47th Session of the World Climate Research Programme

Joint Scientific Committee

Earth System Modelling & Observations

ESMO core project

Chairs: Susann Tegtmeier & Baylor Fox-Kemper

WCRP World Climate Research Programme

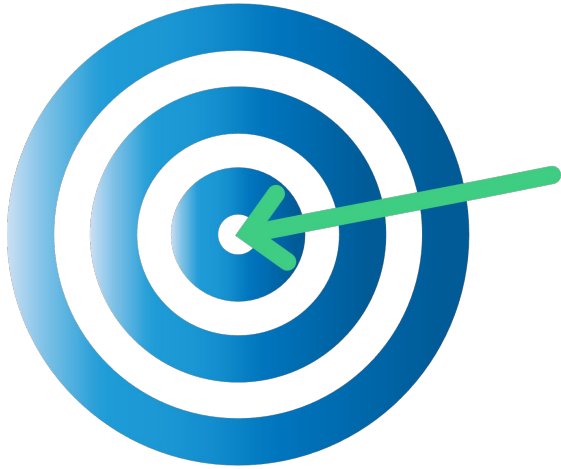
WORLD METEOROLOGICAL ORGANIZATION

unesco Intergovernmental Oceanographic Commission

International Science Council

What is ESMO?

One of the 6 WCRP Core projects

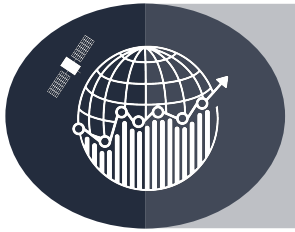


Mission

Coordinate, advance and facilitate modelling, data assimilation and observational activities within WCRP.

Address critical gaps in our ability to monitor, predict, and forecast the climate across different time and spatial scales.

Our Objectives



Advancing predictions and projections of the Earth System

on time scales from weeks to centuries and furthering model-observation integrated frameworks

Improving monitoring, understanding and attribution of climate system changes and impacts

with robust uncertainty quantification through the synthetic use of models and observations

Advancing and harnessing emerging technologies

in modelling and observations

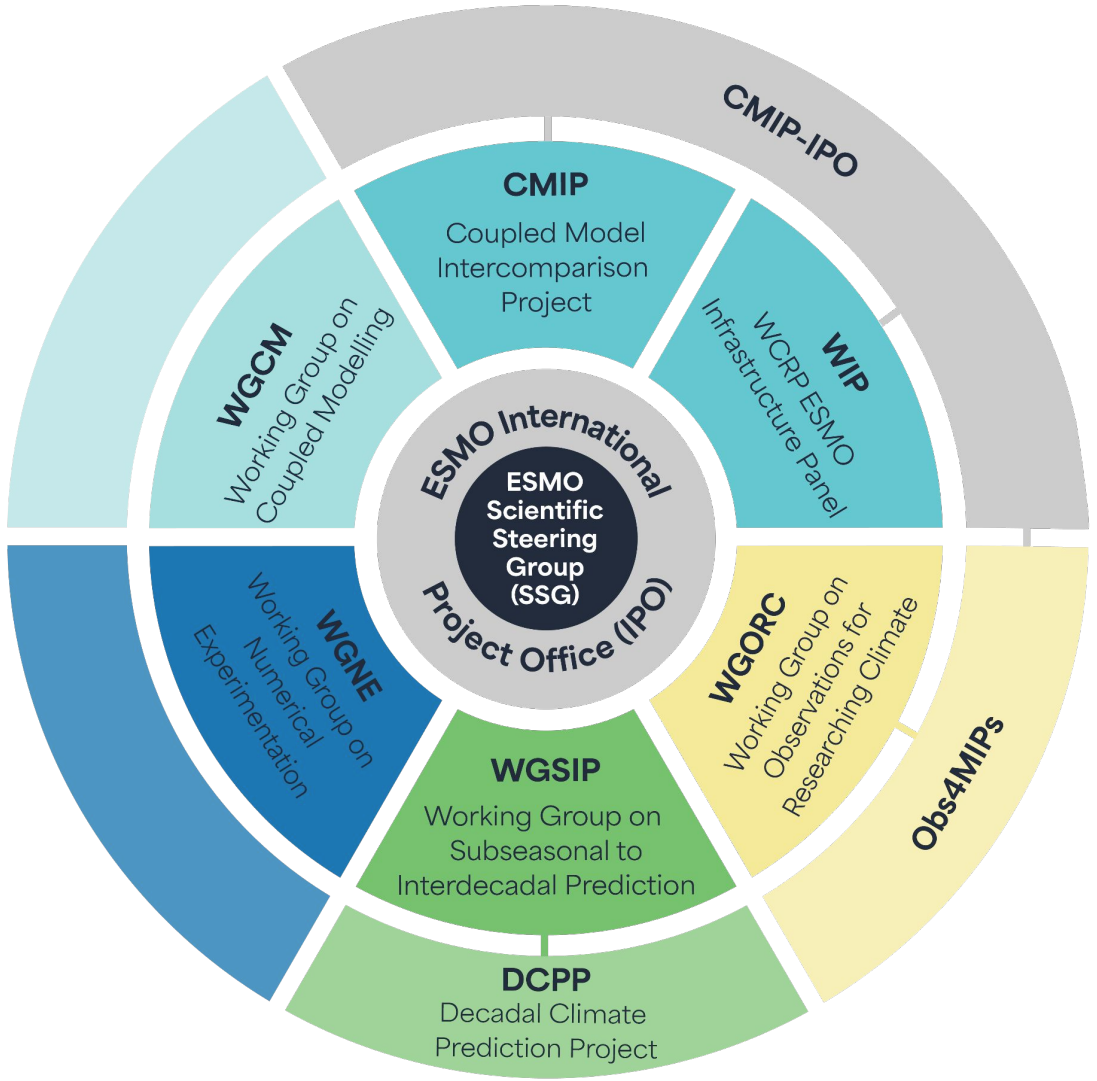
ESMO Structure

WORKING GROUPS

- Working Group on Coupled Modelling (WGCM) => RELAUNCH!
- Working Group on Subseasonal to Interdecadal Prediction (WGSIP)
- Working Group on Numerical Experimentation (WGNE)
- Working Group on Observations for Researching Climate (WGORC) => NEW!

PROJECTS & PANELS

- Coupled Model Intercomparison Project (CMIP)
- WCRP ESMO Infrastructure Panel (WIP)
- Observations for Model Intercomparisons Project (Obs4MIPs)
- Decadal Climate Prediction Project (DCPP)
- Subseasonal to seasonal Panel (S2SP)=> NEW!



Key highlights & Future plans - ESMO wide

Creation of a **Regional Reanalysis Task Team**

- Objective: Establish a coordinated evaluation of regional reanalyses
- Expected Outcomes: Deliver a joint overview paper, develop practical evaluation guidelines, and provide clear documentation of strengths, limitations, and uncertainties.

Emulators Task Team up and running

- Working on a taxonomy review paper
- coordinate a workshop on Climate Emulators in 2027

Rapid Evaluation Framework governance

- To be established as a Panel under ESMO (transition from MBTT to ESMO during 2026)

Key highlights - ESMO wide

Creation of a **Regional Reanalysis Task Team**

- Objective: Establish a coordinated evaluation of regional reanalyses
- Expected Outcomes: Deliver a joint overview paper, develop practical evaluation guidelines, and provide clear documentation of strengths, limitations, and uncertainties.

Emulators Task Team up and running

- Working on a taxonomy review paper
- Workshop in planning for 2027

Rapid Evaluation Framework governance

- To be established as a Panel under ESMO (transition from MBTT to ESMO during 2026)

Key highlights
Working Group on Numerical Experimentation

- WGNE 40 anniversary at CMA in Beijing!
- South America verification pilot project (with JWGFVR). South America will become an official WMO verification region.
  - Publication: Ramon de Elia et al., Verification of global and regional NWP models over South America, 2025
  - WMO training course: model evaluation of WIPPS hazards (Brazil, 2025)
- Ongoing WGNE Projects
  - Weather Prediction Model Intercomparison Project (WP-MIP):
    - Compare ML, hybrid and physical models
    - Support WIPPS in providing guidance on use of ML models by operational centres.
  - EW4ALL survey on research at operational centres for improving forecasts of high impact weather.
- WGNE “Blue Book” - annual collection of articles on recent model developments.

Future plans and priorities
Working Group on Numerical Experimentation

- Planning for Systematic Errors Workshop (Feb 2027, Pune, India)

Systematic Errors Workshop

When

15th-19th February 2027

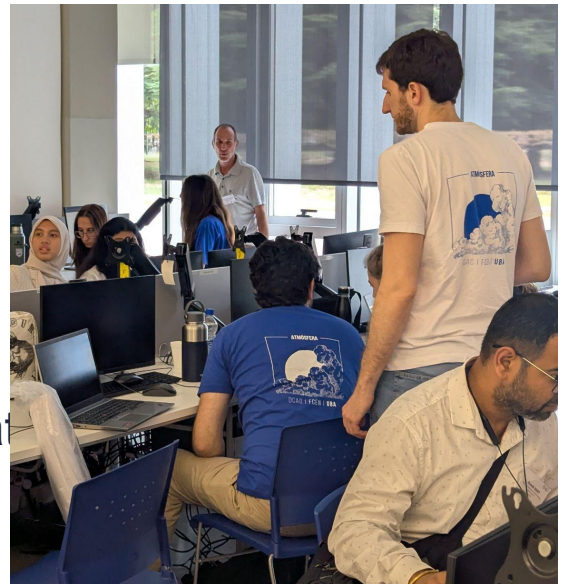
Where

IITM, Pune, India

- Blue Book 2026 - call for contributions out
- Contribution from WP-MIP to WIPPS strategy

Key highlights
Working Group on Subseasonal to Interdecadal Prediction

- School on Climate Prediction Across Timescales (Buenos Aires, Feb 2026), with emphasis on climate services across timescales
- Initiation of **S2SP Panel**. Co-chairs: Yuhei Takaya; Yaga Richter
- Launched an S2S ML webinar series: Exploring data-driven climate prediction from subseasonal to interdecadal timescales
- **Collaboration with ET-OCPS (**Expert Team on Operational Climate Prediction System**)**: production of short, practical guidance docs to support operational climat prediction (key for co-development of climate services)
- **WMO Guidance document on intra-seasonal operational predictions** (to be published soon)



- More than half of students from Global South!
- Half of the students received full support!

WCRP World Climate Research Programme

WORLD METEOROLOGICAL ORGANIZATION

unesco Intergovernmental Oceanographic Commission

International Science Council

Future plans and priorities
Working Group on Subseasonal to Interdecadal Prediction

- Launch of S2S panel
- S2S2D conference (Reading, Sept 2026)

- **40 grants to support attendance from ECRs and GS practitioners!**

- Continued engagement with ET-OCPS on guidance documents
- Research foci:
  - ML models for sub-seasonal and seasonal prediction;
  - Sources of predictability;
  - Ensemble information across timescales (including user-demand-driven focus)

Key highlights
Decadal Climate Prediction Project

- Task team created to focus the development of DCPP-C (mechanisms experiments). Lead Pablo Ortega (BSC).

- Main DCPP Protocol for CMIP7 finalized with key changes:
  - Cheaper Tier 1 with choice of multi-annual or decadal focus in DCPP-A,-B
  - New ‘dynamical pacemaker’ coupled mechanism experiments in DCPP-C

- DCPP co-organized workshop on “*Understanding and Predicting Annual to Multi-Decadal Climate Variations”* in Bologna in November 2025 including in-person panel meeting.

WCRP World Climate Research Programme

unesco Intergovernmental Oceanographic Commission

International Science Council

Future plans and priorities
Decadal Climate Prediction Project

Near:

- Complete DCPP-C test experiments & finalize all parts of protocol
- Publish DCPP protocol (online & paper submission)
- Contribute to S2S2D meeting in September 2026 (& convene panel)

Longer:

- DCPP Panel renewal (including leadership) - a chance to reasses DCPP's priorities going forward
- Analysis and publication of early DCPP/CMIP7 results, including coordinated experiments that fed into DCPP-C protocol

Key highlights
Working Group on Coupled Modelling

- New working group members recruited - first in person meeting with new members held in March in Kyoto

- New Forum “Frontiers in Earth System Modelling” launched at CMIP2026 community workshop in March in Kyoto - inclusive platform for modelling centres to discuss model development and related activities

WCRP
World Climate Research Programme

WORLD METEOROLOGICAL ORGANIZATION

unesco
Intergovernmental Oceanographic Commission

International Science Council

Future plans and priorities
Working Group on Coupled Modelling

- Continue Forum with annual (?) meetings in hybrid format
- Organise a workshop on calibration and tuning in 2027

Other ideas that emerged from the forum:

- Potential white paper on tuning and spin-up (engagement with CLIVAR?)
- Development of evaluation framework and guidance for AI use
- Establish community platform on scientific computing

Key highlights
Working Group on Observation for Researching Climate

- Kick off meeting in person in Reading in December 2025
- Priority topics for scoping were decided and WG members tasked with carrying our the scoping activity.
- WGORC presented at:
  - WGClimate meeting
  - JPI-Climate - Equinox Stocktake meeting

WCRP World Climate Research Programme

unesco Intergovernmental Oceanographic Commission

International Science Council

Future plans and priorities
Working Group on Observation for Researching Climate

- Finalise the scoping activities and set up panels and task teams
- Engage with key stakeholders
- Contribute to GCOS Implementation Plan
- Coordinate a workshop on observation uncertainties (for 2027/2028)

Key highlights obs4MIPs

- New members and co-chair!
- Updated obs4MIPs data specifications (v2.6.1) include guidelines to characterize uncertainty (onging community discussion) and description of anomaly time series.
- Easier-to-navigate data submission and processing workflows, improved version control and end-to-end transparency.
- ~15 datasets processed/published to ESGF since last report including some high resolution precipitation (3hr, ~10km) and monthly mean state fields from atmospheric reanalyses.

Future plans and priorities obs4MIPs

- Continuing efforts to streamline inclusion process as new products are added.
- Additional uncertainty examples, process-oriented (exploratory) datasets (including offline simulators), and further inclusion of in situ datasets.
- Work with WIP, CMIP CV and QA/QC TTs for technical alignment with CMIP7.

Suggestions, issues or challenges

ESMO-wide

- current discussion with CMIP on the governance of **model forcing**

DCPP

- ESMO support has been really great during this past year+, helping us get almost to the finish line on the DCPP protocol.

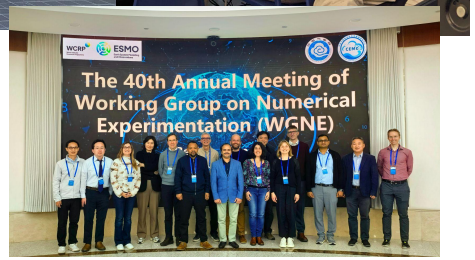
WGORC

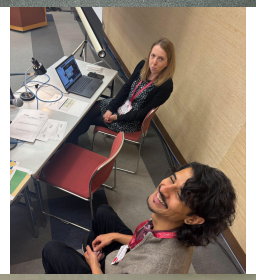
- WGORC would welcome recommendations on other key stakeholders of observations and modeling activities within WCRP to engage with

obs4MIPs

- Closer, ongoing coordination between obs4MIPs SP and REF.
- Collaboration with GDAP and other dataset assessment efforts in support of efforts to quantify uncertainties in products submitted to obs4MIPs.

Humans of ESMO





WCRP
World Climate Research Programme

WORLD METEOROLOGICAL ORGANIZATION

unesco
Intergovernmental Oceanographic Commission

International Science Council

Thank You

WCRP
World Climate
Research Programme

www.wcrp-climate.org

WORLD
METEOROLOGICAL
ORGANIZATION

unesco
Intergovernmental
Oceanographic
Commission

International
Science Council

47th Session of the World Climate Research Programme

Joint Scientific Committee

additional slides WGNE

WCRP World Climate Research Programme

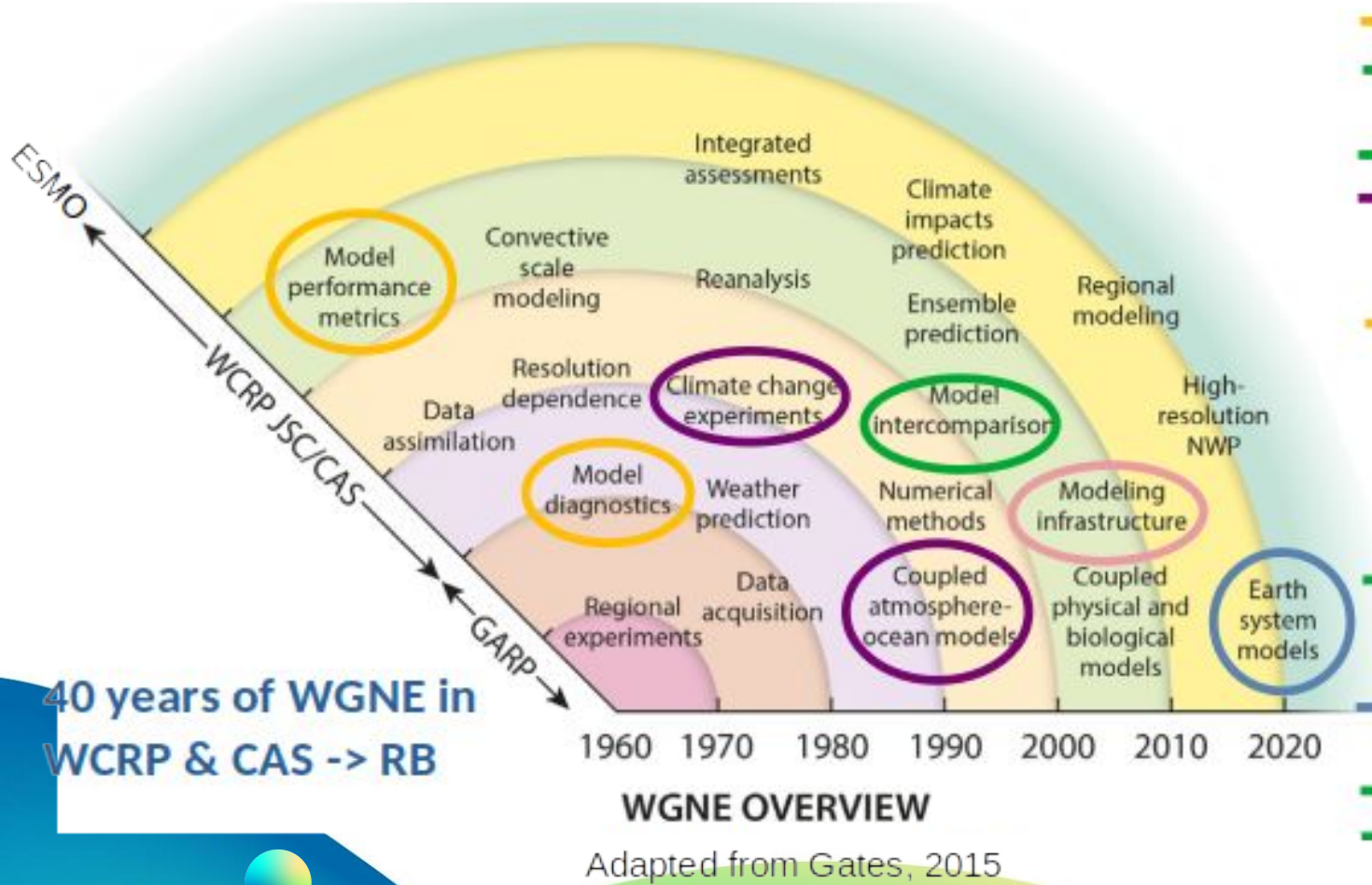
WORLD METEOROLOGICAL ORGANIZATION

unesco Intergovernmental Oceanographic Commission

International Science Council

WGNE was stablished in 1968

"The main objectives for this working group were to set up a programme of numerical experiments and to coordinate the distribution of the work among the cooperating research groups." GARP, 1970



WGNE OVERVIEW

Adapted from Gates, 2015

- 1980 - WCRP established by WMO/ICSU / JSC (Joint Scientific Committee) established for WCRP
- 1985 – WGNE re-establishment for WCRP JSC and CAS
- 1990 - AMIP (Atmospheric Model Intercomparison Project) established by PCMDI and WGNE
- 1991 - TC Intercomparison project
- 1996 - WGCM established by CLIVAR and WGNE; CMIP established by WGCM
- 1997 - WWRP established in cooperation with GEWEX
- 2007 - 3rd WGNE Workshop on Systematic Errors in Climate and NWP Models, San Francisco
- 2008 - GAW established in WWRP
- 2010 - CMMP (Climate Model Metrics Panel) established by WGNE/WGCM
- → WGNE Table overview
- 2017 - 25y Implementation of TC Fct verification
- 2019 - WGNE SE Survey
- 2019/2020 - WMO Constituent Bodies Reform
- 2020 - WGNE evolution - ESM focus
- → WGNE Recommendations for HPC/Exascale
- 2022 - DIMOSIC
- 2024 – WP-MIP

40 years of WGNE in WCRP & CAS -> RB

WCRP World Climate Research Programme

WORLD METEOROLOGICAL ORGANIZATION

unesco Intergovernmental Oceanographic Commission

International Science Council

Research Board – established by WMO Congress in 2019 (Res. 8, Cg. 18)

- Act as coordination body → WMO strategic aims/decisions into research priorities

WMO recognized the need for stronger linkage between research (weather, climate, water, environment) and operational services R2O

- Ensures coordination across WCRP, WWRP and GAW programmes

WGNE supports the goals the RB sets → WGNE's strategic role as a connector between scientific disciplines and operational communities

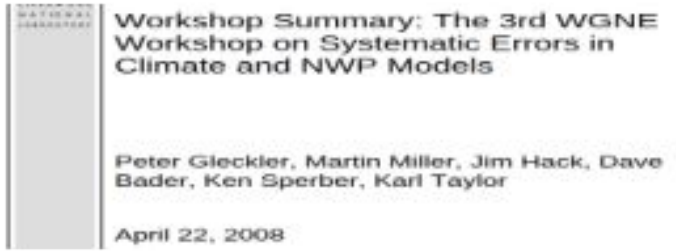
Active projects

- The MJO SST sensitivity Model Intercomparison Project (MSMIP)
- Model Uncertainty — Model Intercomparison Project (MUMIP)
- Ocean initialisation Project
- Evaluating the Impact of Aerosols on NWP and S2S
- The Surface Flux Intercomparison project
- Global model comparison: DIMOSIC Different models – same initial conditions
- South American Regional Model Verification Pilot project: Enhancing the assessment of regional forecasts to contribute to the EW4All initiative – jointly with JWGFVR

Previous projects

- The Drag Project
- The Grey Zone project
- Intercomparison of precipitation forecasts by operational global models
- To cite a few …

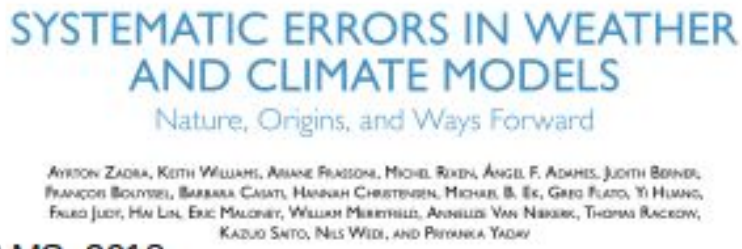
Workshop on Systematic Errors in Weather and Climate Models



Workshop Summary: The 3rd WGNE Workshop on Systematic Errors in Climate and NWP Models

Peter Gleckler, Martin Miller, Jim Hack, Dave Bader, Ken Sperber, Karl Taylor

April 22, 2008



SYSTEMATIC ERRORS IN WEATHER AND CLIMATE MODELS

Nature, Origins, and Ways Forward

Ayrton Zadra, Keith Williams, Ariane Frassoni, Michel Rixen, Ángel F. Adames, Judith Berner, François Bouyssel, Barbara Casati, Hannah Christensen, Michael B. Ek, Greg Flato, Yi Huang, Falko Judt, Hai Lin, Eric Maloney, William Merryfield, Annelize Van Niekerk, Thomas Rackow, Kazuo Saito, Nils Wedi, and Priyanka Yadav

BAMS, 2018

Systematic Errors in Weather and Climate Models

Challenges and Opportunities in Complex Coupled Modeling Systems

Ariane Frassoni, Carolyn Reynolds, Nils Wedi, Zied Ben Bouallègue, Antonio Caetano Vaz Caltabiano, Barbara Casati, Jonathan A. Christophersen, Caio A. S. Coelho, Chiara De Falco, James D. Doyle, Laís G. Fernandes, Richard Forbes, Matthew A. Janiga, Daniel Klocke, Linus Magnusson, Ron McTaggart-Cowan, Morteza Pakdaman, Stephanie S. Rushley, Anne Verhoef, Fanglin Yang, and Günther Zängl

BAMS, 2023

Errors in low-level clouds over the sub-tropical oceans responsible for SE	Improved treatments of cloud microphysics and boundary layer processes -> to reduce uncertainties in low-cloud radiative feedbacks; may have a coupled component/feedback	The southeast Pacific Ocean stratus cloud deck is still misrepresented in kilometer-scale simulations despite improvements in parameterized and explicit shallow convection
Diurnal cycle of near sfc temperature poorly simulated	Outstanding errors in the modeling of surface fluxes; errors in the representation of the diurnal cycle of surface temperature	New techniques (DA/ML) has been used to optimize near-surface parameters (e.g., 2-m temperature) by adjusting uncertain parameters in land surface schemes
Manpower limitation - inability of the field to attract and keep young talent	Foster developments toward kilometer-scale global weather and climate simulations Promote optimal use of future high-performance computing platforms	Promote ECS career development; provide opportunities to improve scientific and technical skills; actively involve ECS in shaping the future of ES modeling

47th Session of the World Climate Research Programme

Joint Scientific Committee

additional slides obs4MIPs

WCRP World Climate Research Programme

WORLD METEOROLOGICAL ORGANIZATION

unesco Intergovernmental Oceanographic Commission

International Science Council

Additional slides and information

- *ESGF (ESGF-NG) reporting of dataset downloads across all nodes is an important metric that we are asked to provide to dataset contributors.*

- *Inclusion of reanalysis is limited to those fields that represent our best estimates (and are routinely used in model evaluation); obs4MIPs SP is happy to coordinate with any team striving to deliver a larger collection of reanalysis fields.*