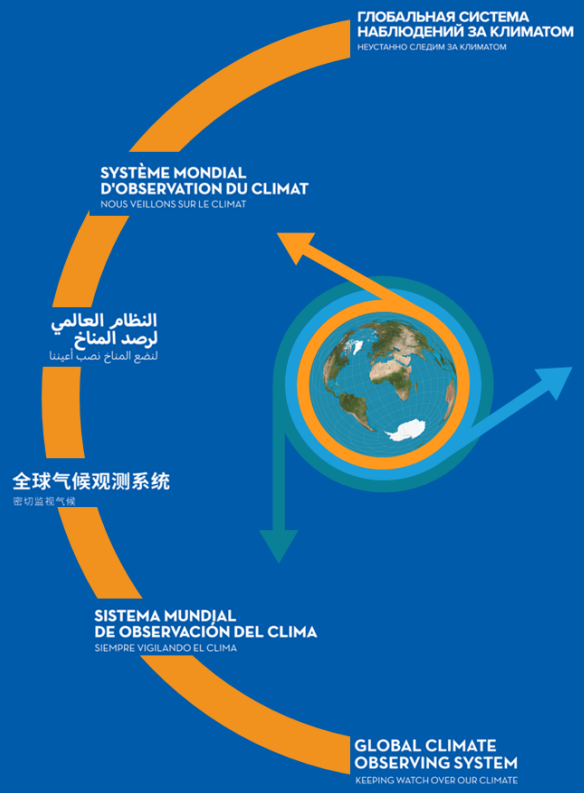


Keeping Watch Over Our Climate: New Recommendations From The Global Climate Observing System

Han Dolman

Chair GCOS Steering Committee

Royal Netherlands Institute for Sea Research and
Free University Amsterdam

Thanks to the GCOS secretariat at
WMO, Geneva

GLOBAL CLIMATE OBSERVING SYSTEM
KEEPING WATCH OVER OUR CLIMATE

WMO IOC International Science Council UN environment

Supported by the European Union
opernicus
Europe's eyes on Earth

Successful delivery and use of climate services depends on all elements in the value chain working properly

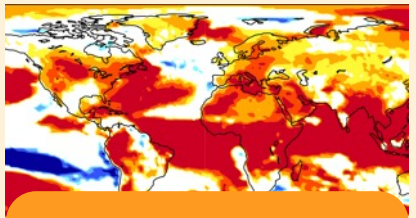
Climate-related infrastructure – must be designed and managed globally

GCOS addresses observations and data exchange but is informed by the needs of the whole value chain

Observations from the entire globe

International exchange of observations

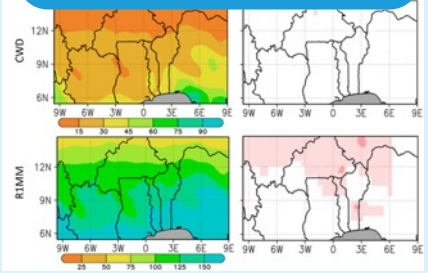
GLOBAL ACTIVITIES



Global climate modelling

Copernicus

Local Data Processing, forecast, warning and advisory products



Delivery of climate services

Effective decision making and action

Last-mile activities undertaken at regional, national and local level

The GCOS Mandate and the concept of ECVs

- GCOS serves a broad range of user needs for globally coordinated climate observations. Its goal is to provide comprehensive data and climate information on the total climate system, including a range of physical, chemical and biological properties, along with atmospheric, oceanic, hydrologic, cryospheric and terrestrial processes.

- GCOS works with existing or planned operational and research programmes for acquiring, storing and distributing systematic global climate system data and identifies gaps in observations, data management and information distribution systems. The ownership and management of the observing systems and networks will remain fully with their operating entities. GCOS advocates for further enhancements of these systems, and encourages new systems to be established, where necessary.

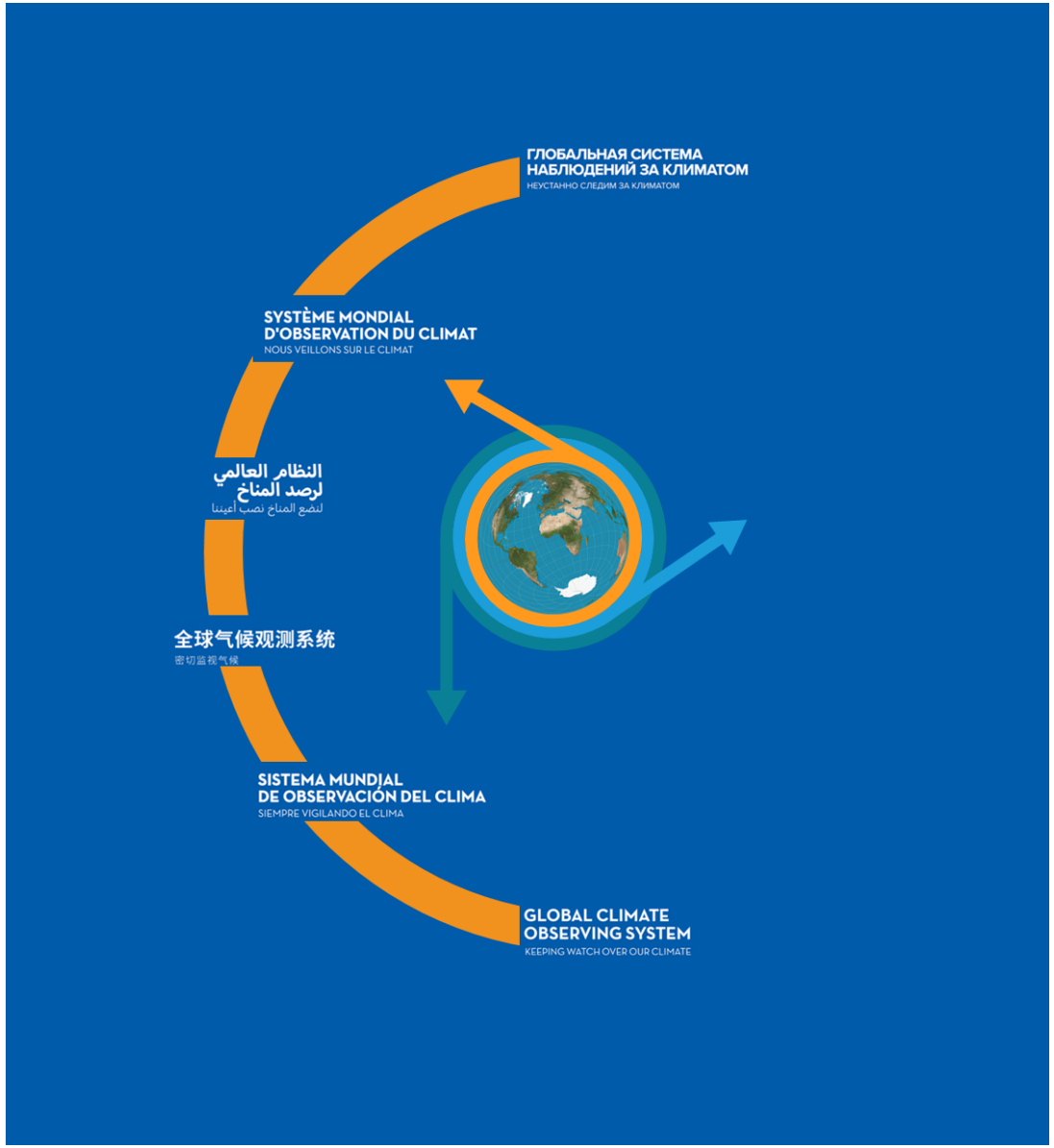
- GCOS identifies user data needs to enable the further development of these programmes to ensure continuity and diversification of climate observations. Data needs are organized around the concept of Essential Climate Variables (ECVs).

- The GCOS ECVs comprise physical, chemical and biological properties that are essential to describe the climate system.

From revised 2022 MoU

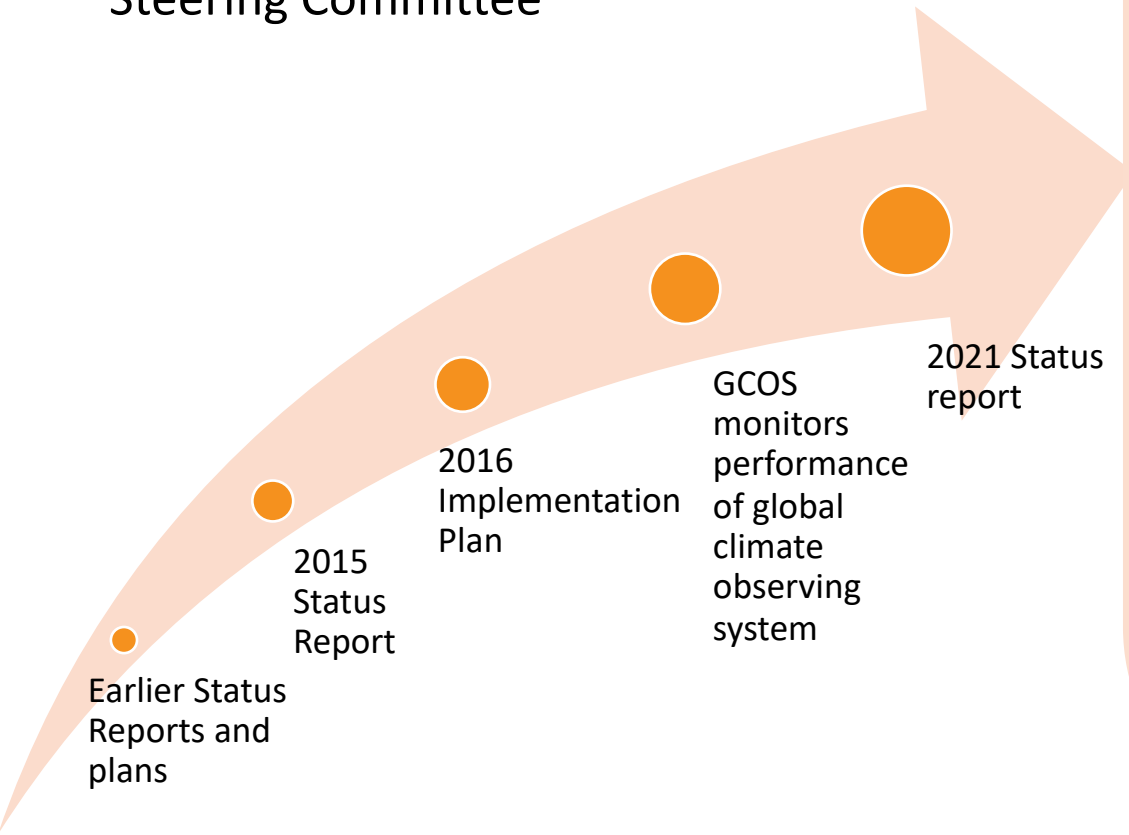
GCOS Implementation Plan

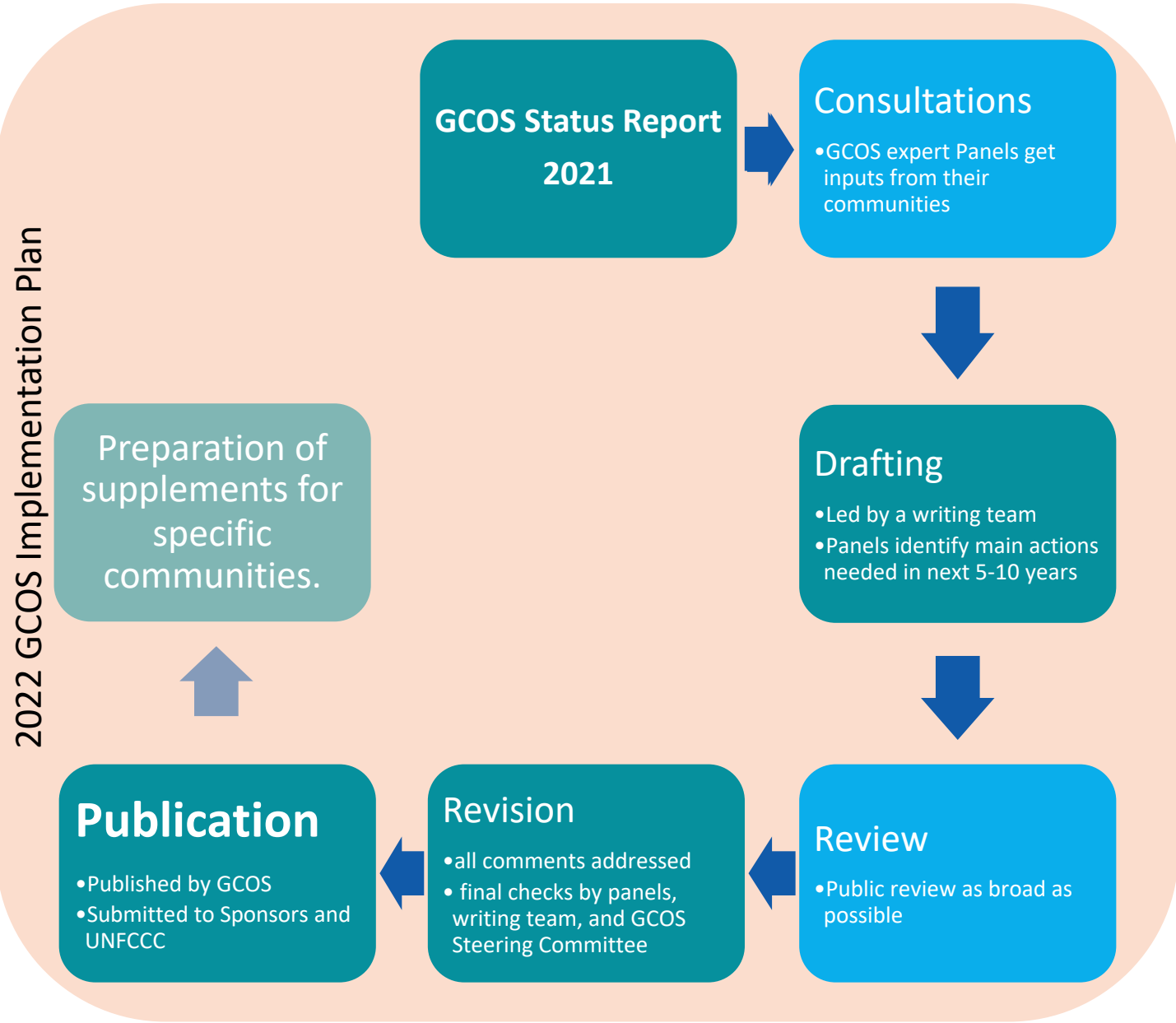
- Produced every 5-6 years, GCOS Implementation Plans:
  - Are submitted to UNFCCC and the GCOS sponsors.
  - Provide recommendations for a sustained **and fit for purpose** Global Climate Observing System.
  - Cover climate monitoring needs over the **entire Earth system** from the atmosphere to the oceans, from the cryosphere to the biosphere.
  - Encompass the water, energy and carbon **cycles**.
- This 2022 GCOS Implementation Plan has a different form to earlier plans, it has:
  - Fewer, more **focused,** and integrated actions.
  - Clearer means of **assessment**.
  - Clearer identification of the stakeholders who need to **respond** to the actions.
  - The updated ECVs requirements are presented in a separate document - *The 2022 GCOS ECVs Requirements* (GCOS 245).



Producing the plan

- GCOS has a cycle or monitoring the climate observing system → status reports → implementation plans
- Based on extensive consultation and public review
- Drafted by expert panels and drafting team, overseen by editorial board and GCOS Steering Committee





Demand for climate information and its impacts is changing

- The frequency of extreme weather events is increasing
- The vulnerability of people living in high-risk areas is growing.
- Concerns are increasing about issues such as food security and migration
- UNFCCC Paris Agreement focuses on adaptation and mitigation

More than 33 million people have been affected by the devastating flooding across Pakistan. Photograph: Rehan Khan/EPA, Guardian 9-9-22

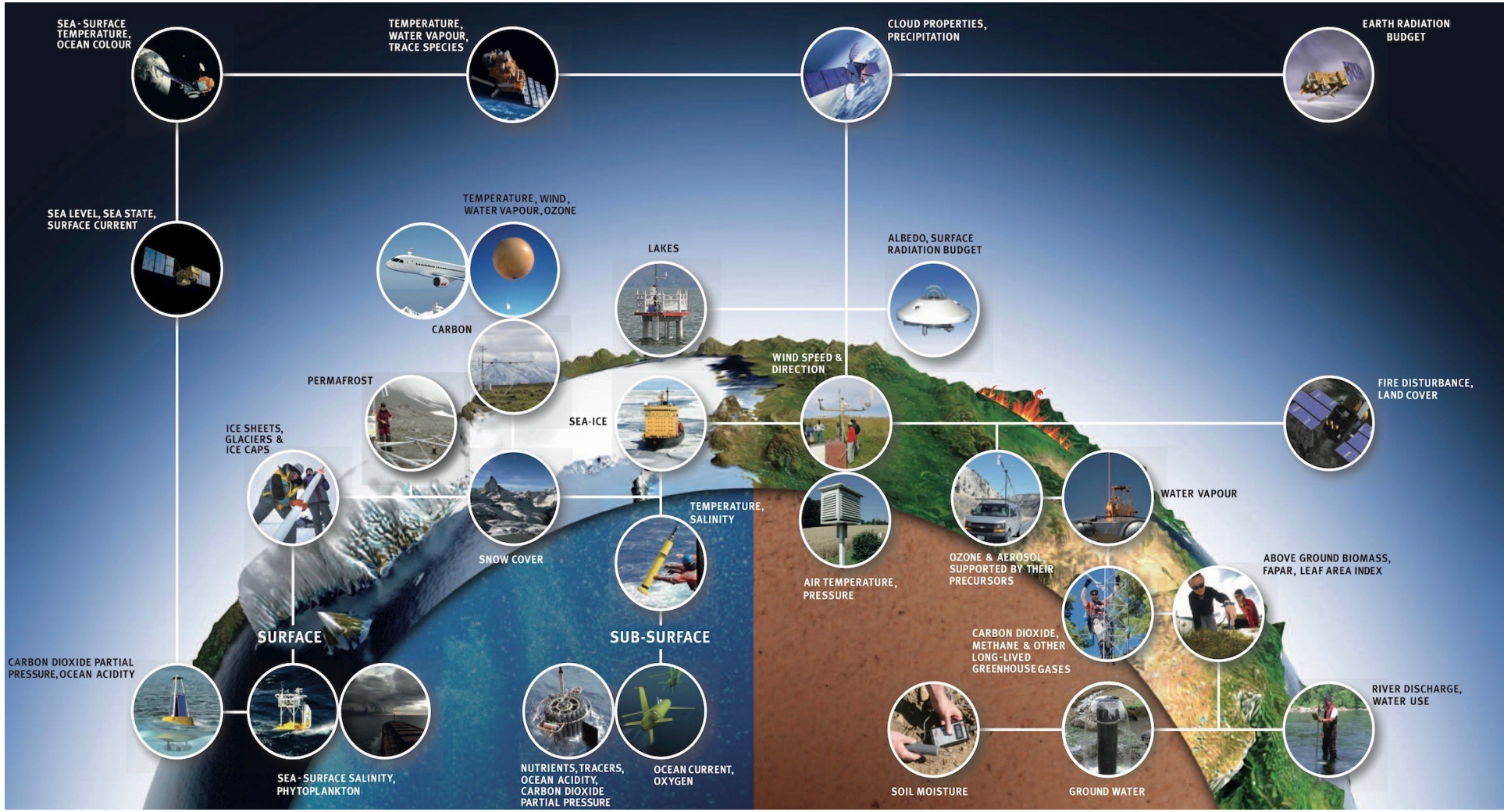
GCOS and the Earth's water, energy and carbon cycle

GCOS monitors ECVs of relevance
to Earth System cycles

Since 2010 we determine how well we can close the cycles of

- Water
- Energy
- Carbon

Aim is to asses gaps, white spots and potential new ECVs



https://climate.copernicus.eu/observations

Producing the GCOS Implementation Plan

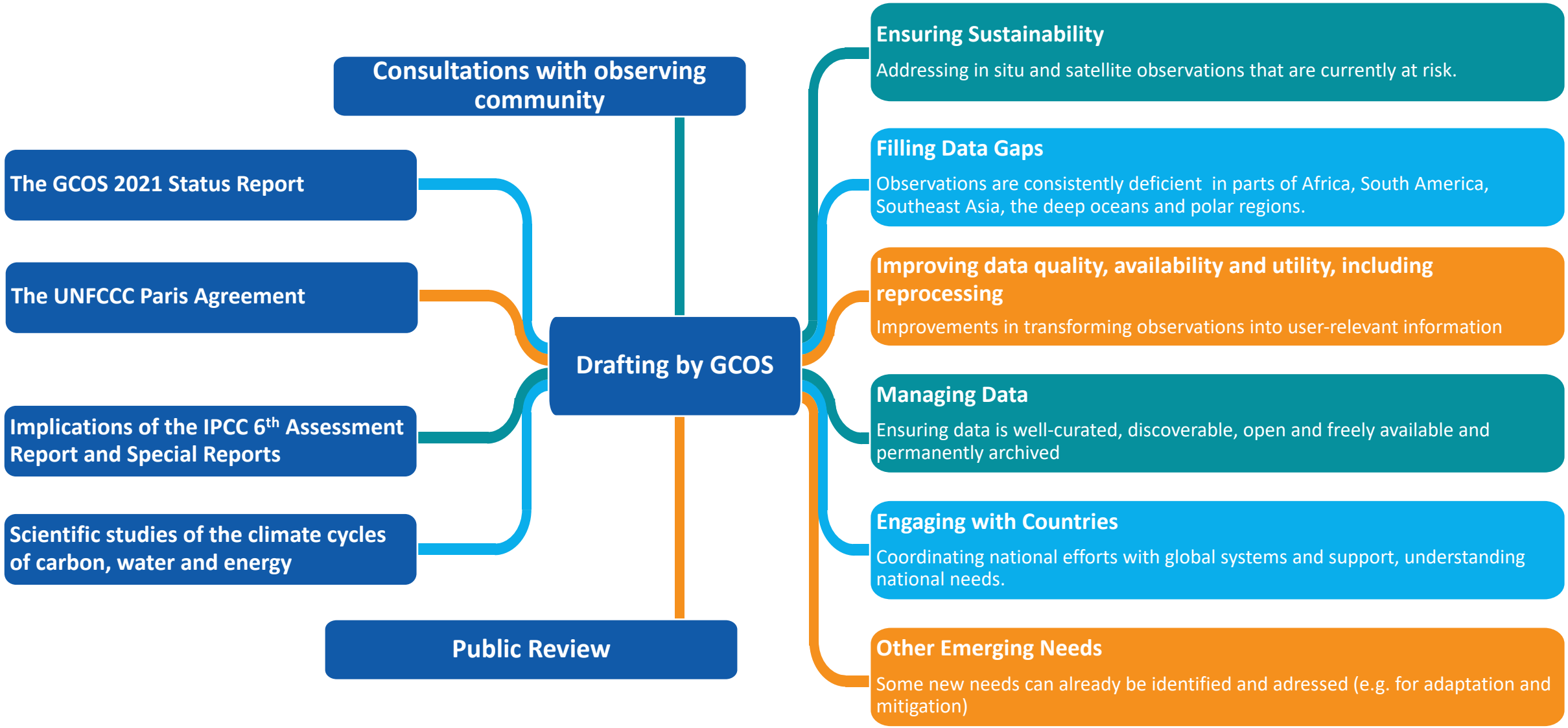
DIFFERENT FROM GCOS IP 2016

- More targeted at observing systems (including Space Agencies)
- Shorter and more concise: only 31 actions
- Actions more integrative, cross-domain
- Explicit attention to the earth cycles
- Updated set of 54 ECV Requirements by panels (A, O, T)

Preparation of draft with contributions from expert panels, invited experts, GCOS Editorial Board → Public review and revision by experts → Publish report following approval by Steering Committee and Editorial Board

Supported by GCOS Secretariat

Wide range of views and inputs condensed into 6 themes



Main Inputs → **Broad Engagement** → **Themes for Action**

Themes and issues in the IP2022

A: ENSURING SUSTAINABILITY

- Ensure long-term support for in situ networks
- Address gaps is satellite observations likely to occur in near future – prepare follow-on plans

B: FILLING DATA GAPS

- Development of reference networks: in situ and satellite
- Implement GBON
- Global reporting of hydrological observations,
- Implement trace gas and aerosol, ocean biological, biogeochemical, CO_2 and N_2O observations
- Improve estimates of latent and sensible heat fluxes and wind

C: IMPROVING DATA QUALITY, AVAILABILITY AND UTILITY, INCLUDING REPROCESSING

- Develop standards and best practices
- Improvements to satellite and in situ products
- New and improved reanalysis products

D: MANAGING DATA

- Define governance and requirements of data centre
- Ensure in situ data centres exist for all ECV
- Improve discovery and access
- Data rescue

E: ENGAGING WITH COUNTRIES

- Improve regional and national engagement in GCOS
- Enhance support for national climate observations

F: OTHER EMERGING NEEDS

- Higher resolution real time data
- Improvements in urban, polar, coastal regions and EEZ
- Develop operational Global GHG Monitoring System

IP2022 Actions with relevance for monitoring missions

Theme A: Ensuring Sustainability

Action A2: Address gaps in satellite observations likely to occur in the near future

Action A3: Prepare follow-on plans for critical satellite missions

Action B1: Development of reference networks (in situ and satellite Fiducial Reference Measurement (FRM) programs)

Action B3: New Earth observing satellite missions to fill gaps in the observing systems

Action B5: Implementing global hydrological networks

Action B6: Expand and build a fully integrated global ocean observing system

Action B7: Augmenting ship-based hydrography and fixed-point observations with biological and biogeochemical parameters

Action B9: Improve estimates of latent and sensible heat fluxes and wind stress

Action B10: Identify gaps in the climate observing system to monitor the global energy, water and carbon cycles

Theme B: Filling Data Gaps

Next Steps

Who has to act?

- WMO
- NMHS
- Space agencies
- GOOS
- Reanalysis Centres
- Global Data Centres
- Research organizations
- National Agencies
- Parties to UNFCCC
- Academia
- Funding Agencies
- GCOS

GCOS will

- Prepare supplements for several of these groups summarising the important relevant actions.
- Address actions allocated to it in Implementation Plan.
- Identify additional needs arising from Paris Agreement (i.e. adaptation & mitigation).
- Continue to monitor performance of global climate observing system.
- Facilitate reviews of observations of climate cycles.
- Review adequacy of ECV requirements.
- Promote national engagement in GCOS.

2nd CLIMATE OBSERVATION CONFERENCE

DARMSTADT, GERMANY
17 OCTOBER-19 OCTOBER 2022

Organised by GCOS and WMO with the support of EUMETSAT

GCOS
KEEPING WATCH OVER OUR CLIMATE

WMO

IOC

International Science Council

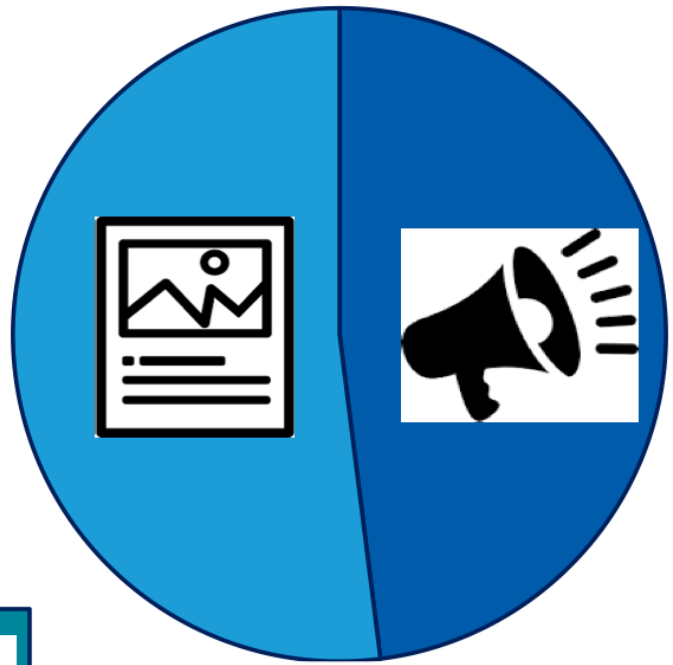
UN environment

EUMETSAT

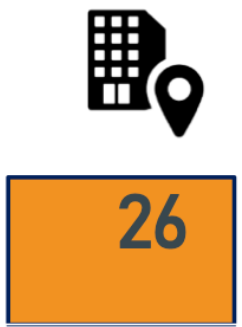
The Conference in numbers

200 submissions accepted

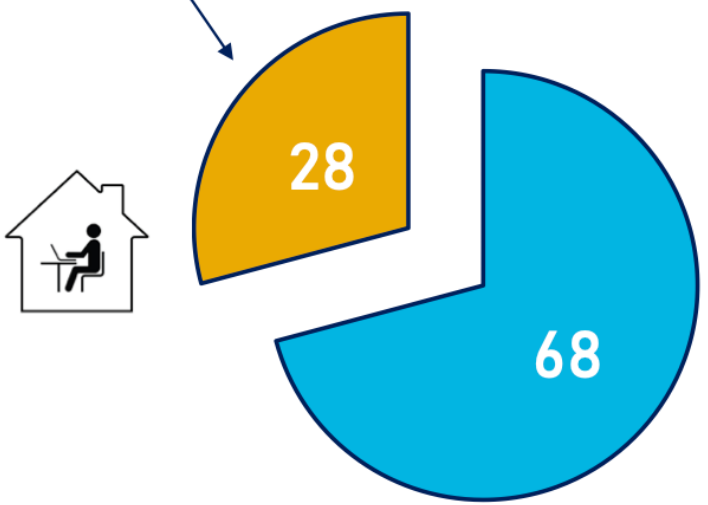
- 3 Keynotes
- More than 400 participants online



104 posters



96 talks



- **Sustained, long-term funding**
- **Addressing the key gaps in observations**.
- **The improvement of data quality, availability, accessibility and utility**. Many climate observations are underexploited because of the lack of consistency, and clarity, in their processing, interoperability and usability. The conference has provided concrete pathways to improvements, identifying that increased effort is required to ensure that the data can be readily used in reanalysis and are fit for purpose..
- **The creation and maintenance of climate data repositories.** To address and understand climate change, the longest possible time series need to be preserved and made available. Climate data must be made available through global data repositories, and their access must be free and unrestricted.

- **Addressing the emerging needs.**
- **The engagement with nations.**
- **The improvement of regional and national climate change information.** Improved understanding of the local decision-making context and associated observational requirements, will help address the gap between the “top-down”, global, production of observations and climate information, and the "bottom-up" local-scale decision making.
- **Integrated and collocated observations** of the physical, chemical, and biological components of the climate system
- **The conference participants call for the establishment of a global goal on observations under the** UNFCCC. This should guide the needed “action–oriented framework for observation" .

ng Needs

Action F5: Develop an Integrated Operational Global GHG Monitoring System	
Activities	The overall aim here is to develop an integrated operational global greenhouse gas monitoring infrastructure. The first steps are: 1. Design and start to implement a comprehensive global set of surface-based observations of CO_2, CH_4 and N_2O concentrations routinely exchanged in near-real time suitable for monitoring GHG fluxes. 2. Design a constellation of operational satellites to provide near-real time global coverage of CO_2 and CH_4 column observations (and profiles to the extent possible). 3. Identify a set of global modelling centres that could assimilate surface and satellite-based observations to generate flux estimates. 4. Improve and coordinate measurements of relevant ECVs at anthropogenic emissions hotspots (large cities, powerplants) to support emission monitoring and the validation of tropospheric measurements by satellites.
Issue/Benefits	The Paris Agreement requests Parties to regularly provide estimates of anthropogenic emissions by sources and removals by sinks of greenhouse gases, and information necessary to track progress made in implementing and achieving their nationally determined contribution under Article 4. The proposed global greenhouse gas monitoring infrastructure would support the development of these estimates (i.e. emission inventories); validate national and regional achievement of Parties' commitments in their NAPs; and monitor changes to the cycles of GHG that may impact the achievement of the temperature goal of the Paris Agreement. Monitoring of hot-spots via dedicated observations to validate specific point-source emissions and identify missing sources form emission inventories. Remote monitoring of atmospheric composition can quantify and identify major emission sources. Anthropogenic emission hotspots like cities and industrial facilities and power plants contribute strongly to the global GHG emissions and to emission of key ozone and aerosol precursors (SO_2, VOCs). Reliable remote observations of these emission hotspots in synergy with source detection models can contribute to verifying emission estimates and monitor and guide mitigation efforts (link to Flux ECV).

Anthropogenic Greenhouse Gas fluxes

Name

Definition

Unit

Note

Item needed

Horizontal Resolution

Vertical Resolution

Temporal Resolution

Timeliness

Required Measurement Uncertainty (2-sigma)

Stability

Standards and References

Estimated fluxes by coupled data assimilation/ models with observed atmospheric –

Name	CO_2 emissions/ removals by land categories				
Definition	Short and long cycle C emissions from land use, land-use and forestry (including carbon stock gains and losses of biomass burning, disease, harvest, net deforestation)				
Unit	ton CO_2 /yr for the region				
Note	This corresponds to UNFCCC reporting of anthropogenic emissions and removals from LULUCF				
Requirements					
Item needed	**Unit**	**Metric**	**[1]**	**Value**	**Derivation, References and Standards**
Horizontal Resolution	NONE – BY COUNTRY	As defined by UNFCCC	G	By country/region	IPCC 2006 GL, UNFCCC Inventory Guidelines
			B		
			T	By country/region	IPCC 2006 GL, UNFCCC Inventory Guidelines
Vertical Resolution	N/A		G		Not relevant
			B		
			T		Not relevant
Temporal Resolution	time	time	G	Annual	IPCC 2006 GL, UNFCCC Inventory Guidelines
			B		
			T	Annual	IPCC 2006 GL, UNFCCC Inventory Guidelines
Timeliness	time	time	G	WITHIN ONE 1.25 YEARS	UNFCCC Inventory Reporting Guidelines
			B		
			T	WITHIN ONE 1.25 YEARS	UNFCCC Inventory Reporting Guidelines
Required Measurement Uncertainty (2-sigma)	% or kT	Twice the estimated standard deviation of the total as a % of the total **or** mass of CO_2	G	15% or 300kT – whichever is largest	IPCC 2006 GL
			B		
			T	20% or 400kT – whichever is largest.	IPCC 2006 GL
Stability			G		IPCC 2006 GL
			B		
			T		IPCC 2006 GL
Standards and References	• IPCC 2003 GPG, IPCC 2006 GL; • UNFCCC National Inventory Reports				

ESA CCI+ and GCOS

- ESA-CCI addresses many of the aims of GCOS: data collection, archiving, dataset generation and dissemination

- ESA-CCI has also had many inputs into the preparation of the Implementation Plan
  - Many experts are shared
  - Through the review process

- We have a shared history but also share a joint responsibility for our future

Thank you

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Supported by the European Union
Copernicus Europe's eyes on Earth