![WCRP World Climate Research Programme logo]

45th Session of the WCRP Joint Scientific Committee (JSC)

27-30 May 2024

DEADLINE: 1 May

Instructions

Overarching content/goal: To provide an update on progress made during the last year, as well as your future plans, and highlight any aspects that you want to bring to the attention of the JSC.

- *The length of the report should be kept to around 4 pages if possible (appendices and links can of course be used).*
- *Include the topics indicated below.*
- *Work with the WCRP secretariat responsible for your activity, in the preparation of the report and/or presentation.*
- *Discuss any points you would like to raise with the JSC with your JSC liaison(s), keeping the WCRP Secretariat focal point informed.*

Report to the WCRP Joint Scientific Committee

Earth System Modelling and Observations

1. Highlights for Joint Scientific Committee (including high-level publications, new achievements/products, and capacity building activities – **in particular anything you feel should go into a WCRP annual achievement report or brochure**)

- ESMO SSG was established (June 2023), first in-person meeting in March 2024.
- new ESMO IPO was established (start in November 2023).
- 1st WCRP ESMO meeting (incl. CMIP and WGCM annual meetings) in March 2024 in Hamburg.
- Provision of a harmonised structure of ToRs across ESMO WGs ensuring consistency and transparency.
- Decision was made on establishing a new WG on Observations for Climate Research (WGORC).
- WGCM led a process to develop some high-level papers on climate model development and planning (WMO Bulletin, November 30, 2023) - (1) overarching paper on New Developments in Climate Modelling, (2) paper on Kilometre-Scale Modelling of the Earth System, and (3) paper on Climate Projections.
- Joint ESMO, WGCM & CMIP Panel meeting fostered coordination amongst the groups, including preparations for the 7th Coupled Model Intercomparison Project. WGCM members provided valuable updates on progress being made by Earth System Modelling centres around the world, almost all of whom have confirmed interest and participation in CMIP7.
- WGCM members have been actively engaged in important meetings related to socio-economic scenario development – including meetings organized by non-WCRP entities, like the IPCC.

![WMO, UNESCO, and International Science Council logos]

- successful WGNE session at EGU 2024: Advances in Numerical Earth System Modeling: Identifying Systematic Errors and Charting Innovative Approaches to Enhance Numerical Weather and Climate Prediction.
- WGNE initiated a new pilot project on South America (with JWGFVR and local weather services): Regional Model Verification and enhancing the assessment of Extreme event global and regional forecasts to contribute to the EW4All initiative.
- WGSIP organized a "WCRP hybrid symposium on Frontiers in Subseasonal to Decadal Prediction", hosted by ECMWF in March 2023.
- WGSIP, in conjunction with DCPP and SPARC's Volcanic Response activity, organized a Volcanic Response Readiness Exercise (VolRes-RE) to prepare 8 decadal prediction centres to rapidly revise their forecasts to incorporate estimated volcanic stratospheric aerosol forcings when a climate-altering volcanic eruption occurs, and provide these to the WMO Lead Centre for Annual to Decadal Prediction. Publication has been submitted to BAMS.
- WGSIP's co-chairs co-organized and convened WCRP Open Science Conference sessions on "Climate predictability and prediction" (in person) and "Ocean predictability and prediction on subseasonal to decadal time scales" (poster cluster).
- WGSIP contributed to a BAMS submission "World Meteorological 1 Organization (WMO) Accredited Infrastructure to Support Operational Climate Prediction" describing the WMO infrastructure for producing and communicating subseasonal to decadal forecasts and associated issues and challenges. This was an outcome of the 3rd WMO Workshop on Operational Climate Prediction.
- Systematic Errors in Weather and Climate Models: Challenges and Opportunities in Complex Coupled Modeling Systems, Frassoni et al, 2023, https://doi.org/10.1175/BAMS-D-23-0102.1. Follow-up after the 2022 WGNE workshop.
- DCPP co-organized with LHA-EPESC the WCRP EPESC/DCPP workshop on integrated attribution and prediction, in Exeter, UK in March 20-24, 2023.
- DCPP-organized session on "Seasonal to Decadal Earth System Prediction" at the 2024 AMS meeting (Jan. 29, 2024).
- DCPP successfully advocated for inclusion of DCPP decadal forecasts in CMIP7 FastTrack.
- DCPP members actively participated in a recent Oxford workshop focusing on signal-to-noise issues in climate predictions (Weisheimer et al. 2024).
- DCPP members contributed to recent studies examining the effects of including volcanic aerosol forcing in decadal hindcasts (Wu et al. 2023; Bilbao et al. 2024) and also coordinated experiments to test the readiness of decadal prediction centres to forecast the impact of a volcanic eruption (Merryfield et al. 2024).
- Since 2022, obs4MIPs has been successfully reinvigorated, with a Steering Group benefiting from the assistance of the CMIP-IPO and the WGCM's WIP, and most recently via engagement with ESMO.

2. Planned science initiatives and major events (over next 1- 5 years)

- WGCM will re-energize long standing collaboration with AIMES on carbon cycle modelling.
- WGCM will improve collaboration with CORDEX on downscaling (e.g. boundary condition availability to drive regional models).
- WGCM will improve coordination on constraining measures of climate sensitivity (eg. ECS, TCR, TCRE).
- WGCM will strengthen engagement with high-resolution modelling community via CMIP and the LHA on Digital Earths.
- WGCM will establish a 'task team' to foster better communication between modelling centres on technical issues related to model development.
- WGCM will seek ways to improve model documentation to support in-depth analysis and comparison of results from different models.
- WGCM will initiate discussion on ways to optimize emerging work on the use of AI/ML in climate and Earth System modelling.

- WGNE - South American Regional Model Verification Pilot project: Enhancing the assessment of regional forecasts to contribute to the EW4All initiative.
- WGNE will evaluate aerosols impacts on Numerical Weather Prediction.
- WGNE will contributing to ocean initialisation project/paper.
- WGNE will contribute to the following MIPs: Model Uncertainty — Model Intercomparison Project (MUMIP) & MJO SST sensitivity Model Intercomparison Project (MSMIP).
- WGNE will evaluate physics-dynamics coupling and energy budgets in Earth System models.
- WGNE will contribute to assessment of ML/AI weather forecasts.
- WGNE will contribute to global model comparison: DIMOSIC (different models – same initial conditions).
- WGNE40 will take place in 2025 - 40th WGNE session.
- 7th WGNE Systematic Errors Workshop is planned for 2026 in South America.
- WGSIP has been undertaking 5-year cycles of science initiatives to facilitate coordinated research and associated publications, targeted sessions and presentations in conferences and workshops, etc. The new cycle (2024-2029) of research focuses to be developed at WGSIP-25 (November 2024) will likely include a focus on application of ML to subseasonal to decadal prediction.
- WGSIP has led the formulation of a proposed S2S panel under ESMO that will provide capacity within WCRP for continuing scientific aspects of the recently concluded WWRP/WCRP S2S Project.
- WGSIP plans to organise an international conference in Fall 2026 (tentative), along the lines of the International Conferences on Subseasonal to Decadal Prediction (Boulder, 20218).
- WGSIP plans to organise a regionally-oriented School on Climate System Prediction and Regional Climate Information for Early Career Scientists, tentatively in Buenos Aires in early 2026, along the lines of previous events such as West Africa in 2016 (Dakar) and Northern Eurasia in 2019 (Moscow).
- DCPP seeks to formalize international coordination on initialised climate predictions through the agreement of the CMIP7 protocol. New foci include multi-annual and high-resolution prediction through a redesign of DCPP-A to establish a minimal DCPP-DECK set of hindcasts that can be optionally expanded to focus on either multiannual or decadal timescales.
- DCPP will advocate for incorporation of emissions-driven carbon cycle prediction metrics in WMO-ADCU.
- DCPP plans to (co-)organize a large workshop on seasonal to decadal prediction in 2025 or 2026.
- WGORC strategy meeting will be planned in 2025 to bring relevant actors together in-person to set the foundation of WGORC, refine its scope and objectives, and prioritise the activities.

3. Planned Products, high-level assessments or other key outputs/publications

- WGCM/WGNE will begin scoping a white paper on potential areas in which more systematic and institutionalized updates to forcing datasets, scenarios, data archives and other aspects of CMIP could be undertaken.
- 2024 - Research Board WMO - Digital Strategy Concept Note, Wedi, Bouchet, et al. 2024, in review.
- 2024 - Artificial Intelligence and Machine Learning for Weather and Climate, Pappenberger, Wedi, et al, 2024, contribution to the WMO United in Science 2024 report.
- WGNE Blue Book issue 2024.
- 2024-2025 - Systematic errors in weather and climate models survey related to the six hazards identified by INFCOM that were most frequently identified as "priority hazards" for 30 countries.
- 2027 - Systematic Errors in Weather and Climate Models Review Paper in BAMS - Documenting the key achievements of the workshop to be held in 2026 in South America.
- WGSIP paper: "Five challenges for subseasonal to decadal prediction research" (under revision).
- DCPP will produce a CMIP7 protocol paper outlining new coordinated experiments, including new DCPP-C experiments.
- obs4MIPs plans to include additional products to advance modeling science such as higher spatio-temporal resolution and other data sets that provide process-relevant information, regional scale datasets, and others that may require more complex analysis for model evaluation.

4. Linkages with other Core Projects, Lighthouse Activities, Academy etc.

- WGCM will continue/enhance its engagement with, many of the LHAs and Core Projects.
- WGNE collaborates with Digital Earth LHA through:
(1) Model Uncertainty — Model Intercomparison Project (MUMIP)
(2) Assessment of extreme event global and regional forecasts in South America
(3) Evaluating physics-dynamics coupling and energy budgets in Earth System models
(4) WGNE representation in Digital Earth Steering Committee
- Close collaboration WGNE-GEWEX: GASS and GLASS are represented in WGNE as ex-officio, and MUMIP includes GASS members.
- Potential for collaboration with CLIVAR as ex-officio in WGNE (tbd with ESMO).
- WGNE-CliC collaboration would be beneficial to advance the accurate representation of physical processes related to the cryosphere to reduce systematic errors in models (Frassoni et al. 2023).
- WGSIP's activities could contribute to the objectives of EPESC, especially WG2 - this will be emphasised at WGSIP-25 annual meeting in Nov 2024.
- WGSIP members participated in the EPESC/DCPP workshop in 2023.
- WGSIP will engage with the WCRP Academy when planning its capacity-building event in 2026.
- WGSIP will be seeking to identify and strengthen connections on prediction-relevant activities across CPs ahead of its November 2024 meeting.
- Obs4MIPs delivers products advising on technical aspects regarding their suitability for model evaluation while leaving data quality assessments to GDAP.
- with the establishment of WGORC, we aim to target the following WCRP groups: APARC (S-RIP, TUNER, SNAP), GEWEX (GDAP, GHP, GLASS, GASS), CLIVAR (OMDP, GSOP), EPESC, Digital Earth.

5. Partnerships with entities outside of WCRP

- WGCM and its CMIP Panel have strong relationships with the Integrated Assessment Modelling Consortium, with the Intergovernmental Panel on Climate Change (particularly WG1), and are seeking to re-energize their relationship with AIMES (within Future Earth).
- WGNE has links to WWRP through: JWGVFR, S2S, High Impact Weather project (HIWeather), S2S (WGNE S2S Aerosol project), potentially SAGE.
- WGNE has links with GAW being represented in its Scientific Advisory Group on Applications, and through the WGNE S2S Aerosol project.
- WGSIP has strong connection with WMO:
(1) joint activities with the WMO Expert Team on Operational Climate Prediction System (ET-OCPS) on matters of Research-to-Operations and Operations-to-Research coordination.
(2) extensive representation of WMO Subseasonal, Long-Range (seasonal), and Annual-to-Decadal Lead Centres and Global Producing Centres among WGSIP's membership.
- DCPP has links to the WMO lead centre activity on annual to decadal climate predictions (LC-ADCP), which has taken over the coordination and dissemination of operational decadal predictions.
- with the establishment of WGORC, we aim to target the following external (non-WCRP) initiatives: Global Carbon Project, WGClimate, GCOS, GOOS, WMO (GAW), CGMS Working Groups, CEOS Virtual Constellation, Reanalyses.org, Destination Earth, EVE, CCMI.

6. Suggestions, issues or challenges, for example:

- WGCM and the CMIP Panel will be presenting the socioeconomic scenarios proposed for use in CMIP7 to the JSC. These scenarios are the result of more than a year of consultations with a very broad community, including two large international expert meetings.
- WGNE would like to propose to connect with Academy LHA, WGCM, WGSIP and DELHA in order to promote career development of ECS and provide opportunities to improve scientific and technical skills in high-res model development, especially in developing and under-developed countries.

- In 2018 the 2nd WCRP Summer School on Climate model Development (http://eventos.cptec.inpe.br/wcrpsummerschool/) was held in Brazil. We propose to re-establish this series under the auspices of WGNE, WGCM, WGSIP and DELHA.
- Intercomparison between NWP models and Machine-Learning models, with the goal to improve NWP: DIMOSIC is considering tackle the activity in a second phase of their activities.
- Suggestion for a Global Fellowship focus for a 2025 call:
  ECMWF and WMO have implemented a scheme allowing forecasters and researchers from developing countries to spend up to one year at ECMWF. Unfortunately, this opportunity is restricted to direct employees of official national meteorological services, excluding researchers from other institutions. To address this issue, a global fellowship program could be established. This program would offer placements to researchers from developing and underdeveloped countries at recognized institutions such as ECMWF, DWD, MPI, NCAR, NCEP, UKMet, and ECCC, primarily in Europe and North America.
- In response to the rapid emergence of potentially powerful applications of machine learning to climate data, modelling, prediction/projection and process understanding, ESMO could facilitate science initiatives, workshops, capacity building events and publications that help to integrate these emerging methods with existing streams of research and development.
- Earth system reanalysis, potentially leveraging machine learning, is an especially important topic in the context of ESMO due to its spanning of observation and modelling, and importance for model evaluation, prediction initialization and verification, and climate process understanding.
- The DCPP remit has become a bit murky with the introduction of LHA-EPESC and WMO LC-ADCP, which both overlap with DCPP's remit on understanding decadal prediction skill and mechanisms of variability (EPESC) and on forecasts (LC-ADCP).
- After discussions with ESMO and WGSIP co-chairs we agree that the remit of DCPP could be refreshed to take a more coordinating and strategic role that would support the WMO-ADCP and EPESC activities. However, we feel that the current priority is the development and completion of the CMIP7 protocol. Such a refresh of the future scope of DCPP should probably be led by, or in partnership with, the next DCPP co-chairs.
- Links to the WMO LC-ADCP need to be developed further as the CMIP7 protocol developed so that the DCPP CMIP7 protocol continues to form the basis of future operational activities.
- DCPP used to have strong links with CLIVAR, but these have dwindled since the completion of CMIP6 DCPP-C studies focused on AMV pacemaker studies. There are potential clear links with all CLIVAR regional panels, and DCPP should develop these links further in future.