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Session B-4: Summer northern hemisphere atmospheric circulation trends

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WCRP World Climate Research Programme

WORLD METEOROLOGICAL ORGANIZATION

unesco Intergovernmental Oceanographic Commission

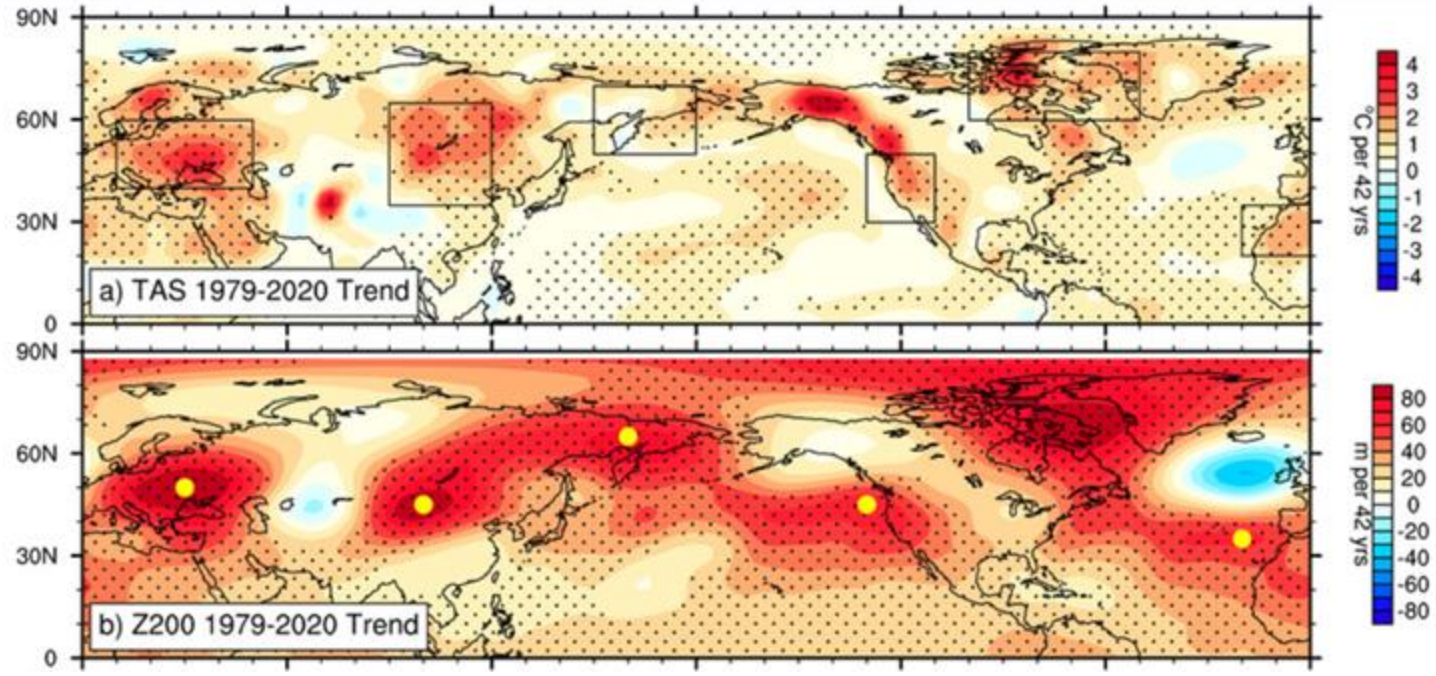
International Science Council

EPESC WG2 on NH Summer Atmospheric Circulation Trends

Team co-leads: Markus Donat and June-Yi Lee

Markus Donat

Linear trend in summer-mean surface temperature and geopotential height at 200mb (Wave-5 pattern)

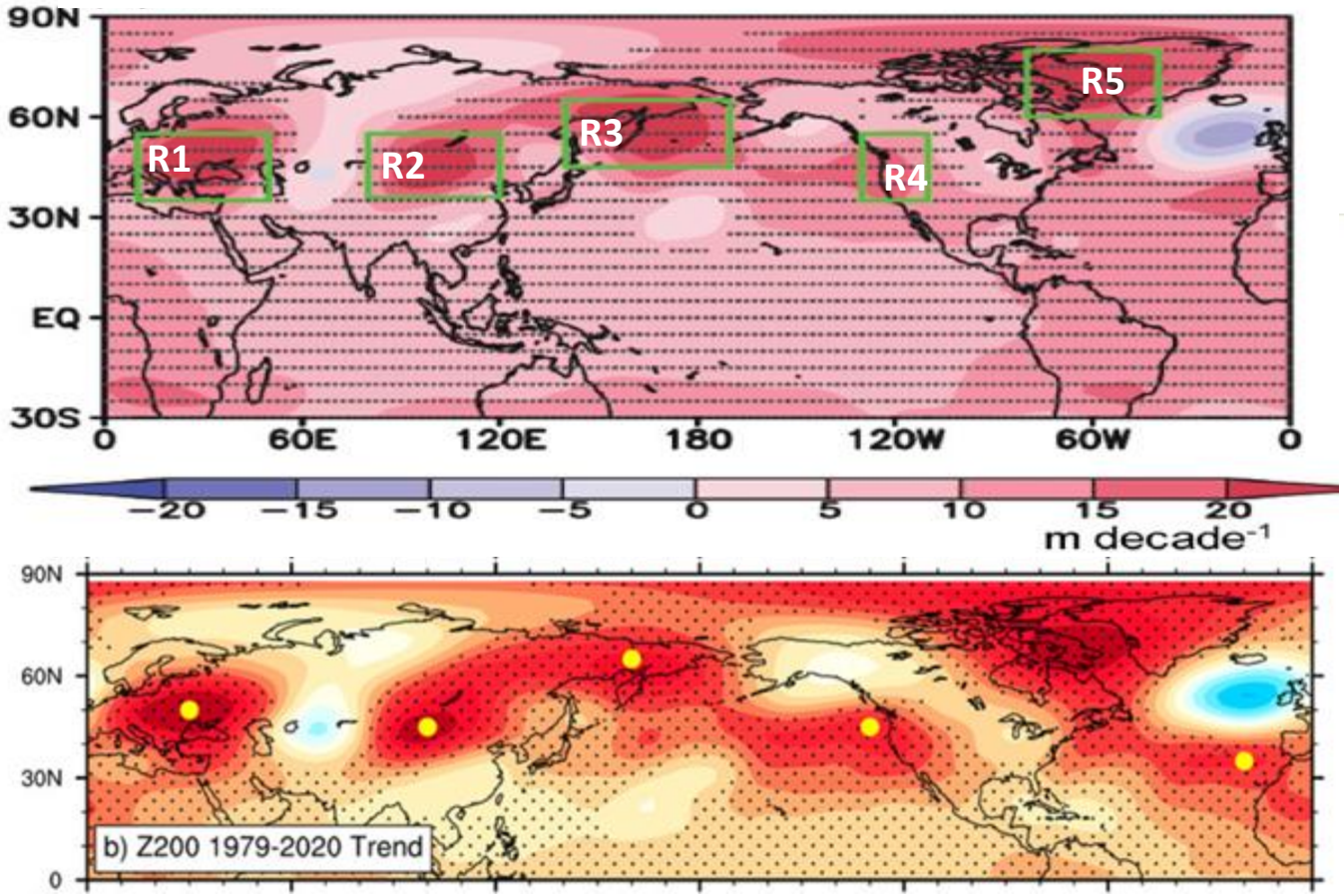


(Teng et al 2022, J of Climate)

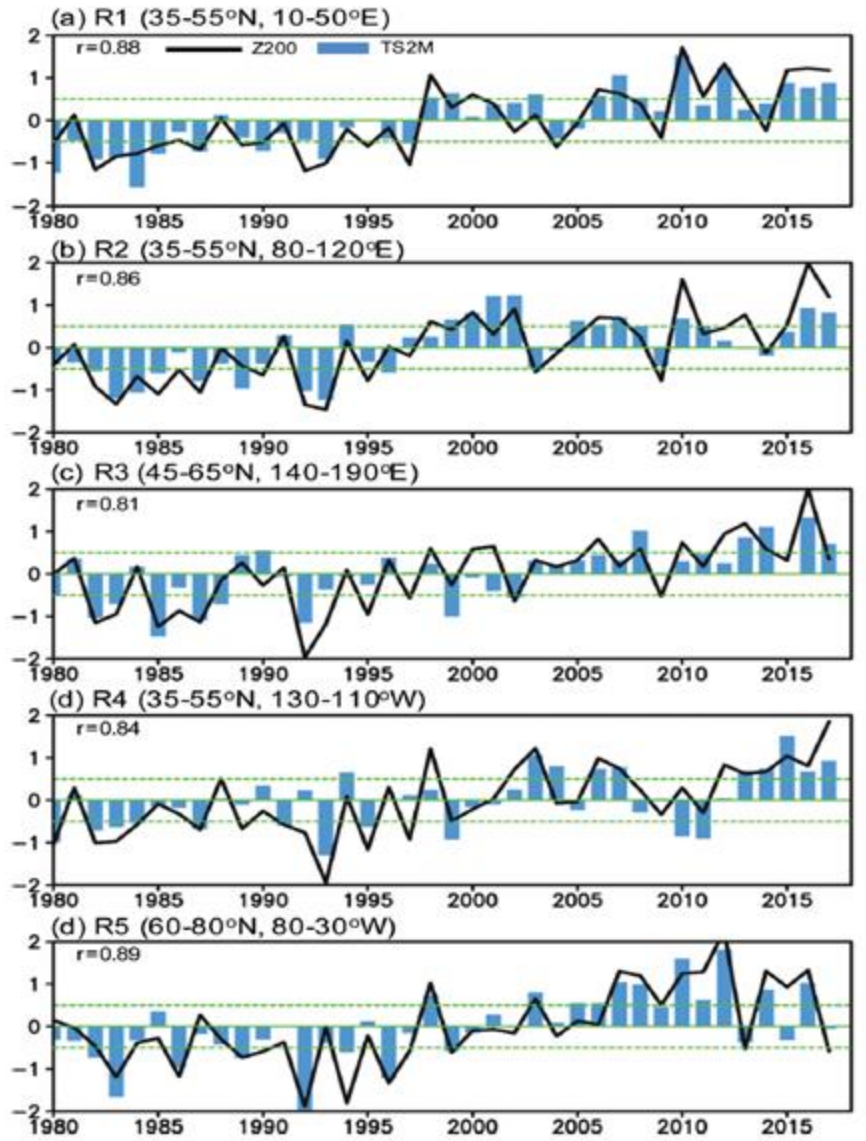
In EPESC WG2 and LEADER, we aim to **advance our understanding and attribution of changes in Northern Hemisphere summer circulation and the associated extremes**, incorporating results from LESFMIP. This activity also involves cross-WG collaboration within EPESC.

EPESC WG2 on NH Summer Atmospheric Circulation Trends

Z200 Trend from 1980 to 2017



(Teng et al 2022, J of Climate)



Lee (2018, Atmosphere KMS)

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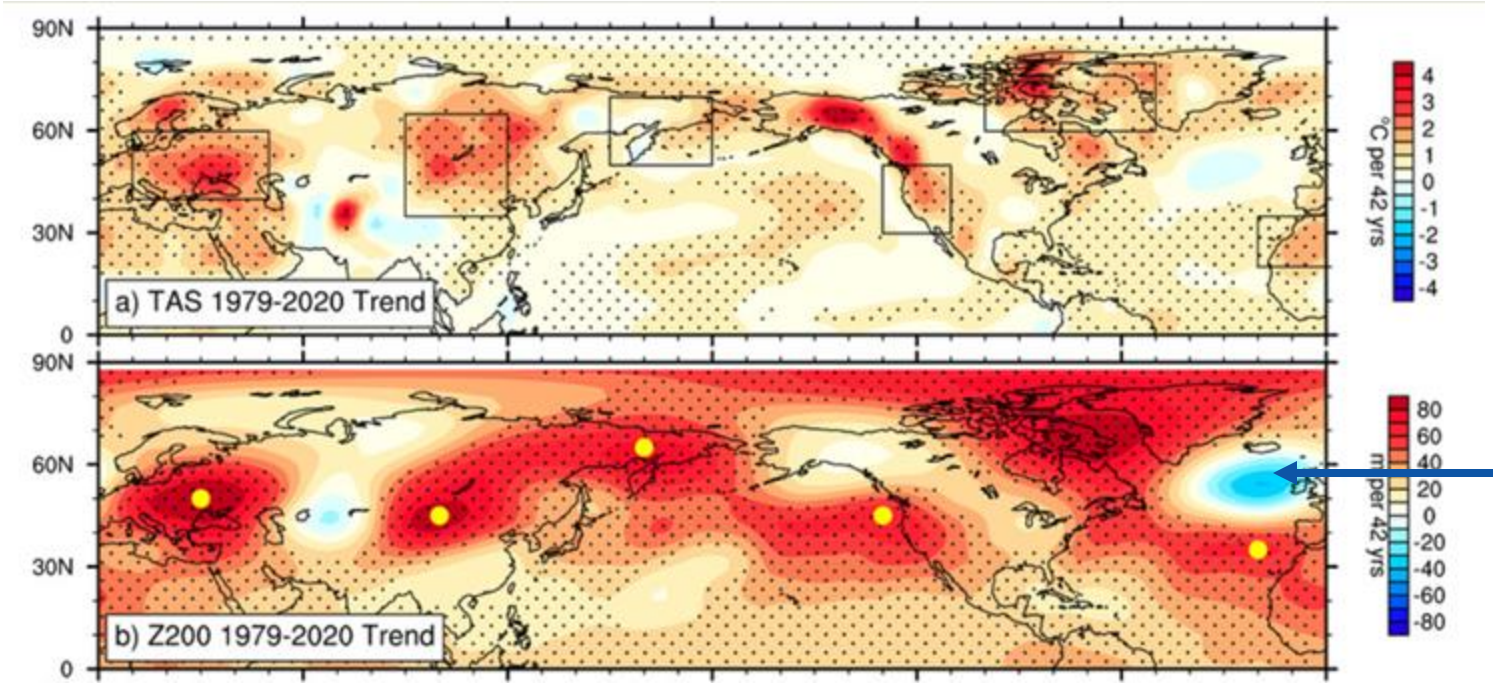


(Teng et al 2022, J of Climate)

- **Concurrent/simultaneous heat waves** (e.g., Petoukhov et al., 2013; Kornhuber et al., 2019,2020)
- **Compound extremes**, such as heat waves, droughts, and wildfires (e.g., Mann et al., 2017; Bui et al., 2022)
- Weakening of the summer Eurasian westerly jet (e.g., Dong et al., 2022) and **increases in summer deep depressions over the north eastern part of the North Atlantic** (e.g., D'Andrea et al., 2024)

EPESC WG2 on NH Summer Atmospheric Circulation Trends

Key Issues

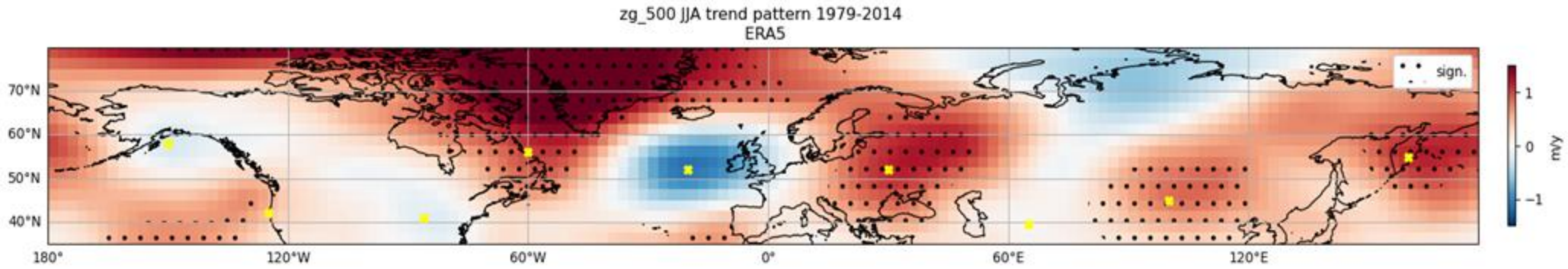
- The **roles of individual forcings**, particularly GHGs and aerosols, in driving recent multidecadal trends in northern hemisphere atmospheric circulation

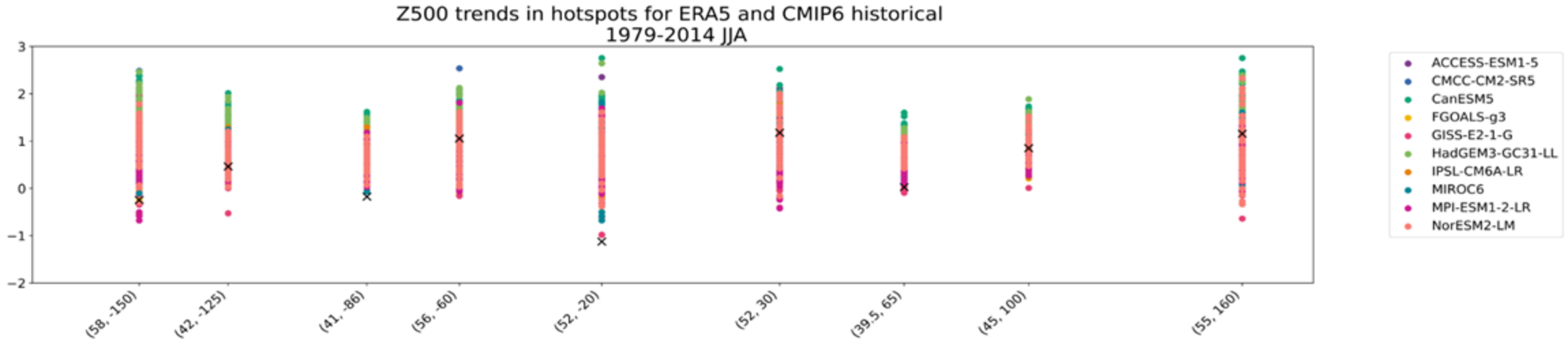
- The **role of internal variability**, particularly over the North Atlantic, the tropical Pacific and other internal drivers

- Model differences and biases in forced responses

We aim to work together for a review/perspective paper on understanding and attribution of changes in NH summer circulation and the associated extremes, incorporating results from LESFMIP.

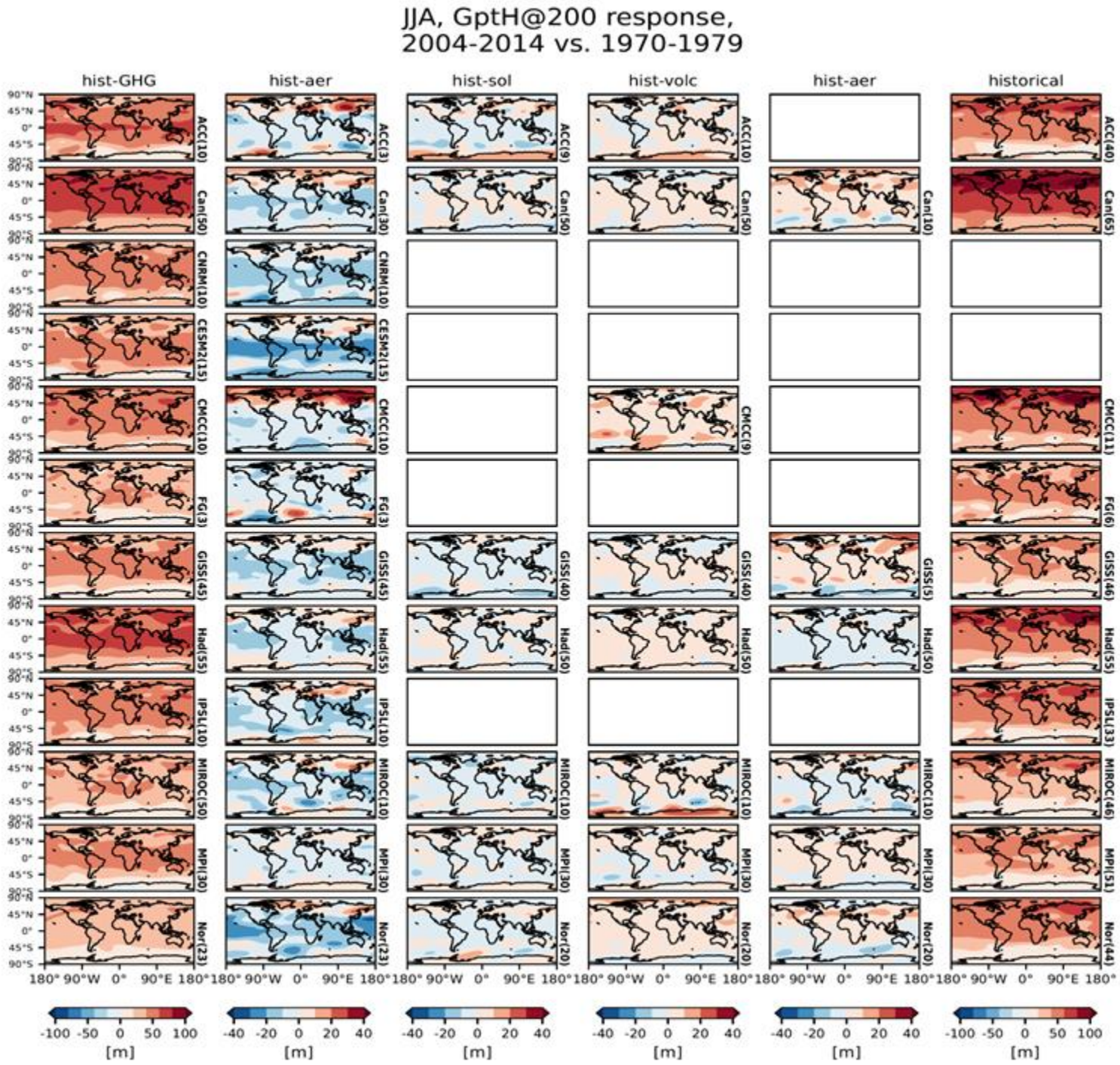
CMIP6 Models' Deficiency in Capturing the Wave-5 Pattern of Circulation Trend





ERA5 in black cross - for some of these it is at the end/outside (especially the lows)

From Tamara Happe's Analysis during LESFMIP Sprint

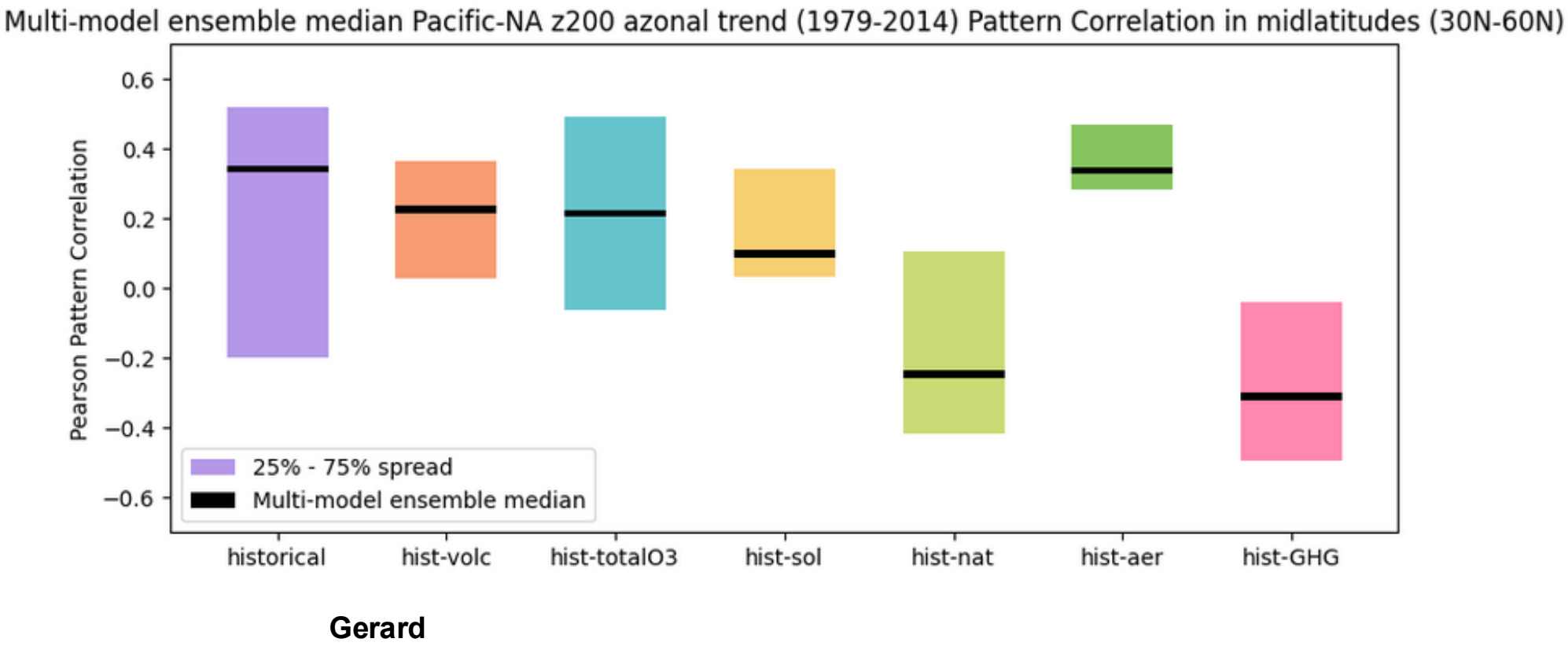


Forced responses in JJA 200-hPa GPH to historical and individual forcings

- All models with historical forcing have difficulty capturing the wave-5 pattern in the observed trend.
- In most models, the forced responses to hist-GHG exhibit a homogeneous pattern in the trend.
- In most models, the forced responses to hist-aer tend to resemble the observed pattern.

From David and Chaim during LESFMIP Sprint

Forced responses in JJA 200-hPa GPH to historical and individual forcings



Gerard

The forced responses to hist-aer in most models tend to resemble the observed pattern.

From Gerard and Markus during LESFMIP Sprint

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16:25 | Alexia Karwat: Exploring multi-year predictability of terrestrial heatwaves in Global Hotspot Regions

16.40 | Tiffany Shaw: Anthropogenic aerosols have significantly weakened the regional summertime circulation in the Northern Hemisphere during the satellite era

16.55 | Tilda Huntingford: External forcing of European summer heatwaves and circulation

17.10 | Gerard Marcet-Carbonell (virtual): On the Northern Hemisphere summer circulation: Disentangling the contributions of different forcings through LESFMIP experiments

17.25 | Jitendra Singh (virtual): Quantifying the role of externally forced atmospheric circulation change in heat extremes from nudged circulation