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DAY 1: Tuesday 2 July 2024 - General Goal: Background information of GCOS; all participants engaged and understanding GCOS broadly

1. Opening of the meeting

The 31st GCOS Steering Committee (SC) meeting was held in Geneva, Switzerland, hosted by GCOS. The agenda of the meeting can be found in Annex 1 and the list of participants in Annex 2. All presentations are available on the dedicated page at GCOS website and downloadable from the meeting Agenda in Annex 1.

1.1 Welcome from WMO and GCOS Director

Ko Barrett, Deputy Secretary-General of the World Meteorological Organization since April 2024, opened the meeting and expressed her appreciation for the opportunity to address the Steering Committee and collaborate again with its Chair, Thelma Krug, and highlighted the importance of the GCOS programme for WMO.

1.2 Approval of the agenda and introduction

Thelma Krug welcomed the participants and stressed the singularity of the meeting, since it is the first in-person meeting of the Steering Committee in 5 years. She explained that the concept for the meeting would be different from the classical one, with more time for interaction and brainstorming to ensure the proper engagement of the participants. This was followed by a brief and informal presentation of the SC members. Finally, the Agenda was adopted.

2. The story of GCOS: Introducing GCOS and its evolution

2.1 Why do we need GCOS and GCOS origin

Thelma Krug recalled the international context in which GCOS was established in the early nineties, just a few years after the World Climate Research Programme (WCRP) and the Intergovernmental Panel on Climate Change (IPCC) were created, as a result of the recognition of the need of observations to support the scientific assessments at the second World Climate Conference.

2.2 The history of GCOS in the last 20 years

Peter Thorne, Deputy Chair of GCOS and Chair of Atmospheric Observation Panel for Climate (AOPC), described the main milestones in the history of GCOS programme, including the adequacy reports (now status reports) and the implementation plans, and the connection to the United Nations Framework Convention on Climate Change (UNFCCC). He provided an overview of the main global networks contributing to the observing system and clarified that the GCOS programme does not make observations, it is a coordination mechanism.

The discussion that followed permitted insights into some details of the history of GCOS programme such as the Global Cooperation Mechanism, and clarifications around its mandate.

3. Panel Discussion: Co-sponsors, UNFCCC, WGClimate, WCRP

3.1 Panel discussion: co-sponsors, UNFCCC, WGClimate and WCRP

Thelma Krug animated this panel where representatives of some of the GCOS key stakeholders participated (UNFCCC, WMO, IOC, UNEP, ISC, WGClimate, WCRP). She initiated the discussion by asking the participants to choose one word for GCOS, summarizing what benefits the institution they represented received from GCOS. The words chosen were:

- Climate-Infrastructure
- Indicators
- Data

- Shared Scientific Officer and Panel
- Scientific legitimacy
- Priority
- Climate Observations

Thelma requested some of the participants to expand on their choices. For instance, ISC explained how they rely on their affiliated bodies (hence, GCOS) to provide research and science inputs into the policy and public space. WGClimate, representing CEOS and CGMS, takes advantage of the work of GCOS to focus their efforts and resources into ECV observations. IOC stressed the importance of champions so that the importance of climate observations is understood. This led to a reflection on the low visibility of GCOS and the observations that should underpin reports and decisions ("*communication gap*"), a concern shared by several of the participants. This connects to the issue of the value chain and where GCOS stops (GCOS is at the start of the value chain, while there are many other steps until climate services and climate information is generated) and downstream activities begin. On the issue of communication, some of the participants pointed out some difficulties in conveying the importance of GCOS and its mission, while some other partners stressed the fruitful interactions at a working level.

In terms of how the different organizations contribute to GCOS, several of the co-sponsors and partners highlighted their role in steering the programme, connecting with policy and advocating the importance of observations for the delivery of services (UNEP, IOC, UNFCCC, WGClimate). ISC provides the contact with a network of academic institutions, but also with other ISC affiliated bodies (e.g. World Data Centre), while WCRP mentioned science questions. WCRP proposes those questions and GCOS defines the observations system, which needs to be optimized to address those scientific challenges.

Thelma concluded on the need to enhance communication, with improved visibility of the strong links between GCOS and its stakeholders.

3.2 GCOS Funders: Copernicus and NOAA

3.2.1 Copernicus

Hugo Zunker, policy officer in the Copernicus unit of the Directorate-General for Defense Industry and Space (DG DEFIS) provided an overview on the Copernicus programme, and how it contributes to European Union policies in different areas (agriculture, security, climate) paying special attention to the role of Sentinel Satellites, producing open data that is freely available. He also highlighted the on-going collaboration between WMO and ECMWF/Copernicus for the production of the European State of the Climate. In terms of foresight, he mentioned the planned satellite missions to measure atmospheric CO_2 (CAMS Emission Services) as well as Destination Earth: an initiative which tries to build a highly accurate Digital Twin of the Earth. He concluded by pointing out the benefits of the engagement between GCOS and Copernicus, including maximizing Copernicus impact beyond Europe, focus provided by the ECVs, links to CGMS and CEOS, as well as the points of commonality between both initiatives such as the multi-domain approach, as well as in-situ/remote sensing. In terms of areas of improvement, Hugo encouraged GCOS to bring to their attention the gaps that Copernicus could fulfil. He also mentioned how support for GCOS had been provided in a context of the acute cashflow issue. A plan was implemented for 3 years, postponed in 2024, and there is a plan to allocate 3 more years, even though it is not done yet. In the future, this is not guaranteed.

Following some of the questions from the floor, Hugo Zunker explained that in situ networks are not at the core of Copernicus, they are generally under the responsibility of national agencies, so in situ observations feed into Copernicus through collaboration with those nations and with the European Environmental Agency. Furthermore, Copernicus collaborates with some international global networks, in particular for the marine in situ.

3.2.2 NOAA

Ann-Christine Zinkann represented NOAA, and specifically the GOMO office (Global Ocean Monitoring and Observing programme). She explained that OOPC activities were their main focus of interest and the component that NOAA funds directly. NOAA stations are also part of some of the GCOS atmospheric networks (GSN, GUAN), satellites etc. NOAA supports GCOS/OOPC through multi-year contracts. Ann-Christine Zinkann also made several suggestions for areas where GCOS could work further, such as use cases to show the value of ECVs, presenting a clear landscape of institutions related to GCOS, as well as some opportunities for expansion of GCOS towards the coast, biogeochemistry and G3W. Strategic areas where some alignment could be sought were mitigation and regional efforts. She finished with some questions for GCOS including how the programme is going to embrace the growing expansion of essential variables, whether GCOS had considered defining ECVs by use case or application area such as forecasting or mitigation, and GCOS involvement in regional efforts. Ann-Christine also suggested that the current Implementation Plan should be more specific in what it is requesting to trigger an adequate response.

During the discussion, participants reiterated the importance of connecting observations and monitoring and use cases. This is important to justify the value of observations, but also to better map the needs. Joanna Post recalled the decisions in the 2022 Sharmk el-Sheikh COP, with the recognition of systematic observations and the GCOS Implementation Plan including G3W. She encouraged GCOS to make use of that recognition in UNFCCC, together with other parties such as GOOS. Participants also brought up front the calibration/validation issue, whereby without in situ data satellite observations would be much less valuable. Permanent calibration/validation stations such as GRUAN and GSRN could be established, providing long-term series. There are working groups within WGClimate and CEO already working on that but collaboration on network design should be enhanced so that this validation can be undertaken. The issue has different implications including proper training to staff working at the validation/calibration sites. WCRP stressed that in situ ocean subsurface observations are not only important for validation, but they are the only available source of information.

Action Number	Description
A31/1	GCOS to invite Space Agencies to enter a dialogue to establish permanent calibration/validation stations taking into account existing efforts such as GRUAN and GSRN to make sure that the increasing amount of data that is being generated can be validated. Participate/do a presentation on GCOS (reference) networks in WGCV - WGClimate/CEOS Working Group on Cal/Val. GCOS Secretariat – Next WGClimate Meeting (February 2025).

Thelma concluded by noting that although GCOS programme is well recognized, in particular by UNFCCC, this recognition is not accompanied by provision of funds. She also warmly thanked the two presenters online from Copernicus and NOAA.

4. A deeper look in GCOS

4.1 The ECVs framework, Status Report and Implementation Plan.

Sabrina Speich described the three main outputs of GCOS programme, produced along a 5-6y cycle and submitted to UNFCCC for endorsement: the definition of Essential Climate Variables and ECV observational requirements, the adequacy report of the global observing system for climate (GCOS Status Report) and the publishing of recommendations for its improvement (GCOS Implementation Plan).

During the round of questions, it was clarified that for an ECV to be designated as such, there is a need to have continuity in the observations, but as for all WMO RRR domains that the requirements are technology free. The aim is that the observing system considered as a whole, with the combined power of all the components of the observing system, meets the ECV

requirements (not each of its components). Sabrina explained that during the definition of the requirements there are consultations through GCOS experts and also through a public review. The IPCC role in identifying observational gaps in their reports (later on used in GCOS Status Report), was highlighted.

4.2 GCOS Panels

AOPC, OOPC Chairs, and TOPC officer presented the panels briefly, focusing on the experts and main duties.

Peter Thorne (AOPC) highlighted the connection between AOPC activities and WMO Infrastructure Department, while Sabrina Speich (OOPC) stressed that most of the ocean observations are supported by research funds, and not part of any operational, sustained programme. Antonio Bombelli underlined the strong connections between TOPC and the other GCOS panels. This interaction is very important and supported by cross-panel meetings with all experts and bimonthly meetings between all panel chairs. Also, many Implementation Plan Actions have a cross-panel nature and are addressed jointly by the three panels.

4.3 GCOS Secretariat

Next, there was time for an informal presentation of the GCOS officers, Caterina Tassone and Tim Oakley (AOPC), Belén Martín Míguez (OOPC), Antonio Bombelli (TOPC), Yeji Kim (intern from South Korea) and Magaly Robbez (Programme assistant) and finally Nir Stav (GCOS Secretariat Director).

4.4 Panel Discussion: Core Members

Thelma Krug invited the GCOS SC core members (most of which are new to the role) to pick up a word that would describe their motivations to join and contribute to GCOS. (See Figure 1.)

Figure 1. Reasons for joining

Next, GCOS SC members Johnny A. Johannessen and Toshio Suga highlighted the cross-disciplinary nature of GCOS as well as the need to advocate for in situ observations in an era where their importance (vs. remote sensing data) is not always understood.

GCOS SC members also explained what was the major hindrance that GCOS had to face in their view and where efforts should be focused. Several issues were mentioned such as the lack of funding available to build and maintain the observing system, but also the fact that the funding needs to be sustained over time. Issues related to communication were stressed. There is a general concern that decision makers at country level (and stakeholders in general) do not understand how fundamental observations are, and they take for granted those basic elements

that ultimately lead to information. It was suggested that GCOS should enhance its engagement with national programmes and try to bring on board younger people.

5. World Café: Delving into matters of importance for GCOS

The first day of meeting ended with a World Café around three topics:

1) Climate Data (led by Peter Thorne)
2) UNFCCC-COP (led by Sabrina Speich and Joanna Post)
3) Regional perspectives (led by Thelma Krug)

Participants to the meeting were separated into the three groups where they exchanged views on these broad topics guided by the leaders. The main objective was to foster interaction between the participants and no major conclusions or guidance was sought as an outcome.

Group 1 (Climate Data) brainstormed on WMO Data Policy, and how to make it a reality for climate data, insisting on the need to communicate better on its relevance, and in providing support to countries so that integration of data into global repositories is facilitated. They also discussed the pros and cons of providing a GCOS label to recognized data centres and what that process would entail. Finally, some ideas were shared on how data rescue could be improved, including liaising with CGMS, citizen science, or AI.

Group 2 (UNFCCC-COP) discussed on the connections between GCOS and UNFCCC and considered how those could be optimised and made broader, in particular in the area of adaptation. It was recognised that ECV requirements are not enough for national needs and that if resources would be available, a working group focused on case studies could be set up. Regarding loss and damage, it was stressed that without sound science-based measurements, claims will be poorly based. Capacity building is also an issue when trying to collect scientific evidence. The group also concluded that in order to have a stronger voice and convey messages more effectively, GCOS should lead the messaging in coordination with WMO. Pre-webinars with parties could be useful to inform them in advance of the Earth Information Day.

Group 3 (Regional perspectives) looked into the advantages and limitations of the "global approach" (vs regional or national) generally followed by GCOS. While many GCOS activities and outputs can be applied both at global and national/regional levels, in other cases they need to be adapted so that they can make sense at the local level. This is well known and some ideas to bridge that gap were shared such as incentivizing the participation of members that can bring that local perspective; engage with countries through supporting GCOS national coordination activities; tailor the recommendations give in GCOS IP setting targets for countries or prioritizing ECVs for each country; improving communication on how global systems are also beneficial for local purposes.

DAY 2: Wednesday 3 July 2024 - General goal: informing about the work of GCOS, using the GCOS IP as the backbone of the presentations

6. Technical reporting and GCOS activities

6.1 General report on GCOS activities

Thelma Krug presented a summary of GCOS activities. The GCOS secretariat workplan is largely based on selected actions from the GCOS Implementation Plan, but it also includes activities which are the continuation of other relevant initiatives that ran in 2023 and activities that are an intrinsic part of its ongoing operation such as outreach and communication, liaison with GCOS partners, or support to GCOS networks, amongst others. The activity related to the air-sea and land-air fluxes (Action B9 of the GCOS IP) was presented in detail. This IP action was first discussed at the Joint Panel Meeting (2023) in one of the cross-panel groups. Following this, a

small group of experts volunteered to continue the work, before extending it to a larger team. However, there has been little progress, partly due to overcommitment of the experts. Additionally, the problems to be solved for the fluxes over the ocean and over land are very different and cannot be treated with the same approach. The study of fluxes is very complex, and several groups are working on this, including the ocean community, WCRP and GAW. Therefore, the Steering Committee recommended that GCOS does not duplicate the work but reports progress on this topic from the relevant groups.

Recommendation Number	Description
R31/1	Air-Sea and Land-Air fluxes. OOPC and TOPC should provide a regular integrated report on the progress made on air-sea and land-air fluxes from relevant groups (e.g. OASIS, WCRP, GAW) including regional initiatives and report to the next SC.

6.2 Report from AOPC

Peter Thorne, Chair of AOPC, presented an overview of the activities of AOPC and the AOPC contribution to the GCOS IP actions. The four GCOS networks, GUAN, GSN, GRUAN and GSRN, are under AOPC governance, additionally the BSRN is an affiliated GCOS network. AOPC members contribute to many of the WMO activities, such as GBON and SOFF, climate data management, tiered networks, data policy implementation for historical observations. AOPC also has several activities together with Copernicus on data rescue, reanalysis, parallel data holding and the GNSS-PW and Thunder Day Database, both hosted by C3S. Meetings planned in 2024-2025 are the AOPC Panel meeting hosted by NCEI and the GSRN-TT hosted by CMA in Fall 2024, a GRUAN Management meeting in early 2025 and the GRUAN Implementation Coordination meeting in Fall 2025. Peter Thorne also presented the challenges for AOPC: the lack of geographical balance for the members of AOPC; the required collaboration with WMO falling always on the same 1-2 experts; and a problem with ownership across successive cycles of the implementation plan and the status report due to the change of the membership.

6.3 Report from OOPC

Sabrina Speich, Co-chair of the OOPC together with Weidong Yu, presented an overview of the activities of OOPC. OOPC is the panel of GOOS and GCOS and within GOOS it is connected with the biogeochemical and bio ecosystem panel. OOPC activities include the identification for ocean requirements for both ECVs and EOVs, the evaluation of the global ocean observing system together with OceanObs and OCG, boundary systems, EOV paper, the global ocean indicators framework, marine heatwaves, air-sea fluxes and pan-tropical observing system. Within WMO, OOPC collaborates with WCRP, with the Global Cryosphere Watch on sea-ice, with GBON for the extension of GBON in EEZs and is responsible for two of the Rolling Review of requirements application areas. Sabrina Speich presented the challenges that OOPC faces, such as the lack of Secretariat support and of time from experts required to navigate a complex landscape, as well as the need to better engage with the modelling community and the difficulty to persuade ocean communities to engage with WMO. At the level of members, there is a lack of career stage and gender balance. Sabrina Speich also asked for the extraordinary extension of 1 year for the term of Meghan Cronin, which was granted by the Steering Committee.

GCOS SC adopted **Decision D31/1**.

6.4 Report from TOPC

Martin Herold, Chair of TOPC, presented an overview of TOPC activities and the TOPC contribution to the GCOS IP actions. There are several global terrestrial networks that are related to TOPC, and two of those, the GTN-H and the GTN-R are now in the process of applying to become GCOS affiliated networks. TOPC has a unique position under the WMO Earth System Approach and is involved in many activities, including the GBON expansion to hydrological variables, and is responsible for two of the Rolling Review of Requirements application areas.

Several Global Hydrological Data Centers linked to GCOS have been recognized by WMO as supporting WMO efforts in hydrological cycle observations. TOPC is also working on a pilot project to support hydrological field stations with the GCOS Cooperation Mechanism. The biggest challenge for TOPC is the coordination of the in-situ networks. Given that most of the adaptation occurs over land, TOPC has an important role in the monitoring of both adaptation and mitigation. In terms of cross-cutting topics with the other GCOS panels, TOPC is concentrating in climate indicators and ECV rationalization.

6.5 The role of WCRP in GCOS' panels

Detlef Stammer, Chair of the WCRP Joint Scientific Committee (WCRP) gave a presentation on the role of the WCRP in GCOS panels. WCRP was founded over 40 years ago with the objective to identify climate variability and predictability and the human impact on climate. WCRP started the infrastructure development, which included the development of climate models, now basis for the climate projections, input for climate research and heavily used by IPCC assessment. In 2015 the input from WCRP led to the decision at COP21 that humans are impacting climate and to set the limit to the raise of the temperature. WCRP relies on the implementation of the observing system, on the dialogue with satellite agencies and on the identification of observing requirements. There are many aspects within WCRP related to observations, which are needed for science, for models, for testing models and GCOS is an important partner especially with respect to the long term ECVs. Closer links between GCOS and WCRP need to be identified.

6.6 Discussion

The discussion following this presentation focused on different ways to strengthen the collaboration between GCOS and WCRP, a collaboration that was stronger 10 years ago and needs now to be reestablished. Among the different options mentioned there is reciprocal attendance to meetings taking advantage of the new online capabilities; collaboration on concrete projects, such as for example the earth cycles or tipping points; formalization of the role of GCOS within ESMO and within the other groups such as CLIVAR, GEWEX and APARC.

Finally, working with WCRP, GCOS panels, IPCC and other partners, it is important to identify a catalogue of science questions. Those questions will provide GCOS the opportunity to identify the potential gaps in observations, leading eventually to the identification of new needs, which could be included in the next GCOS Status Report. Therefore, the Steering Committee recommended that GCOS, WCRP and the co-chairs of IPCC AR6 work together to identify new gaps in observations based on science priorities. Report of progress will be provided at next Steering Committee by the GCOS SC Chair and Deputy Chair.

Action Number	Description
A31/2	Interact with WCRP and the co-chairs of IPCC AR6 in advance of the Status Report, to include new areas based on their science priorities. GCOS SC Chairs – 2025-2026.

7. Delivery of GCOS Implementation Plan

7.1 Report from GCOS Networks: GUAN, GSN, GRUAN and GSRN

Tim Oakley reported on the 4 GCOS networks: the GSN, GUAN, GRUAN and GSRN. Both GUAN and GSN were established over 30 years ago in response to the risk of several stations being shut down. They are a subset of a bigger network, and they were regarded as stations to be used for climate, with some of these stations going back several decades. Reports with the statistics for the performance of these two networks are available online. Statistics for the GSN show regional variations in performance, with Region RA1 showing a low availability of climate data which has not improved in the last 10 years. A similar result can be seen for the performance of upper-air stations, which however shows that the performance is getting worse for all regions. Tim then presented GRUAN emphasizing the work done with EUMETSAT that will

fund additional GRUAN processed soundings in support of Cal/Val for a new satellite to be launched in 2025. Finally, he presented the progress with the GSRN, which has now entered the pilot phase with 17 stations from 13 countries taking part in this pilot phase. The main conclusion is that resources to operate GSN and GUAN are limited, with more stations stopping operations. No GCOS support funds are available to assist, and there is the expectation that SOFF will improve the network performance, though this will not happen in the short term. Supporting specialized measurements, such as in the reference networks, is becoming also very challenging. Also, access to expert time must be considered carefully as there is a lack of experts available to contribute. During the discussion following the presentation, the importance of collocation for different measurements was emphasized.

7.2 GCOS IP A1.1 on sustainability of networks

Belen Martín Míguez presented the work done by the GCOS Secretariat to address the GCOS IP A1.1, which calls to assess current levels of funding support of global in situ networks delivering relevant in situ ECV data. Experts from the 3 GCOS panels were asked to provide information on the funding mechanism used to operate the networks. Once all the information was collected, the networks were assigned to 4 categories: Funding available, observations can be maintained for the next 3-5 years; significant funding uncertainty or problems with data quality; major funding risk, funding ended or will do so within less than 3 years and not applicable as observations are not made in a sustained mode. According to this study, ECVs at greater risk from the point of view of sustainability of the measurements are atmospheric composition ECVs; ocean ECVs in general, and in particular the subsurface and biogeochemical; and the terrestrial ECVs related to biomass and permafrost. The question to the Steering Committee is what kind of message about sustainability should be delivered through UNFCCC, whether it should be general or more specific, containing this study's findings.

The suggestion is to avoid communicating all the details but to communicate the implications clearly, making strong points about the need to support the identified networks. In bringing this message to COP, it is important to add specifics on why the identified networks are important and what kind of remedy action we expect, actionable recommendations easily implemented by the Parties.

The following recommendation captures the conclusion from this topic and the one on the GCOS networks:

Recommendation Number	Description
R31/2	Sustainability of the observing system – GCOS Secretariat to propose to present at the upcoming Earth Information Day (EID) at COP29 on the lack of sustainability of certain observing systems identified in the GCOS IP action A1, including the situation of the declining performance of GSN and GUAN.

7.3 Climate Data Centers

Antonio Bombelli summarized the activity of the group of experts on climate data centers, which responds to the GCOS Implementation Plan Action D1 to define governance and requirements for global climate data centers. The group decided to assess the data centers against the CoreTrustSeal (CTS) requirements, which was found difficult especially for small data centers. Alternative options are being explored, such as designing a GCOS recognition process that could be a simplified process tailored to climate data centers. The proposed way forward includes producing a matrix across the 16 CTS requirements to rank them according to the difficulties vs their importance for climate date centers; defining three categories of requirements, with the highest category matching the requirements needed for the CTS certification and lower

categories with a reduced number of easier requirements. With the latter approach, a data center can apply for the category that best suits their size, capacity, mandate and other needs.

The Steering Committee agreed with this line of work. Given that Global Climate Data Centers are needed to implement the data policy, the Secretariat is asked to set up deadlines so to deliver the list of requirements for a GCOS recognized center within a reasonable time.

7.4 Engaging with countries

Antonio Bombelli provided a summary of GCOS Secretariat activities on GCOS Implementation Plan Actions E on improving the engagement with countries. After the approval of updated ToRs for the National Coordinators in January 2024, the GCOS Secretariat has started interviews with the National Coordinators of Ireland, Germany and Switzerland with the scope of understanding the relationships and the mutual benefits. From the first interviews it emerged that: the GCOS national mechanism is important to provide coordination and consistency across the wide range of players at national level; their national strategies for climate monitoring are (or can be) based on the GCOS IP and other GCOS related documents and activities; the link with GCOS helps in putting the national activities into the global context; GCOS provides the justification for developing systematic long-term observations of ECVs at the national level and for claiming for the required financial support.

The Steering Committee agreed that it is a priority to reinvigorate the national coordinators and volunteered to support the identification of the right contacts in their respective nations. The list on the website shows only 24 coordinators and it is not updated so GCOS needs a strategy to update this list. One possibility is to organize online meetings with the representatives of countries for research and systematic observations grouped by regions. At these meetings GCOS could explain the role of the national coordinators and ask participants to nominate one for their respective country. Another possibility is to contact the UNFCCC national focal points for all countries which is an open list. Finally, another suggestion is to organize a GCOS webinar in advance of COP and ask UNFCCC to invite Parties.

Therefore, the Steering Committee recommended the following:

Recommendation Number	Description
R31/3	GCOS National coordinators. Update the list of national coordinators by: 1. The GCOS Secretariat organizing online meetings per region with the RSO representatives, using UNFCCC list of contacts. 2. Requesting SBSTA parties to nominate the National Coordinators (based on existing mandate). GCOS SC Members can help with this process once the GCOS Secretariat provides them with the right documentation (ToR for GCOS National Coordinators etc.)

Action Number	Description
A31/3	GCOS SC members to help with identifying and connecting with GCOS National Coordinators (GCOS SC-by next SC).

7.5 Satellite Actions

Wenying Su presented the main objectives of the Joint CEOS/CGMS Working Group on Climate (WGClimate) and the space agency response to the GCOS Implementation Plan. One of the overarching goals of (WGClimate) is to improve the systematic availability of climate data records through the coordination of the research-oriented space agencies and the operational

space agencies and to further develop the architecture for climate monitoring from space, including optimizing the planning of future satellite missions to expand existing and planned climate data records. WGClimate has also a close relationship with WMO G3W. Wenying Su presented the ECV inventory which provides a very comprehensive overview of what is currently observed from the space agencies. GCOS provides a stable framework for space agency priority making. Finally, the approach of WGClimate in addressing the space-related actions of the GCOS Implementation Plan was presented. WGClimate has worked very closely with the GCOS Secretariat, holding bimonthly meetings and has co-developed the process to address the actions which includes access for both the WGClimate and the GCOS experts to a living document where actions are addressed. There are a total of 48 activities to be addressed, of which roughly half were delivered by WGClimate in 2023. GCOS panels had the opportunity to review this first response before WGClimate finalized it. The remaining activities will be delivered in 2024, and the final report will be available in Q2 2025.

7.6 ECV Rationalization

Peter Thorne presented the work done on the ECV rationalization. The main questions that led to this work were whether the 55 ECVs are all still to be considered essential; the current grouping is the best possible one; and the process to be followed for an ECV to be adopted is transparent and coherent. So far, the group has proposed revised definitions for ECV and ECV quantities, a proposal for an adoption process including governance, and a new proposal of a set of ECVs and ECV quantities that would replace the current one. The Task Team has also discussed what key stakeholders should be consulted preferentially; what tools should be used for that consultation and how/when the public review should take place. Peter Thorne presented the timeline defined by the task team to undertake the consultation and review process of the updated list of ECV and ECV quantities, which includes an in-person meeting at the end of 2025. The Steering Committee approved the timeline in **Decision D31/2.**

7.7 Earth Cycles

Sabrina Speich presented the work of GCOS relative to Earth cycles, which started several years ago.

This work is done with WCRP to look at gaps both in science and observations to reduce uncertainty. In 2023, a joint WCRP-GCOS workshop was organized to assess the current state of knowledge of the key cycles. The workshop produced a set of recommendations that need now to be addressed. In this respect, a paper is being written to start addressing the recommendations from the workshop. Once the paper is ready, it will become clearer how to move forward. It is also suggested to involve early career stage scientists to look at the carbon cycle, which was not addressed in the workshop. Some of the work can also be picked up in the context of ESMO and CLIVAR. The Steering Committee recommends following up on the recommendations of the joint WCRP-GCOS workshop.

GCOS experts are also working on the assessment using the ECVs to define the status of the cycles, the uncertainty and to identify the gaps in terms of observations. These assessments should be updated regularly. The experts working on the cycles in GCOS is asking for endorsement of regular assessment of these cycles from observation. The Steering committee agreed and recommended continuing the regular assessment of earth cycles from observations.

Recommendation Number	Description
R31/4	Earth Cycles. The GCOS Secretariat with the GCOS Panels to follow up on the recommendations of the joint WCRP-GCOS workshop once the initial paper is published.
R31/5	Earth Cycles. The scientific community to continue the regular assessment of earth cycles from observations, in line with action B10 of the GCOS Implementation Plan.

7.8 Indicators

Martin Herold presented the work done on climate indicators which is also a cross-cutting topic started during the JPM meeting in 2023. Climate indicators are used in the state of climate report and are meant to inform on the observed change in the state of the Earth climate system in an easy-to-understand way for policymaker and the public. It has been recognized that there are some omissions in the current list of indicators and a process to amend this list has started already a couple of years ago. A cross-panel group of experts from the 3 panels has met several times and has proposed 11 new indicators, among which 3 were selected: ecosystem drought, earth energy imbalance, terrestrial carbon storage. The Steering Committee was asked to give some feedback on the choice of these 3 indicators.

During the discussion that followed, the point was made that the indicators are not recognized by the community as GCOS indicators, and whether this should imply that we should not continue work on this. However, the consensus is that even though they are not recognized as GCOS indicators, these indicators are built using ECVs and observations and can therefore be GCOS endorsed indicators. They can also be regionalized, and GCOS can provide a scientific process and some best practice. The Steering Committee decided that the work on the indicators will continue and the proposal for 3 new climate indicators will be presented to WMO Service Commission for their consideration. GCOS SC adopted **Decision D31/3**.

7.9 Miscellaneous

7.9.1 Caterina Tassone presented the background for the decision on the addendum to the GCOS requirements GCOS-245. The GCOS Secretariat will update the GCOS-245 to include a revised introduction containing better explanations on how to interpret the requirements and targeted updates of some of the ECV requirements. The Steering Committee agreed and adopted **Decision D31/4.**

7.9.2 Caterina Tassone presented the decision on GCOS co-authoring papers. Over the last several months, the GCOS Secretariat has been asked to co-author a paper together with scientists not directly involved with GCOS. The GCOS Secretariat is seeking advice from the Steering Committee on how to answer this request and similar ones that can occur in the future. GCOS SC adopted **Decision D31/5**.

7.9.3 Tim Oakley presented a suggestion from the GCOS Secretariat on how to manage the GCOS documents. As of now, there are 261 documents published, some of them are reports, technical guides, plans. The suggestion is to add for each of the published document the type (report, plan, technical documentation), the status (open, closed or deprecated), and whether the document should be reviewed, which in case of a technical report will be decided by the panel. The table with the list of documents and this information will be on the GCOS website.

The Steering Committee accepts this suggestion and agrees that it will be discussed further and refined with the chairs of the panels.

7.10 Breakout groups: topics of interest to GCOS stakeholders

The meeting split into two groups under the leadership of Detlef Stammer on Science and of Vanessa McBride on open data.

Break-out Group on Science

Detlef Stammer presented the group with some selected challenges for science: water, and science of climate intervention.

Water:

There is the need to have better observations for the water cycle and water availability. This also implies understanding what observations are needed to reduce uncertainty in surface fluxes and a better understanding of ground water. A possible collaboration between GCOS and WCRP

on precipitation and evaporation could be done through GEWEX, the Global Precipitation Experiment, where there will be an observational component and better analysis of existing datasets.

Furthermore, several issues around water observation were discussed such as: importance of soil moisture and the need to increase the spatial resolution; push for the inclusion of Fluxnet (biosphere/atmosphere fluxes) as a GCOS affiliated network; scarcity of precipitation observations over the oceans and need of better communication about the importance of water for survival

Science of climate intervention

At present there does not exist a system component that can monitor the impact of climate intervention. Regarding geo-engineering, GCOS should think about what should be monitored and reflect on its role in this emerging topic.

Break-out group on open data

Vanessa McBride introduced the importance of open data. Data are global public goods; they can be used (and reused) in different ways by different communities. Therefore, they need to be open and follow the FAIR (Findability, Accessibility, Interoperability, and Reusability) principles.

The discussion touched several topics: Open Data; Open Science; Quantity (needed more for AI) vs Quality (needed more for science); Metadata; AI; Added Value; Data Policy; Commercial use of data; Timeliness (real time data).

Open data are fundamental for an open science, and the question was raised if there is a role for GCOS to provide definition and guidance on open data and open science. Engagement with CODATA and WDS could be envisaged.

It was also raised that the rapidly development of artificial intelligence (in particular generative AI) opens up risks and the opportunities (AI can be used, for instance, for data rescue, to digitalize paper sources) that GCOS should consider more in the future. Currently GCOS is providing the framework about how to make observations but not how they will be used.

DAY 3: Thursday 4 July 2024 - General Goal: interaction with WMO; adaptation

8. WMO related activities/interactions

8.1 GCOS in WMO Climate Infrastructure

Nir Stav, Director, Infrastructure Department and GCOS Secretariat, presented a summary of the structure and history of WMO, in particular, the most recent restructure into only two commissions (Infrastructure and Services) and a Research Board, alongside the Regional Associations. He further explained the programs under the World Weather Watch (WWW), being WIGOS, WIS and WIPPS, and the more detailed aspects of the WIGOS processes and roles.

8.2 GBON-SOFF

Ana Heureux, Programme Management Officer, SOFF Secretariat briefed the SC on the work of SOFF, in particular the work of the SOFF advisory board and the potential key linkages between SOFF and GCOS.

SOFF Steering Committee has agreed that GCOS can join the SOFF Advisory Board and the SC agreed that Peter Thorne will be the GCOS representative on the SOFF AB, with Tim Oakley acting as an alternate (**Decision D31/6**).

Comments from SC participants were focused on the potential expansion of the SOFF to support other ECVS (i.e. GHG, Ocean and Terrestrial) and the engagement with GCOS in this process.

At the moment, SOFF is designed to only support GBON (LCDs and SIDs), and any ongoing support will be result based (GBON compliance). Due to the short time to present much of the details of the SOFF processes were not presented but in answer to a few questions, it was confirmed that SOFF has so far raised USD 95 million but needs at least USD 250 million to meet 'minimum' current GBON requirements for target countries. To expand in support of the EW4all initiative will require at least an additional USD 150 million. There are currently 22 peer advisors & 9 implemented entities, and current funding is for a period of 5 years.

8.3 G3W

Gianpaolo Balsamo presented an overview of the Global Greenhouse Watch (G3W) and showed the link to the GCOS IP (2022) action F5, and the relationship between G3W and GCOS. This activity started as a concept note at WMO EC-76 and was adopted by Cg-19 and endorsed by EC-78. Whilst there is large investment and implementation in satellite greenhouse gas monitoring, G3W is focused on the in-situ capability (ground based). In the implementation plan 75% of resources are assigned to the observing capability, 24% on the integration of the in-situ and satellite and 1% on the coordination. Final slides of the presentation provided schematics on the collaboration between GCOS, G3W and GCW.

Questions raised were on topics of; the challenges given that much of the surface-based capability is undertaken by non-NMS institutes; coordinating with TCCON (Total Carbon Column Observing Network) and NDACC (Network for the Detection of Atmospheric Composition Change); do the ECV requirements need to be adjusted/enhanced to support G3W and engagement in all regions, including those that don't have any G3W observations/networks. The SC recommended the following:

Recommendation Number	Description
R31/6	Work with G3W, jointly with WCRP (global carbon project), GAW (atmospheric composition) and GOOS, to align GHG-related work and G3W actions for the 2027 G3W Implementation Plan.

8.4 WMO Climate Services Report to GCOS

Amir Delju, Senior Scientific Officer, WMO Climate Services Branch, showed the mapping of WMO-UNFCCC climate activities, and highlighted the different communication channels to submit information to the UNFCCC process and COP.

WMO is an observer to the UNFCCC, without any negotiation role. However, WMO can provide inputs for the negotiation through the NMHS delegates. WMO established the Climate Policy Advisors (CPA), chaired by Carlos Fuller previous SBSTA Chairman, as a mechanism to interact with NMHS for providing advice to UNFCCC.

It was then highlighted that GCOS has a strong recognition inside UNFCCC, it has a mandate to report on Research and Systematic Observations (RSO) and usually it has its own name plate to make interventions in the SBSTA plenary. GCOS also plays a major role at the Earth Information Day. The role of WCRP is more important in the frame of IPCC.

There was a question on the visibility of different programmes at SBSTA and COP, and it was confirmed that whilst GCOS, WMO and CGMS have a mandate to report to SBSTA, particularly through the Earth Information Day at COP, other programmes are not mandated.

9. Adaptation

9.1 Presentation on a historical overview of GCOS and Adaptation: what has GCOS done over the years?

Adaption was not in the original GCOS mandate and was neither mentioned in its foundational MoU (1992) nor in the following revision (1998). In 2014, one year before the Paris Agreement, the GCOS Programme Review Synthesis Report asked the sponsors to "consider giving GCOS a mandate that includes adapting to and mitigating climate change and its regional impact". Then, the GCOS Joint Study Group report in 2022 recommended to "support climate adaptation and mitigation measures and policies" and this is reflected in the new MoU.

The first GCOS IP mentioning adaptation was in 2010, but without specific actions. In 2013 and 2015 two workshops were organized on "Observations for Adaptation to Climate Variability and Change" and "Enhancing Observations to Support Preparedness and Adaptation in a Changing Climate", this last addressing specifically needs stemming from IPCC. The GCOS IP published in 2016 contained the first two actions on adaptation, namely: **Action G1:** Produce guidance and best practice for adaptation observations, and **Action G4:** Identify indicators for adaptation and risk.

In 2018 the first GCOS Task Team on Adaptation, under the TOPC responsibility, was established, evolving, two years later, in the GCOS Adaptation Task Team (GATT), involving also external experts. Three case studies (on forest wild-fire, pluvial flooding, and ocean extremes) were developed to see how ECVs are useful for adaptation and a report was released in 2023. In the meanwhile, the 2022 GCOS IP contained at least 5 actions relevant to adaptation. This session dedicated to adaptation was requested by the GCOS Chairs to ask the SC to take a decision on a GCOS way forward on adaptation.

Ensuring the availability of climate datasets with global coverage, as GCOS does, is essential for Adaptation for several reasons, including:

- Reanalysis: is an integrator between different time scales, combining vast amounts of observations into maps without gaps;
- Forecasts/Extremes: require operational global data sets available at daily resolutions;
- Climate predictions: global data sets and historical data are important for validating climate model outputs;
- Climate projections: global data sets and historical data are important for evaluating projections.
- Higher resolution climate datasets (e.g. Daily Climate Data Exchange – DayCl): are particularly relevant for adaptation.

9.2 UNFCCC on adaptation

Maryam Navi, responsible for the Global Goal on Adaptation (GGA) in the UNFCCC Secretariat, gave an overview on GGA, that was established in the Paris Agreement with three pillars: 1) enhancing adaptive capacity, 2) strengthening resilience, and 3) reducing vulnerability to climate change. The GGA concept was further developed at COP26 in Glasgow, where a framework with 11 targets was established to assess progress towards its achievement. At COP28 a two-year work programme (the UAE–Belém Work Programme) on indicators for measuring progress achieved towards the GGA targets was developed. Proposals for these indicators, including compilations and mapping of existing indicators, must be submitted by 31 July 2024. A previous deadline asks for nominating technical experts to assist in the technical work under the UAE–Belém Work Programme.

The SC suggested that GCOS should not engage too much on the definition, but could contribute in terms of data feasibility, linking to existing ECVs and assessing whether requirements need updates. It would be interesting if countries in their NAPs and NDCs inform also on the state of the ECVs monitoring and how ECVs are informing those indicators.

The SC decided that GCOS would prepare an input underlining that observational data, building on ECVs, are essential to inform those indicators. Availability of observations and data readiness are very important. Sometimes there are misleading messages just because of the lack of observations. WMO is also preparing a submission of indicators for GGA, linking to SDGs, and to be coordinated with the GCOS one.

Action Number	Description
A31/4	Prepare a GCOS submission to the GGA process (GGA Indicator mapping) advocating for the importance of systematic observations & data rescue. GCOS Secretariat – 31 July

9.3 Paper on fire

Chiara Cagnazzo presented the follow up of the work of the GCOS Adaptation Task Team (GATT), leading to the preparation of two papers, one focusing on how current ECVs products can support the adaptation in the forest wildfire domain, and another one on the importance of reanalysis as an integrator of observations for many adaptation applications (9.4). The methodological approach to identify the key ECVs considers the three components of the IPCC risk assessment: hazard (probability that the fire starts and propagates), exposure (defining the area and the assets which are potentially burned), and vulnerability (indicating the potential damage that the fire may cause). The ECVs requirements are reviewed and their relevance for adaptation assessed. Obviously other elements than ECVs must be considered. The main audience of this document are agencies for fire management, research community, and climate services that need to prioritize, for example, which kind of ECVs to offer in their portfolio.

9.4 Paper on reanalysis and adaptation

A group of GCOS experts, led by Chiara Cagnazzo, is preparing a paper on the role of climate reanalysis in the context of adaptation to climate change, focusing on the example coming from the Copernicus climate change service. Climate change is global and the challenge is to highlight how global data sets are useful for local adaptation applications. Reanalysis allows to analyze past climate trends and extreme weather events, and, if used in combination with climate projections, allows to assess the possible future climate scenarios, supporting the policy intervention. The last GCOS IP already identified a set of actions to reduce observational gaps for adaptation. In particular, Action C4, recognizing the relevance of climate reanalysis in effectively integrating various types of observations, focuses on enhancing reanalysis products. The proposed paper focuses on atmospheric reanalysis, but a complete overview should be undertaken at earth system level, coupling with ocean and land, and considering also compound events. The evolution of this work should consider how these additional elements are useful to better represent processes and reduce uncertainties.

9.5 Adaptation and ESA: report from Bern/ISSI

Thelma Krug reported on her participation in the Forum on Using Earth Observation Systems to Improve Climate Adaptation Policy and Action, organized by the International Space Science Institute (ISSI) in Bern, on 25–28 June 2024, where a small group of people (about 20) was gathered to brainstorm on the current methods and capabilities of EO to support adaptation planning and monitoring, with the final objective to write a white paper. The focus was on space-based observations useful for SDG targets and adaptation relevant applications, considering examples on air pollution and urban heat, and their links to climate change, health, conflicts, and migrations, etc. Several indicators potentially valuable for adaptation were discussed, like NDVI, tree cover, soil moisture, ecosystem distribution, land cover and land use, burned areas, FRP, FAPAR, wetland extent, precipitation, and others (some of them are ECVs and it was proposed to provide a list of ECVs that can support the ongoing discussions on GGA).

The themes addressed were water, food, and agriculture, health, biodiversity, infrastructure, poverty, and cultural heritage. There was the usual discussion on how to scale down from global

to regional and local, especially for indicators. The last day focused on which Earth observations are already in place that could be relevant for adaptation indicators, considering barriers and needs. Thelma highlighted the importance of the in situ component, especially for calibration and validation. Thelma also recalled the GCOS work on the ECVs, to avoid duplications and build on what is already in place in terms of requirements. Not everyone was fully aware of GCOS and the lesson learnt is that we need to better communicate. GCOS has the great opportunity to contribute to the development of indicators for adaptation, starting with the coming submission for GGA.

9.6 Discussion on the role of GCOS on Adaptation and way forward

The SC concurred that GCOS should not miss the opportunity to contribute to the adaptation discussion, particularly the GGA process. Policy decisions require evidence-based information. It is important to communicate that observations underpin any kind of assessment, including scientific assessments like IPCC. While GCOS mandate focuses on physical, chemical and biological variables, adaptation also needs social science. Societal benefits of monitoring ECVs should be better communicated to policy makers. In some cases, this is straightforward (e.g. hydrological ones).

The SC suggested that the GCOS submission to the UNFCCC Global Goal on Adaptation (see Action A31/4) should demonstrate the importance of maintaining and upgrading the observational networks and ensuring that both ongoing and historical observations are available to inform policy and decision-making in developing effective and robust local services. GCOS supports the provision of long-term global datasets of ECVs and related climate information that allow for better validation of satellite derived products and climate models, better climate projections, better reanalysis, better understanding of long-term trends and attribution of extreme events, as well as identification of areas with increasing climate extremes and compounded extremes (e.g. heat and drought). Therefore, the ECVs are instrumental for developing robust information-based methodologies, indicators, and metrics needed for risk and impacts attribution, adaptation planning and monitoring, and for providing complementary information under a consistent global perspective.

Peter Thorne led an interactive discussion along the following four questions on adaptation:

- Question 1 - Which observations/variables (or ECVS) do you think the most important to the adaptation?
- Question 2. What are the most important things GCOS already does in support adaptation?
- Question 3. GCOS mandate is global, adaptation is local: what role do global observations have in adaptation?
- Question 4. Context: GCOS as a Programme, consists of a Secretariat + Task Team, Working Groups, etc. Given the Resources we have, what can GCOS do?

Every participant was requested to provide up to three answers to each question. Then there was an open discussion around the received replies, especially the most recurrent ones. The main elements[1] of this discussion are summarized in the following bullets, not to be considered as recommendations since any official decision on adaptation was considered premature (and dependent on the available capacities and resources):

- **Advocacy, especially in the UNFCCC frame.** GCOS needs to better communicate the relevance of its activities in contributing to adaptation, highlighting the importance of systematic observations & data rescue for the GGA process.

[1] For more details, all the replies to the four questions are available in a table format in the Annex 4 - Results from workshop on adaptation.

- **ECVs monitoring at national level.** It will be important to understand the state of ECVs monitoring at country scale and how many ECVs datasets and derived products are used to produce indicators for adaptation at national level. High resolution datasets are particularly important. A survey with national climate coordinators would be required, linking also with WMO regional coordinators. This action was put on hold for the moment.
- **National engagement.** It is fundamental and needs to be improved. GCOS SC members can help in linking with GCOS National Coordinators and engage with them to collect feedback on the observations useful for adaptation.
- **Users' engagement.** Users' surveys and regional workshops would be beneficial, but there are budget limitations. UNFCCC COPs can be exploited to organize meetings and promote active engagement of users and countries in key events, like the Earth Information Day.
- **GCOS position paper on adaptation.** The opportunity of such a paper was discussed, and it was concluded that the current two papers in preparation (on fire and reanalysis) must be completed before initiating any new effort.

DAY 5: Friday 5 July 2024 - General Goal: Conclusion, agree on decisions and way forward

10. Decisions and actions

10.1 GCOS Annual Workplan and 5-yr Timeline

Peter Thorne illustrated the five-year timeline for the GCOS Secretariat/Programme meetings and events. To reduce costs and carbon footprint the GCOS regular in-person meetings, like steering committee and panels meetings, will be held every 18 months (except for the next GCOS SC that shall be held in one year). To optimize synergies and coordination among panels, every two times the GCOS panels will meet jointly, meaning that every three years there will be a GCOS Joint Panels Meeting. Also, the next GRUAN (GCOS Reference Upper-Air Network) Implementation Coordination Meetings (ICM-16 and ICM-17) will be held every 18 months. In the next three years there will be at least four meetings of the WMO GSRN (GCOS Surface Reference Network) Task Team. The timeline also shows meetings on specific topics, like the one for the Data Centres, the GCOS Lead Centres and the ECVs Rationalization process.

Among the most important milestones shown in the timeline there are the next GCOS Status Report (to be aligned with the next Global Stocktake), the next GCOS IP (both to be submitted to UNFCCC), and the next GCOS Climate Conference. GCOS activities need to be aligned to key external events like UNFCCC COP and SBSTA, as well as WMO Congress and commissions (e.g. INFCOM).

The GCOS SC approved the 5y timeline for the Secretariat/GCOS programme (**Decision D31/7**).

10.2 GCOS Participation in SBSTA-COP

Antonio Bombelli underlined that GCOS is mandated by UNFCCC to report on matters related to systematic observations. Evidence based data and information are essential in the UNFCCC process, as they are required for NDC, NAPS, and the Global Stocktake (noting that the systematic observations were not properly considered in the first GST). Data requirements for adaptation is another major area that needs input from the systematic observations' community, as already discussed. Typically, GCOS submits to the UNFCCC the following documents along a cycle lasting 5-6 years: the GCOS Status Report, assessing the status and gaps of the global observing system for climate, and the GCOS Implementation Plan, describing actions to address those gaps and improve the observing system and including the observational requirements for

the ECVs. GCOS also defined the "UNFCCC reporting guidelines on global climate change observing systems" as part of the national communications by Annex I Parties to the Convention, and that now need to be updated. GCOS delivers statements during the SBSTA plenaries and actively participates in the Earth Information Days during COPs. At the last SBSTA60 (Bonn, June 2024) GCOS work was further appreciated by SBSTA that, in its Draft Conclusions on Research and Systematic Observation (FCCC/SBSTA/2024/L.9)," emphasized the need to ensure the continuity and sustainability of research and systematic observation for data availability, which are fundamental for research, including for the Global Climate Observing System, and encouraged enhanced support in that regard".

Amir Delju showed how the GCOS mandate is reflected in Article 5 of the Convention, on Research and Systematic Observation, and in Article 7 (sub-article 7c) of the Paris Agreement. WMO coordinates the WMO, WCRP, and GCOS submissions to UNFCCC SBSTA/COP to ensure consistency and complementarity. These documents, like statements in the plenaries, are very important, because their content can be included in COP decisions. Another important way to contribute to UNFCCC are mandated events, like Earth Information Day, Research Dialogue, and the Ocean Dialogue. It is also important to have an effective coordination mechanism with parties and GCOS can also benefit from the WMO Climate Policy Advisors group that includes, in addition to the GCOS Chair, NMHS parties to provide advice on SBSTA and COP sessions. GCOS SC suggested that GCOS will coordinate with WGClimate, WMO and GOOS for the submission to the Earth Information Day.

Action Number	Description
A31/5	Coordinate with WGClimate/WMO/GOOS in the process of submissions for topics for Earth Information Day. GCOS Secretariat - end of August.

10.3 Decisions, Recommendations and Actions

GCOS Secretariat presented the compilation of provisional list of decisions, recommendations and actions resulting from the meeting. The final list is provided in Annex 3.

10.4 How is the Steering Committee going to work together?

Thelma Krug sought the opinion of the SC participants as regards the frequency and modality for making sure that the SC can carry out their duties effectively. It was suggested that the SC could meet online every 4 months, with a first online meeting in September 2024. To keep the momentum, it was proposed that a physical meeting takes place in 2025, to then go to a 18-month period in between in person meetings.

10.5 Getting feedback from Steering Committee Members, Including UNFCCC and co-sponsors

The participants expressed their satisfaction about the meeting organization and the contents of the discussion. It was good to meet in person finally. The SC expressed the desire to have more room for introducing themselves, to show how GCOS is relevant for their work and how they can contribute more. Some of the GCOS Sponsors would have appreciated having the opportunity to provide details on their activities which can be of benefit for GCOS. Everyone concurred on the importance of more national and regional engagement for GCOS, and the SC core members offered to assist with that process in their respective countries.

Another recurrent point was the need to enhance the visibility of the GCOS programme by advocating the importance of climate observations and better communicating what GCOS does. Again, GCOS members on the whole, including SC, panels chairs, GCOS sponsors, as well as GCOS national coordinators, can play a very important role in that.

10.6 AOB and closing of the meeting

Next in person meeting shall be in Brazil in summer 2025.

Annex 1: Agenda

Day 1: 2 July 2024 – 09:00-17:30
General Goal: Background information of GCOS; all participants engaged and understanding GCOS broadly.

Time	Item	Topic	Presenters	Topic and Documents
09:00-09:30	1.	Opening of the meeting		
10’	1.1	Welcome from WMO and GCOS Director	Ko Barrett Nir Stav	
15’	1.2	Approval of agenda and introductions	Thelma Krug and core SC members	Short introductions by SC core members - Presentation
5’	1.3	Running of the meeting	Thelma Krug	
09:30-10:30	2.	The story of GCOS: Introducing GCOS and its evolution		
30’	2.1	Why do we need GCOS and GCOS origin	Thelma Krug	The UN context in the nineties (Rio Convention, the birth of GCOS, GOOS and WCRP, support to IPCC and then to UNFCCC) - Presentation
60’	2.2	The history of GCOS in the last 20 years	Peter Thorne	GCOS history in the last 20 years. Changes of the global observing system for climate and of GCOS programme through time – PPT, Background Doc
10:30-11:00	Coffee Break			
11:00-12:15	3.	PANEL DISCUSSION: Co-sponsors, UNFCCC, WGClimate, WCRP		
50'	3.1	Panel discussion: co-sponsors, UNFCCC, WGClimate and WCRP	Thelma Krug	Elements of the machinery behind/surrounding GCOS
25’	3.2	GCOS funders: Copernicus and NOAA	Hugo Zunker Ann-Christine Zinkann	Copernicus : Presentation NOAA : Presentation
12:15-13:30	Lunch Break			
13:30-15.30	4.	A deeper look in GCOS		
20’	4.1	The ECVs framework + Status Report and Implementation Plan	Sabrina Speich and Thelma Krug	GCOS Status Report: GCOS-240 GCOS-IP: GCOS-244 GCOS ECV Requirements: GCOS-245 - Presentation
15’	4.2	GCOS panels	Thelma Krug and the panels’ chairs	Short introduction of the panels - Presentation AOPC_PPT, OOPC_PPT, TOPC_PPT
15’	4.3	GCOS Secretariat	GCOS Sec.	Short introduction of the Secretariat supporting GCOS - Presentation
10’		Questions		
14:30-15:30	4.4	PANEL DISCUSSION: Core SC Members		
60’		The role of the Steering Committee	Thelma Krug and GCOS SC members	

15:30-16:00	Coffee Break	
16:00-17:30	5.	World Café: Participants will be divided into 3 groups under the leadership of the panels' chairs and Thelma Krug
		1. Climate Data (Peter Thorne) 2. UNFCCC-COP: raising awareness on need for observations globally and sustainably (Sabrina Speich) 3. Regional perspectives: does GCOS machinery make sense at your regional level, what are the differences between global and regional (Thelma Krug)
17:30	End of day 1.	

Self-paid dinner at the UN beach

Day 2: 3 July 2024 – 09:00-17:30
General goal: informing about the work of GCOS, using the GCOS IP as the backbone of the presentations

Time	Item	Topic	Presenters	Topic and Documents
09:00-10:30	6.	Technical reporting and GCOS activities		
15'	6.1	General report on GCOS activities	Thelma Krug	INF.6.1 - Presentation
15'	6.2	Report from AOPC	Peter Thorne	Presentation
15'	6.3	Report from OOPC	Sabrina Speich	Presentation
15'	6.4	Report from TOPC	Martin Herold	Presentation
15'	6.5	The role of WCRP in GCOS' panels	Detlef Stammer	The role of WCRP as cosponsors of GCOS' panels. Presentation
15	6.6	Discussion		
10:30-11:00	Coffee Break			
11:00-12:30	7.	Delivery of GCOS IP		
20'	7.1	Report from GCOS Networks: GUAN, GSN, GRUAN and GSRN	Tim Oakley	INF.7.1a - GUAN and GSN Report INF.7.1b - GRUAN Report INF.7.1c - GSRN Report
20'	7.2	GCOS IP A1.1 on sustainability of networks	Belen Martin Miguez and SC members	INF.7.2: Summary of panels input. SC to advice on how to interpret and communicate the assessment - Presentation
20'	7.3	Climate Data Centers	Antonio Bombelli	INF.7.3: Update on work on the Climate Data Centers - Presentation
15'	7.4	Engaging with Countries	Antonio Bombelli	INF.7.4: Presentation on work done on regional/national engagement of GCOS and discussion on way forward - Presentation
15'	7.5	Satellite Actions	Wenying Su	Close up on the Actions in GCOS IP where space agencies (represented by WGClimate) are the main implementers. Presentation
12:30-14:00	Lunch break			
14:00-15:30	7.	Continue GCOS IP Delivery: Cross-cutting activities – Follow up from cross-panel groups at JPM		
10'	7.6	ECV Rationalization	Peter Thorne	DEC.7.6: Decision Report from the task team - Presentation

10’	7.7	Earth Cycles	Sabrina Speich and Caterina Tassone	Update on action B10 of GCOS IP on Earth cycles and parallel work with WCRP - Presentation / Background Doc
30’ (15+15)	7.8	Indicators	Martin Herold	INF.7.8: Report on progress and discussion on the value proposition to GCOS on the indicators – Presentation
30’	7.9	Miscellaneous	Caterina Tassone Tim Oakley	DEC.7.9.1: Decision on Addendum to GCOS requirements (GCOS-245) DEC.7.9.2: Decision on requests to GCOS Sec. for co-authoring papers - Presentation DEC.7.9.3: Decision on GCOS documentation
15:30-16:00	Coffee Break			
16:00-16:30		Report from breakout groups of day 1		
16:30-17:30	8.	Breakout groups: Engagement with stakeholders		
		Breakout groups around topics of interest to GCOS stakeholders. To be discussed with stakeholders attending the meeting. Possible topics: Communication; Funding opportunities; Local engagement.		
17:30	End of day 2			

Day 3: 4 July 2024 – 09:00-17:30
General Goal: interaction with WMO; adaptation

Time	Item	Topic	Presenters	Details
09:00-09:30	Report back from breakout groups of Day 2.			
09:30-10:30	9.	WMO-related activities/interactions		
15’	9.1	GCOS in WMO Climate Infrastructure	Nir Stav	
15’	9.2	GBON-SOFF	Markus Repnik	5’ presentation 10’ discussion - Input from the GCOS SC on how GCOS should engage in SOFF
15’	9.3	G3W	Gianpaolo Balsamo	5’ presentation 10’ discussion: Input from GCOS SC on how GCOS can contribute to G3W
15’	9.4	WMO Climate Services Report to GCOS	Omar Baddour	Climate Services activities, including monitoring and the State of the Climate reports
10:30-11:00	Coffee Break			
11:00-12:30	10.	Adaptation		
20’	10.1	Presentation on a historical overview of GCOS and Adaptation: what has GCOS done over the years?	Thelma Krug	Background (GATT Report, GGA) - Background Doc - Presentation
10’	10.2	UNFCCC on adaptation	Maryam Navi	
10’	10.3	How are global climate datasets and global climate data networks already supporting Adaptation	Peter Thorne	Presentation

15’	10.4 10.5	Paper on fire Paper on reanalysis and adaptation	Chiara Cagnazzo	Presentation on 10.4 Presentation on 10.5
10’	10.6	Extremes	Sabrina Speich	Presentation
10’	10.7	Adaptation and ESA: Report from Bern/ISSI	Thelma Krug	
12:30-14:00	Lunch			
14:00-17:00	10.	Adaptation (continued)		
	10.8	Discussion/Break-out Groups: Set the goal: Where can GCOS make a difference in a congested world of climate information/action for adaptation, also considering the work that has already been done – What does it mean for GCOS to support adaptation?		
17:00-17:30	10.9	Report back from adaptation session and possible decision on how GCOS should proceed		
17:30	End of Day 3			
Excursion - Soirée across the lake				

Day 4: 5 July 2024 – 09:00-12:30
General Goal: Conclusion, agree on decisions and way forward.

Time	Item	Topic	Presenters	Topic and Documents
09:00-10:30	11.	Decisions and actions		
30’	11.1	GCOS Annual Workplan and 5-yr Timeline	Thelma Krug	DEC.11.1: Decision on GCOS Annual Workplan and 5yr Timeline - Presentation
30’	11.2	GCOS Participation to SBSTA-COP	Thelma Krug, Amir Delju, Wenying Su	Strategize in how best to participate, side events - Presentation
30’	11.3	Adoption of Decisions and Actions	Thelma Krug, all	Depending on outcomes from the discussions on the previous days
10:30-11:00	Coffee Break			
11:00-12:30	Closing of the meeting			
20’	11.4	How is the SC going to work together?	All led by Thelma	Working procedures, online meetings, subgroups-focal groups
30’	11.5	Getting feedback from Steering Committee Members, including UNFCCC and co-sponsors	Thelma Krug, all	
20’	11.6	Buffer time		
20’	11.7	AOB and closing of the meeting		
12:30	End of the meeting			

Annex 2: List of Participants

STEERING COMMITTEE MEMBERS				
Chair	Brazil	Prof.	Thelma	Krug
Member	Senegal	Dr	Aïda	Diongue-Niang
Member	Costa Rica	Dr	Ana María	Durán Quesada
Member	Norway	Dr	Johnny	Johannessen
Member	China	Dr	Bo	Lu
Member	United States	Dr	Walter	Meier
Member	Japan	Dr	Toshio	Suga
EX-OFFICIO MEMBERS				
AOPC Chair & SC Deputy Chair	Ireland	Prof.	Peter	Thorne
OOPC Co-chair	France	Prof.	Sabrina	Speich
TOPC	Germany	Prof.	Martin	Herold
SPONSORS AND FUNDING AGENCIES				
WMO	Switzerland	Ms	Ko	Barrett
ISC	France	Dr	Vanessa	Mc Bride
IOC of UNESCO	France	Dr	Joanna	Post
UNEP	Kenya	Dr	Jochem	Zoetelief
Copernicus	Belgium	Mr	Michel	Rixen
Copernicus (Online)	Belgium	Mr	Hugo	Zunker
NOAA (Online)	United States	Dr	Ann-Christine	Zinkann
WCRP	Switzerland	Dr	Mike	Sparrow
WCRP	Switzerland	Prof.	Detlef	Stammer
INVITED EXPERTS				
GEO	Switzerland	Ms	Madeeha	Bajwa
WMO	Switzerland	Dr	Gianpaolo	Balsamo
AOPC	United Kingdom	Dr	Chiara	Cagnazzo
WMO	Switzerland	Mr	Amir	Delju
WMO	Switzerland	Ms	Jitsuko	Hasegawa
SOFF	Switzerland	Dr	Ana	Heureux
WMO	Switzerland	Dr	Paolo	Laj
UNFCCC	Germany	Ms	Maryam	Navi
WGClimate	United States	Dr	Wenying	Su

GCOS Secretariat				
Director	Switzerland	Mr	Nir	Stav
AOPC	Switzerland	Dr	Caterina	Tassone
OOPC	Switzerland	Dr	Belén	Martín Míguez
TOPC	Switzerland	Dr	Antonio	Bombelli
Network Manager	United Kingdom	Mr	Tim	Oakley
Intern	Switzerland	Ms	Yeji	Kim

Annex 3: List of Decisions, Actions and Recommendations

Decision Number	Description
D31/1	To approve the extension of membership for Meghan Cronin (OOPC Member)
D31/2	To approve the timeline of GCOS SC Rationalization including a meeting in 2025
D31/3	To present to WMO Services Commission the proposal for 3 new climate indicators
D31/4	To approve the update of GCOS-245 relying on the chairs
D31/5	To decide on how to respond to requests to GCOS to co-author papers
D31/6	Peter Thorne will be the GCOS representative on the SOFF Advisory Board, with Tim Oakley acting as alternate
D31/7	To approve the 5y timeline for the Secretariat/GCOS programme (including advancing GCOS Status Report by one quarter)

Action Number	Description
A31/1	GCOS to invite Space Agencies to enter a dialogue to establish permanent calibration/validation stations taking into account existing efforts such as GRUAN and GSRN to make sure that the increasing amount of data that is being generated can be validated. Participate/do a presentation on GCOS (reference) networks in WGCV - WGClimate/CEOS Working Group on Cal/Val. GCOS Secretariat – Next WGClimate Meeting (February 2025).
A31/2	Interact with WCRP and the co-chairs of IPCC AR6 in advance of the Status Report, to include new areas based on their science priorities. GCOS SC Chairs – 2025-2026.
A31/3	GCOS SC members to help with identifying and connecting with GCOS National Coordinators. GCOS SC – By next SC.
A31/4	Prepare a GCOS submission to the GGA process (GGA Indicator mapping) advocating for the importance of systematic observations & data rescue. GCOS Secretariat – 31 July
A31/5	Coordinate with WGClimate/WMO/GOOS in the process of submissions for topics for Earth Information Day. GCOS Secretariat - end of August.

Recommendation Number	Description
R31/1	Air-Sea and Land-Air fluxes. OOPC and TOPC should provide a regular integrated report on the progress made on air-sea and land-air fluxes from relevant groups (e.g. OASIS, WCRP, GAW) including regional initiatives and report to the next SC.
R31/2	Sustainability of the observing system – GCOS Secretariat to propose to present at the upcoming Earth Information Day (EID) at COP29 on the lack of sustainability of certain observing systems identified in the GCOS IP action A1, including the situation of the declining performance of GSN and GUAN.
R31/3	GCOS National coordinators. Update the list of national coordinators by: 1. The GCOS Secretariat organizing online meetings per region with the RSO representatives, using UNFCCC list of contacts. 2. Requesting SBSTA parties to nominate the National Coordinators (based on existing mandate). GCOS SC Members can help with this process once the GCOS Secretariat provides them with the right documentation (ToR for GCOS National Coordinators etc.)
R31/4	Earth Cycles. The GCOS Secretariat with the GCOS Panels to follow up on the recommendations of the joint WCRP-GCOS workshop once the initial paper is published.
R31/5	Earth Cycles. The scientific community to continue the regular assessment of earth cycles from observations, in line with action B10 of the GCOS Implementation Plan.
R31/6	Work with G3W, jointly with WCRP (global carbon project), GAW (atmospheric composition) and GOOS, to align GHG-related work and G3W actions for the 2027 G3W Implementation Plan.

Annex 4: Results from workshop on adaptation

GCOS SC-31 Adaptation Brainstorming Summary

Question 1.

Topic	Post-it Content		Count
Which Observations/Variables (or ECVs) Do You Think the Most Important to the Adaptation?	Precipitation	Amount	11
		Intensity	
		Type	
	Sea Level and Coastal Waves		7
	Marine Ecosystems	Marine Habitat	6
		Plankton	
		Oxygen	
	Temperature		4
	Land Cover		3
	Wind		3
	Soil Moisture		3
	SST		3
	Fire (including wildfires)		2
	Hydrological Variables	Water Availability (snow/glacier, groundwater)	2
		River flow and water level	
	Observation	Urban observation	2
		Real-time observation	
	Drought		1
	Heatwave		1

Question 2.

Topic	Post-it Content		Count
What are the Most Important Things GCOS Already Does in Support Adaptation?	(Facilitate Global) Observations/Monitoring/Measurement		14
	Advocacy for	Monitoring	8
		Long-term observations	
		Sustained observations	
		Open data	
	Data Management	QA/QC	7
		Data Rescue	
		Promote/Support Climate Data Repositories	
	Engaging with UNFCCC		4
	ECV and indicators	Defining ECVs for climate monitory	4
		ECV design	
		Standardized + Consistent Observation of Adaptation-related ECV	
		Feasibility of Indicator	
	Reanalysis		3
	Standard/ Guidance	Authority for Standards	2
		Provide Experts Guidance	
	Regional Workshop		1
	Coordination		1

Question 3.

Topic	Post-it Content		Count
GCOS Mandate is Global, Adaptation is Local: What Role Do Global Observations Have in Adaptation? **GCOS Mandate is Global, Adaptation is Local: What Role Do Global Observations Have in Adaptation?**	Provide the Global Context	Global context provides a consistent framework: Supports the Region Boundary Conditions[2]; Enables Region to Region comparisons and gives Background on Local Change	13
		Global Cryosphere Observations indicate the Expected Change in Sea-Level	
		Global Assessment on Needs + Risks + Progress of Adaptation	
		Global Observations can have Local Relevance to Impact	
		Impact of Large-Scale Changes on Regional and Local Impacts	
		Influence Local Action Through Global Perspective	
		Without Global Knowledge, it might Not be Possible to Homogenize/QC Local Observations	
	Reanalysis and modelling	Historical observations are needed for reanalysis and modelling	8
	ECVs & Indicators	Defining Global Indicators that can be Compared for Monitoring[3]	4
		Monitoring the State of the ECVs	
		Global Observing Networks might be Sufficient for Adaptation (because requirements for the ECVs are sufficient to address adaptation specifically)	
		Spatial Resolution Requirement[4]	
	Identify gaps	Identify Gaps in Regional (and global) Observational Facilities	3
		No Local Observation	
		Reveal the Needs & Deficiencies (gap etc.) at Regional Scale	

[2] GCOS and Global support the regions, and don't need boundary conditions to do.
[3] The Fact that we can define global indicator is important for monitoring; if you want to monitor adaptation, we need to have one indicator for everyone.
[4] Observations from the space actually have some local components in there.

	Earth System	Earth System – Global/Regional/National are connected	3
		Earth System Approach	
	Baseline	Baseline (in particular for extremes)	2
	Guidance/ Principles	Provide Guidance and Principles[5]	2
	Others	Identify Areas at Risk	2
		Exchange Ideas among Local Efforts	

[5] ex) To do the exercise of downscaling, we need some principles of how you're going to generate the data

Question 4.

Topic	Post-it Content		Count
Context: GCOS as a Programme, consists of a Secretariat + Task Team, Working Group etc. **Given the resources we have, what can GCOS do?**	Advocacy and links with UNFCCC	Advocate for the use of GCOS Data, Platform at different levels to inform UNFCCC	10
		Advocate for Better, More, Complete Precipitation Observations	
		Advocate for the Importance of Observations for Adaptation via reports/meetings/etc. to COP, UNFCCC, WMO, IPCC, etc., including Adaptation Indicators, Earth Info Day	
	Indicators	Contribute to GGA indicators, refine ECV requirements	8
		Receive Information/Promote Dialogue with the Partners on Co-design of Indicators and How ECVs are Relevant to Inform the Indicators	
		Collaborate for the Adopted Indicators by Ensuring Physical Dataset Exist and are Monitored	
		GCOS to propose indicators suited to the WMO Early Warning for All	
		Experts to Define Indicators with WCRP and Climate Services	
		Propose Indicators to be Merged with Other Social Indicators	
	Engagement with users and stakeholders (including workshops)	Organize Workshops; Regional Workshops on Observations in Support of Adaptation as a +Indicators for Adaptation	8
		Facilitate User Engagement to better Understand Requirements for Adaptation: e.g. Survey of Main Stakeholders and new Potential Stakeholders of Adaptation Asking for Use Cases	
		GCOS Lead Conference on Adaptation	
		Provide an Interaction Space for Young Scientists & Policy Makers -> Now Operation to be more Integrated in Collaboration with WMO & WCRP	
	ECVs	Recruit Additional Experts, to link ECVs to Adaptation (and co-sponsors support)	5
		Mapping ECV Space to Indicator Space	

		Communicate the applicability of the present ECVs (or improved) to Some Relevant Adaptation Needs	
	Publications	GCOS Position Paper on Adaptation	4
	IPCC	Common goal GCOS/IPCC on adaptation for Urban/Coastal Areas	2
		GCOS to Engage Discussion with IPCC WG-II in the context of the Update of the Impacts & Adaptation Guidelines	
	National Coordinators	National Coordinator	2
		Stimulate Appointment of National GCOS Coordinators	
	Nothing	Nothing if not more funding/enhancement of Secretariat	1
	Others	Call for High Resolution Observational Regions or National Datasets that can Support Regional Variables QA/QC at km-scale	3
		Create Narrative of Adaptation Examples and Observation Linkages	
		Provide Guidance to go from Global to Regional/Local Including Data Needs	

Annex 5: GCOS SC-31 Decisions

GLOBAL CLIMATE OBSERVING SYSTEM

WMO unesco Intergovernmental Oceanographic Commission International Science Council UN environment programme

GCOS SC-31

Decision 31/1

Item 11.3

GCOS STEERING COMMITTEE
THIRTY FIRST SESSION

GCOS SC-31, 2–5 July 2024
WMO, Geneva, Switzerland

Extension of membership for OOPC expert

Extension of membership for OOPC expert

Meghan Cronin has been part of OOPC since 2017 and has been leading one of the flagship initiatives of GCOS programme, namely advancing our understanding of air-sea fluxes of heat and water. She is also co-leading the scientific programme OASIS, which has been endorsed under the UN Decade Programme.

Her contribution to OOPC is extremely important as steward to the EOV/ECV Surface fluxes and bringing many connections to the international community working in this space, and in particular to CLIVAR and GEWEX programmes (WCRP). She is also part of the ad hoc GCOS group of experts in charge of GCOS Implementation Plan action B9 (Improve estimates of latent and sensible heat fluxes and wind stress).

The Terms of Reference for GCOS panels indicate that "*After 6 years of service, further extensions may be possible, but these must be approved by the GCOS Steering Committee*." The Steering Committee is asked to provide that approval.

DECISION 31/1

The Steering Committee decides to grant an extension of one year (end of 2024) to Meghan Cronin (OOPC).

GLOBAL CLIMATE OBSERVING SYSTEM

GCOS SC-31

Decision 31/2

Item 7.6

GCOS STEERING COMMITTEE
THIRTY FIRST SESSION

GCOS SC-31, 2–5 July 2024
WMO, Geneva, Switzerland

Timeline of the GCOS Task Team on Essential Climate Variables (ECV) Rationalization

Timeline of the GCOS Task Team on ECV Rationalization

The Steering Committee is asked to consider and approve the timeline of activities of the GCOS Task Team on ECV Rationalization, including an in-person meeting at the end of 2025.

DECISION 31/2

The Steering Committee decides that the GCOS TT on ECV Rationalization will work according to the timeline listed in Table 1.

Background:
The development and stewardship of the Essential Climate Variables framework is one of the main outputs from GCOS. These constitute the minimum set of observations required to systematically observe the Earth's changing climate across three domains: the ocean, land and atmosphere. ECVs have facilitated the implementation of the observing system through a user-driven design, guiding investment decisions and sustaining observations. They have been utilized to assess the system's fitness for purpose, identify gaps, and establish standards and global practices for monitoring and data management. Additionally, ECVs serve as a powerful communication tool, mobilizing climate observing communities. A set of Essential Climate Variables were developed by GCOS in the late 1990's with the first set of requirements for observing these variables published in 2010 (GCOS Implementation Plan, 2010). Bojinski et al. (2014) provides an overview on the rationale, development and uptake of the ECV framework. GCOS expert panels develop sets of requirements for the ECVs every 5 years as part of the Implementation Plan process, and these are published by GCOS, and integrated into the WMO OSCAR database of requirements.
The list of ECVs and their requirements has evolved through time, with panels having a somewhat heterogenous approach. The Steering Committee in 2021 (Decision 29/1) assigned the GCOS Secretariat, in consultation with the panel chairs, the task of proposing a new grouping (rationalization) of ECVs. This matter was further addressed by the GCOS Steering Committee 30 (2022), which adopted a workplan for the rationalization through Decision 30/3. A cross-panel group of experts discussed the proposal at the 2023 GCOS Joint Panel Meeting, leading to the establishment of the GCOS ECVs Rationalization Task Team, consisting of three

members from each panel and three external members. The ultimate goal is to ensure the ECV list's transparency, consistency, and fitness for purpose.

The work of the Task Team:

The TT was established with the following mandate:

1. To define the process that must be followed for an ECV or ECV product/quantity to be adopted.
2. To revise the concept and definition for both an "ECV" and an "ECV quantity".
3. To revise the existing ECVs and ECV quantities and produce a proposed new set of ECVs and ECV quantities.
4. To conduct a consultation and review process of the updated ECV list and edit.
5. To update and re-revise the ECV list taking consideration of the stakeholder feedback.

The Task Team had a first meeting on 21 November 2023, followed by three further online meetings and an in-person meeting at the end of May 2024.

The Task Team has to date worked on points 1, 2 and 3 of the mandate. The Task Team has also discussed what key stakeholders should be consulted preferentially, what tools should be used for that consultation and how/when the public review should take place. Finally, it defined a timeline to undertake the consultation and review process of the updated list of ECV and ECV quantities, presented below in Table 1, which includes an in-person meeting at the end of 2025.

Table 1: ECV Rationalization Task Team Timeline 2024-2025

Time	Activity	Responsible
Q3 2024	Consultation of ECV/ECV quantities list v.1 with GCOS panels	GCOS officers
Q3 2024	Preparation of materials to be used during the consultation with key stakeholders	TT chair and Secretariat
MILESTONE Sep 2024	• ECV/ECV quantities list v.2 • Materials for consultation process finalized • Final list of key stakeholders	TT
Q4 2024	10-15 structured interviews with stakeholders	TT chair and Secretariat and TT members
Q1 2025	Analysis of the results from the interviews and preparation of material for public review	TT chair, Secretariat and TT members
MILESTONE March 2025	• ECV/ECV quantities list v.3 • Materials for public review, including PPT to inform in Conferences finalized	TT (online meeting)
Q2 2025	Public Review	GCOS Secretariat
Q3 2025	Analysis of the results from the public review	TT chair, Secretariat and TT members
MILESTONE End of 2025	• ECV/ECV quantities list v.4 • Draft 0 of an ECV paper describing the process and introducing the new ECVs and procedures	TT (final in person meeting)

GLOBAL CLIMATE OBSERVING SYSTEM

GCOS SC-31

Decision 31/3

Item 7.8

GCOS STEERING COMMITTEE
THIRTY FIRST SESSION

GCOS SC-31, 2–5 July 2024
WMO, Geneva, Switzerland

Climate Indicators

Climate Indicators

The GCOS Steering Committee 30 decided (Decision GCOS SC-30/4, 2022) that "GCOS Secretariat works with WMO/Climate Services to explore the adoption of additional climate indicators. These new indicators could, for instance, cover new domains, reflect the earth cycles, and/or address extremes."
The GCOS Steering Committee 31 is requested to provide their view and guidance to the GCOS Secretariat on the proposed timeline for the development and inclusion of additional indicators.

DECISION 31/3

The Steering Committee decided that the work on the climate indicators will continue and the proposal for 3 new indicators will be presented to WMO Service according to the proposed timeline.

Background

A cross-panel group of 16 experts, chaired by Karina von Schuckmann (OOPC) and Martin Herold (TOPC), discussed the proposal of new climate indicators at the 2023 GCOS Joint Panel Meeting (JPM), held in Bonn on 26-30 June 2023.
Participants were asked to indicate which were the main elements that should be part of the definition of global climate indicators and what the purpose of such a GCOS Indicator should be. Participants also provided feedback on the descriptions of the 5 criteria currently used: relevance, representativeness, traceability, timeliness and data adequacy.
These are the main points of the discussion:

- The history of the GCOS global climate indicator framework and the rationale behind GCOS Steering Committee Decision were presented.
- It was clarified that the global climate indicator framework governance depends on WMO Services, not exclusively on GCOS.
- It was highlighted the role of the climate indicators as elements of the science-policy nexus.
- Panel members presented 11 proposals for new indicators, justifying their relevance and explaining how they complied with the rest of criteria.

These are the main outcomes:

- The definition of a global climate indicator was revised (see Section 3 below).
- The description of the 5 criteria to identify the global climate indicators was refined (see Section 4 below).
- The new proposed indicators were ranked to establish a preliminary prioritization (see Section 5 below).

Definition of a Global Climate Indicator

Based on the discussion, the following proposition for a definition for the global climate indicators was achieved:

A global climate indicator informs on the observed change in the state of the Earth climate system in an easy-to-understand way for policymakers and the public. A global climate indicator is based on robust, scientific-sound and timely data and methods, and emphasizes detectable change in the state of the climate system in a comprehensive and holistic way across space and temporal scales.

Definition of the Criteria

Based on the discussion, the existing criteria for the following proposition were refined as proposed here below:

1. **Relevance:** A global climate indicator should inform on observed change in the state of the Earth climate system in an easy-to-understand way relevant for policymakers and the public. The indicator should also serve to guide on observing system gaps across time and space scales.
2. **Representativeness:** The climate indicator represents change in the Earth climate system at global scale and can be also used at regional scale. The indicator integrates detectable change in the state of the climate system in a comprehensive and holistic way and will have value across temporal scales.
3. **Traceability:** Each indicator should be calculated using commonly endorsed and transparent scientific-sound methods.
4. **Timeliness:** It should be possible to calculate the indicator regularly, annually at least, and with a short lag between the end of the period and the publication of the data.
5. **Data adequacy:** The data and method needed for the indicator must be sufficiently robust, verified and accessible.

Propositions of new Global Climate Indicators

The interactive discussion led to a set of propositions for the following new potential indicators:

- TOPC: Ecosystem drought, Phenology, Terrestrial carbon storage, Extreme Fires, Terrestrial water storage;
- AOPC: Globally averaged number of cold & warm days; Precipitation; Tropospheric Ozone; Global methane concentration;
- OOPC: Earth energy imbalance; Ocean oxygen content.

All propositions were presented in detail, followed by common Q&A, before then moving to an interactive allocation approach. After careful discussion, the following 3 new indicators have been brought forward:

- Earth energy imbalance
- Ecosystem drought
- Terrestrial carbon storage.

A factsheet for each of the 3 indicators needs to be prepared for further internal evaluation and discussion.

Factsheet template

The factsheet should address key questions in support of the approval of the proposed indicators, it should be built on a sound scientific basis but should be written with a simple narrative for communication and dissemination purposes.
The proposed factsheet's structure can be:

1. Introduction, with a brief summary describing the background, including complementary with existing indicators.
2. A short description, responding to the question: what is 'new indicator name'?
3. A sound justification – providing scientific evidence – responding to the question: why is 'new indicator name' important?
4. How is 'new indicator name' measured (including data sources, level of operationality)?
5. A paragraph (or a matrix) showing how the new indicator matches with the 5 criteria.
6. What easy-to-communicate information can deliver (message to bring to the general public and decision makers)?

Proposed Timeline

Time	Activity	Responsible
Q4 2024	Prepare Fact-Sheet	GCOS Sec + Panel Experts
Q1 2025	Present the findings and proposals to WMO Services for their consideration.	GCOS Sec
Q2 2025	Discuss the need and development of information sheets (e.g., policy brief style) for informing on current indicators, and for the proposed ones.	Panel Experts
Q4 2025	Present the new indicators at the Earth Information Day, UNFCCC COP-30	GCOS Sec + GCOS Chair
Q4 2025	Face the opportunity of regionalization of global climate indicators in the future (to be discussed).	Panel Experts

GLOBAL CLIMATE OBSERVING SYSTEM

GCOS SC-31

Decision 31/4

Item 7.9.1

GCOS STEERING COMMITTEE
THIRTY FIRST SESSION

GCOS SC-31, 2–5 July 2024
WMO, Geneva, Switzerland

Update of GCOS-245

Document Tile

The GCOS Steering Committee is asked to consider the update of the GCOS-245[6] for the ECV Requirements

DECISION 31/4

The GCOS Steering Committee decides that:

1. The GCOS Secretariat will update the GCOS-245 to include a revised introduction containing better explanations on how to interpret the requirements and targeted updates of some of the ECV requirements.

2. The GCOS Secretariat will produce a draft of this update by November 2024.

3. The GCOS SC Chair and the Panel chairs will revise the update.

4. The updated version of the GCOS-245 will be published by December 2024.

Summary:

In 2022 GCOS published the GCOS Implementation Plan and the ECV Requirements (GCOS-245). The latter contained the requirements for the ECVs. The report is structured in 5 sections: an introduction, a table that lists the changes in the ECVs since the GCOS IP 2016, and 3 sections, one for each domain, containing the ECV requirements for ECVs and ECV products. The introduction provides the definition of the criteria for the requirements (spatial resolution, temporal resolution, uncertainty, stability, timeliness) and a definition for the 3 values of goal, breakthrough and threshold. It does fail to describe how these requirements should be used and the fact that the requirements are technology free and cannot be met by means of a single observing method. This lack of explanation has resulted in confusion within the community and in some cases the requirements were misinterpreted.

Additionally, for some of the requirements there are revisions available.

[6] https://library.wmo.int/viewer/58111/?offset=

As next document with the ECV requirements will be published together with the GCOS IP in 2028, the GCOS Secretariat in consultation with the Panels' chairs, suggest updating this document in order to avoid further misunderstanding. The proposed revision will be restricted to the introduction and the update of a very limited number of ECV requirements.

GLOBAL CLIMATE OBSERVING SYSTEM

GCOS SC-31

Decision 31/5

Item 7.9.2

GCOS STEERING COMMITTEE
THIRTY FIRST SESSION

GCOS SC-31, 2–5 July 2024
WMO, Geneva, Switzerland

GCOS co-authoring article

GCOS co-authoring paper

Over the last several months, GCOS Secretariat has been approached with the request to co-author a paper. The Steering Committee is asked to provide advice to the GCOS Secretariat on how to answer this kind of requests.

DECISION 31/5

1. The Steering Committee decides that the GCOS Secretariat will only co-author papers that are led by GCOS and are within the clear mandate of GCOS. If the GCOS Secretariat has doubts about specific requests, the decision can be deferred to the GCOS Panels' Chairs.

2. The Steering Committee decides that acknowledgments to GCOS should be avoided in papers and publications.

GLOBAL CLIMATE OBSERVING SYSTEM

GCOS SC-31

Decision 31/6

Item 9.2

GCOS STEERING COMMITTEE
THIRTY FIRST SESSION

GCOS SC-31, 2–5 July 2024
WMO, Geneva, Switzerland

GBON-SOFF

GBON-SOFF (Global **B**asic **O**bserving **N**etwork – **S**ystematic **O**bservations **F**inancing **F**acility)

The GCOS Steering Committee Chair, AOPC Chair and GCOS Secretariat have been working with the GBON-SOFF Secretariat to develop a more coordinated process to link the ECV requirements, and their associated observing systems, with that of GBON and the financial/technical support offered by SOFF. This included a joint GCOS/SOFF paper presented to COP-28 and several presentations to the SOFF SC and AB on the work of the panels in support of climate observing systems, in particular the GCOS Cooperation Mechanism.

At the most recent SOFF SC (June 2024) it was agreed that GCOS be invited to join the SOFF Advisory Board.

DECISION 31/6

1. The Steering Committee welcomes the proposal from the SOFF SC, and decides that Peter Thorne will be the GCOS representative on the SOFF Advisory Board, with Tim Oakley acting as an alternate.

GLOBAL CLIMATE OBSERVING SYSTEM

GCOS SC-31

Decision 31/7

Item 11.1

GCOS STEERING COMMITTEE
THIRTY FIRST SESSION

GCOS SC-31, 2–5 July 2024
WMO, Geneva, Switzerland

GCOS 5-yr Timeline and the Annual Workplan

5-yr Timeline and GCOS Annual Workplan

The Steering Committee is asked to consider and approve the 5yr timeline for GCOS (Table 1) and the GCOS Annual Workplan of the Secretariat (Table 2).

DECISION 31/7

The Steering Committee decides that the GCOS Secretariat will work according to the activities listed in Table 1 and that GCOS will follow the timeline in Table 2, including the publication dates of the next Status Report and Implementation Plan.

Summary:

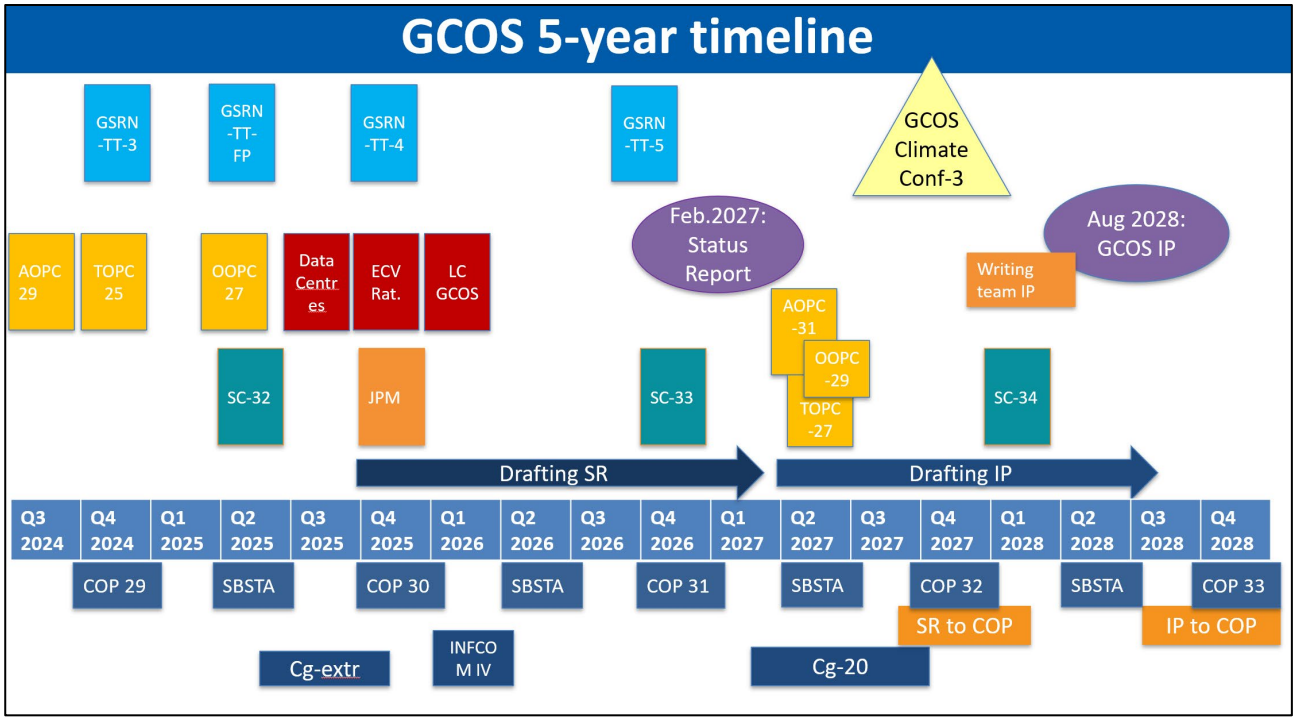
1. 5-year Timeline

The timeline shown in Table 1 covers the next 5 years. It includes inter alia: meetings of the GCOS Panels and Steering Committee; meetings that are organized by GCOS; external meetings where GCOS needs to participate; and finally, a timeline for the preparation of the next GCOS Status report and Implementation plan. It does not include the several meetings where GCOS Secretariat or GCOS panel members are regularly requested to attend, such as for example the WGClimate, WCRP or GOOS meetings.

Table 1: GCOS Timeline 2024-2028

Time	Panel Meetings	GCOS Steering Committee	Meetings on specific topics	Other meetings	Milestones
Q3 2024	AOPC				
Q4 2024	TOPC		GSRN-TT-3	COP-29	
Q2 2025	OOPC	Steering Committee SC-32	GSRN Focal Points	SBSTA	
Q3 2025			Data Centers		
Q4 2025	JPM: AOPC-OOPC-TOPC		ECV Rational GSRN-TT-4 GRUAN-ICM 16	COP	Start work on Status Report

Q1 2026			LC-GCOS 8th Workshop	INFCOM-IV	
Q2 2026				SBSTA	
Q4 2026		Steering Committee SC-33	GSRN-TT-5	COP	
Nov-Dec. 2026					Public Review
Q1 2027					
Feb 2027					Publish Status Report
Q2 2027	Separate meetings AOPC, OOPC and TOPC		GRUAN- ICM 17	SBSTA WMO Congress?	Start work on IP
Q4 2027			GSRN-TT-6	COP	SR to COP
October 2027	Tentative: GCOS Climate Conference				
Q1 2028 (Jan)		Steering Committee SC-34	Drafting Team for IP		
Q2 2028				SBSTA	
Q2 2028 (March-April)					Public Review
August 2028					Publish IP
Q4 2028			GSRN-TT-7 GRUAN-ICM 18	COP	IP to COP



2. Updated GCOS Secretariat Workplan 2024 (Q3-Q4)-2025 (Q1-Q2)

The GCOS secretariat have considered the tasks that are necessary to support the GCOS expert panels, task teams and the Steering Committee, and implementation of the GCOS Implementation Plan. Tasks needed to ensure visibility and impact of the programme, as well as engagement with GCOS stakeholders, including its co-sponsors (in particular WMO) have been considered too. Many of the activities for 2024 and 2025 have been started and are

described in detail in Doc. 6.1. Table 2 shows a summary of the workplan for 2024 and Q1-Q2 of 2025, including deliverables and timeline. In brackets the reference to the activities described in Doc 6.1. Any other activity decided during the SC-31 will be added to this table.

Table 1: GCOS Secretariat Workplan 2024 (Q3-Q4)-2025 (Q1-Q2)

Continuous/ongoing Activities

#	Activity	Objective	Deliverable	Ongoing
1.	Support to GRUAN WG Chairs, task teams, online meetings (2)	Implementation of GRUAN		Meeting in Q3 2024
2.	Monitoring GUAN and GSN (2)	Long-time series of observations	Reports	
3.	Participation into the process for recognition of Global Climate Data Centres in WMO (6.2 and 6.3)	Implementation of WMO Data Policy; increase of historical observations in data centers	Climate needs (includes data management aspects) considered in the WMO process for data centers	
4.	GCOS and SOFF (6.4)	Support to climate observations	GCOS rep in SOFF Advisory Board; climate observations in SOFF. GCOS member in ET-SON	
5.	Participation in co-sponsors subsidiary meetings and other WMO meetings (SC-ON, INFCOM-3, AG-Oceans, EC) plus requests and reviews (6.7)			
6.	Support panels (reports, online and in person meetings) (10.)	Improvement of climate observations	IP actions related to panels advanced. AOPC and TOPC reports published	AOPC Meeting in Q3; TOPC meeting in Q4 OOPC meeting in Q2 2025
7.	Earth's cycle	Action B10: Identify gaps in the Climate observing system to monitor earth cycles	Support to regular assessment of observations gaps to monitor.	

Underway Activities

#	Activity	Objective	Deliverable	Timeline Q3-Q4 2024, Q1-Q2 2025
8.	Identification of entities that can provide support to networks in 1. And of strategy to obtain support (1.1)	Ensure continuity and development of long-term time-series needed for climate monitoring	List of entities; list of strategies	Q3-Q4 2024 Q1-Q2 2025
9.	Review existing monitoring standards, guidance and best practices for each ECV (1.2)	Improvement of consistency of observations across countries	List of ECVs for which standards do not exist	Q2-Q4 2024

10.	Identify ECVs for which adequate global centres do not exist or are not sufficiently supported	Availability and distribution of all observations for each ECV	List of climate data centres for all ECVs and identification of those in need of additional support	Q1-Q3 2024
11.	Support of GSRN Pilot Phase (2)	Implementation of pilot GSRN	GSRN: Plans for next period agreed, including interaction with stations contacts; initial metadata and data flow	Q1-Q4 2024 Meeting in Q4 2024 Q1-Q4 2025
12.	ECV Rationalization TT (3.1)	Ensure transparency, consistency and fitness for purpose of the ECV list	Governance of the process to be followed for adoption of ECVs and ECV products/quantities and a proposed new set of ECVs and ECV quantities. Consultation with users.	Q1-Q4 2024 Q1-Q4 2025
13.	Climate Data Centers (3.2)	Ensure consistent management across all climate data archives	Broad agreement within all GCOS panels of a set of requirements to use to assess data repository adequacy	Q1-Q4 2024
14.	Improve estimates of latent and sensible heat-flux (3.3)		1. Paper or report on available observations and gaps of fluxes ready for publication. 2. Depending on outcome in 1.	1. Q4 2024 2. Q1-Q4 2025
15.	Earth's cycle: addressing recommendations from Workshop (3.4)		Paper on the global integrals ready for publication; Continue liaising with WCRP to decide next steps.	Q4 2024 Q1-Q4 2025
16.	Indicators	Propose new climate indicators to cover new domains, reflect the cycles, and/or address extremes	Factsheets for the proposed new indicators	Q4 2024
17.	Interviews with GCOS National Coordinators, Contact countries where GCOS National Programme does not exist (4.)	Raising GCOS profile, learning about climate needs, fundraising	Initiate communication with identified national coordinators; Online forum	Q1-Q4 2024
19.	Establish regular interactions with a stable core group of GCOS National Coordinators	Get insight at national level, including inputs to the UNFCCC process. Promote the creation of GCOS National Programmes	Group established and first in-person meeting held (depending on the available resources)	Q1-Q4 2025
20	Update list of national coordinators			Q3-24;Q1-Q4 2025
21.	GCOS Coordination Mechanism: apply to terrestrial case (4.)	Support the Hydrological Networks	Draft pilot project for supporting field(s) site(s) in Uzbekistan.	Q3-Q4 2024
22.	Adaptation: Finalize paper on the ECV Fire; Draft paper on the role of reanalysis for adaptation (5.)	Define the role of GCOS in adaptation	Published paper on ECV-fire Draft paper on reanalysis for adaptation	Q3 2024 Q4 2024

23.	Expansion of GBON to hydrology	Support the GBON Expansion	Draft concept document	Q2-Q3 2024
24.	Update OSCAR/RRR with the ECV requirements from GCOS-245 (6.6)	Climate requirements in RRR	ECVs updated in RRR after interaction with JET-EOSDE	Q1-Q4 2024 Q1-Q2 2025
25.	Approval of MoU (7.)	Approved MOU	Signed MoU	Q3-Q4 2024
26.	Prepare and participate in SBSTA 61 and COP 29 (8.)	Visibility, communication strategy	Presentation at Earth Information Day; Revised GCOS Climate Monitoring Principles endorsed	Q3-Q4 2024
27.	Organization of GCOS Steering Committee Meeting (10.)	To get guidance and decisions from SC	Report with decisions agreed	Q1-Q3 2024
28.	Redesign/rebuild of GCOS Website (11.)	Improvement of communication as part of GCOS strategy	Updated Website	Q2-Q4 2024
29.	EU project (12.)	Streamline climate-related activities between GCOS, WMO and GEO and obtain financial support for GCOS	Project submitted	Q2-Q4 2024

Annex 6: List of Acronyms

AI	Artificial Intelligence
AOPC	Atmospheric Observations Panel for Climate
APARC	Atmospheric Processes and their Role in Climate
BSRN	Baseline Surface Radiation Network
C3S	Copernicus Climate Change Service
CAMS	Copernicus Atmosphere Monitoring Service
CEOS	Committee on Earth Observation Satellites
CGMS	Coordination Group for Meteorological Satellites
CLIVAR	Climate Variability and Predictability (WCRP)
CODATA	Committee On Data for Science & Technology
COP	Conference of the Parties (UNFCCC)
CPA	Climate Policy Advisors
CTS	CoreTrustSeal
DG-DEFIS	Directorate-General for Defense, Industry and Space
ECV	Essential Climate Variable
EEZ	Exclusive Economic Zone
EOV	Essential Ocean Variables
ESMO	Earth Science Modelling and Observations
EUMETSAT	European Organization for the Exploitation of Meteorological Satellites
FAIR	Findability, Accessibility, Interoperability, and Reusability
G3W	Global Greenhouse Gas Watch
GATT	GCOS Adaptation Task Team
GAW	Global Atmospheric Watch
GBON	Global Basic Observation Network
GCOS	Global Climate Observing System
GCW	Global Cryosphere Watch
GEO	Group on Earth Observations
GEWEX	Global Energy and Water Exchanges
GGA	Global Goal on Adaptation
GHG	Greenhouse gases
GNSS-PW	Global Navigation Satellite System Precipitable Water
GOMO	Global Ocean Monitoring and Observing programme
GOOS	Global Ocean Observing System
GEPEX	The Global Precipitation Experiment
GRUAN	Global Reference Upper Air Network
GSN	Global Surface Network
GSRN	Global Surface Reference Network
GST	Global Stocktake
GTN-H	Global Terrestrial Network for Hydrology
GTN-R	Global Terrestrial Network for River Discharge
GUAN	Global Upper Air Network
ICM	Implementation Coordination Meeting
IOC	Intergovernmental Oceanographic Commission
IP	Implementation Plan
IPCC	Intergovernmental Panel on Climate Change
IPCC AR6	IPCC Sixth Assessment Report
ISC	International Scientific Council

LC	Lead Center
LDCs	Least Developed Countries
MoU	Memorandum of Understanding
NCEI	National Centers for Environmental Information
NDACC	Network for the Detection of Atmospheric Composition Change
NMHS	National Meteorological and Hydrological Services
NOAA	National Oceanographic and Atmospheric Administration
OASIS	Observing Air-Sea Interactions Strategy
OOPC	Ocean Observations Physics and Climate Panel
OSCAR	Observing Systems Capability Analysis and Review Tool
PCFH	Peltier Cooled Frost Point Hygrometer
QA/QC	Quality Control/Quality assurance
RRR	Rolling Review of Requirements
RSO	Research and Systematic Observations
SBSTA	Subsidiary Body for Scientific and Technological Advice
SC	Steering Committee
SIDs	Small Island Developing States
SOFF	Systematic Observations Financing Facility
SOFF AB	Systematic Observations Financing Facility Advisory Board
TCCON	Total Carbon Column Observing Network
TOPC	Terrestrial Observations Panel for Climate
ToRs	Term of References
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
VICIRS	Vicarious Calibration using GRUAN sondes
VLT	Very Large Telescope
WCRP	World Climate Research Programme
WDS	World Data System
WG	Working Group
WGClimate	Working Group on Climate
WGCV	Working Ground Calibration/Validation
WIGOS	WMO Integrated Global Observing System
WIPPS	WMO Integrated Processing and Prediction System
WIS	WMO Information System
WMO	World Meteorological Organization

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