The Global Observing System for Climate

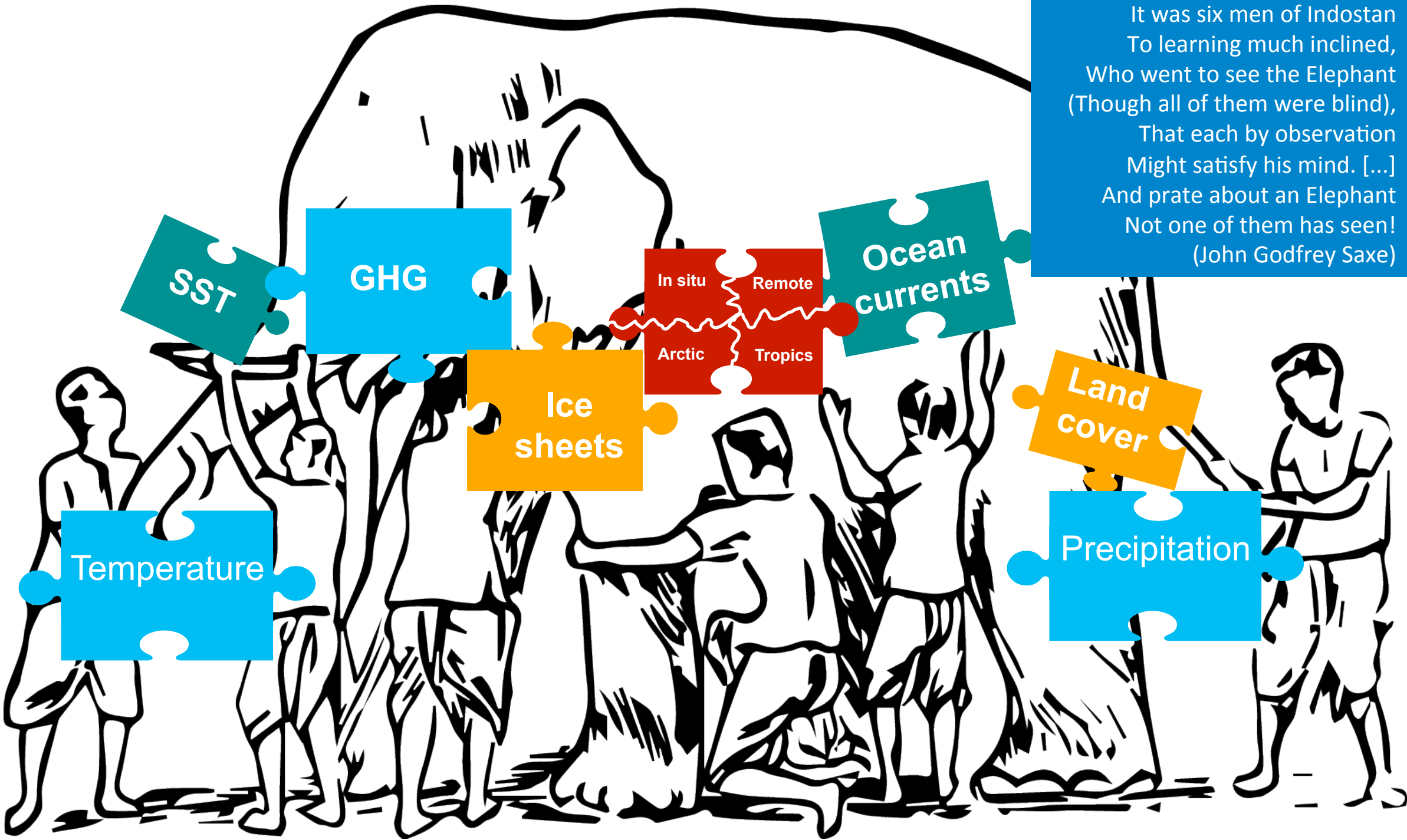
GCOS

ERA-CLIM2 – Climate Reanalyses and Services for Society
14 December 2017, Uni Bern

GCOS Secretariat, WMO
Carolin Richter, Director

WMO UNESCO IOC ICSU International Council for Science UNEP

It was six men of Indostan
To learning much inclined,
Who went to see the Elephant
(Though all of them were blind),
That each by observation
Might satisfy his mind. [...]
And prate about an Elephant
Not one of them has seen!
(John Godfrey Saxe)



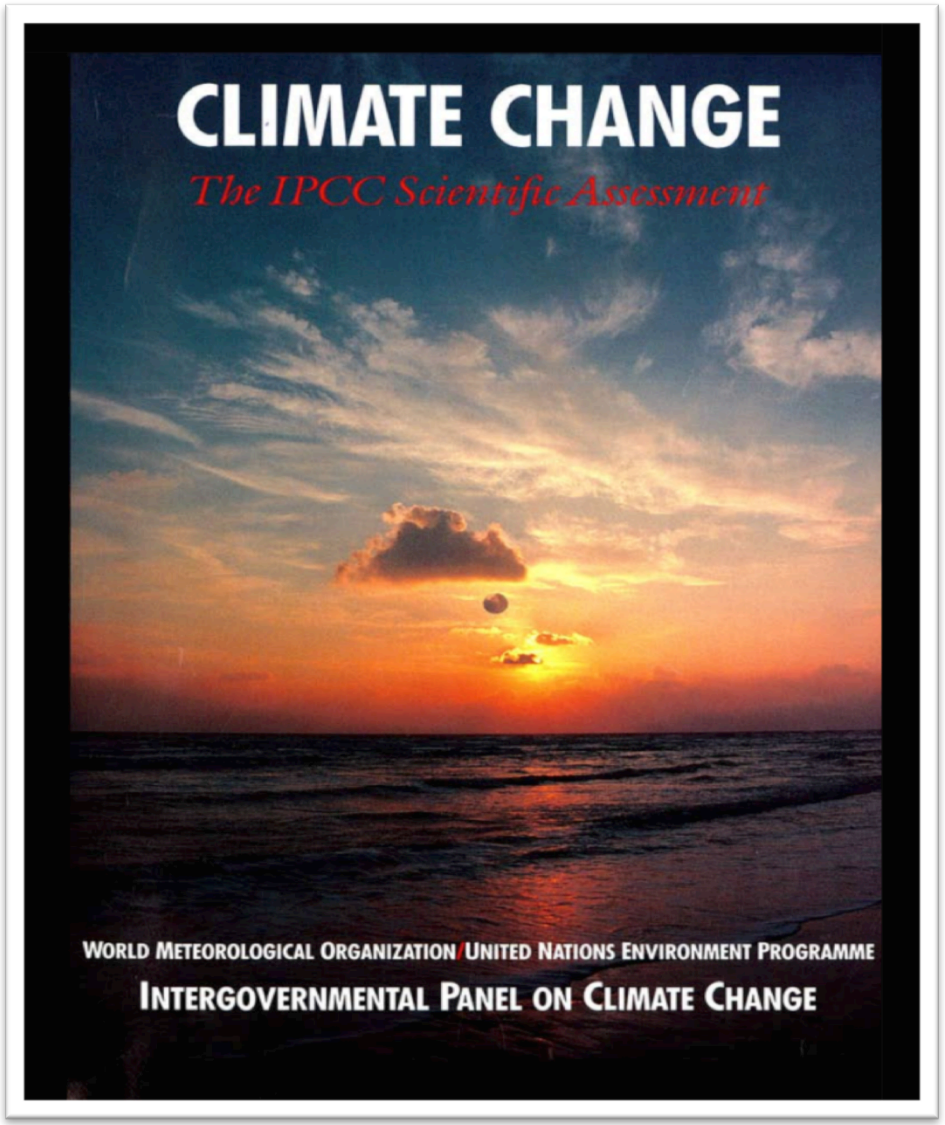
GCOS is a system of systems

It comprises any data and information on the climate system taken by in situ, airborne or space-based techniques and platforms, while the ownership of the observing systems and networks will remain fully with their operating entities.

IPCC First Assessment Report 1990

IPCC First Assessment Report (1990)

IPCC concluded „that improved predictability of (human induced) climate change would require improved systematic observation of climate related variables on a global basis“



GCOS
GLOBAL CLIMATE OBSERVING SYSTEM

UNEP

ICSU International Council for Science

IOC

UNESCO

WMO

GCOS established April 1992

The vision of GCOS is that all users have access to the climate observations, data records and information which they require to address pressing climate-related concerns. GCOS users include individuals, national and international organizations, institutions and agencies.

The role of GCOS is to work with partners to ensure the sustained provision of reliable physical, chemical and biological observations and data records for the total climate system – across the atmospheric, oceanic and terrestrial domains, including hydrological and carbon cycles and the cryosphere.

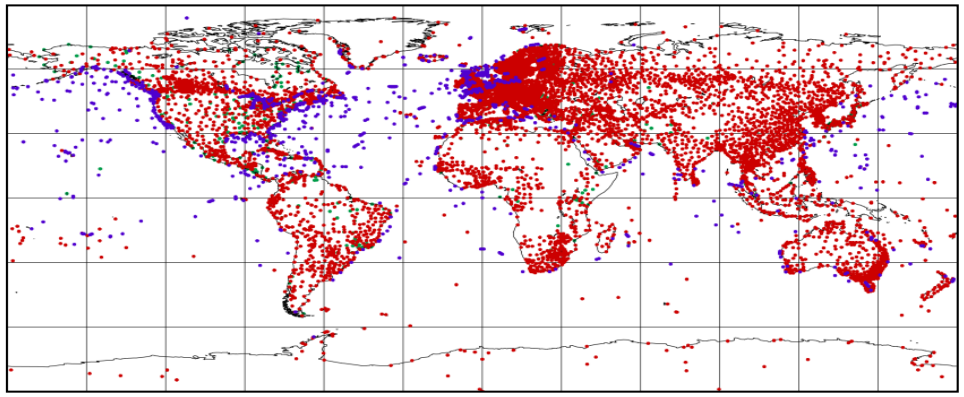
gcos.wmo.int

Flip 1: © Jürgen Graeser/Alfred Wegener Institute. Radiosonde launch at Ny-Ålesund, Norway.
Flip 2: © ESA–Pierre Carril. Artist's view of Meteosat Third Generation. The MTG system is being established through cooperation between EUMETSAT and the European Space Agency (ESA).

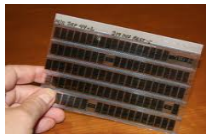
April 2017

GCOS is concerned with

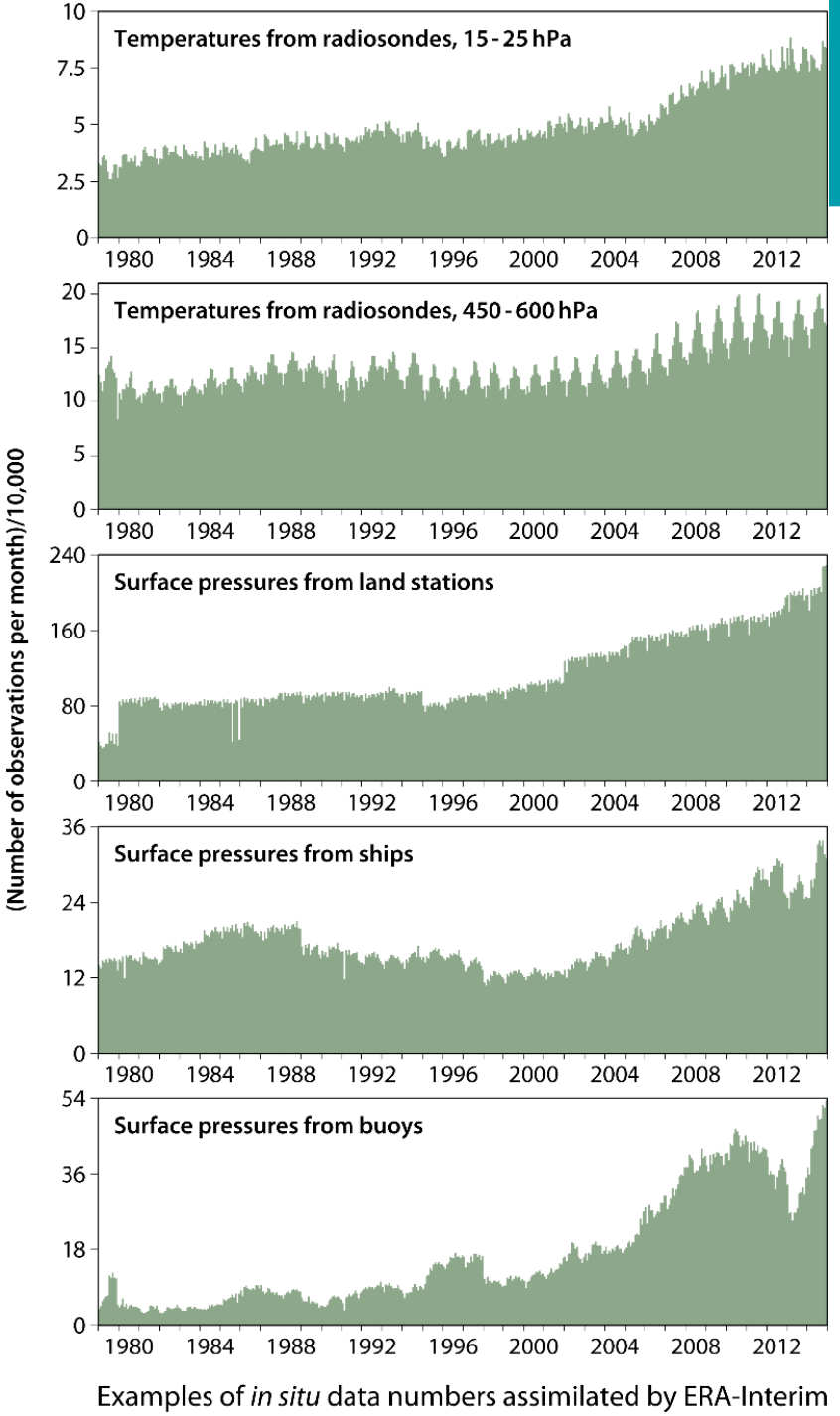
- **the observations**
  - what is measured, how it is measured,
  - where it is measured, how measurement is sustained,
  - how change is managed
- **data transmission**
  - what is transmitted, with what time delay, in what code
- **data management, including data rescue**
  - archiving and access to raw data, metadata, processed data records and products
  - recovery and rehabilitation of past data
- **data records and products**
  - fundamental records, including recalibration and homogenisation
  - satellite retrievals, gridded fields from *in situ* and remotely-sensed measurements, comprehensive reanalyses of multiple observational datasets based on weather-prediction systems



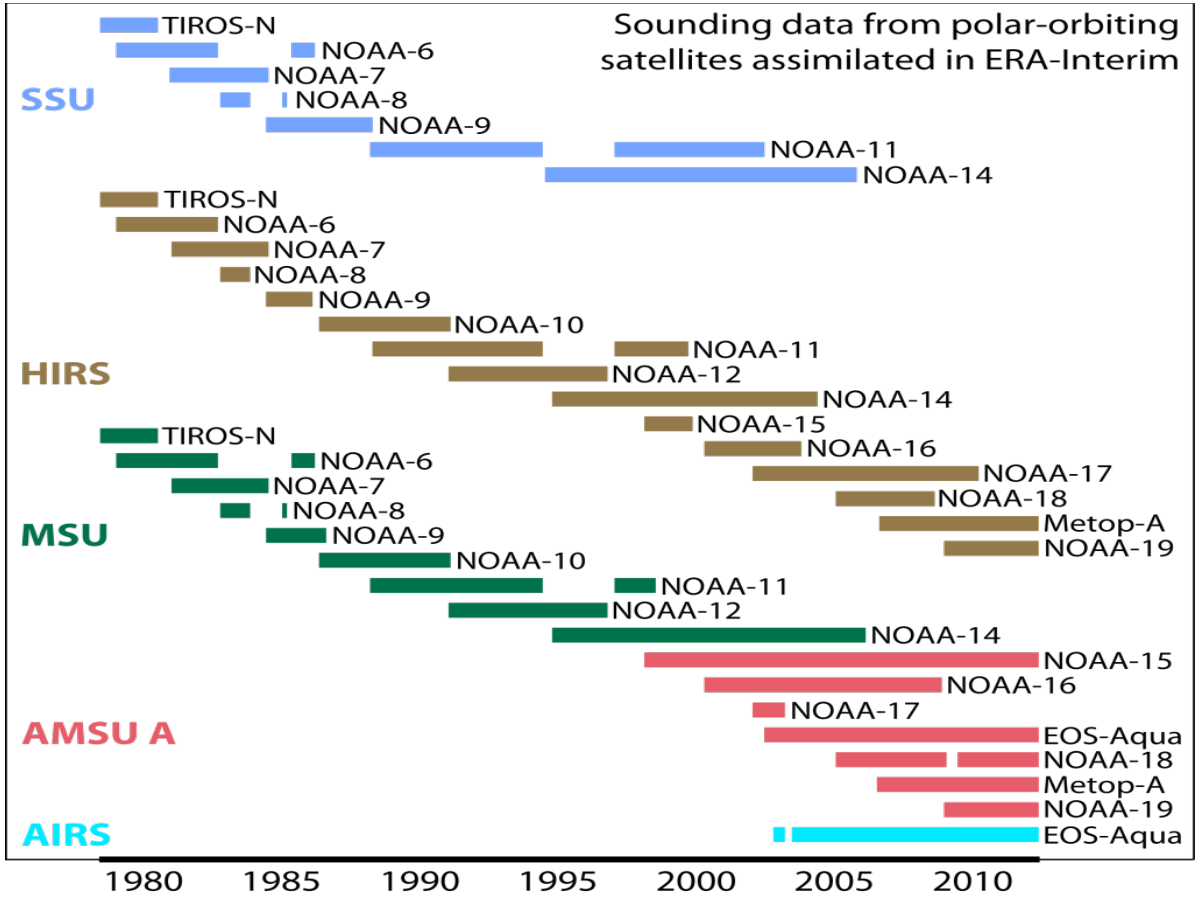
Locations of 36064 surface weather observations received by ECMWF 09-15UTC 12 June 2012



Evolution of the observing system – Assessment in 2015



Examples of *in situ* data numbers assimilated by ERA-Interim

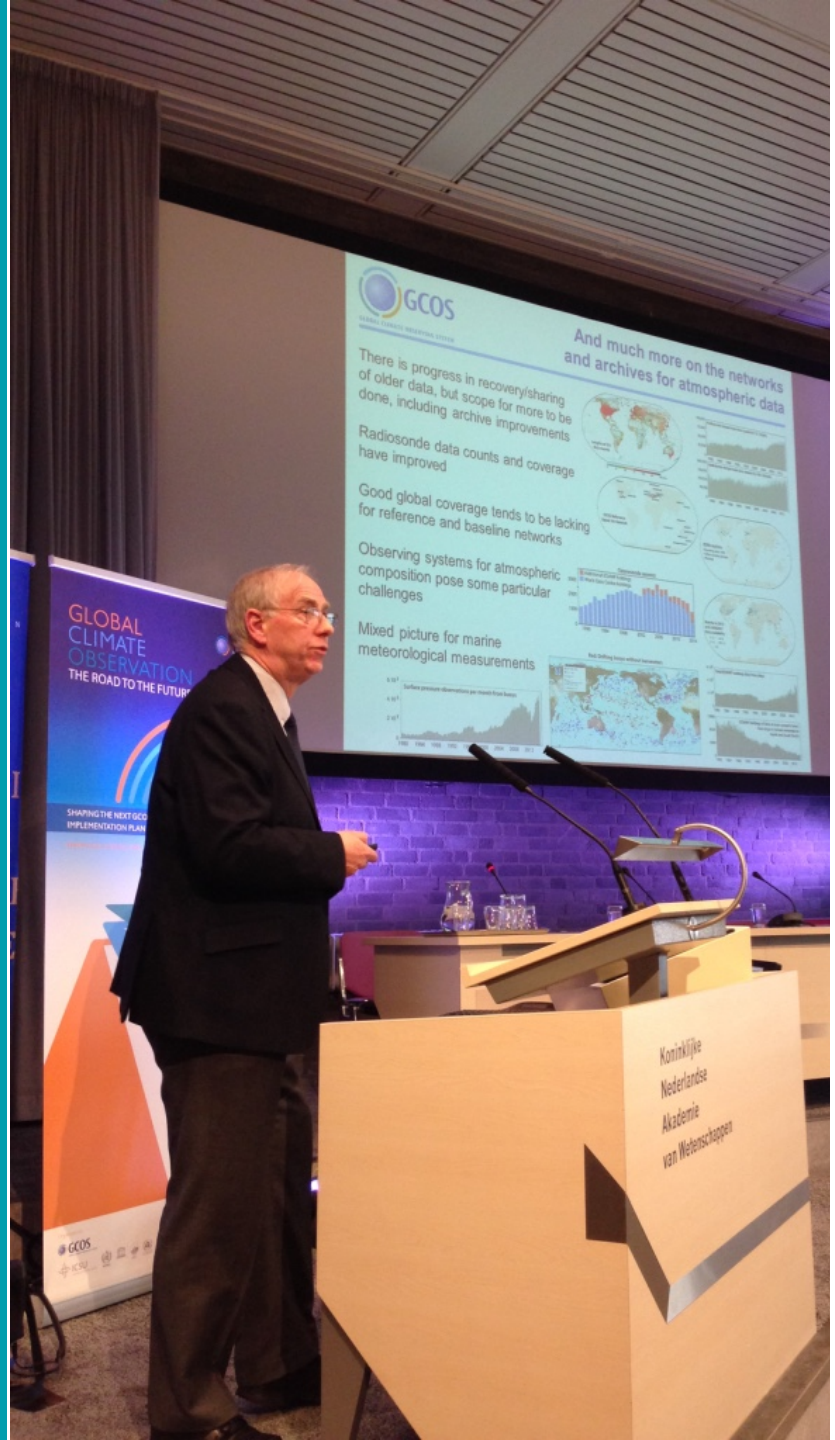


Data from IASI and NPP could not be used in 2006 version of assimilation system frozen for ERA-Interim. Use of data from Metop-B was not activated in 2012

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

Source: A. Simmons



Some continuing concerns, including

- **deterioration of some *in situ* networks; lack of progress in filling gaps in others**
- **limited provision for limb sounding and 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**
- **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**

Source:Status Report 2015, A. Simmons

Concept of ECVs published– 2014

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.

Observations are fundamental to advancing scientific understanding of climate (Doherty et al. 2009; Shapiro et al. 2010) and delivering the vetted, timely, and purposeful climate information needed to support decision making in many sectors. Observations and monitoring are key elements of the emerging Global Framework for Climate Services (WMO 2011a) and more generally support climate research, the assessment of climate change, and the development of policy responses (Fig. 1). For these purposes, observational datasets in general need to be traceable to quality standards, be readily interpretable and freely available, and cover sufficiently long periods: for example, the 30 years traditionally used for calculating climate normals (WMO 2011b). Transparency in the generation of climate datasets is

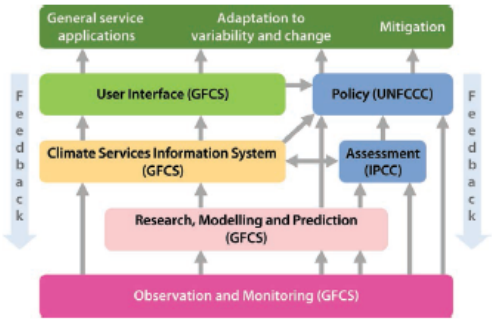


FIG. 1. The role of observation within the Global Framework for Climate Services (GFCS) and in support of research; the assessment of climate change, in particular as undertaken by the IPCC; and the development and implementation of policy responses, in particular under the UNFCCC. Gray arrows denote the main directions of flow of climate data and derived information. Feedback for system improvement flows mainly in the opposite direction. The GFCS includes a substantial capacity-development component that underlies all illustrated components. Adapted from WMO (2009, 2011a).

https://doi.org/10.1175/BAMS-D-13-00047.1
Published Online: 30 October 2014

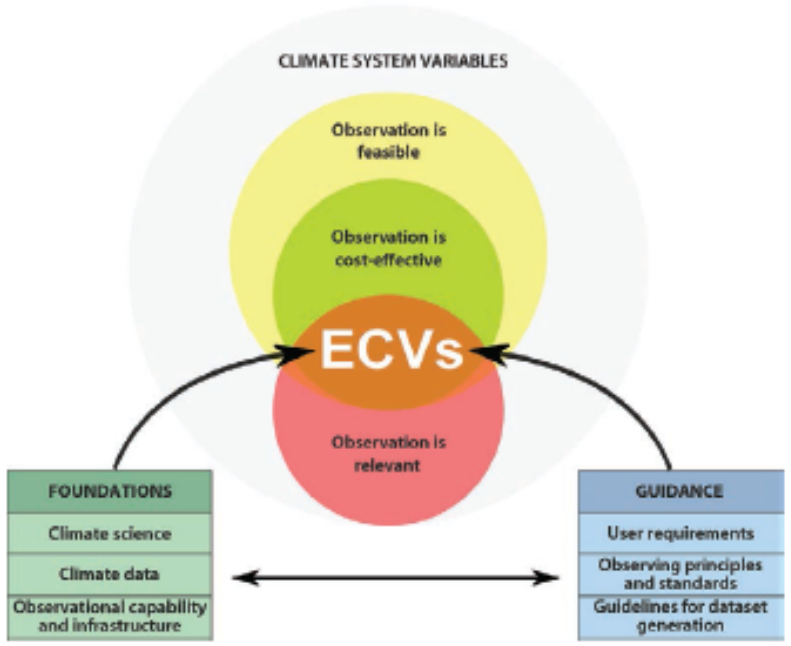
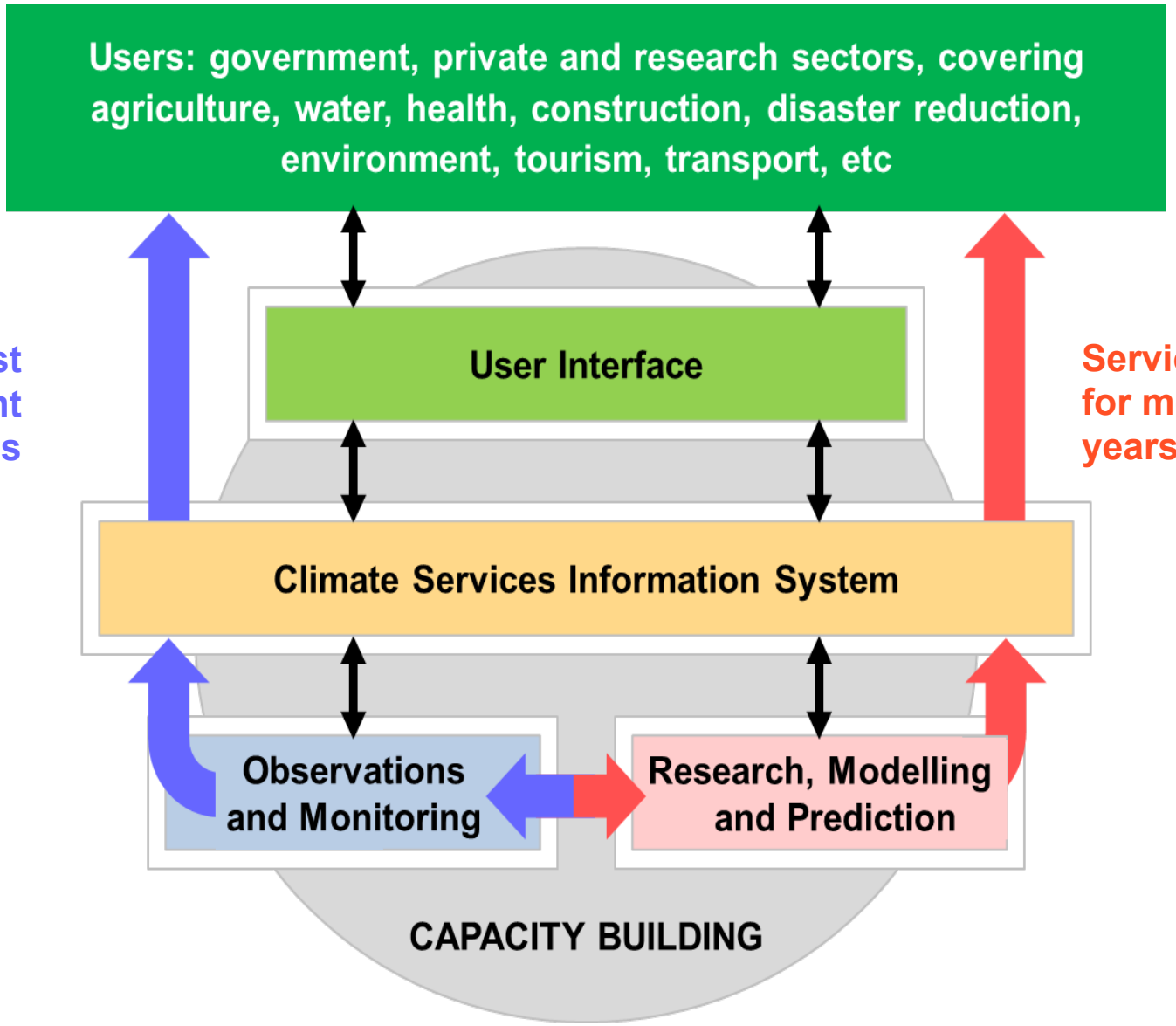


FIG. 2. Schematic of the ECV concept: knowing existing climate-relevant observing capabilities, climate datasets, and the level of scientific understanding of the climate system are the foundations (lower-left box) necessary for selecting the ECVs from a pool of climate system variables. In addition, 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.

Observations for climate services

Services related to past and present climate and vulnerabilities



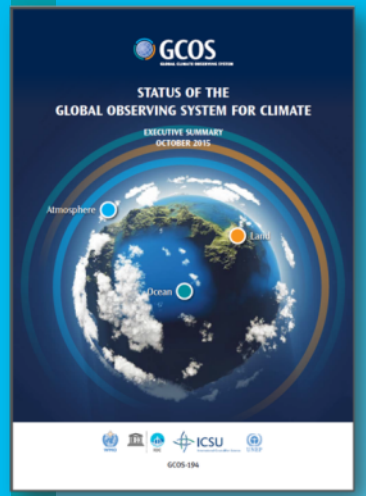
Services related to climate for months, seasons, years, decades, … ahead

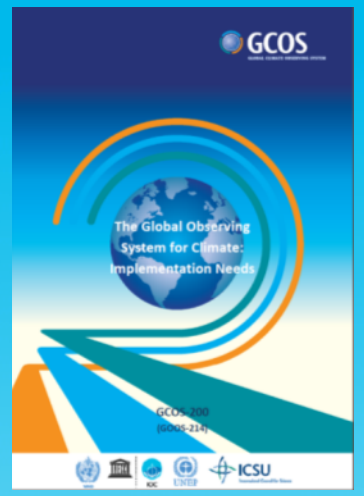
(Prof. A. Simmons, GFCS II side event, Cg-XVI, 19 May 2011)

GCOS Progress: Improving global climate observations

United nations conference on climate change
COP21/CMP11

COP-22, Marrakech,
Decision 19/CP.22
SBSTA Conclusions





Support Adaptation & Mitigation

Water, Energy and Carbon cycles

Additional Essential Climate Variables

More help for networks in developing countries

Climate Indicators

- First Regional workshop held in Fiji for Pacific Island States
- Working group in Lightning starts work
- Working group on GCOS Reference Surface Network meets for first time

WGClimate CEOS CGMS

ECV Inventory: The Architecture for Climate Monitoring from Space in Action

2015 **2016** **2017**

Essential Climate Variables

"Products for specific ECVs are generated from in situ data, satellite data or a combination of the two.

The requirements … are being increasingly well met by products based on integration of data from a comprehensive mix of in situ networks and satellite systems, achieved largely through the process known as reanalysis, but also referred to as synthesis.

This involves using a fixed data-assimilation system to process observations that extend back in time over multiple decades, employing a model of the atmosphere, ocean or coupled climate system to spread information in space and time and between variables and otherwise to fill gaps in the observational record."

The Global Observing System for Climate: Implementation Needs, GCOS-200, Section 2.4 Production of Integrated ECV products

Download from: gcos.wmo.int
DOI: 10.13140/RG.2.2.23178.26566

Actions from the GCOS Implementation Plan on «Reanalysis»

Action G22: Implementation of new production streams in global reanalysis

Action G23: Develop coupled reanalysis

Action G24: Improve capability of long-range reanalysis

Action G25: Implementation of regional reanalysis

Download from: gcos.wmo.int
DOI: 10.13140/RG.2.2.23178.26566

The Global Observing System for Climate: Implementation Needs, GCOS-200, Section 2.4 Production of Integrated ECV products

ICR5, November 2017, Discussions

Notes about «anchor series», set of observations which are key to reanalyses as they reduce uncertainty so much, for example:

Sea Surface Temperature

Sea Ice Concentration and Thickness

Surface Pressure

Soil Moisture

Scatterometer wind

ECV Inventory Data & Download

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ID	Domain	ECV	Product	Physical Quantity	Status	Org	From	To
11536	Atmosphere	Earth Radiation Budget	Total Solar Irradiance	Total Solar Irradiance	Current	NOAA NCEI	2003-03-01	2016-12-31
11535	Atmosphere	Earth Radiation Budget	Total Solar Irradiance	Total Solar Irradiance	Current	NOAA NCEI	2003-03-01	2016-12-31
11534	Atmosphere	Earth Radiation Budget	Solar Spectral Irradiance	Solar Spectral Irradiance	Current	NOAA NCEI	2003-03-01	2016-12-31
11533	Atmosphere	Earth Radiation Budget	Solar Spectral Irradiance	Solar Spectral Irradiance	Current	NOAA NCEI	2003-03-01	2016-12-31
11532	Atmosphere	Water Vapour	Total Column Water Vapour	Total Column Water Vapour	Current	NASA	1987-07-01	2016-12-31
11531	Atmosphere	Water Vapour	Total Column Water Vapour	Total Column Water Vapour	Current	NASA	1987-07-01	2016-12-31
11530	Atmosphere	Water Vapour	Total Column Water Vapour	Total Column Water Vapour	Current	NASA	1987-07-01	2016-12-31
						NASA	1987-07-01	2016-12-31
						NASA	1987-07-01	2016-12-31
						NASA	1987-07-01	2016-12-31

showing 1 to 10 of 913 records

DOMAIN: TERRESTRIAL

ECV: *Soil Moisture*

Product: Volumetric Soil Moisture
ID: T.11.1
Number of items:

TARGET RESOLUTION: horizontal: 50 km; vertical: N/A; temporal: Daily

TARGET ACCURACY: 0.04 m3/m3

TARGET DECADAL STABILITY:: 0.01 m3/m3 /year

Benefits

Improved accuracy of GCMs and soil-vegetation- atmosphere transfer schemes, increased understanding of the feedback between climate and vegetation, gas flux estimation in permafrost regions.

Other Applications

NWP and nowcasting; Hydrological modelling, groundwater management, agricultural management and hazard forecasting, including flood and drought prediction; Epidemiology, though prediction of water-borne diseases.

DOMAIN: TERRESTRIAL

ECV: *Land Surface Temperature*

Product: Land-Surface Temperature
ID: T.12.1
Number of items: 3

TARGET RESOLUTION: horizontal: 1 km; vertical: N/A

Benefits

Relevance to detailed observations of TOA longwave upwelling radiance; Synergistic with making observations of SST; Relevance to spatial and temporal characterization of freeze-thaw cycles; Land-surface temperature as a driver of vegetation phenology; Response of the land surface to radiative and boundary layer forcing, modulated by hydrological conditions; Early and sensitive indicator of drought conditions.

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http://climatemonitoring.info/ecvinventory

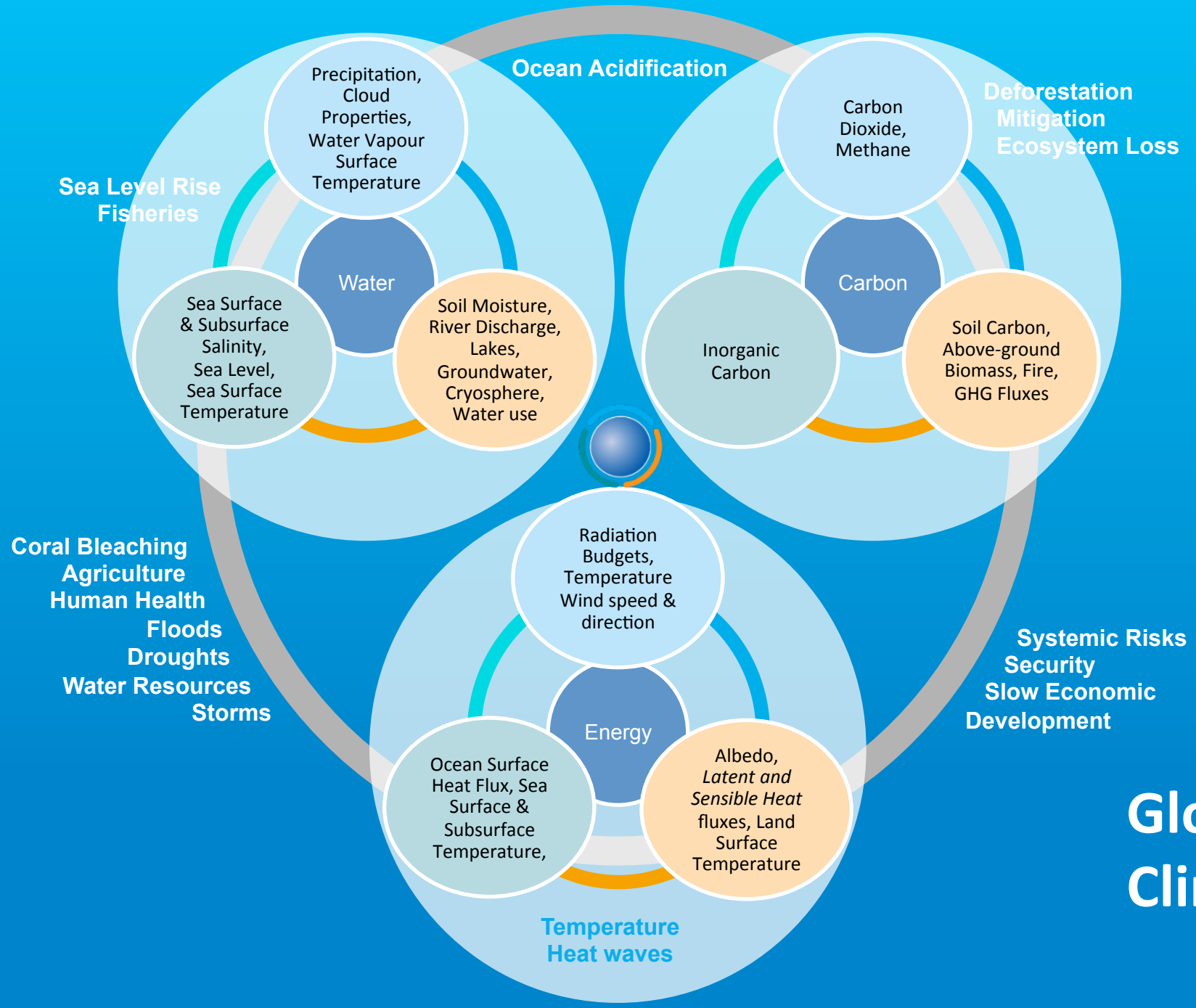
32 ECVs available

WMO | UNESCO | IOC | INTERNATIONAL COUNCIL FOR SCIENCE | UN environment

Global Climate Indicators

Headline Indicators

Temperature and Energy	Atmospheric Composition	Ocean and Water	Cryosphere
Surface Temperature	Atmospheric CO_2	Ocean Acidification	Glacier Mass Balance
Ocean Heat		Sea Level	Arctic and Antarctic Sea Ice Extent



Global Climate Cycles

new GCOS Implementation Plan aims to improve monitoring of Global Climate Cycles

- **Carbon Budget**
  - Quantify fluxes of carbon-related greenhouse gases to +/- 10% on annual timescales
  - Quantify changes in carbon stocks to +/- 10% on decadal timescales in the ocean and on land, and to +/- 2.5 % in the atmosphere on annual timescales
- **Global Water Cycle**
  - Close water cycle globally within 5% on annual timescales
- **Global Energy Balance**
  - Balance energy budget to within 0.1 Wm^{-2} on annual timescales
- **Explain changing conditions of the biosphere**
  - Measured ECVs that are accurate enough to explain changes of the biosphere (for example, species composition, biodiversity, etc.)

Considerations

- How well do existing requirements match with the targets for cycles?
  - What changes are needed to the requirements to meet these targets
  - Are any additional parameters needed to close the cycles?
    - Can they be proposed as ECVs?
  - Are the targets for the cycles reasonable and practical?
- Climate cycles cross domains: atmosphere-oceans-terrestrial
  - Science panels will need to collaborate on each cycle
- Should GCOS hold workshops on each climate cycle?
- How should GCOS make this process authoritative?

Adapting to a changing climate – what observations are needed ?

“Virtually all observations support adaptation.”

“We must model what we cannot measure (or predict with global systems).”

Adrian Simmons, Workshop on Observations for Adaptation, DWD, Offenbach, Feb 2013

Presentation: “The Global Climate Observing System: Observations and products from global to local”

ECV Inventory Data & Download

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11530	Atmosphere	Water Vapour	Total Column Water Vapour	Total Column Water Vapour	Current	NASA	1987-07-01	2016-12-31
11529	Atmosphere	Precipitation	Precipitation	Liquid precipitation	Current	NASA	1987-07-01	2016-12-31
11528	Atmosphere	Precipitation	Precipitation	Liquid precipitation	Current	NASA	1987-07-01	2016-12-31
11527	Atmosphere	Precipitation	Precipitation	Liquid precipitation	Current	NASA	1987-07-01	2016-12-31

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Click on the records to view the record details

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