46th Session of the World Climate Research Programme

Joint Scientific Committee

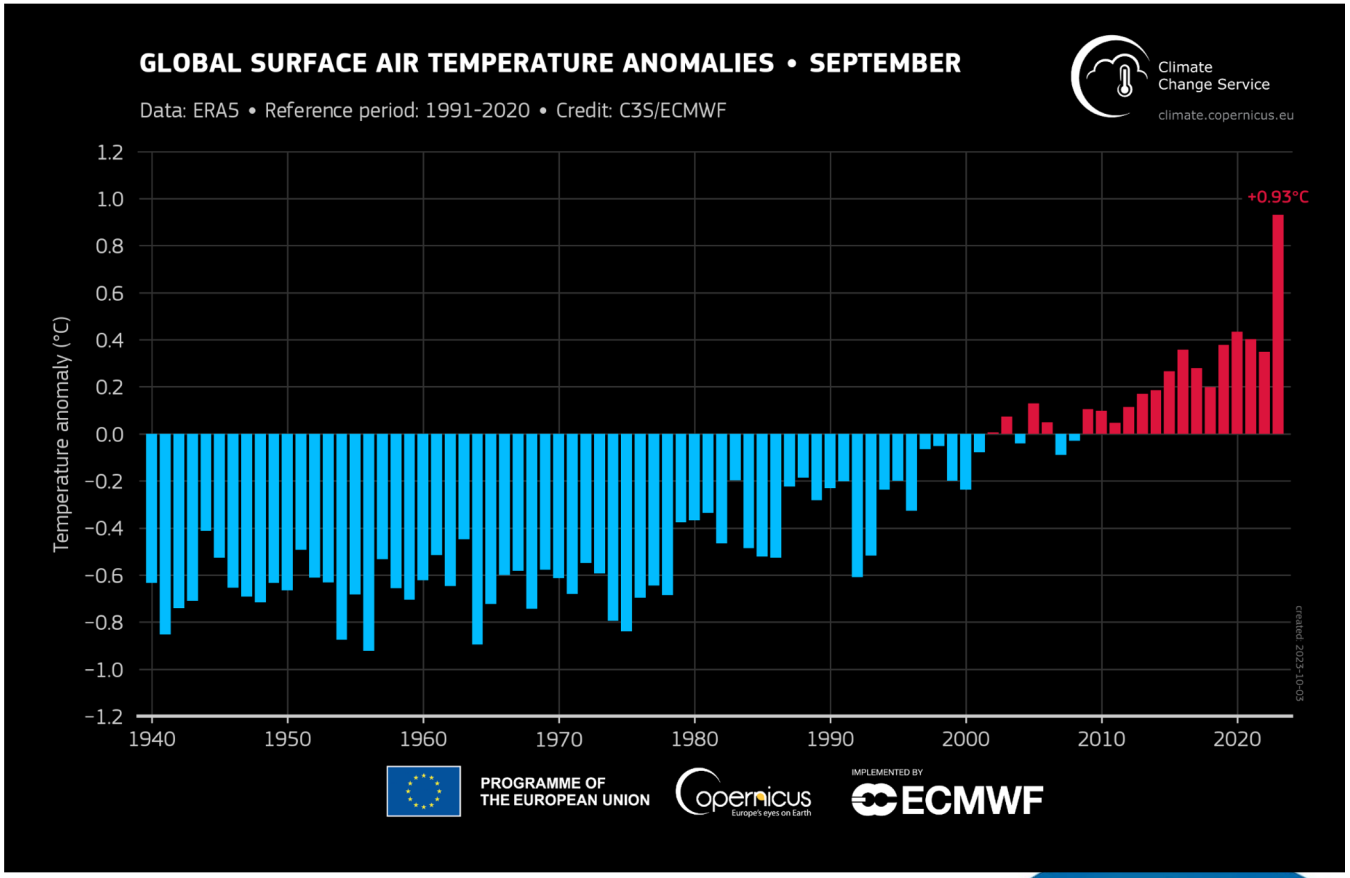
Explaining and Predicting Earth System Change

Erich Fischer and Kirsten Findell

On behalf of the EPESC SSG and members

Why EPESC?

Unprecedented extremes of 2023 and 2024 provided (more) motivation to understand the drivers of large-scale changes in the Earth system



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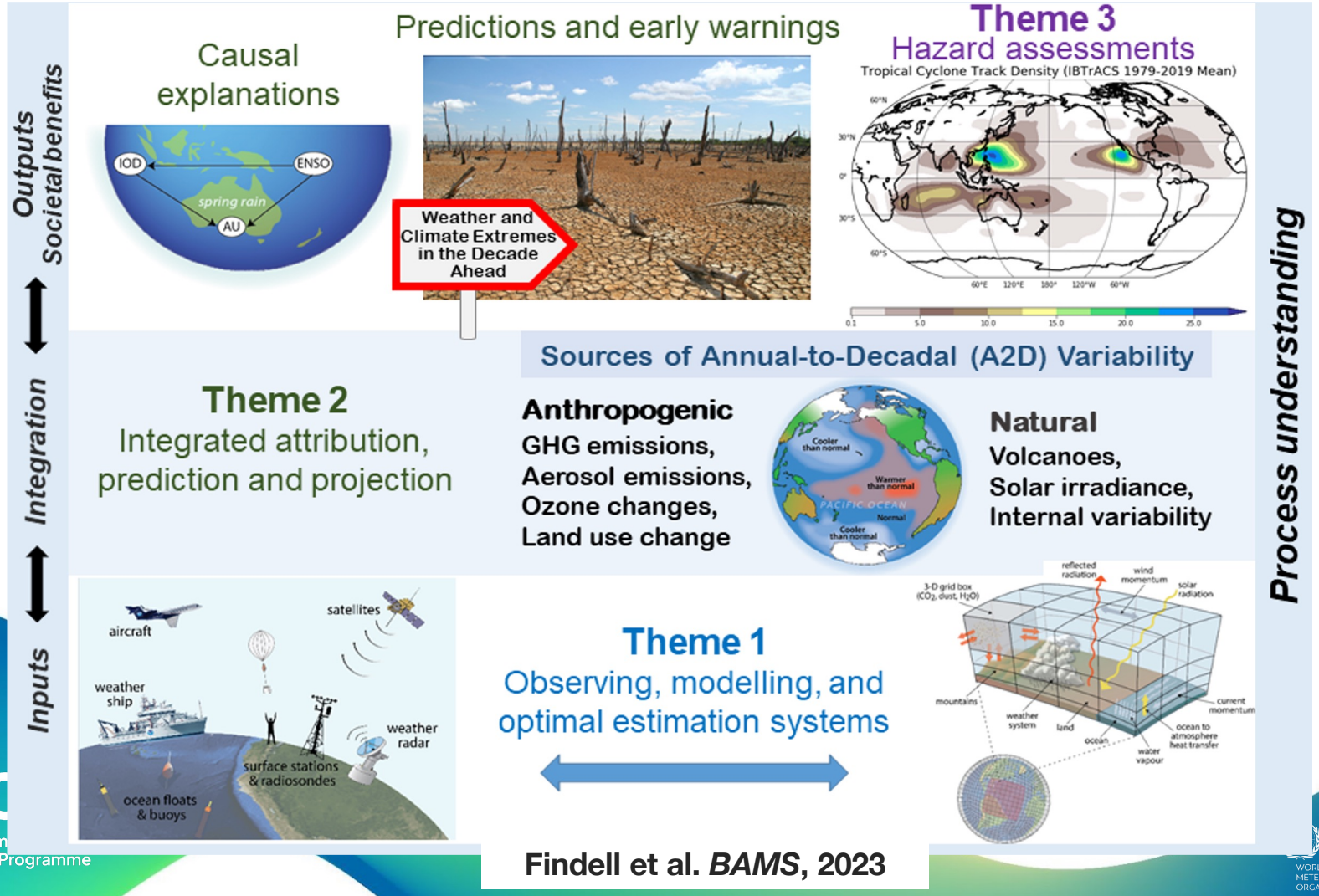
Understanding and attributing such events - this is EPESC



Findell et al. *BAMS*, 2023

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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Key science highlights

Minobe et al (2025): EPESC co-authors speaking to high-impact change in the Earth system with multi-annual implications

➔Causal factors of unprecedented extremes of 2023/24:

- ◆Positive decadal trend in Earth's Energy Imbalance, *(plotted Net Rad)*
- ◆persistent La Niña conditions beginning in 2020, and the switch to El Niño in 2023 *(plotted MEI)*

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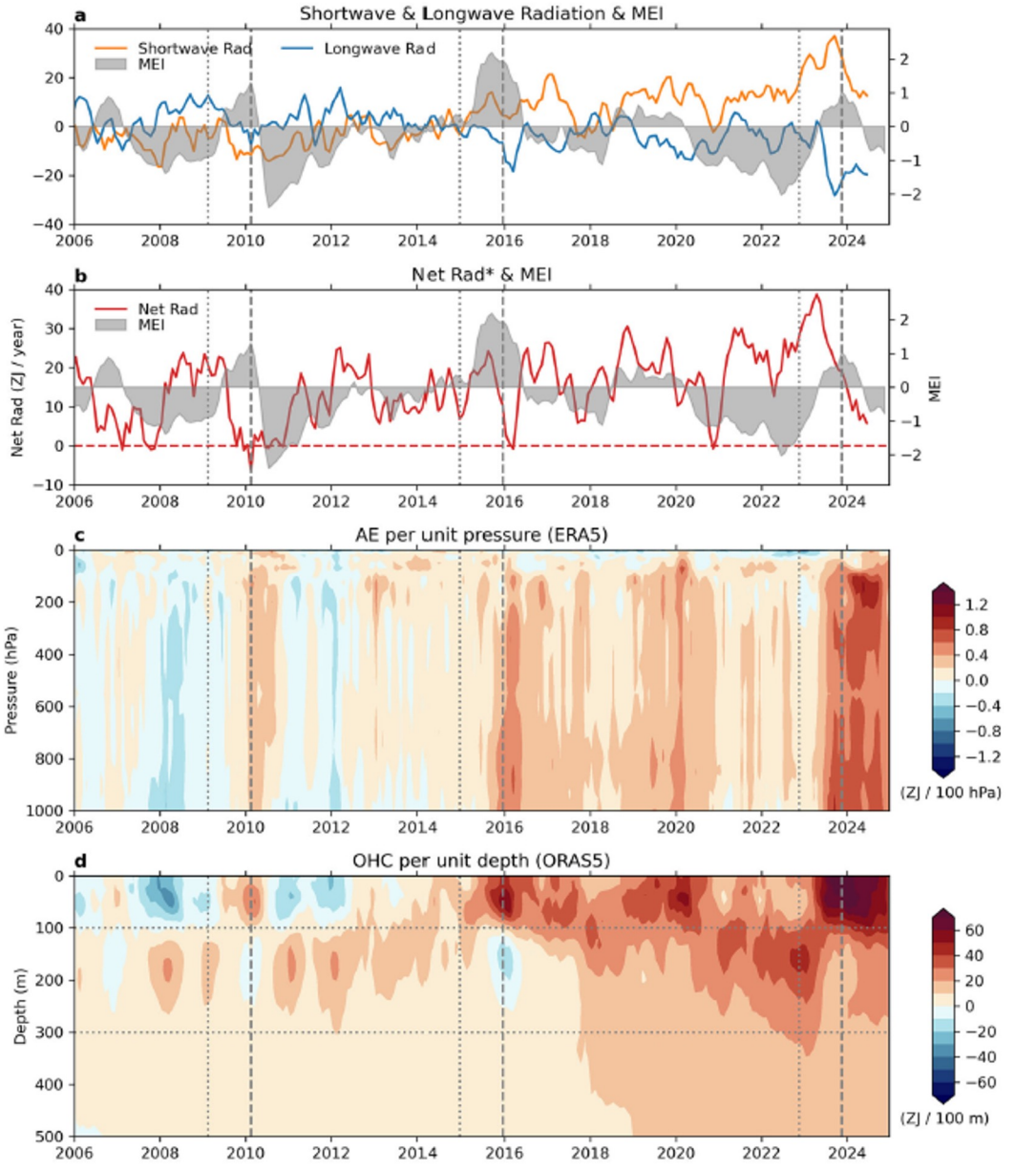
Minobe et al., *npj Clim Atm Sci* (2025)

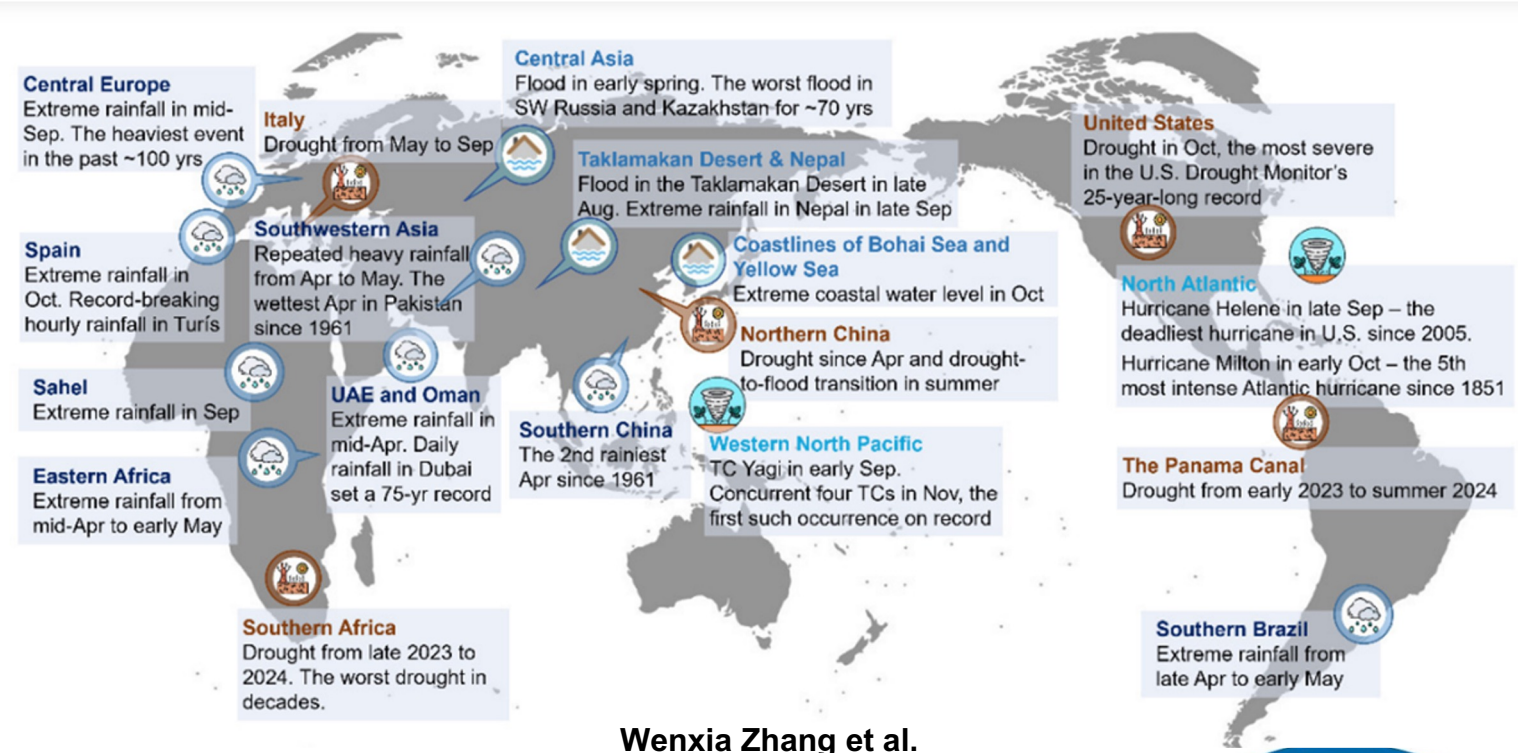


Key science highlight: Extremes in 2024

Zhang et al (2025):

- Considering extreme:
  - precipitation
  - floods
  - tropical cyclones
  - droughts
- The physical drivers and the role of global warming

Zhang et al (2025): Global mapping of concurrent hazards and impacts associated with climate extremes under climate change. *Earth's Future*, in press.



Wenxia Zhang et al.
***Adv Atmos Sci* (2025);**
with 5 EPESC WG3 authors

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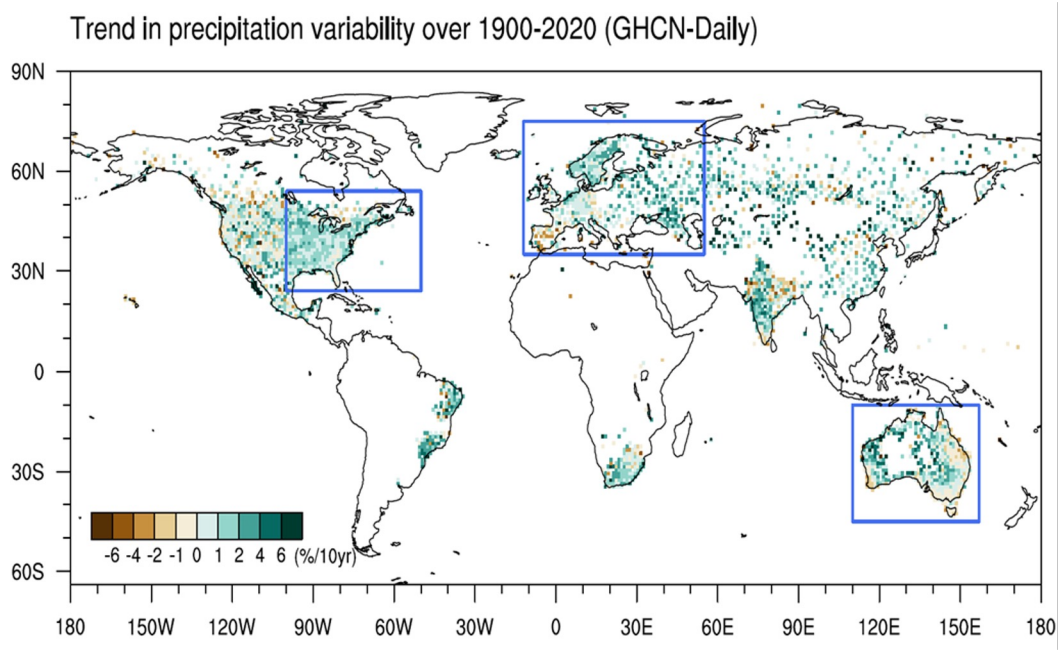
Key science highlight: Understanding and attributing extremes

- ➔ On precipitation extremes and variability: Zhang et al. *Science* (2024)
  - ◆ **Precip variability has amplified over ~75% of land area** with sufficient data
  - ◆ Attributed to anthropogenic GHG emissions
  - ◆ Dominated by thermodynamic effect due to atmospheric moistening,
  - ◆ **Modulated at decadal timescales by atmospheric circulation changes**



W. Zhang et al. *Science* (2024)

WG1: Towards a tighter integration of models and observations

- Advanced the project on Earth's Energy Imbalance (EEI) trend analysis
  - Lead: Benoit Meyssignac; has led a proposal to ISSI* and working with Paul Kushner on proposal to KITP/UCSB**, both for collaborative workshops.
  - Well-aligned with the GEWEX EEI Assessment group
- New focus: updated short-lived climate forcing datasets and their implications for A2D - recently added member Stephanie Fiedler (member CMIP forcings team)
  - Endorsed ESA Earth Explorer 11 mission CAIRT for short-lived climate forcers.
- Assessment of land-atmosphere coupling (GEWEX GLASS; Findell et al., 2024)
  - Highlights the need for sub-daily data (models and obs)
- Connections to Theme 1 of the EU Horizon 2020 EXPECT project
  - Plésiat et al. 2024: *Artificial intelligence reveals past climate extremes by reconstructing historical records*

**ISSI = International Space Sciences Institute*
***KITP/UCSB = Kavli Institute for Theoretical Physics at U California, Santa Barbara*

WG1: Future plans - new themes

- New project on snow process assessment with perspectives on A2D prediction (Jacobi and Kushner):
  - Better understanding of trends and variability and uncertainties related to decadal prediction of cold climates (Champagne et al., 2024; Elias Chereque et al. 2024; Mudryk et al. 2025)
  - Eventually extend to snow-on-sea ice and sea ice analysis, depending on capacity
- New project on in-situ ocean observations with A2D perspective (Chidichimo)
  - Looking at consistency between under utilized in-situ ocean observations (data sets that are not yet assimilated) and reanalysis products
  - Evaluate consistency of ocean in situ observing networks with global reanalysis products for representing key regional processes
  - This could improve annual WMO Annual A2D updates to cover regional ocean updates.

WG2: partnership with APARC/LEADER

- Important partnership between EPESC and LEADER (Large Ensembles for Attribution of Dynamically-driven ExtRemes, part of APARC)
  - Targeted and coordinated analysis of LESFMIP simulations
    - Large Ensemble Single Forcing Model Intercomparison Project: spearheaded by EPESC WG2 co-lead Doug Smith (Smith et al., *Frontiers* 2022)
  - Focused on understanding and attributing dynamical drivers of extremes
  - Facilitated by access to JASMIN (UK data analysis facility)
    - Archive post-processed model output
    - Create shared code repositories
    - *Currently 68 registered users on the CEDA collaborative group workspace LEADER_EPESC!*

WG2: EPESC & LEADER LESFMIP Analysis Groups

- Joint between EPESC and APARC/LEADER (> 10 people per topic)
- All hold regular meetings (~ 1-2 monthly)
- All are preparing community papers
- Hackathon held in March 2025: co-led by Andrea Dittus and Annalisa Cherchi

Activity Focus	Activity Co-leads
North Atlantic atmosphere and ocean circulation	Chaim Garfinkel and Isla Simpson
Southern Hemisphere circulation trends and extremes	Amy Butler and Leandro Diaz
Tropical circulation variability and trends	Andrea Dittus and Annalisa Cherchi
Summer northern hemisphere atmospheric circulation trends	June-Yi Lee and Markus Donat
Role of external forcings and internal variability for atmospheric temperature trends	Andrea Steiner, Matthias Stocker, Amanda Maycock

Cross-EPESC membership

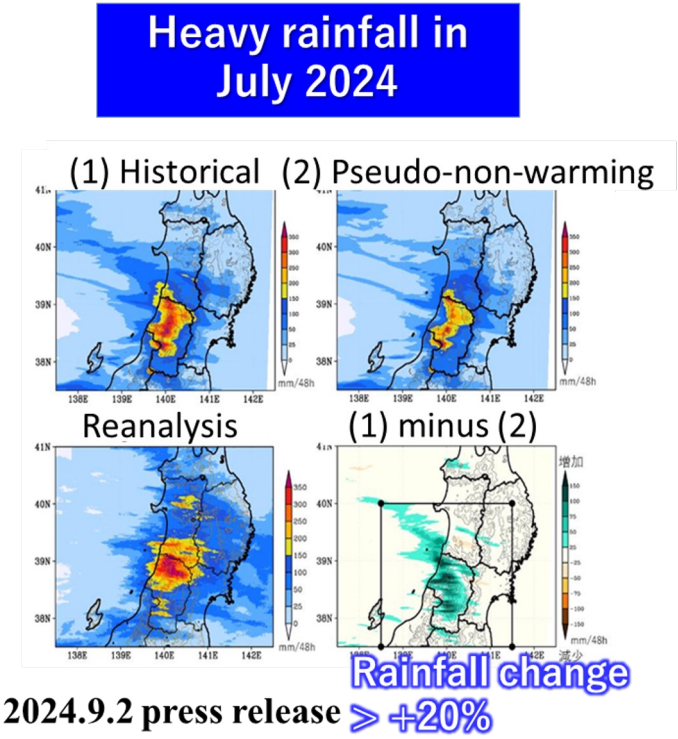
WG3: Assessment of Current and Future Hazards

➔ On extreme event attribution (EA):

- Yukiko Imada is also a member of the RIfS Global Extremes Platform working group on EA
- Operational EA systems in Japan (Yukiko Imada) using multiple methodologies (Risk-based, storyline, statistical)
- ClimaMeter: a framework for contextualizing extreme weather in a changing climate (Faranda et al., *Wea Clim Dyn*, 2024; G. Messori)

➔ New WG3 Theme: Common EA Effort:

- Apply multiple methods to one common extreme event
- To help evaluate the uncertainty induced by different methods
- Busan meeting will provide the opportunity to decide:
  - Choice of the event?
  - Definition of the event?
  - Datasets (observations, reanalysis, existing model simulations, LESFMIP)



Future plans and priorities

- The Joint EPESC – LEADER Science Meeting
  - 15-18 July 2025, Busan, Korea
  - Hosted by June-Yi Lee (WG2)

- Bring together EPESC and LEADER communities
- Focus on LESFMIP and other analyses working to:
  - Understand the role of external forcing and internal variability in different regions of the world;
  - Assess and attribute natural and anthropogenic drivers of climate hazards;
  - Diagnose circulation responses to model forcing, the role of model error, and the predictability of large-scale circulations;
  - Advance the vision of operationalization of decadal forecasts

Building towards the vision of an integrated capability for attribution, early warning and prediction of Earth System Change on global and regional spatial scales and annual to decadal (A2D) timescales.

Future plans and priorities

- Joint EPESC/ASPECT/EXPECT/I4C/DCPP Science Meeting
  - 18-20 November 2025 in Bologna, Italy
  - understand the drivers of decadal climate
  - begin developing integrated attribution and prediction
- Endorsed WGSIP/ESMO Summer School “Climate Prediction Across Timescales”
  - February 2026 in Buenos Aires, Argentina.
  - EPESC WG2 member Leandro Díaz is on the organizing committee

Suggestions, issues or challenges

- Greater geographic representation needed on our SSG and in our Working Groups
  - Priority task: recruit and/or issue a call for new SSG members
  - *For JSC Consideration: The nomination of Leandro Díaz (CONICET and U.Buenos Aires) to join our SSG*
- Recurring question: How can we capitalize on the overlapping interests of EPESC WG1, Digital Earths, and ESMO in ways that are most productive and beneficial for all?

Thank You

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