

46th Session of the WCRP Joint Scientific Committee (JSC)

Date: 12-16 May 2025

DEADLINE: 15 Feb 2025 (extended to 14 March 2025)

Instructions

Overarching content/goal: To provide an update on progress made during the last year, and to identify issues etc. in advance of the JSC meeting. This will allow more discussion and less reporting at the JSC meeting itself. The outcomes from this report will also feed into a highlights brochure planned for the first quarter of the year. The Secretariat will arrange calls prior to the JSC meeting with JSC liaisons (as appropriate) to discuss the input and any issues to the JSC meeting itself. Please work with the WCRP secretariat responsible for your activity, in the preparation of the report.

Please keep the information as focused as possible and provide links to websites where more details can be accessed.

Update report for the WCRP Joint Scientific Committee

Explaining and Predicting Earth System Change

1. High-level publications (in particular strategic publications/assessments that are direct outcomes of your activity)

- **Cross-cutting EPESC publications:**
 - Minobe, Shoshiro, Erik Behrens, Kirsten L. Findell, Norman G. Loeb, Benoit Meyssignac, and Rowan Sutton, 2025. Global and Regional Drivers for Exceptional Climate Extremes in 2023-2024: Beyond the New Normal. *npj Climate and Atmospheric Science*. In press.
- **Publications most relevant to WG1 on Tighter Integration Between Models and Observations:**
 - Hakuba, M.Z., Fourest, S., Boyer, T. et al. (2024) Trends and Variability in Earth's Energy Imbalance and Ocean Heat Uptake Since 2005. *Surv Geophys*. <https://doi.org/10.1007/s10712-024-09849-5>
 - Loeb, N.G., Ham, S.H., Allan, R.P. et al. (2024) Observational Assessment of Changes in Earth's Energy Imbalance Since 2000. *Surv Geophys*. <https://doi.org/10.1007/s10712-024-09838-8>
 - Findell, Kirsten L., Zun Yin, Eunkyo Seo, Paul A. Dirmeyer, Nathan P. Arnold, Nathaniel Chaney, Megan D. Fowler, Meng Huang, David M. Lawrence, Po-Lun Ma, and Joseph A. Santanello Jr., 2024: Accurate assessment of land-atmosphere coupling in climate models requires high-frequency data output. *Geoscientific Model Development*, 17(4), DOI:10.5194/gmd-17-1869-20241869–1883.
 - Pléziat, Étienne, Robert J.H. Dunn, Markus G. Donat, and Christopher Kadow, 2024. Artificial intelligence reveals past climate extremes by reconstructing historical records. *Nature Communications*. 15, 9191 (2024). <https://doi.org/10.1038/s41467-024-53464-2>
 - Champagne, O., Zolina, O., Dedieu, J.-P., Wolff, M., & Jacobi, H.-W. (2024). Artificial trends or real changes? Investigating precipitation records in Ny-Ålesund, Svalbard. *J. Hydrometeorol.*, 25(6), 809-825. <https://doi.org/10.1175/JHM-D-23-0182.1>
 - Elias Chereque, A., Kushner, P. J., Mudryk, L., Derksen, C., & Mortimer, C. (2024). A simple snow temperature index model exposes discrepancies between reanalysis snow water equivalent products. *The Cryosphere*, 18(11), 4955–4969. <https://doi.org/10.5194/tc-18-4955-2024>

- Mudryk, L., Mortimer, C., Derksen, C., Elias Chereque, A., & Kushner, P. (2025). Benchmarking of snow water equivalent (SWE) products based on outcomes of the SnowPEX+ Intercomparison Project. *The Cryosphere*, 19(1), 201–218. <https://doi.org/10.5194/tc-19-201-2025>
- **Publications most relevant to WG2 on Integrated Attribution, Prediction and Projection:**
 - Simpson, I. R., Shaw, T.A., Ceppi, P., Clement, A.C., Fischer, E.M., Grise, K.M., Pendergrass, A.G., Screen, J.A., Wills, R.C.J., Woollings, T., Blackport, R., Kang, J.M., and Po-Chedley, S., 2025- Confronting Earth System Model trends with observations. *Science Advances*, 11(10), eadt8035. <https://www.science.org/doi/10.1126/sciadv.adt8035>:
 - Sippel, S., Kent, E.C., Meinshausen, N., Chan, D., Kadow, C., Neukom, R., Fischer, E.M., Humphrey, V., Rohde, R., de Vries, I. and Knutti, R., 2024. Early-twentieth-century cold bias in ocean surface temperature observations. *Nature*, 635(8039), pp.618-624.
 - Materia, Stefano, Lluís Palma García, Chiem van Straaten, Sungmin O, Antonios Mamalakis, Leone Cavicchia, Dim Coumou, Paolo de Luca, Marlene Kretschmer, and Markus Donat, 2024. Artificial intelligence for climate prediction of extremes: State of the art, challenges, and future perspectives. *WIREs Clim Change*. <https://doi.org/10.1002/wcc.914>
 - Markus G Donat, Rashed Mahmood, Pep Cos, Pablo Ortega and Francisco Doblas-Reyes, 2024. Improving the forecast quality of near-term climate projections by constraining internal variability based on decadal predictions and observations. *Environ. Res.: Climate*. DOI 10.1088/2752-5295/ad5463
- **Publications most relevant to WG3 on Assessment of Current and Future Hazards:**
 - **Risbey, J.**, D. Irving, D. Squire, R. Matear, D. Monselesan, M. Pook, N. Ramesh, D. Richardson, and C. Tozer 2023: A large ensemble illustration of how record-shattering heat records can endure. *Env. Res. Climate*, {2} (3), 1--18. doi 10.1088/2752-5295/acd714
 - Irving, D., **J. Risbey**, D. Squire, R. Matear, C. Tozer, D. Monselesan, N. Ramesh, P. Reddy, and M. Freund 2024: A multi-model likelihood analysis of unprecedented extreme rainfall along the east coast of Australia. *Meteorological Applications*, {31} (3), 1--14. <https://doi.org/10.1002/met.2217>
 - Grose, M., P. Hope, **J. Risbey**, C. Mora, S. Perkins-Kirkpatrick, A. King, L. Harrington, S. Rosier, R. Matear, M. Black, D. Stone, D. Frame, R. McKay, H. Ramsay, L. Zhou, and G. Tolhurst 2024: Processes and principles for producing credible climate change attribution messages: lessons from Australia and New Zealand. *Env. Res. Climate*, 10.1088/2752-5295/ad53f5
 - Zhang, W. et al. 2025: A year marked by extreme precipitation and floods: weather and climate extremes in 2024. {Adv. Atmos. Sciences}, 10.1007/s00376-025-4540-4, 1--19
 - Emanuel, K., Alberti, T., Bourdin, S., Camargo, S. J., Faranda, D., Flaounas, M., Gonzalez-Aleman, J. J., Lee, C.-Y., Miglietta, M. M., Pasquero, C., Portal, A., Ramsay, H., and Romero, R.: A Unified Framework for Surface Flux-Driven Cyclones Outside the Tropics, EGUsphere [preprint], <https://doi.org/10.5194/egusphere-2024-3387>, 2024.
 - Johnson Z. F., Chavas D. R., Jones J. J., Chikamoto Y., and H. A. Ramsay, 2025. Impacts of zonal SST gradients on subtropical highs and implications on seasonal tropical cyclone landfall risk, *Journal of Climate* (close to acceptance).
 - Messori, G., Segalini, A., Ramos, A. M. (2024) Climatology and trends in concurrent temperature extremes in the global extratropics. *Earth Sys. Dyn.*, doi: 10.5194/esd-15-1207-2024.
 - Faranda, D., Messori, G., Coppola, E., Alberti, T., Vrac, M., Pons, F.M.E., Yiou, P., Saint Lu, M., Hisi A.N.S., Brockmann, P., Dafis, S., Vautard, R. (2024) ClimaMeter: Contextualising Extreme Weather in a Changing Climate. *Wea. Clim. Dyn.*, doi: 10.5194/wcd-5-959-2024
 - Mömken, J., Pinto, J.G., Messori, G. (2024) Windstorm losses in Europe - What to gain from damage datasets, *Wea. Clim. Extremes*, doi: 10.1016/j.wace.2024.100661

- Olivetti, L., **Messori, G.** (2024) Do data-driven models beat numerical models in forecasting weather extremes? A comparison of IFS HRES, Pangu-Weather, and GraphCast. *Geosci. Mod. Dev.*, doi: 10.5194/gmd-17-7915-2024.
- **WCRP Concept Papers with EPESC contributors:**
 - Sillmann, Jana, Timothy H Raupach, Kirsten L Findell, Markus Donat, Lincoln M. Alves, Lisa Alexander, Leonard Borchert, Pablo Borges de Amorim, Carlo Buontempo, Erich M. Fischer, Christian L. Franzke, Bin Guan, Marjolijn Haasnoot, Ed Hawkins, Daniela Jacob, Roché Mahon, Douglas Maraun, Monica A. Morrison, Benjamin Posch, Alex C. Ruane, Shampa, Tannecia Stephenson, Narelle van der Wel, Zhuo Wang, Xuebin Zhang, and Josipa Županić, December 2024: Climate extremes and risks: links between climate science and decision-making. *Frontiers in Climate*, 6, DOI:10.3389/fclim.2024.1499765.
 - Díaz Leandro B, Gulizia C, Jain S, Langendijk GS, Palanisamy H, Rabanal V, Charlton CS, Dajuma A, Donkor FK, Egbebiyi TS, Kondi Akara G, Jrrar A, Siddiqui MR, Brahim YA, Angnuureng BD, Anschütz A-A, Awo FM, Builes-Jaramillo A, Cobb A, Diallo MA, Er-Retby H, Fotso-Nguemo TC, Gwinneth B, Gudoshava M, Kemgang Ghoms FE, Leyba IM, Lguensat R, Mahon R, Mandal SK, Mumo L, Muzuva M, Nonki RM, Rivera JA, Segnon AC, Tanimoune LI, Zauisomue E-HEI and Siame G (2025) Connecting climate science and society: reflections from early and mid-career researchers at the World Climate Research Programme Open Science Conference 2023. *Front. Clim.* 6:1501216. doi: 10.3389/fclim.2024.1501216
 - Perkins-Kirkpatrick SE, Alexander LV, King AD, Kew SF, Philip SY, Barnes C, Maraun D, Stuart-Smith RF, Jézéquel A, Bevacqua E, Burgess S, Fischer E, Hegerl GC, Kimutai J, Koren G, Lawal KA, Min S-K, New M, Odoulami RC, Patricola CM, Pinto I, Ribes A, Shaw TA, Thiery W, Trewin B, Vautard R, Wehner M and Zscheischler J (2024) Frontiers in attributing climate extremes and associated impacts. *Front. Clim.* 6:1455023. doi: 10.3389/fclim.2024.1455023
 - Shaw TA, Arias PA, Collins M, Coumou D, Diedhiou A, Garfinkel CI, Jain S, Roxy MK, Kretschmer M, Leung LR, Narsey S, Martius O, Seager R, Shepherd TG, Sörensson AA, Stephenson T, Taylor M and Wang L (2024) Regional climate change: consensus, discrepancies, and ways forward. *Front. Clim.* 6:1391634. doi: 10.3389/fclim.2024.1391634

2. Capacity Building/Education and Training Highlights

- EPESC-LEADER Hackathon: An online LESFMIP analysis sprint will be held during the week of 17-20 March for the EPESC and LEADER communities. The goal of this online analysis sprint is to encourage active analysis of the Large Ensemble Single Forcing Model Intercomparison Project (LESFMIP) simulations.
- WG1 EEI activity: We have submitted a revised proposal for workshops on this subject to the ISSI, and will investigate another seminar format workshop at the Kavli Institute for Theoretical Physics at the University of California, Santa Barbara.
- We have continued to host webinars: <https://www.wcrp-climate.org/epesc-webinar>

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

- Synergistic alignment of the new APARC initiative Large Ensembles for Attribution of Dynamically-driven ExtRemes (LEADER) and EPESC WG2 activities is substantial. These activities focus on analysis of the Large Ensemble Single Forcing Model Intercomparison Project (LESFMIP) simulations. We anticipate the work leading to publications examining the scientific feasibility of using the LESFMIP output to provide attribution statements to WMO State of Climate and Global Annual to Decadal Climate Updates. Multiple WG2

workstreams have significant overlap in membership and leadership with associated LEADER activities:

- North Atlantic atmosphere and ocean circulation
- Summer northern hemisphere atmospheric circulation trends
- Tropical circulation variability and trends
- Southern hemisphere circulation trends and extremes
- As a result of this substantial alignment, we are currently planning a [joint EPESC-LEADER science meeting](#) which will take place 15-18 July 2025 at the APEC Climate Center, Busan, Republic of Korea, hosted by June-Yi Lee (WG2).
- EPESC continues to make the case for regular updates to CMIP forcings, which are required for operational attribution. This issue has received substantial attention across the WCRP family in the past year.
 - EPESC participation on the CMIP7 Forcings Team includes Bernd Funke and Stephanie Fiedler (member, WG1), in addition to Doug Smith as a key Stakeholder.
- In addition to the collaborations mentioned above, dialogue between EPESC and many other WCRP activities continues, often through the form of updates at SSG meetings. There are overlapping interests, so communication will continue with the hope of coordinated activities happening in the future. A few areas of common interest are noted below.
 - Common objectives of the RfS Global Extremes Platform and our WG3 with its focus on hazards and extremes.
 - Yukiko Imada is a member of both EPESC WG3 and the GEP Extreme Event Attribution Working Group. She also serves as the RfS-EPESC liaison.
 - Common interests between Safe Landing Climates and EPESC on extremes, hazards, and attribution efforts.
 - Erich Fischer and Kirsten Findell both participated in the SLC workshop on High-Risk Cascading Events in November 2024. Others from EPESC were invited but unable to attend. Continued interactions are expected; papers from the workshop are planned.
 - Common interests between GEWEX's GDAP project assessing Earth's Energy Imbalance and our WG1 activity focused on understanding the trend in EEI.
 - Some overlapping membership between these groups: Benoit Meyssignac leads our EEI trend activity and co-leads the GEWEX EEI Assessment group.
 - EPESC updates provided to WCRP groups:
 - June-Yi Lee was a co-organizer of the Joint WGSIP/WGNE Meeting in November 2024. Scott Osprey provided an EPESC update.
 - Scott Osprey provided an EPESC update at the APARC SSG meeting in October 2024.
 - Kirsten Findell provided an EPESC update at the RfS SSG meeting in September 2024.
- EPESC and Digital Earths LHA coordinating on upcoming seminar on ML practice for A2D timescales and role of observations.
- Wenxia in WG3 has just been put forward as the WG3 ECR rep to GEP Contact Group. That will aid Yukiko in building the links between GEP and EPESC.

4. Partnerships with entities outside of WCRP

- Account access for EPESC and LEADER community members has been secured on JASMIN to facilitate analysis of the LESFMIP data. JASMIN is a UK-based data analysis facility that is part of the UK Research and Innovation's Centre for Environmental Data Analysis (CEDA).
- EPESC WG2 member Shoshiro Minobe serves as an EPESC liaison to PICES, The North Pacific Marine Science Organization, WG49 "Climate Extremes and Coastal Impacts in the Pacific." At the upcoming PICES annual meeting, EPESC is a co-sponsor of a session focused on the concerns of this working group.
- Close collaboration (and overlapping membership) with the EXPECT team. EXPECT is a Horizon Europe research project that aims to address the issue of rapid Earth system change. The project's main goal is to develop the capability for integrated attribution and prediction of changes, including changes in European summer extremes. EXPECT seeks to identify and quantify the factors that drive regional changes over periods ranging from years to decades. In addition, EXPECT seeks to synthesize, extend and better exploit under-utilized observational datasets. These goals are clearly closely aligned with those of three working group activities of EPESC.
- EPESC is a co-sponsor of an upcoming meeting organized by the ASPECT team, planned for November 2025. ASPECT is a Horizon Europe Research and Innovation Action project that will produce and improve seamless climate predictions covering the next 30 years to facilitate adaptation decisions in a range of sectors.

5. Future Science Directions for JSC consideration (e.g., new groups, activities)

- WG1: Plans for a additional activity focusing on seasonal snow and snow process representation in models. Better understanding of trends and variability in snow-related observations (snow extent, density, thickness, etc.) and uncertainties in the ability of models to accurately capture these features has enormous implications for regional hydroclimate and Earth's energy balance on all time scales, certainly including the annual-to-decadal time scales of interest to EPESC. This idea should also be expanded to include sea ice analysis, snow on sea ice, and trends, drawing on additional expertise across the WCRP sphere, beyond the current membership of WG1.

6. New Activities (e.g., structural changes to your activity, plans for databases and other products not covered in the above)

- WG2: Plans for a second phase of the LESFMIP project will be substantively informed by the ongoing analyses of the current LESFMIP simulations. LESFMIP2 plans will be a topic of consideration at the Busan meeting in July 2025.
- WG3: A Common Event Attribution working group has been formed as a vehicle for investigating methodological uncertainties associated with different even attribution techniques. Yukiko Imada has agreed to lead this working group. Some groundwork will be laid in the coming months, but the Busan meeting will serve as an opportunity to bring participants together to discuss the road ahead.

7. General (Highlight any other outcomes etc. that you wish to make the JSC and other WCRP activities aware of (in particular regionally focussed activities we could use in any highlights brochure). Are there particular challenges faced in the last year that the JSC should be aware of?

- Two EPESC-relevant sessions at EGU 2025:
 - *Explaining and Predicting Climate Changes on Regional to Global Scales*. Convened by members of EPESC and EXPECT: Marus Donat, Dim Coumou, Christian Lessig, and Antje Weisheimer.
 - High-impact climate extremes: from physical understanding and storylines to impacts and solutions. Convened by members of Safe Landing Climates and EPESC: Laura Suarez-Gutierrez, Erich Fischer, Henrique Moreno Dumont Goulart, Ed Hawkins, Antonio Sánchez Benítez.