAL CLIMATE VARIABLES IN SUPPORT OF CLIMATE RESEARCH, APPLICATIONS, AND POLICY

BY STEPHAN BOJINSKI, MICHEL VERSTRAETE, THOMAS C. PETERSON,
CAROLIN RICHTER, ADRIAN SIMMONS, AND MICHAEL ZEMP

Described is the concept of Essential Climate Variables developed under the Global Climate Observing System for a range of applications, as well as to provide an empirical basis for understanding past, current, and possible future climate variability and change.

BAMS, September 2014
pp 1431-1443

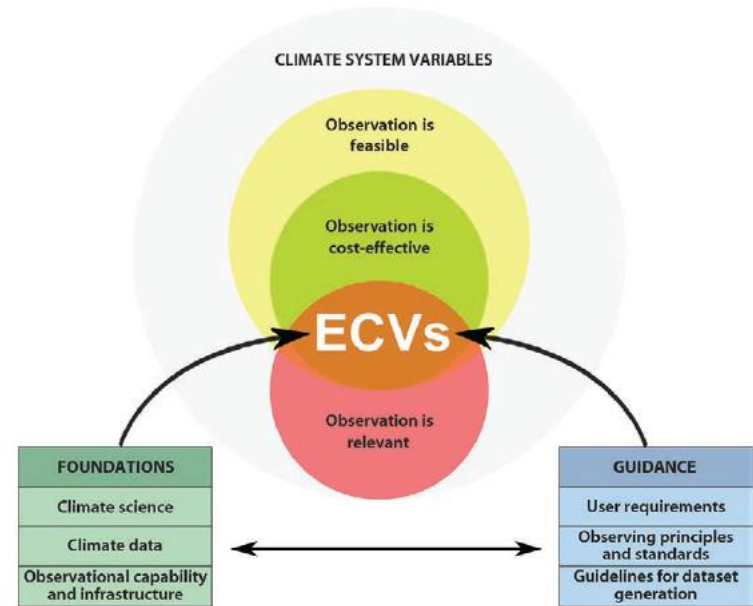
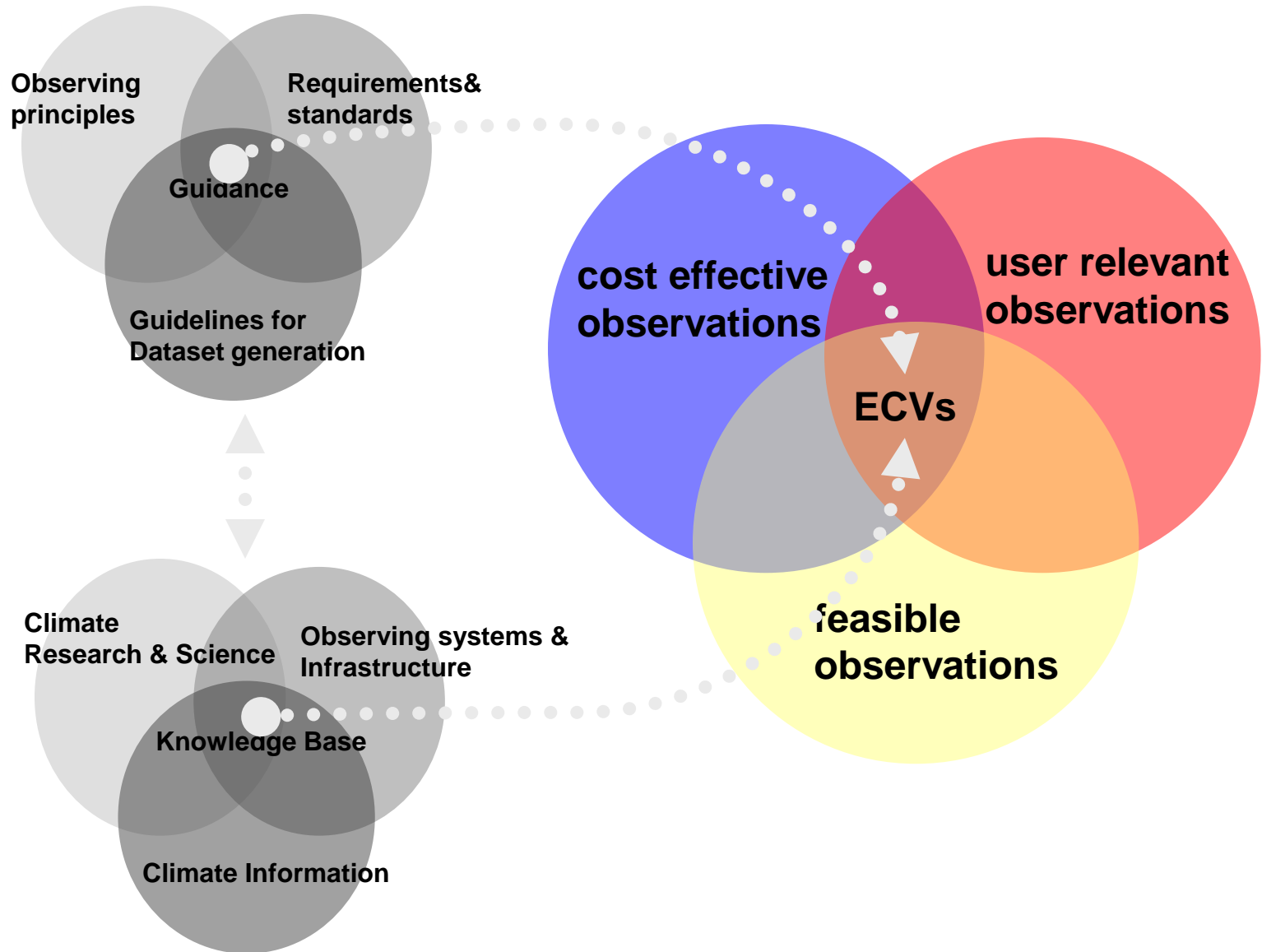


FIG. 2. Schematic of the ECV concept: knowing existing climate-relevant observing capabilities, climate datasets, and the level of scientific understanding of the climate system are the foundations (lower-left box) necessary for selecting the ECVs from a pool of climate system variables. In addition, guidance is needed to make practical use of the ECVs (lower-right box): user requirements capture the data quality needs of science, services, and policy; climate-specific principles guide the operation of observing systems and infrastructure; and guidelines facilitate the transparent generation of ECV data records. The latter address the availability of metadata, provisions for data curation and distribution, and the need for quality assessment and peer review.

Schematic Concept of 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

The GCOS Essential Climate Variables (ECVs) are required to support the work of WMO, IOC of UNESCO, UNEP, ICSU, and also in particular UNFCCC and the IPCC.

All ECVs are technically and economically feasible for systematic observation. It is these variables for which international exchange is required for both current and historical observations.

Normative work: guidelines and principles

GLOBAL CLIMATE OBSERVING SYSTEM



WORLD METEOROLOGICAL ORGANIZATION

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION

Guideline for the Generation of Satellite-based Datasets and Products meeting GCOS Requirements



WORLD METEOROLOGICAL ORGANIZATION

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION

Guideline for the Generation of Datasets and Products Meeting GCOS Requirements*

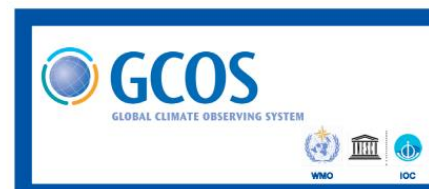
*An update of the "Guideline for the Generation of Satellite-based Datasets and Products meeting GCOS Requirements" (GCOS-128, WMO/TD-No. 1488), including *in situ* datasets and amendments

May 2010

GCOS-143
(WMO/TD No. 1530)

UNITED NATIONS ENVIRONMENT PROGRAMME

INTERNATIONAL COUNCIL FOR SCIENCE



WORLD METEOROLOGICAL ORGANIZATION

IN OCEAN

SYSTEMATIC OBSERVATION REQUIREMENTS FOR SATELLITE-BASED DATA PRODUCTS FOR CLIMATE

2011 Update

Supplemental details to the satellite component of the "Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC (2010 Update)

December 2011

GCOS – 154

UNITED NATIONS ENVIRONMENT PROGRAMME

INTERNATIONAL COUNCIL FOR SCIENCE

Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC (2010 Update)

Appendix 4

GCOS Climate Monitoring Principles

Effective monitoring systems for climate should adhere to the following principles¹¹²:

1. The impact of new systems or changes to existing systems should be assessed prior to implementation.
2. A suitable period of overlap for new and old observing systems should be required.
3. The results of calibration, validation and data homogeneity assessments, and assessments of algorithm changes, should be treated with the same care as data.
4. A capacity to routinely assess the quality and homogeneity of data on extreme events, including high-resolution data and related descriptive information, should be ensured.
5. Consideration of environmental climate-monitoring products and assessments, such as IPCC assessments, should be integrated into national, regional and global observing priorities.
6. Uninterrupted station operations and observing systems should be maintained.
7. A high priority should be given to additional observations in data-poor regions and regions sensitive to change.
8. Long-term requirements should be specified to network designers, operators and instrument engineers at the outset of new system design and implementation.
9. The carefully-planned conversion of research observing systems to long-term operations should be promoted.
10. Data management systems that facilitate access, use and interpretation should be included as essential elements of climate monitoring systems.

Furthermore, satellite systems for monitoring climate need to:

- (a) Take steps to make radiance calibration, calibration-monitoring and satellite-to-satellite cross-calibration of the full operational constellation a part of the operational satellite system; and
- (b) Take steps to sample the Earth system in such a way that climate-relevant (diurnal, seasonal, and long-term interannual) changes can be resolved.

Thus satellite systems for climate monitoring should adhere to the following specific principles:

11. Constant sampling within the diurnal cycle (minimizing the effects of orbital decay and orbit drift) should be maintained.
12. A suitable period of overlap for new and old satellite systems should be ensured for a period adequate to determine inter-satellite biases and maintain the homogeneity and consistency of time-series observations.
13. Continuity of satellite measurements (i.e., elimination of gaps in the long-term record) through appropriate launch and orbital strategies should be ensured.

¹¹²The ten basic principles were adopted by the Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC) through decision 5/CP.5 at COP 5 in November 1999. The complete set of principles was adopted by the Congress of the World Meteorological Organization (WMO) through Resolution 9 (Cg-XIV) in May 2003; agreed by the Committee on Earth Observation Satellites (CEOS) at its 17th Plenary in November 2003; and adopted by COP through decision 11/CP.9 at COP 9 in December 2003.

142

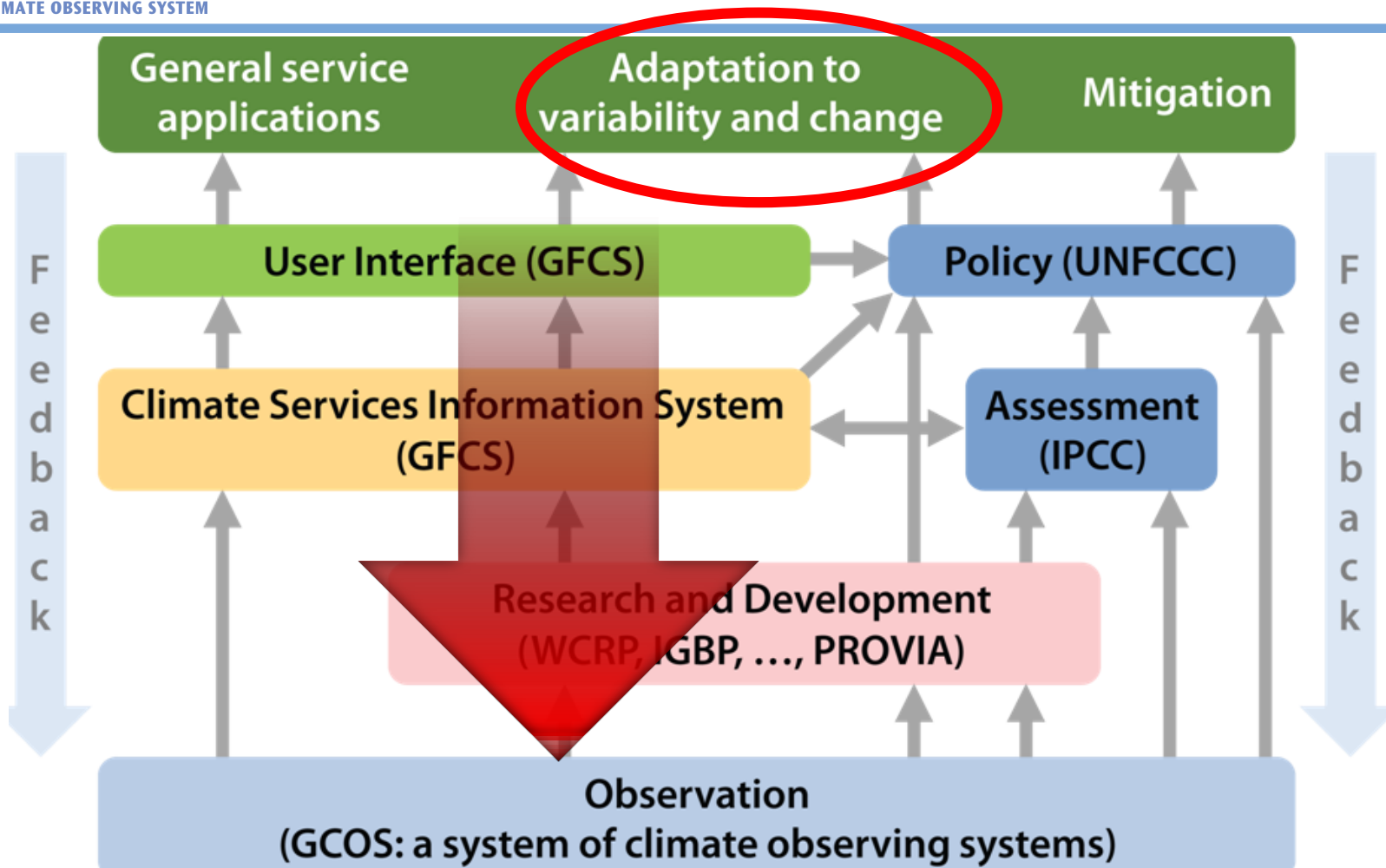


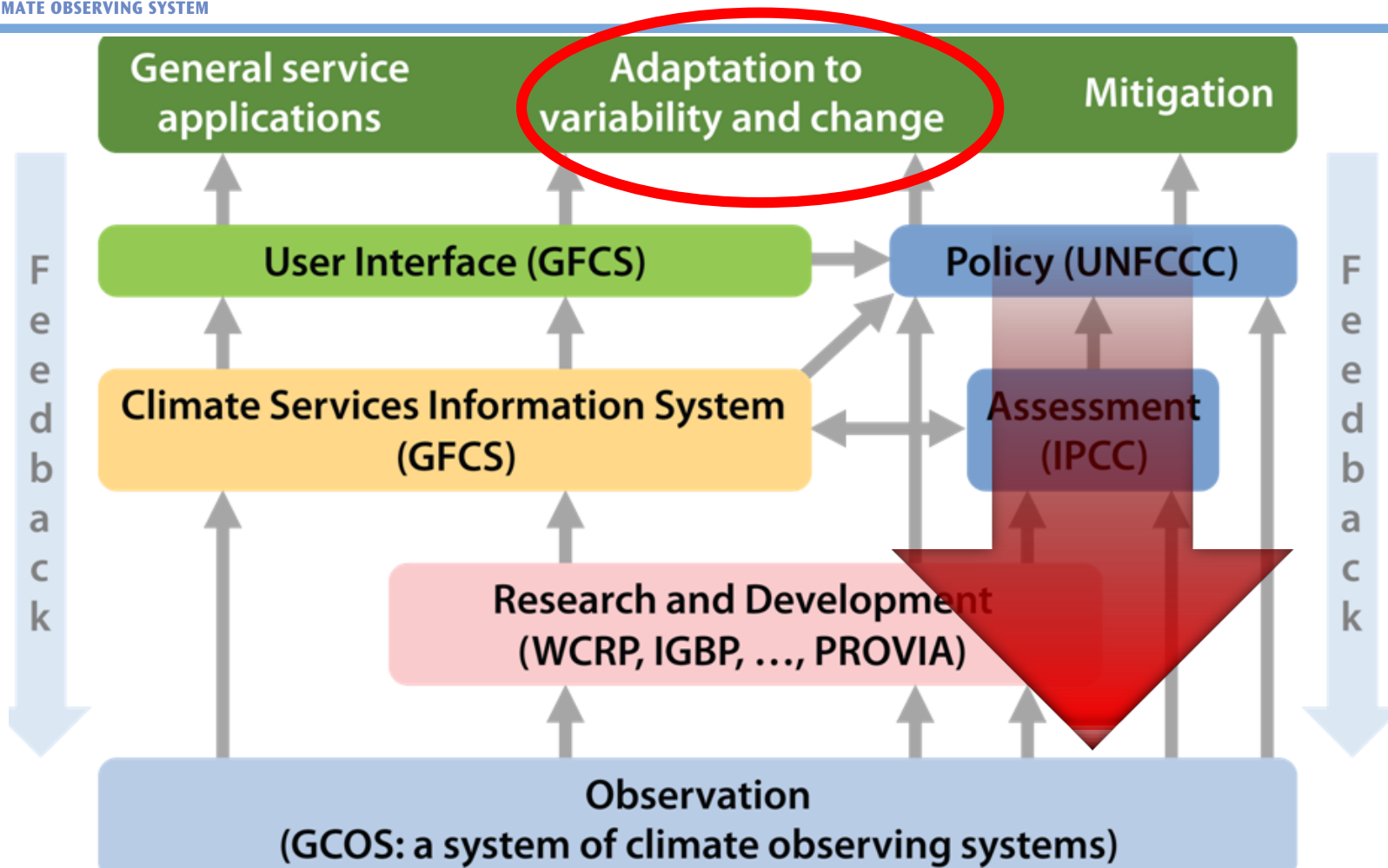
(3) Regional and national requirements:

Assessing the needs for adaptation and mitigation planning.

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**





“Enhancing observations to support preparedness and adaptation in a changing climate – Learning from the Fifth IPCC Assessment Report (AR5)”

10-12 February 2015

UNFCCC, Bonn, Germany

Addressing needs in the priority areas of the Global Framework for Climate Services (GFCS):

- **Water**
- **Agriculture and food security**
- **Disaster risk reduction**
- **Health**

Support of:

- **SBSTA Agenda Item
Research & Observation**
- **Adaptation under the**

Based on IPCC AR5:

- **WG I (Bern, 2014)**
- **WG II (Bonn, 2015)**

Common themes regarding observation requirements:

- Need for higher spatial and temporal resolution (“smallest pixel is too large”);
- Need to focus on regions where climate change will have significant sector effects and where there are vulnerable populations;
- Need to develop infrastructure and governance to support sustained data rescue (historical data is highly valuable, but data rescue is very expensive);
- Need to support research initiatives such as PROVIA and Future Earth.
- Improve climate observations systems with a special emphasis on Terrestrial and Ocean and where the two meet.

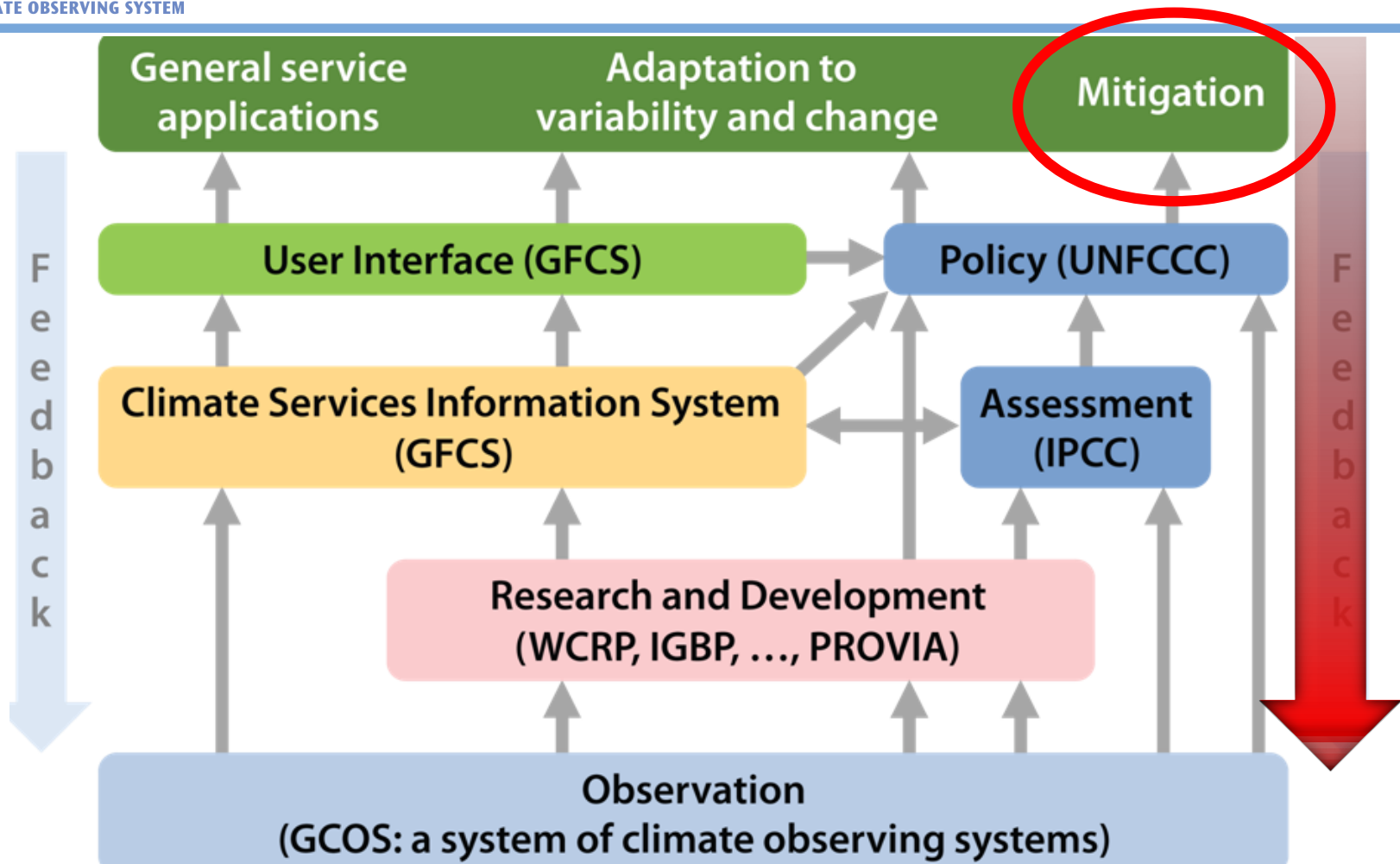
Some of the Outcomes of the Bonn Workshop


It is essential to generate good, publicly available and standardized data, in particular at regional, national and local levels, on the vulnerability of key sectors to the impacts of climate change including:

- improve climate observations systems with a special emphasis on Terrestrial and Ocean and where the two meet.

Guidance and guidelines (or references to other sources of advice) on data and sources of products, as well as their limitations, are needed. In particular:






- Establishing and maintaining requirements for the collection and dissemination of national observations to specified quality standards with understood and quantified uncertainties is a key role of GCOS
- High-resolution data, required for adaption planning, needs to be documented (especially for non-meteorological data).
- GCOS should identify international data centres for all ECVs.
- The experience of developing adaptation plans and assessments should be carefully documented and recorded to enable transferable expertise and improvements to observation systems,
- Requirements for data latency, timeliness and availability are critical and should be clearly specified.





GCOS
GLOBAL CLIMATE OBSERVING SYSTEM


<http://gcos.wmo.int>



**GCOS Workshop on Observations for
Climate Change Mitigation**

Geneva, Switzerland
5–7 May 2014

Co-sponsored by the Land Cover Project Office of the Global
Observation for Forest Cover and Land Dynamics (GOFC-
GOLD) Programme



GCOS-185


Mitigation

Atmospheric Composition:
CO₂, methane (CH₄), NO₂,
other long-lived GHGs,
ozone, aerosols,

including estimation of net
sources and sinks, fluxes,

Land-Use and Land-Cover,
Fires

Table shows relationship between ECVs that could be potentially used to support emissions estimates using the IPCC guidelines:

-  Strong relationship between emission components
-  Some relationship
-  No clear relationship

IPCC has published guidance and guidelines providing methodologies to estimate national anthropogenic emissions and removals of greenhouse gases. Focus on anthropogenic GHG emissions and removals.

ECVs	Activity data		Emission Factors			Bio-mass burning	Soil management	Live-stock	Rice
	Land Use & change	Land use	Bio-mass	Dead org. matter	Soil org. carbon				
IPCC									
Land cover	Strong	Strong	Strong	Some	Some	Strong	Strong	No	Strong
Above ground biomass	No	No	Strong	Some	Some	Strong	Some	No	No
Soil Carbon	No	No	No	No	Strong	Some	Strong	No	No
Fire disturbance	Some	Some	No	No	No	Strong	Some	No	No
Soil moisture	No	No	No	No	No	Some	Strong	No	Strong
Water use	No	No	No	No	No	No	Strong	No	Strong
Leaf Area Index	Some	Some	No	No	No	Some	No	No	No
Albedo	Strong	No	No	No	No	Strong	No	No	No
Temperature	No	Some	No	No	No	Some	No	Some	No
Precipitation	No	Some	No	No	No	Some	No	Some	Strong
Methane	No	No	No	No	No	Some	No	Strong	Strong
CO ₂	No	No	Strong	Strong	Strong	Strong	Some	No	No
N ₂ O	No	No	No	No	No	Some	Strong	Strong	Some

(4) New requirements:

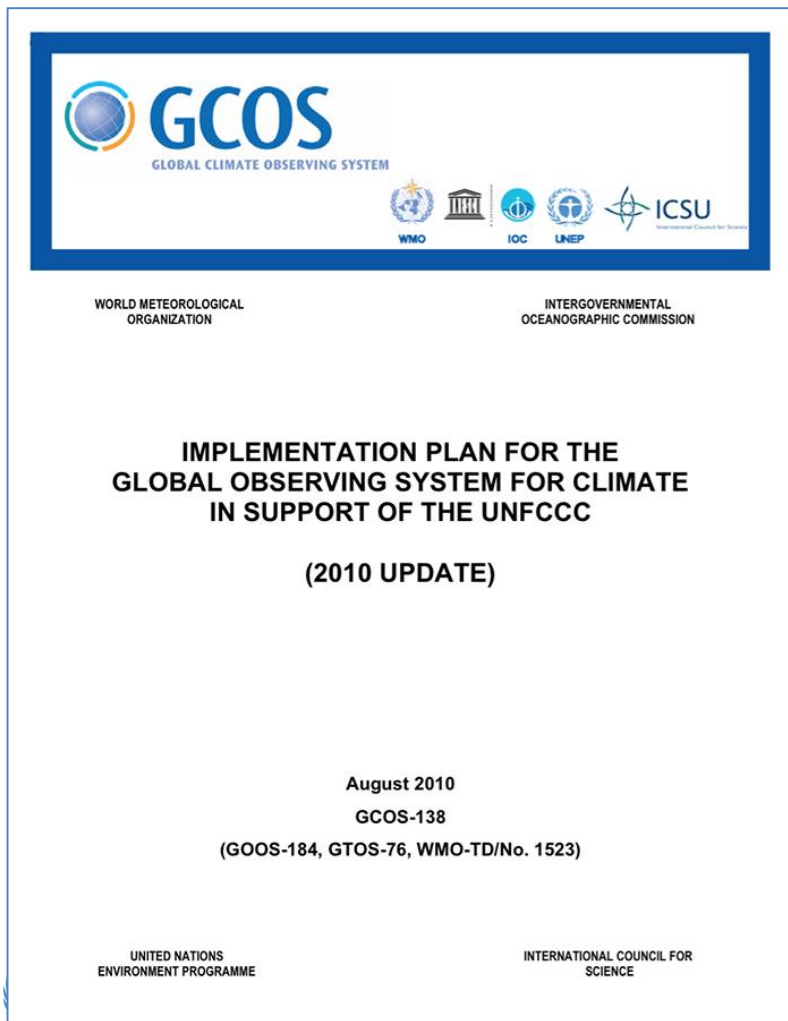
Discussing requirements in support of new developments in the Earth observing programmes.

Taking up the lessons learnt: adaptation is happening on a national level. GCOS is providing advice and support on a global level....which will need to be handed down and translated into local scales.

Responsability lies with the national users

From

To



GCOS
GLOBAL CLIMATE OBSERVING SYSTEM

WMO IOC UNEP ICSU

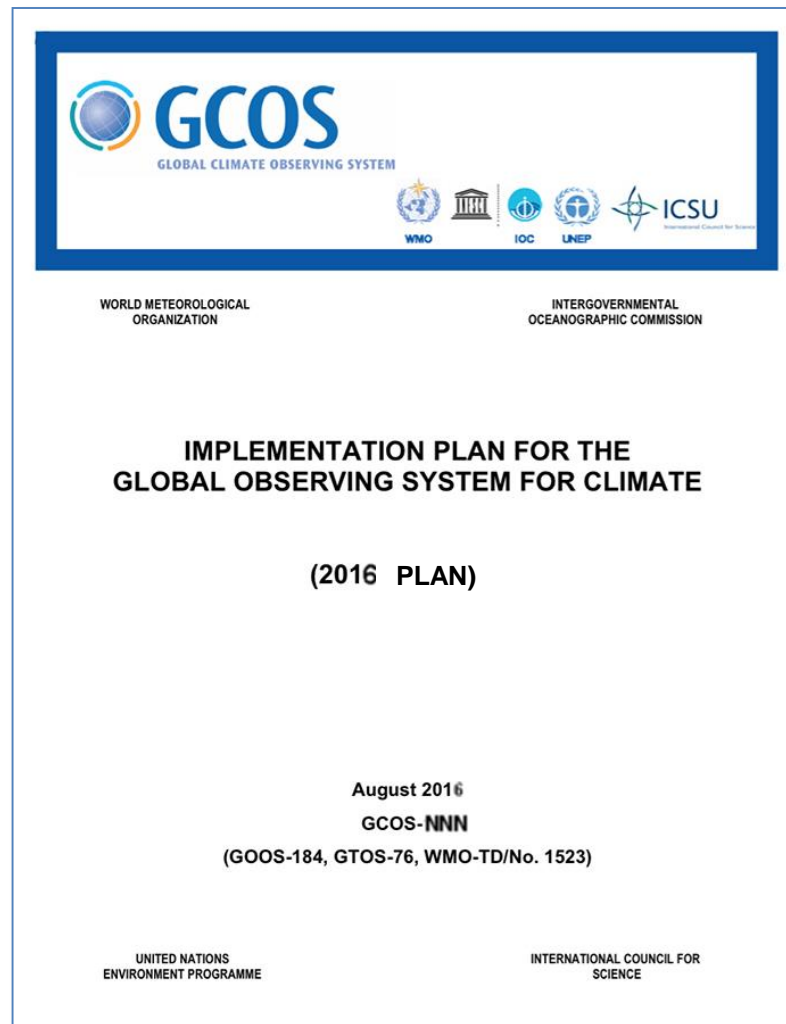
WORLD METEOROLOGICAL ORGANIZATION INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION

IMPLEMENTATION PLAN FOR THE GLOBAL OBSERVING SYSTEM FOR CLIMATE IN SUPPORT OF THE UNFCCC

(2010 UPDATE)

August 2010
GCOS-138
(GOOS-184, GTOS-76, WMO-TD/No. 1523)

UNITED NATIONS ENVIRONMENT PROGRAMME INTERNATIONAL COUNCIL FOR SCIENCE



GCOS
GLOBAL CLIMATE OBSERVING SYSTEM

WMO IOC UNEP ICSU

WORLD METEOROLOGICAL ORGANIZATION INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION

IMPLEMENTATION PLAN FOR THE GLOBAL OBSERVING SYSTEM FOR CLIMATE

(2016 PLAN)

August 2016
GCOS-NNN
(GOOS-184, GTOS-76, WMO-TD/No. 1523)

UNITED NATIONS ENVIRONMENT PROGRAMME INTERNATIONAL COUNCIL FOR SCIENCE

- 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



GCOS International Science Conference –The Road to the Future (Shaping the next GCOS Implementation Plan)

2 – 4 March 2016

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

Infos: gcos.wmo.int

Mail to organising committee: GCOS-SC@eumetsat.int