GLOBAL CLIMATE OBSERVING SYSTEM

WMO | unesco Intergovernmental Oceanographic Commission | International Science Council | UN environment programme

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GCOS STEERING COMMITTEE
THIRTY FIRST SESSION

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GCOS Implementation Plan - Action A1.1 – First Report

Background

The current document summarizes the work undertaken by GCOS experts to address Action A1 in GCOS Implementation Plan, focused on the situation of in situ networks: "*Ensure necessary levels of long-term funding support for in situ networks, from observations to data delivery*", and in particular to realize Activity A1.1 "*Undertake an assessment of current levels of funding support for global in situ networks delivering relevant in situ ECV data, including cal/val measurements, and identify those in situ networks with immediate of short-term problems around adequacy and sustainability of funding*".

This Action addresses the need to ensure the continuity and development of long-term time-series needed for climate monitoring, which rely on stable observing systems and programmes.

Development of the Activity

In order to realize the assessment requested in Activity A1.1, GCOS Secretariat prepared a table "Sustainability of in situ observing networks" to collect feedback from experts of the three GCOS panels. Panel experts met in person during the Joint Panel Meeting held in Bonn in June 2023 and produced a first version of the table. Each panel focused on the global in-situ networks that were measuring ECVs and were more relevant for each of the realms: atmosphere, ocean, terrestrial. Experts listed the relevant global in situ networks and filled in the different fields of the table for each of them. Those fields referred to different aspects of the networks, such as what ECVs they monitored, and what is the funding mechanism that is used to operate them. There were also some additional fields which were used to provide extra information on the relative importance of each of the networks, such as global coverage and to what extent they were meeting the requirements established by GCOS-245[1]. The complete list of fields and an example are contained in Table 3.

[1] GCOS-245. The 2022 GCOS ECVs Requirements, WMO, Geneva, 2022, accessible at: *https://library.wmo.int/idurl/4/58111*

The colour code and categorization are explained below:

Current Status of funding
Funding available, observations can be maintained for the next 3-5 years
Significant funding uncertainty or problems with data quality. Sustained quality conservations at risk
Major funding risk, funding ended or will do so within <3 year, instruments lost or not deployed, no prospect of redeployment
Not applicable, not making these observations in sustained mode

Table 1: Color coding used to categorize the in-situ networks based on the status of funding

It is important to remind ourselves that the activity intended to provide a snapshot of the system's health in terms of stability of the funding for observing each of the ECVs and highlight the main deficiencies. The final objective is to identify which parts of the observing system are more fragile because they are funded on soft money, and advocate for a global observing system for climate which is sustained in the long term.

The exercise and the colour coding:

- was not an assessment of whether the network is actually meeting the observational requirements. A network considered fully operational (green) may nevertheless be insufficient in aspects like geographical coverage, data management or data quality, but these aspects are considered under other actions in the GCOS Implementation Plan, in particular under themes B, C and D of the GCOS Implementation Plan.
- was not an evaluation of the level of funding invested in each network/ECV. Two networks scored as "green" may have very different levels of total funding, and one network scored as "red" may have a greater funding, but still be precarious in that the funding is not guaranteed in the mid-term.

The exercise was undertaken using the networks (not the individual ECVs). A single ECV can be measured by several networks (and a network can measure several ECVs) and this can lead to some nuances in the interpretation of the results.

Finally, when communicating the results it is important to be aware that not all networks contribute to the global observing system equally. Some of the fields of the table contribute to qualify this aspect.

While the exercise can be considered a non-exhaustive assessment, as we see in Table 2 the use of a colour coding allows us to establish clear differences between the overall funding situation for each of the panels/realms.

Table 2: Current status of funding supporting the observational networks measuring different ECVs per panel

AOPC		OOPC		TOPC	
National synoptic observation networks (land based)	Pressure, air temperature, surface wind, surface water vapour, precipitation, cloud (some products)	**Core Argo**	SST, Subsurface T, SSS, Subsurface S, Subsurface current		Soil moisture (Surface Soil Moisture, Freeze/Thaw, Surface Inundation, Root Zone Soil Moisture)
National synoptic observation networks (ocean)	Pressure, air temperature, surface wind, surface water vapour, precipitation			**International Soil Moisture Network**	
Global observing system (radiosondes)	UA T, UA WV, UA windspeed and direction	**SOT**	SST, Subsurface T		Land surface temperature
AMDAR	UA T, UA WV, UA windspeed and direction	**GO-SHIP**	ALL EOVs, all depths	**USCRN**	Land surface temperature
Pilot balloons	UA windspeed and direction	**Sea level**	Sea Level	**SURFRAD**	
GNSS-PW	UA WV	**OceanSITES**	SST, Subsurface S, Surface Currents, Subsurface Currents, Sea State, Surface Stress, Ocean Surface Heat Flux, Oxygen	**GTN-R (River Discharge)**	River Discharge
Wind profilers	UA windspeed and direction	**DBCP - Moored**	SST, Subsurface S, Surface Currents, Subsurface Currents, Sea State, Surface Stress, Ocean Surface Heat Flux	**Global Runoff Database at GRDC**	River Discharge
Dual-pol radar	Precipitation, boundary and tropo winds	**HF Radars**	Surface Currents	**GTN-L**	Lakes: lake lewel, lake surface temperature
VOS / ASAP sondes	UA T, UA WV, UA windspeed and direction	**DBCP drogued**	SST, Surface Currents, Surface Pressure	**FLUXNET (and contributing networks)**	Evaporation from land
				Global Groundwater Monitoring	Groundwater

Ozonesondes (NOAA, NASA, EU)	UA T, UA WV, UA windspeed and direction, ozone (concentrations and columns)
Baseline Surface Radiation Network (BSRN), but also NHMS provide data to GAW, WRDC, GEBA. Separate row?	Downward Short-Wave Irradiance at Earth Surface, Downward Long-Wave Irr. at Earth Surface, Upward Long-Wave Irr. at Earth Surface
Atmospheric Composition	Atmospheric Composition (GHG, Ozone, Aerosols)
LIGHTNING	Lightning

DBCP – drifting wave	Sea State, Surface Pressure
Biogeochemical Argo	Oxygen, Ocean Inorganic Carbon, Nutrients, Ocean nitrous oxide N2O, pH (not in table)
Deep Argo	Subsurface Temperature, Subsurface Salinity, Subsurface Currents
OceanGliders (UAV)	SST, Subsurface Temperature, SSS, Subsurface Salinity, pH, O2, subsurface current
USV	SST, SSS, Surface Currents, Subsurface Currents, Sea State, Surface Stress, Ocean Surface Heat Flux
AniBOS	SSST Subsurface Temperature, SSS, Subsurface Salinity

Network (GGMN)	
WGMS	Glacier Mass Change
FAO/AQUASTAT	Irrigation water use
	Biomass
GEOTREES	
GTN-G	
	Glaciers
BSRN	Surface albedo (only broadband)
Copernicus GBOV	Land surface temperature; (not only as for validation); FAPAR; Albedo; LAI; Soil Moisture
Copernicus LAW	Land surface temperature
SAPFLUXNET	Evaporation from land (transpiration)
GTN-P	Permafrost

PRELIMINARY CONCLUSIONS PER PANEL

ATMOSPHERE

- A vast majority of ECVs are measured with systems that are operational, inserted in long term programmes that are not only research oriented (green colour code).

- The clearest exception are the ECVs related to **atmospheric composition**, whose measurements depend to a great extent on research funds and are not part of permanent monitoring programmes. Atmospheric composition ECVs have been scored as yellow and for the atmosphere the systems measuring these ECVs are the most fragile in terms of funding.

- As mentioned before, this does not mean that the density of the atmospheric networks is always sufficient and, in fact, this feature has not ceased to worsen in the last years (hence the creation of GBON), with significant regional variations.

OCEAN

- Unlike the atmosphere, **the majority of the networks** are scored as yellow, meaning that they **are not supported by institutional, long-term funding**, but on cycles of less than 5 years.

- The situation is **particularly fragile for biogeochemical variables and subsurface variables**, while variables measured at surface and near the coast are generally better supported.

- Only the sea level network and some parts of the DBCP (Data Buoy Cooperation Panel, part of WMO, drogued component) can be considered sustained observations (green scoring). However, in both cases the density of measurements is decreasing.

- **ECVs at the subsurface cannot be monitored with remote sensing**, which increases the importance of sustaining the in-situ networks.

TERRESTRIAL

- Approximately half of the in-situ networks and variables have sustained funding (those related to hydrology), **while the other half are supported mostly on research funding (biomass, soil moisture)**. But we need to understand this in a context where a lot of the global observations rely mostly in remote sensing, and the role of the in-situ measurements is less critical.

- The situation is particularly worrisome for permafrost.

- For some of the ECVs like Fire, Snow or Terrestrial Water Storage, there is not an in situ global observing network associated, so the assessment was not possible. They are measured mostly by remote sensing.

MAIN MESSAGE (to be considered by GCOS Steering Committee)

The exercise shows that there are some networks/ECVs whose lack of sustainable funding risks creating a knowledge gap, more critical when remote sensing is not an option.

GCOS panels should highlight the in-situ networks which are at risk and advocate for a change on how they are funded.

ECVs that are supported in a less sustained way are:

- Atmospheric composition ECVs
- Most of the ocean ECVs in general, and in particular the subsurface and biogeochemical.
- Terrestrial ECVs related to biomass and permafrost.

The Steering Committee is asked to consider these results and decide on what message should be extracted and communicated, as this can be controversial in view of the factors previously mentioned: for example, even the well sustained networks have huge problems of coverage.

In a second step, the Action foresees identifying entities that can provide support for the networks identified at risk and advocate with funding agencies to support them.

Date of the assessment: *June 2023*

Name of the in situ network	ECVs provided	Monitoring Platform	Type of funding	Funding cycle/horizon	Projected change in density/coverage (5y)	Meeting ECVs Spatial Requirements	Global/Regional coverage (specify)	Current Status (colour code)	Remarks
Core Argo (example)	Temperature, SSS, Subsurface Salinity, Subsurface current	in situ (drifting floats)	Mixture of A and B	Typically 5 y; it depends very much on the nation	-5%	60%	Global except polar and shallow waters not covered		For Argo specifically, national funding could show differences and be less/more sustained too. This is an abstraction
Network 2									

Fields Explanations to fill in the fields in the table

Provided ECVs	One network can allow to observe several ECVs. List of ECVs can be found on "table ECV" tab.
Monitoring Platform	(optional, but maybe useful for a reader not familiar with the names of the networks)
Type of funding	A. Fixed-duration funding (<5y) (this can be funded through research programmes at international or national levels e.g NSFD grants etc. B. Institutional funding (operational, generally supported by national funds and with longer duration) C. In-kind (opportunistic or voluntary)
Funding cycle/horizon	**X- years**. Funding received every 2-3 years, can be part of a longer funding cycle which can ensure some continuity. Besides, while operational funding is generally associated with long-term commitment of funds, but this could still be subject to revisions every X-years. **Permanent** (Sustained/Systematic observations)
Projected change in density/coverage	Projections of changes in operating instruments over the next 5 years based on budget projections, in %.→ it could be indicating an expansion but also a decrease
Meeting Spatial Requirements *(optional field)*	It refers to the ECV requirements using the threshold value for H or V resolution as it fits better, and provides an estimation of what % is covered by the network.
Global coverage *(optional field)*	Indicate if the network is operating globally. If not, explain what regions is covering.

* *The two optional fields can be useful to give an idea of how relevant the network is in the global system*

Current status of funding
Taking into consideration the information provided in the table, experts asign a colour code to the status of funding for each network

Use colour codes below to shade in the cells under the "Status" column

	Funding available, observations can be maintained for the next 3-5 years
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Table 3: Template used by GCOS experts to evaluate the status of funding for in situ networks providing ocean climate data.