

Report to the WCRP Joint Scientific Committee for their 44th Session, 8-11 May 2023

Earth System Modelling and Observations (ESMO) Core Project

1. Highlights achieved since JSC-43

- Establishment of the ESMO International Project Office (IPO) at the German Supercomputing Centre (DKRZ) in Hamburg, following an open call. An advertisement for the Director of the IPO should go out soon.
- Several modelling workshops have been organised in 2022:
 - Model Hierarchies workshop (Stanford, CA, USA, 29 August - 1 September 2022): a report has been submitted to Journal of Advances in Modeling Earth Systems, with main recommendations and conclusions from the workshop. Model hierarchies are and will continue to be crucial: their use supports understanding of the relationships between CMIP-class GCMs and regional models, both of which represent different parts of the Earth system's complexity, as well as the relationship between coarse and high-resolution models.
 - WCRP km-scale modeling workshop (Boulder, CO, USA, 3-7 October 2022): this workshop was organised in collaboration with the Digital Earths Lighthouse Activity A report has been published (https://www.wcrp-climate.org/WCRP-publications/2022/WCRP_Report_08-2022_k-scale-report-final.pdf). It brought together researchers from the Earth system communities – land, atmosphere, ice, and ocean – and researchers working on different scales – regional to global, weather to climate. The extensive breakout discussions covered critical scientific questions and key technical challenges for k-scale models. Several recommendations have been made related to scientific and technical issues. Process Intercomparison Projects and coordinating meetings of relevant model development groups across spheres will be organised in 2023 and 2024 through both ESMO and DE structures.
 - Analysis of PPEs in Atmospheric Research (APPEAR) workshop (online, 18-19 October 2022): it showcased the wide range of Perturbed Physics Ensembles (PPE)-related research across atmospheric science. The overall aims were to define the range of approaches and applications, to share expertise on how the many challenges of PPE creation and analysis are being tackled, to build a community of researchers, and to scope out the opportunities for further development and collaboration. A report is in preparation, and an outcome has been the organisation of a bi-monthly community seminar series, the first of which will be in May 2022.
 - 6th WGNE workshop on systematic errors in weather and climate models (Reading, UK, 31 October – 04 November 2022): the workshop brought together a wide range of experts on simulating the Earth system and associated disciplines to advance the understanding of the root causes of systematic model errors across time scales. The workshop was organized around seven themes: errors in the representation of **Clouds and precipitation**; coupled **Atmosphere-ocean-land-cryosphere** system **interactions**; **(Sub-)tropical circulations** including errors in the simulation of tropical-extratropical teleconnections; **Stratosphere-Troposphere interactions**; novel techniques with particular emphasis on **Machine Learning (ML) and Data Assimilation (DA)** to diagnose, measure and resolve systematic errors; **Quantifying uncertainty**; and **Challenges and surprises in simulating the climate system**. Breakout groups discussion focused on answering two questions directed to prioritize systematic errors needed to be addressed and recommendations for moving forward in reducing errors in coupled systems. A meeting report is in preparation and will be submitted to BAMS for publication.

- Joint WGCM-WGNE meeting (Boulder, CO, USA, 8-10 November 2022): a successful joint meeting with multiple collaborations between the two groups particularly in relation to data access and observations, verification/validation of models, and coupling of Earth-System components. WGNE is looking at engagement with many of the new WWRP projects, continued work on systematic errors and model bias, and further connection with CLIVAR/OMDP and GEWEX/GASS. WGCM discussion focused on the new work in model development done by modelling centres around the world, and the planning for CMIP 7 (see details below on “CMIP progress”)
 - WGSIP-24 (Reading, UK, 27-29 March 2023): in this transition period with establishment of WCRP’s new structure, WGSIP is identifying activities of interest that are being developed by other Core Projects and LHAs and seeking points of interaction. WGSIP members could then make the connection depending on areas of interest. It will also develop initial concepts for a set of research foci for 2024-2029, to be decided at WGSIP-25. With the end of the WWRP/WCRP S2S Prediction Project, WGSIP will develop a concrete proposal to present to ESMO for continuing the scientific legacy of S2S within WCRP.
- CMIP progress

The last year has seen considerable change in the CMIP governance prompted by the exit of Jean-François Lamarque, NCAR, as CMIP Panel Chair in September 2022. The WGCM co-chairs proposed Helene Hewitt, Met Office (UK) as the new Chair to the 25th Session of the WGCM in November 2022, which was accepted, and Helene started in the role in January 2023. A new and more robust governance structure, membership and Terms of Reference proposal was approved by the WGCM in March 2023. This included adding a co-chair, in line with other WCRP activities and to provide greater resilience, with John Dunne, NOAA-GFDL (USA), taking on this role after WGCM approval. A review of the WIP governance and Terms of Reference is currently underway but no changes in membership are expected imminently.

Planning for CMIP7 has continued apace under the excellent support and organisation of the CMIP-IPO. This has included the establishment of CMIP7 Task Teams to drive forward the definition of CMIP7 in an open and collaborative manner. An open call to the community for applications was launched in August 2022 and nearly 150 applications were received. Seven task teams are now running: Data Access, Data Citation, Data Request, Forcings, Model Benchmarking, Model Documentation and Strategic Ensemble Design. Each task team has two co-leads, with facilitation support from the IPO, and are tasked to provide recommendations to the CMIP Panel, who are working to deliver the CMIP7 experimental design later this year. The task teams will also provide recommendations to the WIP, who are focused on evolving the CMIP infrastructure to meet the requirements of current and future CMIP data users and providers. The CMIP panel is also working to define the strategic science drivers of CMIP7 which will provide the broad direction for the community engagement.

In addition to facilitating the CMIP Panel, WIP and task teams in their work the IPO, strengthened by the addition of communications and technical expertise in early 2023, has driven enhanced communication and engagement activities for the CMIP community and beyond. This includes a new CMIP website at wcrp-cmip.org, social media channels, virtual community drop-in sessions, forcings and priority variables surveys, and engagement activities at a number of events and conferences including EGU23 ensuring the CMIP7 development process is open and transparent for all. A new “Fresh eyes on CMIP” working group is also being established comprised of scientists, researchers, and practitioners in the early stages of their careers to sit alongside the CMIP7 task teams providing a fresh perspective on CMIP, and further support global South engagement and participation.

2. Planned science initiatives and major events (next 3 to 5 years)

With the establishment of the ESMO-SSG now imminent, a first goal will be to use the approved science strategy to develop an implementation plan including new initiatives and events. Given the ubiquitous nature of modelling and observations we anticipate many of these events to be jointly organised with other core projects and LHA, seeing the role of ESMO to promote and develop modelling and observational capability in support of science goals

- As part of the potential new initiatives, two new observational Working Groups (WGs) are envisioned; one being a WG on Observational Requirements within WCRP (WGOR) and the other one being a WG on Systematic Errors in observational Data (WGSED).
- Currently, there is one reanalysis task team that contributes to ESMO's science plan: the Task Team for Intercomparison of ReAnalyses (TIRA). The plan is to revise the role of and activities under this task team to include all data assimilation aspects and to convert the task team to a WG.
- Events being organized by ESMO
 - ESMO Kick-off meeting bringing together the new SSG, ESMO groups, as well as internal and external partners, late 2023 or early 2024.
 - WCRP 6th International Conference on Reanalysis (November 2024, Tokyo, Japan): a Local Organising Committee has been setup with members from the Japan Meteorological Agency (JMA) and University of Tokyo. Next steps will be the setup of a Scientific Organising Committee so that the discussion of the scientific programme can start.
- Events with ESMO participation
 - WCRP Workshop on Improving climate models and projections using observation (June 12 – 14, 2023, MIT, Cambridge, USA)
 - Berlin Summit on EVE - Earth Virtualization Engines (July 3-7, 2023, Berlin, Germany)

3. Active or planned collaborations with other Core Projects, Lighthouse Activities etc.

- Strong collaboration with Digital Earths Lighthouse activity on the km-scale activity.
- ESMO was presented at various meetings of the other core projects and LHAs as a starting point for potential collaborations. More detailed plans and collaborative activities will be developed based on the expertise of the new SSG.

3a. Requests for the WCRP Academy to support your training activities?

- None at the moment.

4. Partnerships with projects outside WCRP

ESMO aims to act as a modelling and observations focal point for collaborations with external partners such as regional and global research and operational groups, as well as observational coordination bodies.

- External partners of ESMO will include, but are not limited to, the Global Climate Observing System (GCOS); the Global Ocean Observing System (GOOS); the CEOS/CGMS Working Group Climate (WG Climate); the World Weather Research Programme (WWRP) and the Global Atmosphere Watch (GAW) of the World Meteorological Organization (WMO); Future Earth; and the Global Carbon Project.
- ESMO will foster all existing collaborations of its WGs with external partners and will establish currently missing collaborations via specific activities and events.

5. Issues and challenges:

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