

47th Session of the World Climate Research Programme
Joint Scientific Committee

Explaining and Predicting Earth System Change

Erich Fischer and Kirsten Findell
On behalf of the EPESC SSG

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27-29 April 2026

Virtual Meeting



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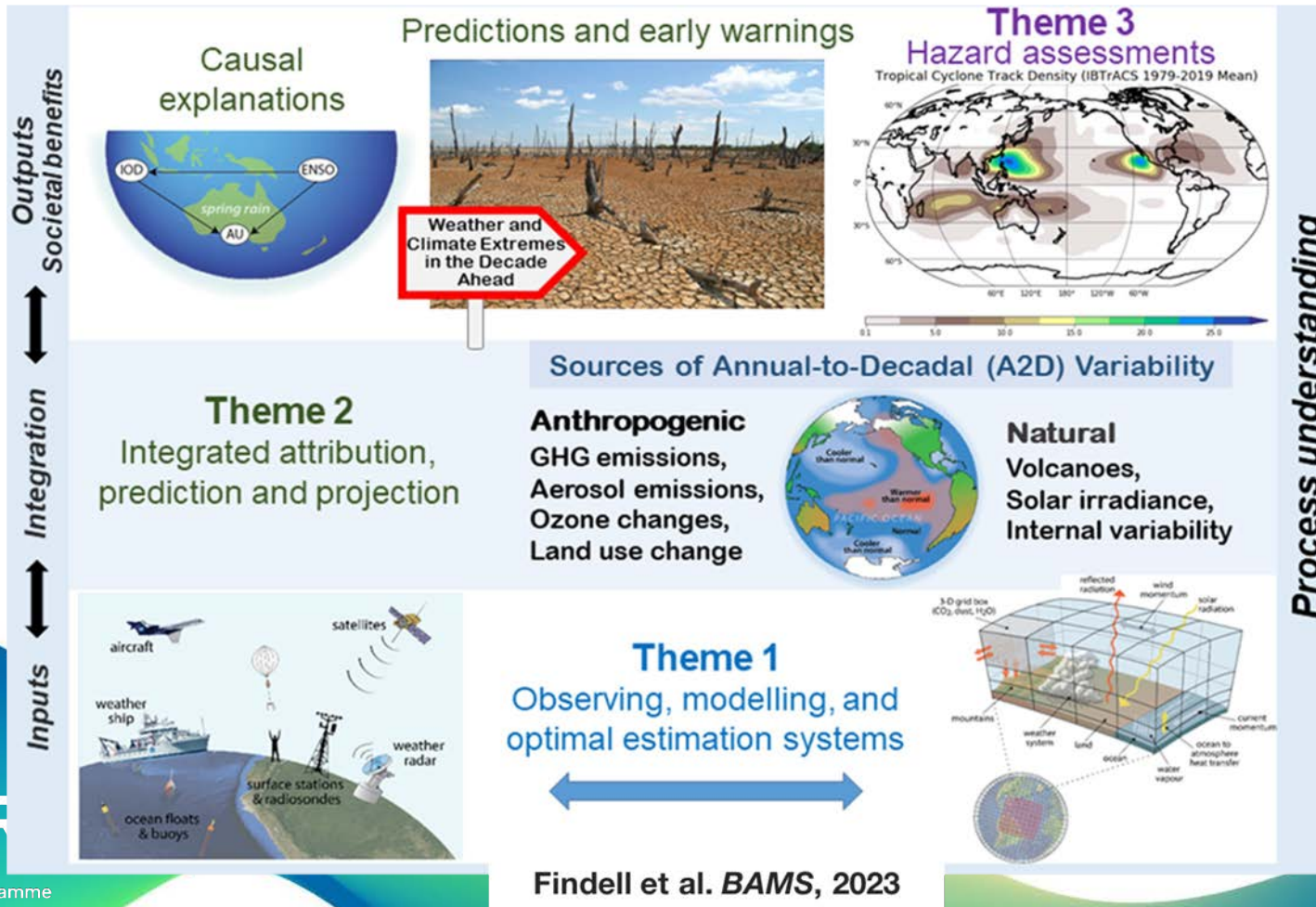


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Understanding and Attributing Annual to Decadal Events and Changes



WG3 co-chairs:
James Risbey
Zhuo Wang

WG2 co-chairs:
Doug Smith
Scott Osprey

WG1 co-chairs:
Paul Kushner
Anca Brookshaw

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CONTRIBUTOR

Key highlights: Joint EPESC—LEADER* meeting

Joint EPESC—LEADER meeting, July 2025

- Busan, Republic of Korea hosted by June-Yi Lee
- Notable outcomes:
 - **BAMS meeting summary:** update of science plan, recommendations and perspectives
 - **Special Issue of Weather and Climate Dynamics** (and other EGU journals) led by Chaim Garfinkel, Stephanie Fiedler, and Amy Butler

**Large Ensembles for Attribution of Dynamically-driven ExtRemes (an APARC activity)*

Our 2026 meeting was held last week, mostly online



BAMS
Meeting Summary

Toward Improved Understanding and Attribution of Large-Scale Circulation Changes and Associated Extremes: Challenges and Opportunities

Kirsten L. Findell,^a Chaim I. Garfinkel,^b June-Yi Lee,^{c,d} Erik Behrens,^e Leonard Borchert,^f Lijing Cheng,^g Annalisa Cherchi,^h Leandro B. Diaz,^{i,k} Andrea Dittus,^l Stephanie Fiedler,^m Erich Fischer,ⁿ Alexia Karwat,^o Yukiko Imada,^o Fei Luo,^{p,q,r} Shoshiro Minobe,^s Suyeon Moon,^t Scott Osprey,^u James Risbey,^v Tiffany A. Shaw,^w Doug Smith,^x Andrea K. Steiner,^y Zhuo Wang,^z Maureen Wanzala,^{aa} Jonathon S. Wright,^{bb} and Jeong-Eun Yun^c



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Key highlights: EPESC Webinar Series

Two successful webinars on emerging science topics

- *Characterising observational uncertainties*
- *Potential futures of computational climate science: learning from the AI revolution*

Chapter 9 - Characterising observational uncertainties
World Climate Research Programme

Climate change · Climate change refers to long...
Predicting Earth System (EPESC) webinar series

Topic: Characterising observational uncertainties
Speakers: Duo Chan, Lijing Cheng & Stephanie Fiedler

12 December 2025 11:00 UTC
Watch on YouTube

World Climate Research Programme
3.62k subscribers

Climate change · Climate change refers to long...
Predicting Earth System (EPESC) webinar series

Topic: Potential futures of computational climate science: learning from the AI revolution
Speaker: Pierre Gentine (Columbia University)

14 October 2025 14:00 UTC
Watch on YouTube

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WG1: Tighter integration of models and obs

1. Understanding and explaining the **trend in Earth's Energy Imbalance (EEI)**

Lead: Benoit Meyssignac, connections with GEWEX's EEI Assessment project

2. Characterization and impacts of **updated forcings**

Lead: Stephanie Fiedler, connections with the CMIP Forcings Task Team

3. Confronting models with observations

- Jonathon Wright (reanalysis/A-RIP, connections with APARC)

- Lijing Cheng (reanalysis/ocean heat content, connections with GOOS)

- Tiffany Shaw (model/obs discrepancies, best practices)

4. Dataset infilling and reconstruction, accounting for variable data availability

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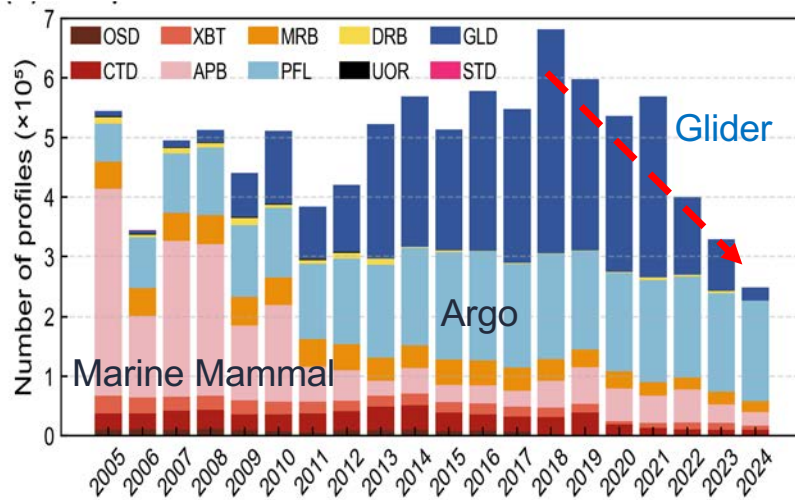
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Key highlight: Monitoring Ocean Heat Content

Ocean subsurface temperature profiles **decline**



Zhu, Cheng, et al., 2026 in prep

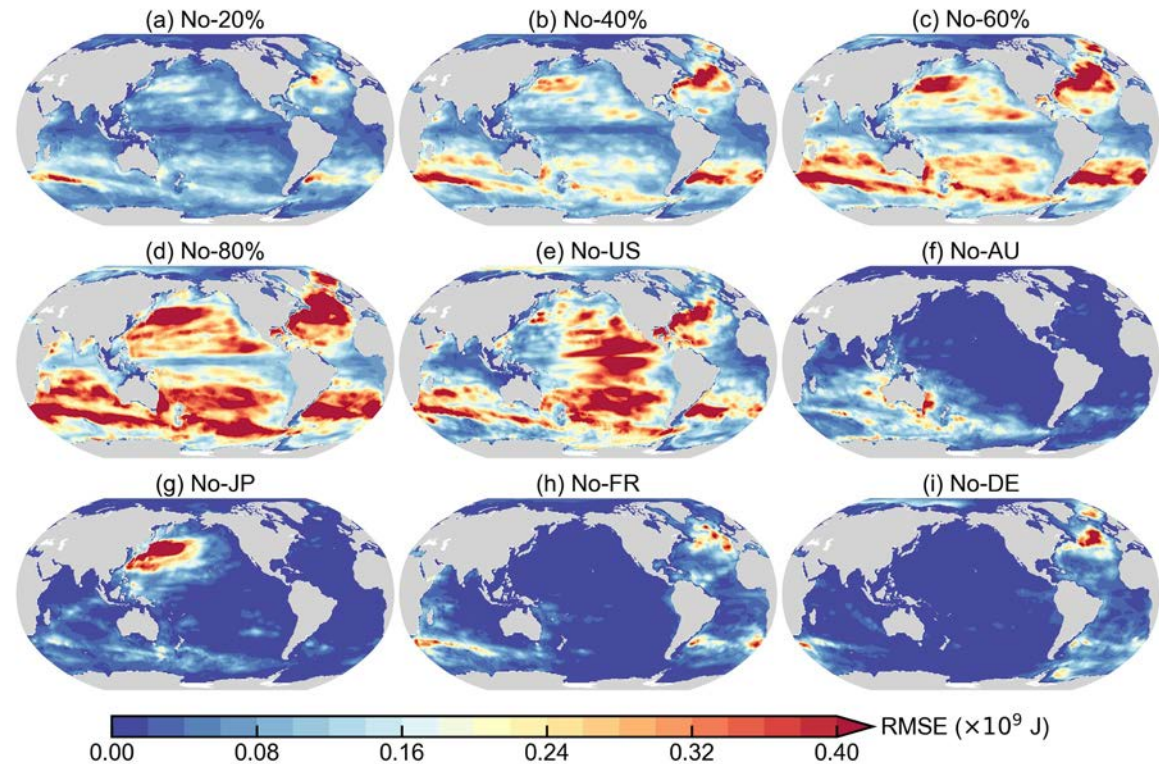
Impact of depends not only on data volume but also on the spatial distribution of observations.

Only US data are global!

Zhu, Cheng, et al., 2026, acc. *Nat Clim Ch*

OHC data removal experiments:

- What if 20, 40, 60, 80% of GOOS data were randomly removed?
- What if different nations withheld data?



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WG2: Integrated Attribution, Prediction, and Projection (with LEADER)

- Regionally-based groups analyzing output from LESFMIP* simulations
 - Summer northern hemisphere atmospheric circulation trends
 - Southern hemisphere circulation trends and extremes
 - North Atlantic atmosphere and ocean circulation
 - Tropical circulation variability and trends
- Each group has active memberships, with papers in review or nearing completion
- Nearing submission of an EPESC Perspective paper led by Doug Smith articulating a large-ensemble analysis protocol

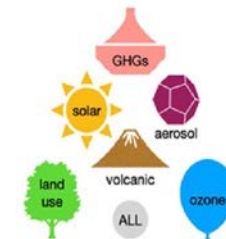
*LESFMIP =

Large Ensemble



What are the characteristics of internal variability and extremes?

Single Forcing



What is the response to different forcings?

Model Intercomparison Project (MIP)



How well do models represent observed mean states, variability, and changes?

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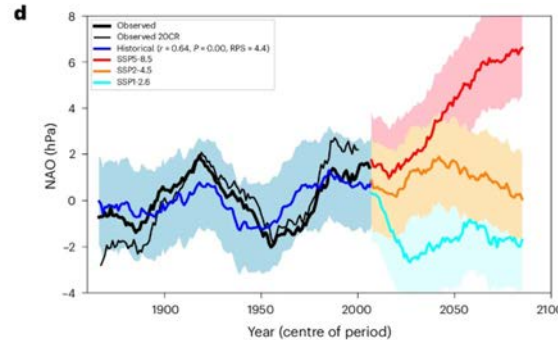
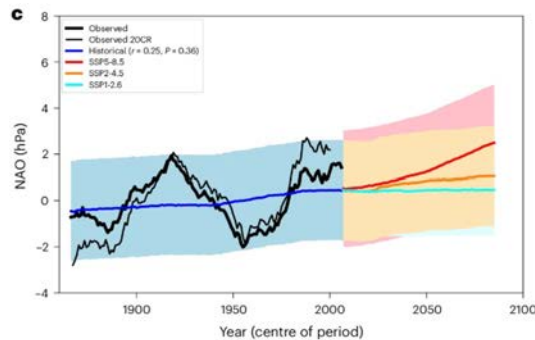
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Key highlight from WG2

- Models have opposite atmospheric circulation responses to same forcing
- Need emergent constraint to find plausible real-world response
- Constrained range is correlated with observations – suggests external forcing!
- Future changes may be bigger than expected from unconstrained range (consistent with signal to noise paradox)



Article

<https://doi.org/10.1038/s41558-025-02277-2>

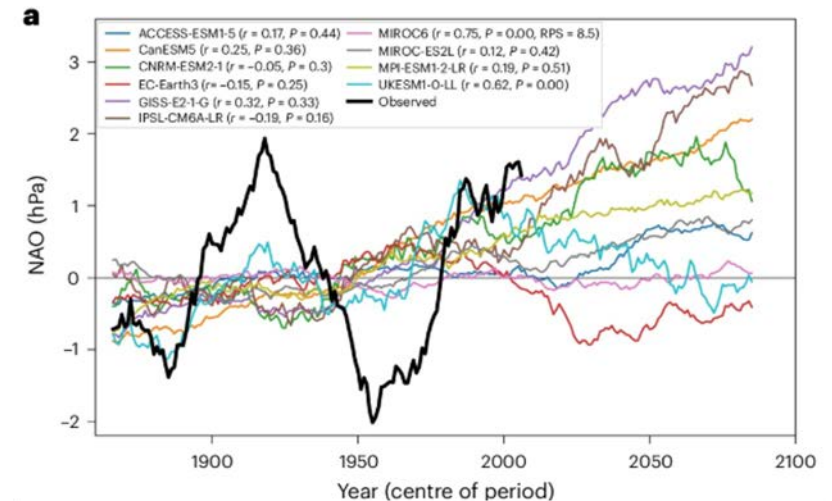
Mitigation needed to avoid unprecedented multi-decadal North Atlantic Oscillation magnitude

Smith et al., *Nature Climate Change*, 2025

Received: 6 April 2024

D. M. Smith¹, N. J. Dunstone¹, R. Eade¹, S. C. Hardiman¹,
L. Hermanson¹, A. A. Scaife^{1,2} & M. Seabrook¹

Accepted: 5 February 2025



Constrained:
→ high correlation with obs
→ decadal variability is externally forced (at least partly)

But subject to signal to noise paradox → scale by ~4 x

Projected to increase to unprecedented levels ⇒ missed when taking models at face value!

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WG3: Assessment of Current and Future Hazards

Establishment of new activities on:

- *predictability of climate extremes and hazards*
- *actionable climate hazard science*
- *impacts of extremes*

WG3 Priority: Common Event Attribution Project

- Compare multiple attribution methods applied to the same high-impact events.
- By developing shared guidelines on event definitions, baselines, metrics, bias correction, counterfactuals, and standard outputs, this effort seeks to improve consistency and transparency across attribution studies.
- Initial focus events: *the 2021 Pacific Northwest heatwave, 2022 Pakistan floods, and 2023 North China heavy rainfall*
- Expected outcomes include community guidance, coordinated assessments, and peer-reviewed synthesis.
- Working in consultation and collaboration with the Global Extremes Platform's attribution team. (*Yukiko Imada is involved in both groups.*)

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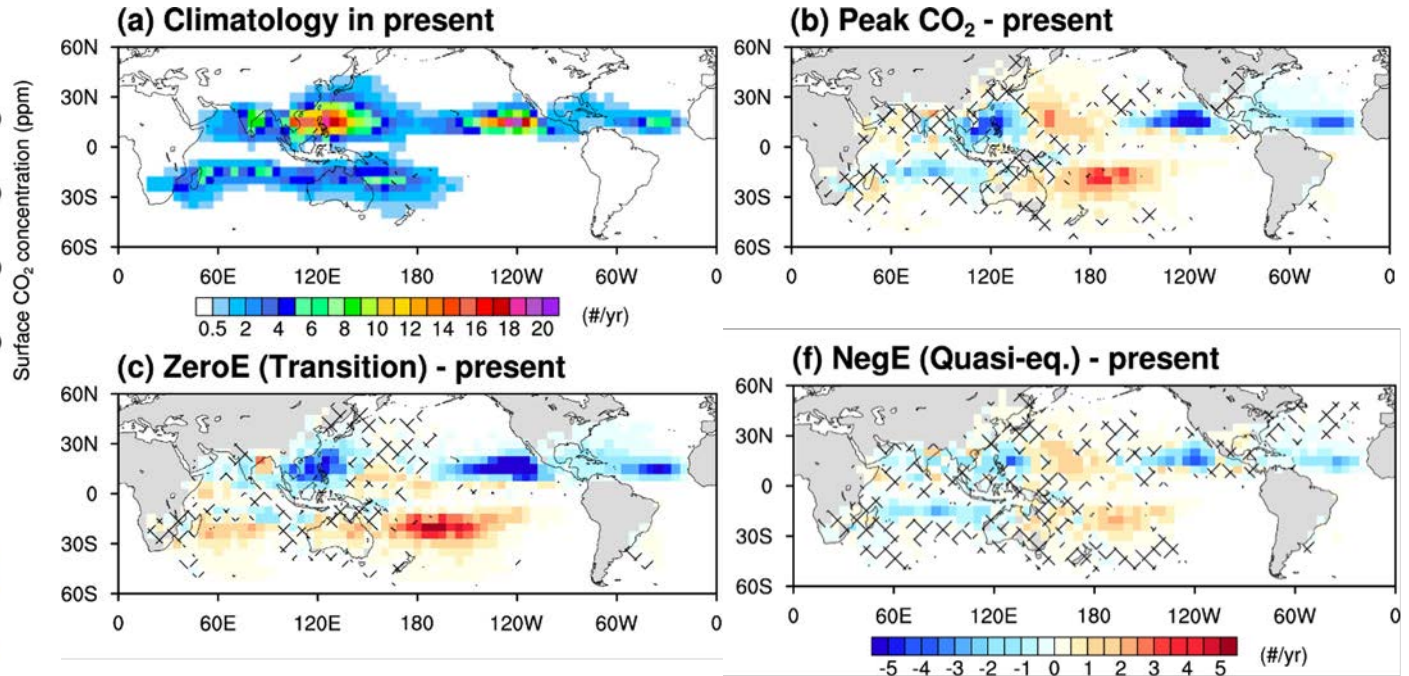
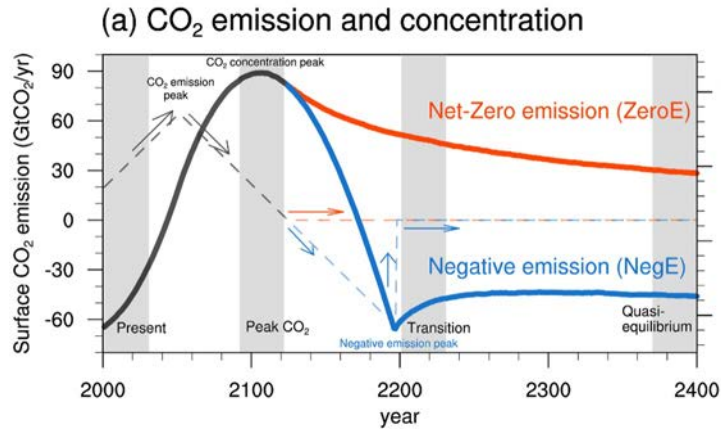


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WG3 Key Highlight: Reversibility of Tropical Cyclone Response



npj | climate and atmospheric science Article
 Published in partnership with CECCR at King Abdulaziz University
 Moon et al., 2025
<https://doi.org/10.1038/s41612-025-01122-9>

Tropical cyclone response to ambitious decarbonization scenarios

Mincheol Moon¹, Seung-Ki Min^{1,2}, Jung-Eun Chu¹, Soon-Il An^{1,4}, Seok-Woo Son¹, Hamish Ramsay⁵ & Zhuo Wang¹

Check for updates

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- Interhemispheric asymmetry in TC response
- Even with net-zero shifts remain irreversible
- Only with strong negative emissions patterns gradually recover over centuries.



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Suggestions, issues or challenges

- *Funding for the 2027 Joint EPESC-LEADER meeting*
 - *We want to roll our 2026 funding over to 2027*
- *Integration of the Africa-focused group initiated during the WCRP OSC*
 - *SSG representation: we want a member of the Africa-focused group on our SSG*
- *We have articulated multiple research challenges (recent BAMS paper). Moving beyond those challenges towards the “operational” vision of decadal attribution, prediction, and projection will take more years than remain in the Lighthouse Activity lifespan...*

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Thank You

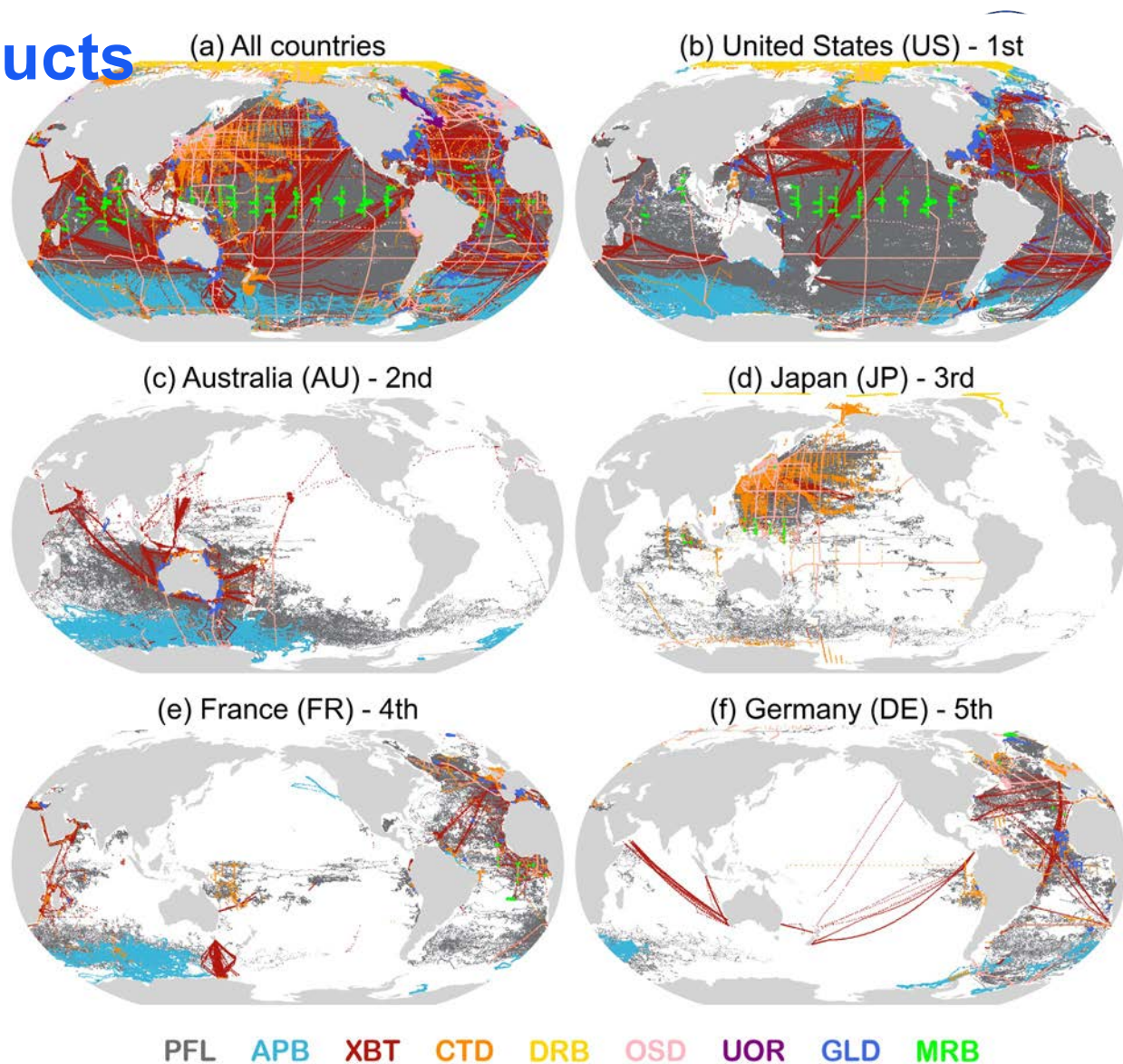


Observational data products

Country contributions are very different:

- US: 53%
- AU: 17%
- JP: 5%
- FR: 5%
- DE: 3%

Zhu et al. 2026a
Nature Climate Change



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Additional slides and information

- *Any additional info that you would like the JSC to be aware of but that you won't have time to present*

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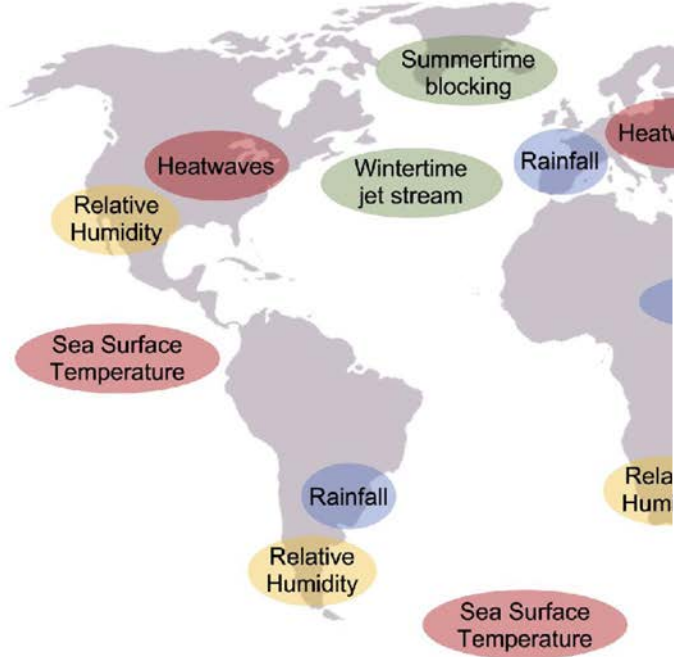
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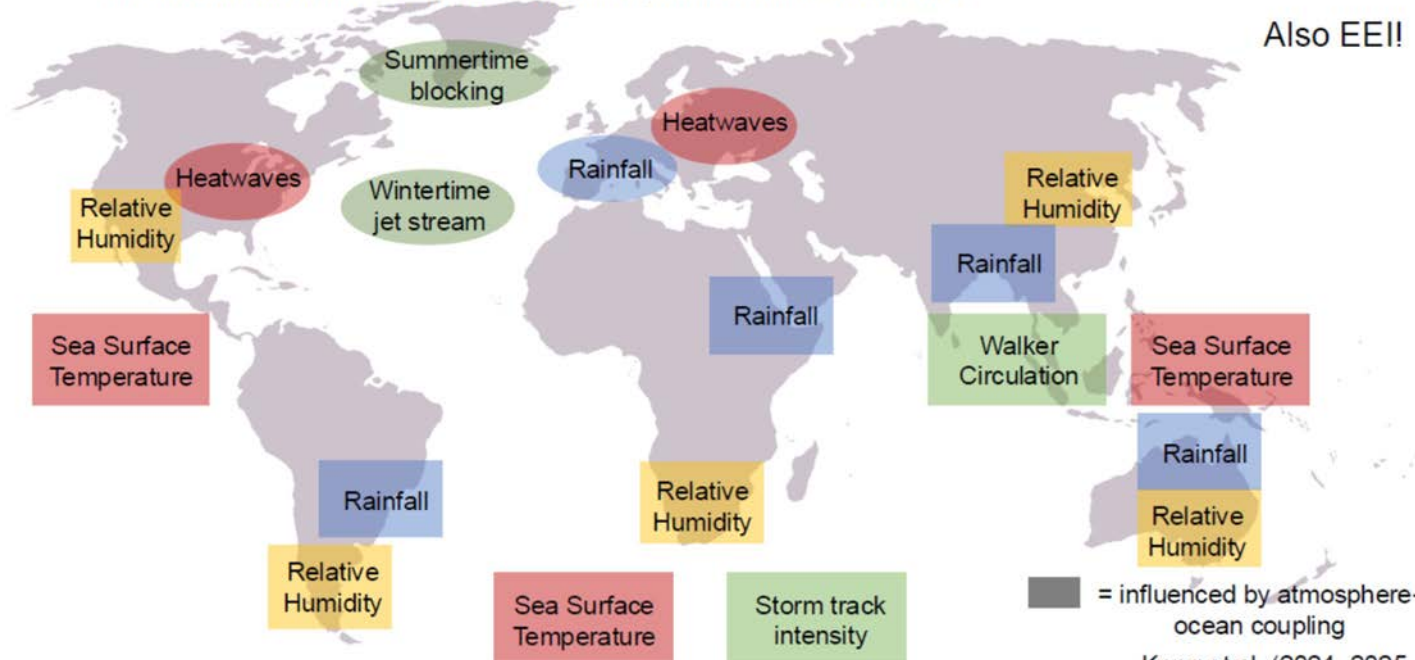
Discrepancies highlight importance of atmosphere-ocean coupling

Location of known model-observation discrepancies in historical trends



Shaw et al., 2024, Fi

Location of known model-observation discrepancies in historical trends



Kang et al. (2024, 2025, npj)

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WG3: Assessment of Current and Future Hazards

Vision: To understand, quantify and predict/project changes on multi-annual-to-decadal timescales in the characteristics and statistics of weather and climate hazards

Establishment of new activities on:

- *common event attribution and assessment*
- *predictability of climate extremes and hazards*
- *actionable climate hazard science*
- *impacts of extremes*

Future plans and priorities

- Perspective paper and webinar series on actionable hazard science
- Guidance paper on predictability of extremes
- Conduct first common event case studies — two cases (2021 PNW heatwave and 2022 Pakistan floods) planned for coming months
- Methodology comparison for compound extreme and impact assessment

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EPESC Future plans and priorities

- *Combine theoretical understanding, models, observations and reanalysis to address key scientific challenges for AR7:*
 - (a) *EEl and potential warming acceleration*
 - (b) *reconciling model-observation discrepancies*
 - (c) *constraining circulation response*
 - (d) *methods of extreme attribution and prediction*
- *Fostering close collaboration and fruitful exchange with APARC-LEADER, GEP, and other core projects*

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