

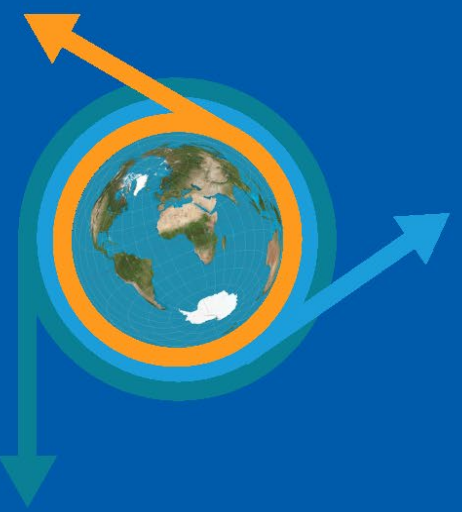


ГЛОБАЛЬНАЯ СИСТЕМА
НАБЛЮДЕНИЙ ЗА КЛИМАТОМ
НЕУСТАННО СЛЕДИМ ЗА КЛИМАТОМ

SYSTÈME MONDIAL
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NOUS VEILLONS SUR LE CLIMAT

Report on the WCRP & GCOS June 2023 Meeting, activities and GCOS assessment updates

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GLOBAL CLIMATE
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KEEPING WATCH OVER OUR CLIMATE

The Earth cycles: Report on the WCRP & GCOS June 2023 Meeting, activities and GCOS assessment updates

Caterina Tassone



Overview of Work from GCOS on Earth Cycles in the last 8 years

- Work on Earth Cycles is reflected in GCOS Implementation Plan 2016 with several Actions related to observational needs to close the carbon, energy and water cycles.
- This was discussed in a GCOS cross-panel meeting held in Marrakesh in 2019
- After that, three papers were prepared describing which the main gaps that hinder our understanding of the cycles are.
- A new ECV was proposed to better reflect the water cycles (terrestrial water storage, resp. Terrestrial Panel).
- 2022 GCOS IP has a section on The Earth Climate Cycles summarising the findings of the papers and an Action proposing to continue to periodically review observations of the Earth's energy, water, carbon cycles to identify gap.
- 2022 GCOS Steering Committee approves a Decision supporting the work on Earth Cycles and the organization of a workshop jointly with WCRP.



The 2022 GCOS Implementation Plan



GCOS – 244
GOOS – 272



WMO

IOC

ISC

environment

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

Activities	<ol style="list-style-type: none"> 1. Continue to periodically review observations of the Earth's energy, water, carbon cycles to identify gaps and areas of high uncertainty. 2. Review consistency of the underlying observations. 3. Develop plans to address the gaps identified in (1), if feasible.
Issue/Benefits	<p>This action will implement an objective approach to identifying gaps and major uncertainties in the global climate monitoring system.</p> <p>The energy, water and carbon cycles and their closure/imbalance are fundamental to understanding current climate state and change, and improved observations of the cycles will lead to improved climate projections and reduced model biases.</p>
Implementers	From 1 to 3: GCOS , Research organizations, Funding agencies, WCRP.
Means of Assessing Progress	<ol style="list-style-type: none"> 1. <ol style="list-style-type: none"> a) Periodic assessments of each cycle and its components at least as part of the Status Report (about every five years); b) Periodic reviews of suitability of existing ECV structure to monitor energy, water and carbon cycles at least as part of the Status Report. 2. Periodic assessment of consistency of the underlying ECVs. 3. Include plan to address the main issues for the next GCOS Implementation Plan.
Additional Details	<p>GCOS has reviewed how well the existing structure of ECVs monitors these cycles and their components. This has revealed significant gaps in observations and highlighted areas of highest uncertainty – this information will be used to guide developments and improvements to the observing system.</p> <p>Expert teams reviewing observations of the cycles will report on gaps and major uncertainties for inclusion in the next GCOS Status Report. They will develop plans to address these issues in subsequent Implementation Plans.</p> <p>See also Section 2.4 in this GCOS IP for more details and references.</p>
Links with other IP Actions	<p>This action indirectly links with many others but in particular with:</p> <ul style="list-style-type: none"> B3: Better EEI measurements. B4: In situ GHG observations. B8: Coordinate observations and data product development for ocean CO₂. C5: Activity 2 (estimation of aboveground biomass).

WCRP-GCOS June 2023 Paris Workshop



The overall aim of the workshop was to assess the current state of knowledge of the Earth's key cycles of water, carbon and energy, both with a view to identifying gaps in our understanding and in our observations. Review where community stands (survey)

- a. Global view
- b. Regional views

Specific aims for each cycle

1. Assess the **current state of knowledge of the cycle** as well as emerging changes in the cycle. Identify challenges from research (knowledge of processes) to modelling and observing system capabilities.
2. Identify key indicators for monitoring, measuring (observational needs) and modelling the cycle and indicate how they can be used in global assessment frameworks (IPCC, WMO, other). Take into account the WCRP Strategy and GCOS ECVs.
3. Identify **key processes** which require a better understanding to improve cycle monitoring or coupling to other cycles. What research is needed towards closing the budgets, bearing in mind that the budgets are not static, but are dynamic.

The workshop report & recommendations



PROCEDURES

A broad roadmap for GCOS-WCRP joint work coordinated by a joint GCOS-WCRP working group that will liaise with their respective expert groups (including the Global Carbon Project) and scientific communities.

- 1. Formulate the global integrals corresponding to the 12 continuity equations,** encompassing land, ocean, cryosphere, atmosphere and the 3 distinct cycles + a rigorous quantification of the uncertainties + systematic and random errors.
- 2. Describe in detail the procedures for submitting estimates of the global integrals** and the minimum requirements. These could be the first elements of a good practice guide.
- 3. To reduce systematic errors** GCOS/WCRP will provide a reference ocean/land/cryosphere mask. All integrals will need to be calculated using a **reference ocean/land/cryosphere mask and averaged over the annual cycle.**
- 4. Write a technical guide to define a common framework for how best to calculate the integral quantities and document the various types of errors.** Document known pitfalls. This should be part of a best practices guide.
- 5. Building on existing community activities, establish a scientific community (including early career scientists and experts from the Global South)** to evaluate the global integrals needed for closing the continuity equations + identifying observational gaps & process understanding is needed.
6. Seek funding opportunities

$$\partial\rho/\partial t = \iint F_p dS + Q_p, F_p \text{ is the flux of } p \text{ (the conservative quantity), } Q_p \text{ the sink and source terms}$$

Possible way forward (continued)

$$\text{ENERGY CYCLE} \int C_p \frac{\partial T_x}{\partial t} = \text{fluxes terms}$$

$$\text{WATER CYCLE} \int \frac{\partial W}{\partial t} = \text{fluxes terms}$$

$$\text{CARBON CYCLE} \int \frac{\partial C'_x}{\partial t} = \text{fluxes terms}$$

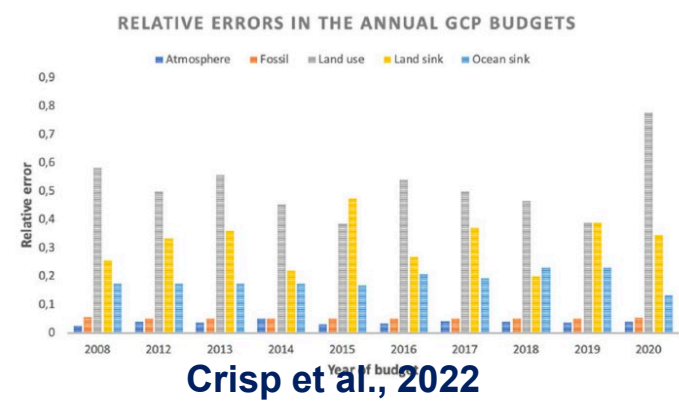
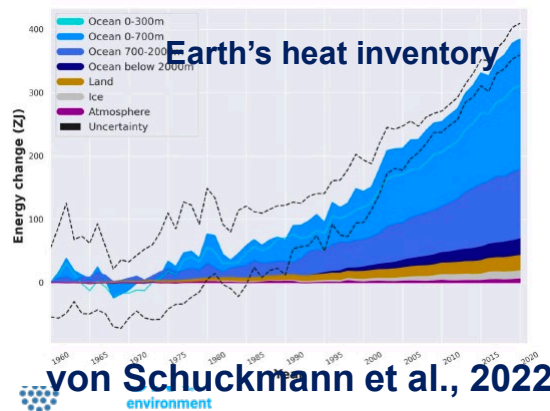
ACTIONS:

- **Bring the communities together around each term**
- **Production of agreed-upon time series for each**, based on the scientific decisions made by each community and compiled in a publication.
- Then **put all terms together for each cycle** with documented uncertainties
- **Assess how regular updates can be published for each of the time series** (e.g., the DKRZ data centre, IPCC data centre; and/or a dedicated dashboard, etc.).
- **Funding opportunities:** Existing initiatives + funding sought by the community: should we also programmatically look for funding schemes/collaborations with the IPCC fund
- **Bring in early career scientists** in particular from the global south.

Progress as of July 2024

- 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.
- ✓ **Steering Committee recommendation:** 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 – First step: Sabrina will follow up with Jan Polcher, lead author of the paper.

To monitor, understand, model and predict the Earth system cycles & their feedbacks, systematic and long-term measurements are fundamental, and need to be sustained and enhanced in the future to support decisions on climate change action and sustainable development



✓ **Steering Committee Rec.**
The scientific community will continue the regular assessment of earth cycles from observations, in line with action B10.

Thank you



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