A First Look at the E3SMv1 Large Ensemble

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with
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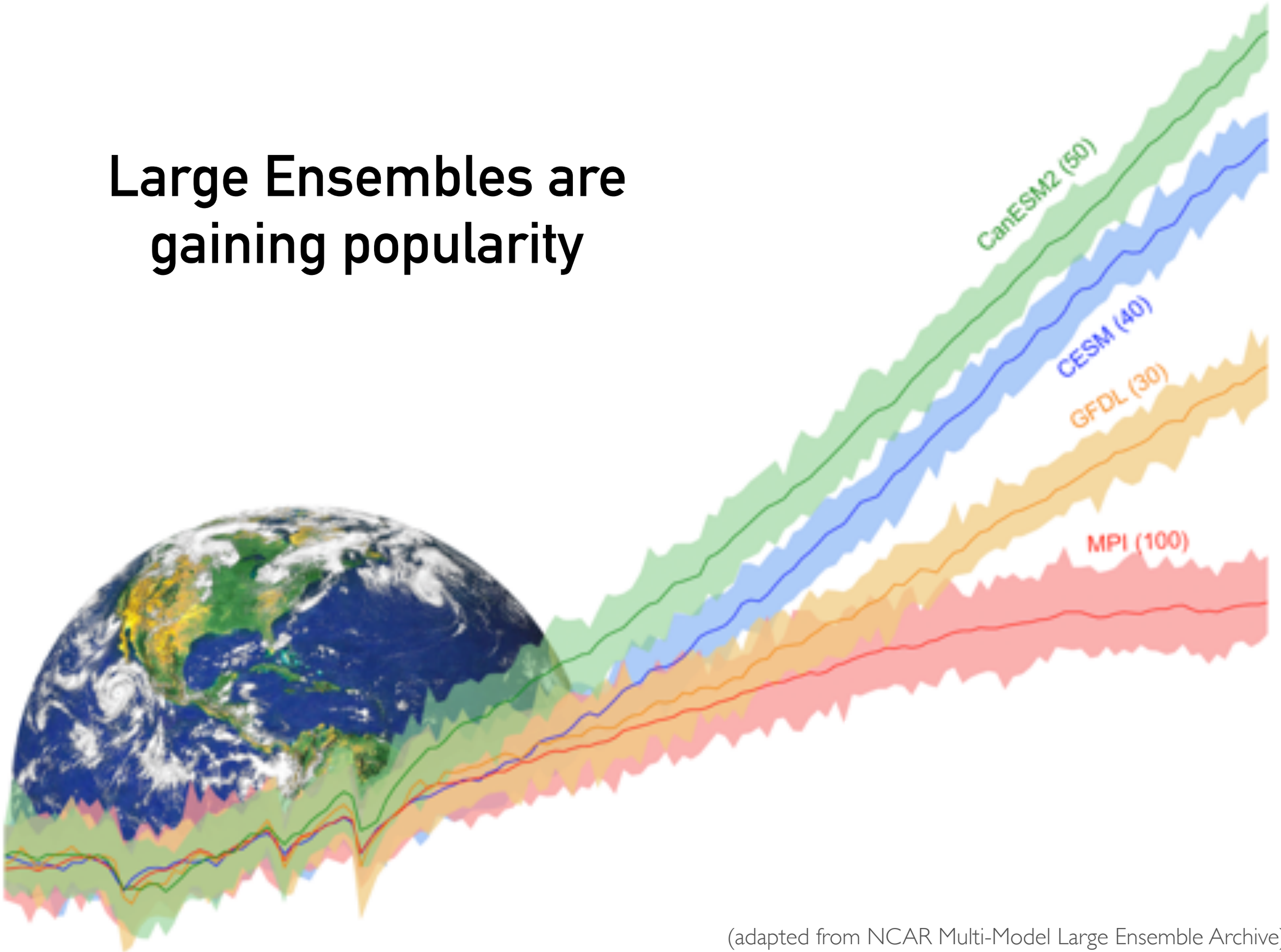
Large Ensembles are gaining popularity



(adapted from NCAR Multi-Model Large Ensemble Archive)

E3SMv1: internal variability unexplored

E3SMv1 Large Ensemble

20 members (computational cost-limited)
Run on NERSC Cori, PNNL Compy

Historical period: 1850-2015

21st century: 2016-2100 (SSP370)

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✔ Historical period: 1850-2015

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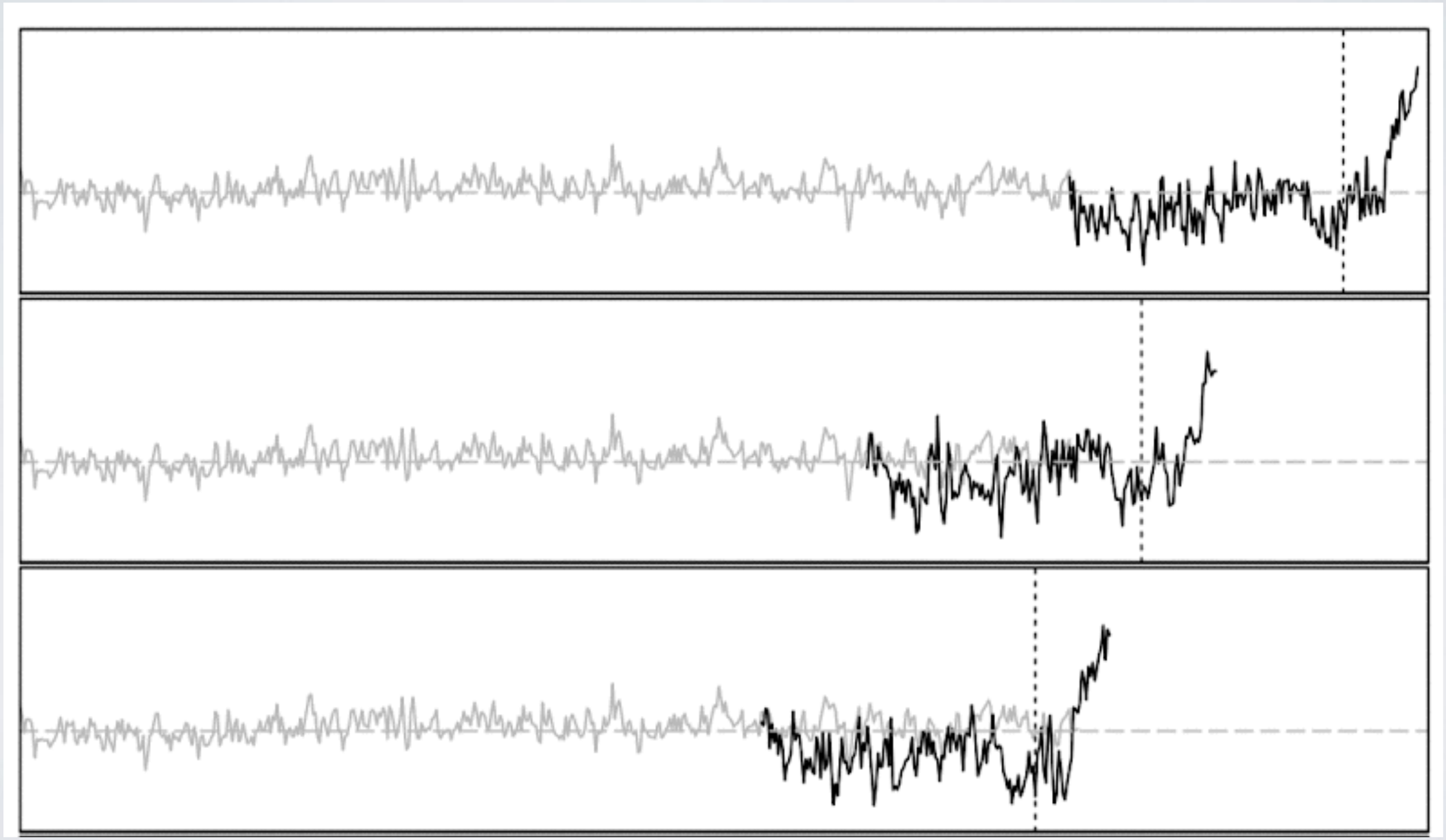
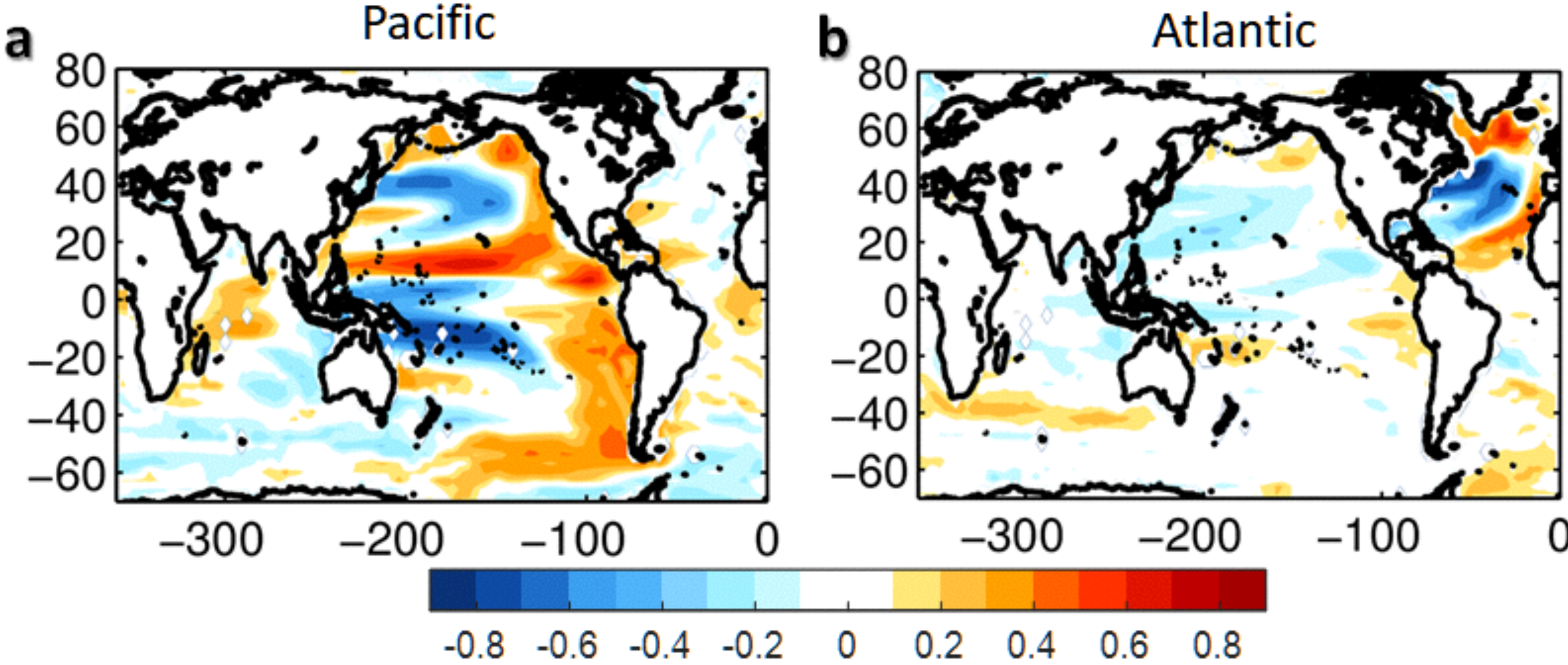
Ensemble Initialization Strategy

Begin with existing low-res PI control: branch members from restarts



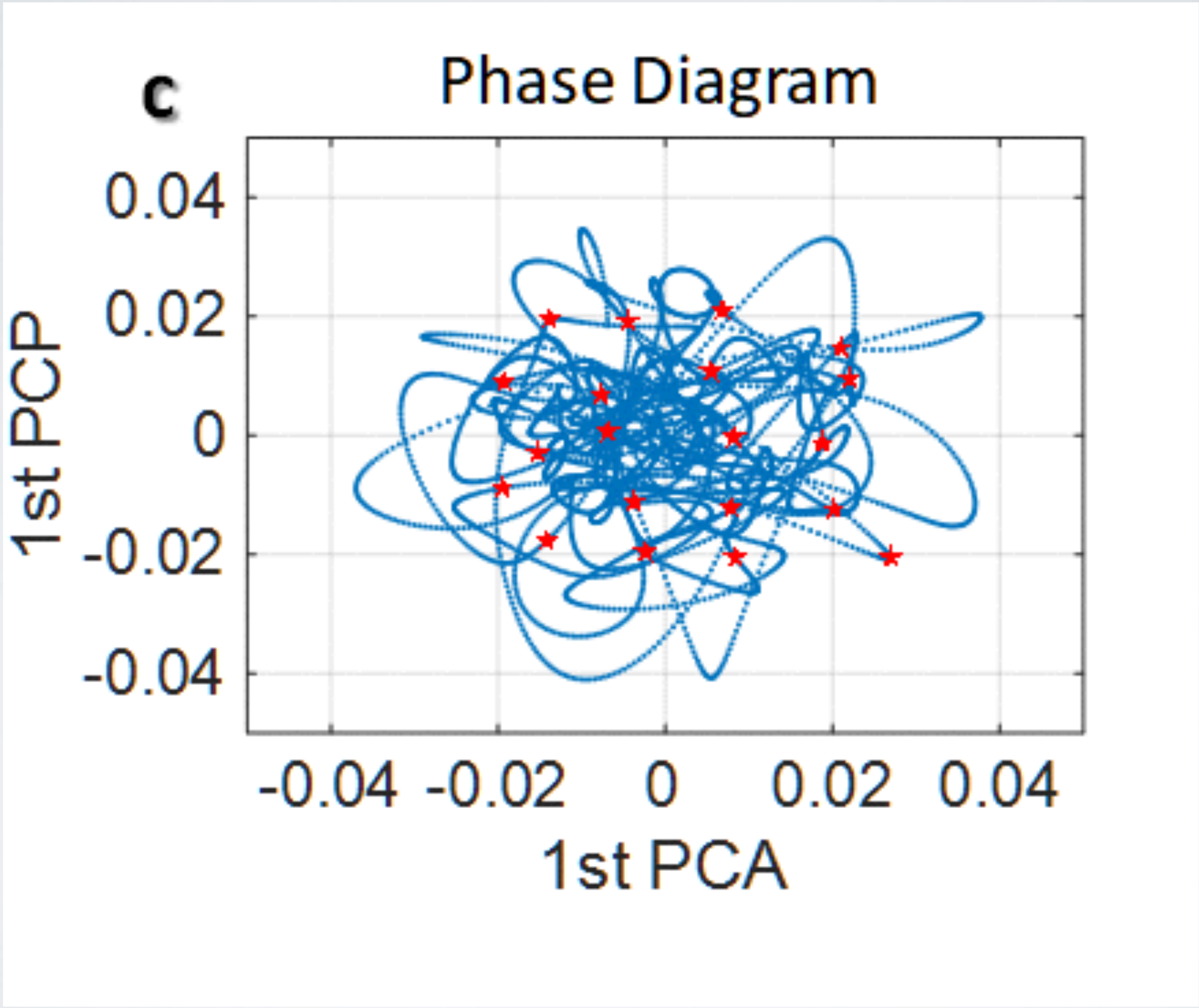
Initial conditions: selected by ocean basin state



Stevenson et al. (2021), in prep

E3SM Depth Average Temperature of Upper 300m (ATU300)
Correlation map between PC1 of 8-year lowpass ATU300 in different basins and 8-year lowpass ATU300

Initial conditions: selected by ocean basin state



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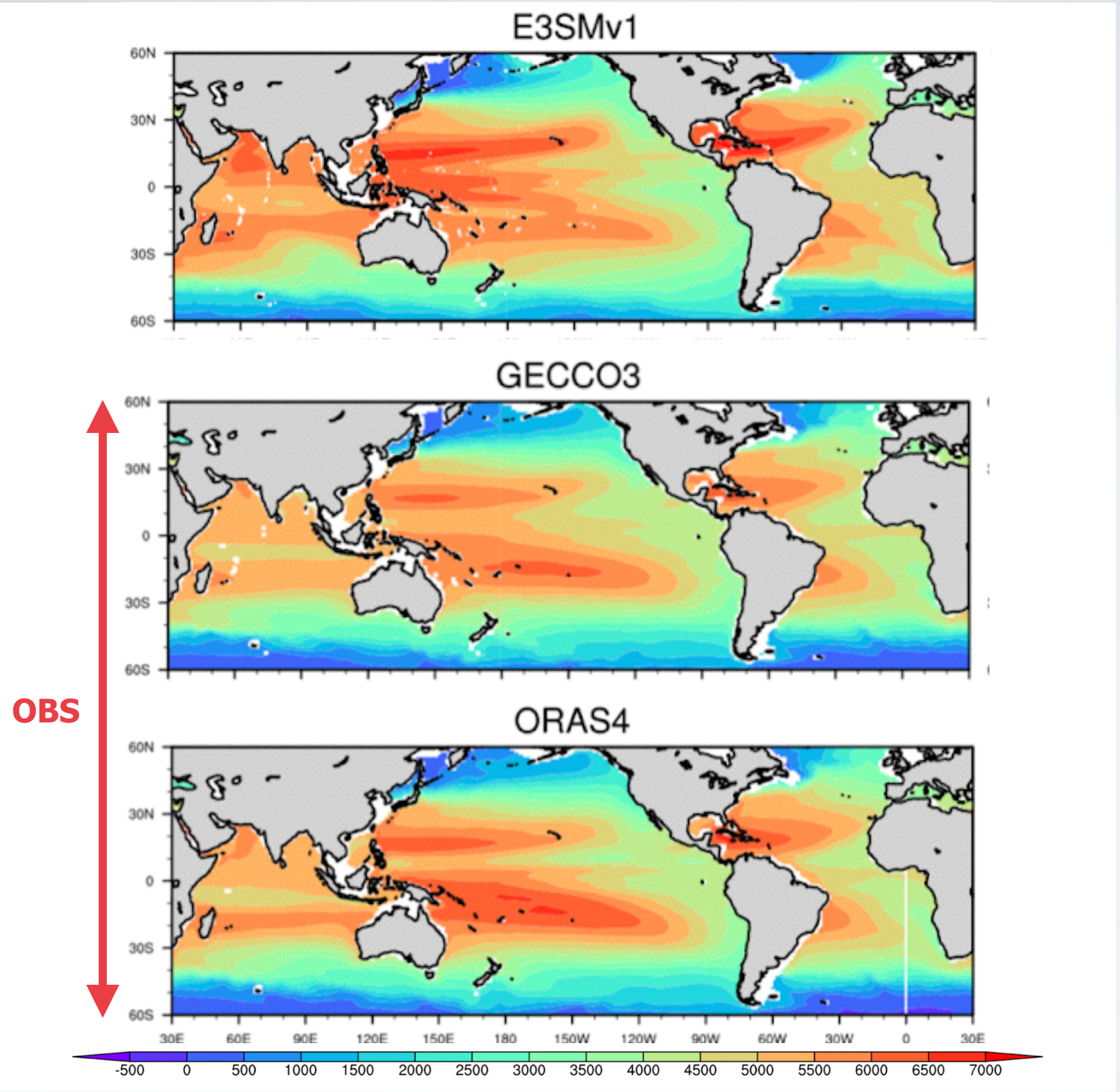
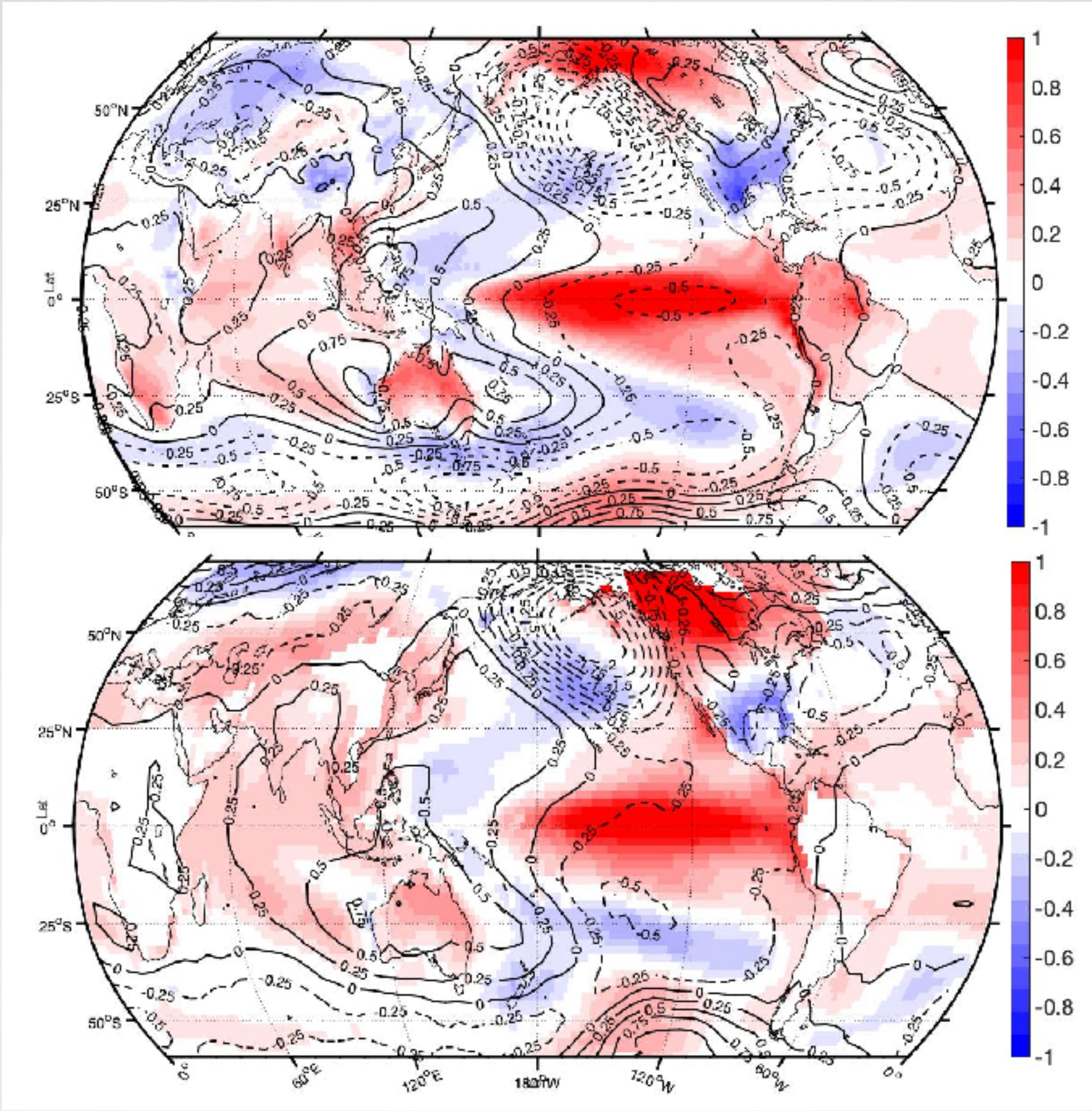


0-300m ocean heat content, 1958-2005

Stevenson et al. (2021), in prep

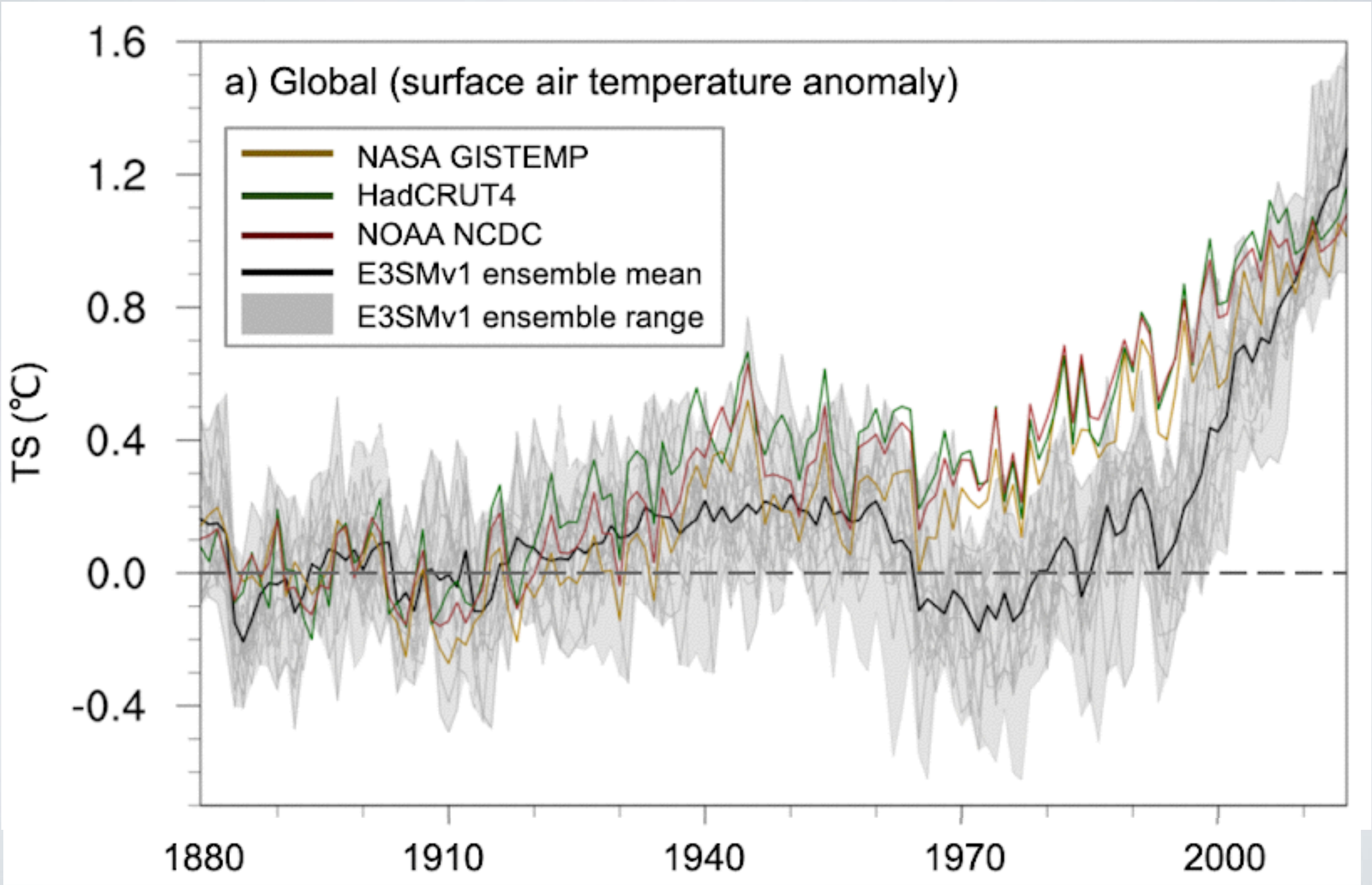
E3SM

OBS



Regression of TS (colors), SLP (contours) on NINO3.4 SSTA

20th century warming underestimated



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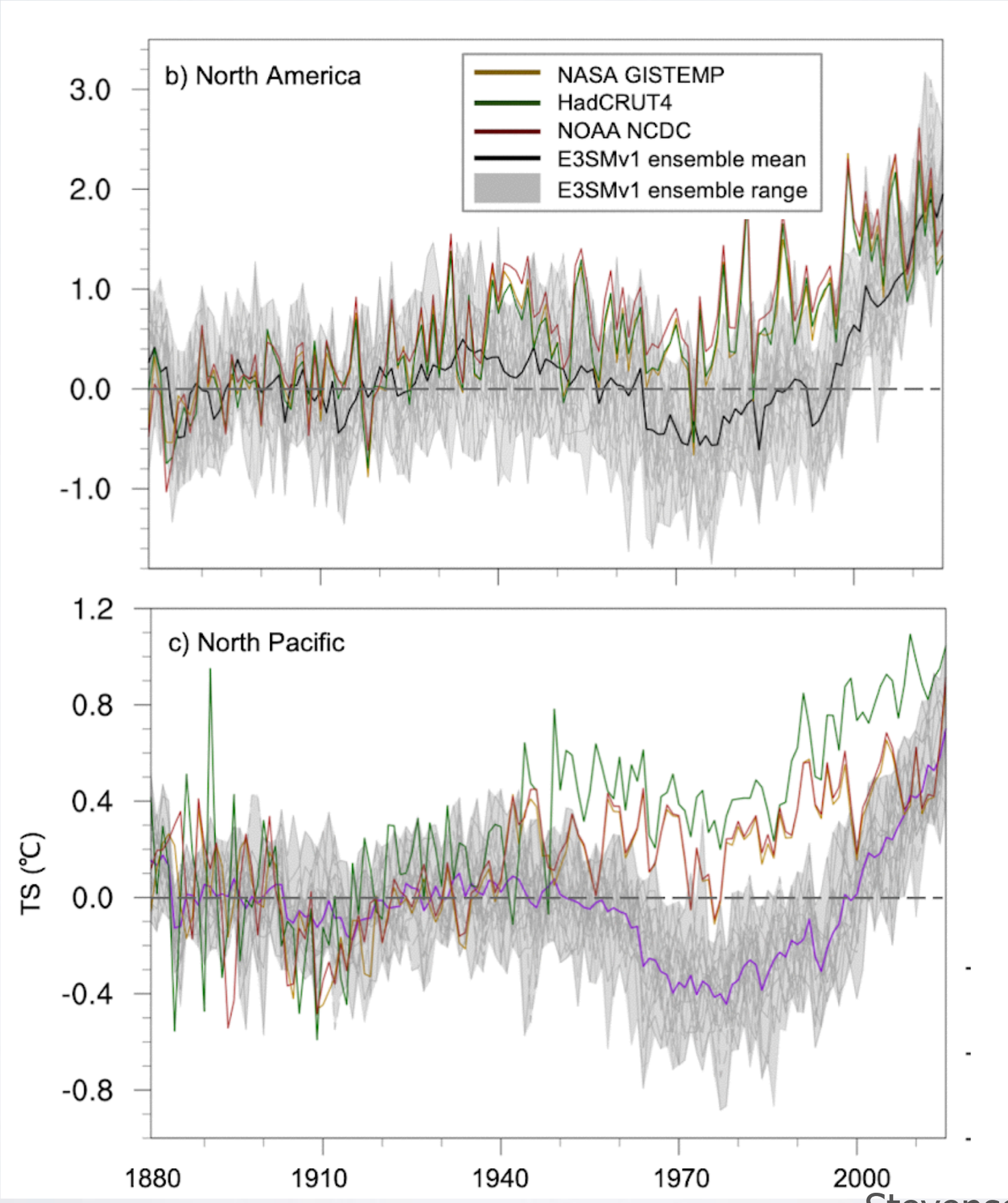
Slower warming more pronounced over N. Pacific



Stevenson et al. (2021), in prep

Macro vs. micro

How should we be building ensembles??

E3SMv1 vs. Other Large Ensembles

E3SMv1: 20 members, 1850 start

CESM1: 40 members, 1920 start (micro)

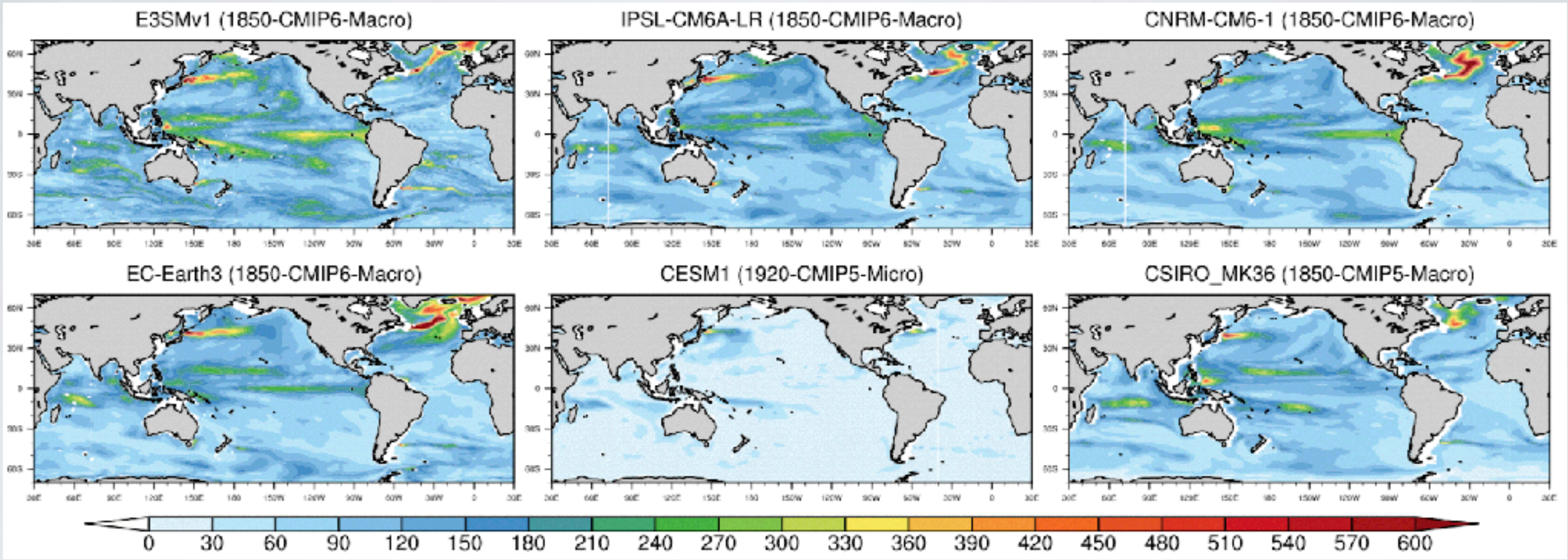
CSIRO Mk3.6: 30 members, 1850 start

IPSL-CM6A-LR: 32 members, 1850 start

CNRM-CM6-1: 30 members, 1850 start

EC-Earth3: 50 members 1850 start

Ensemble spread in FIRST MONTH

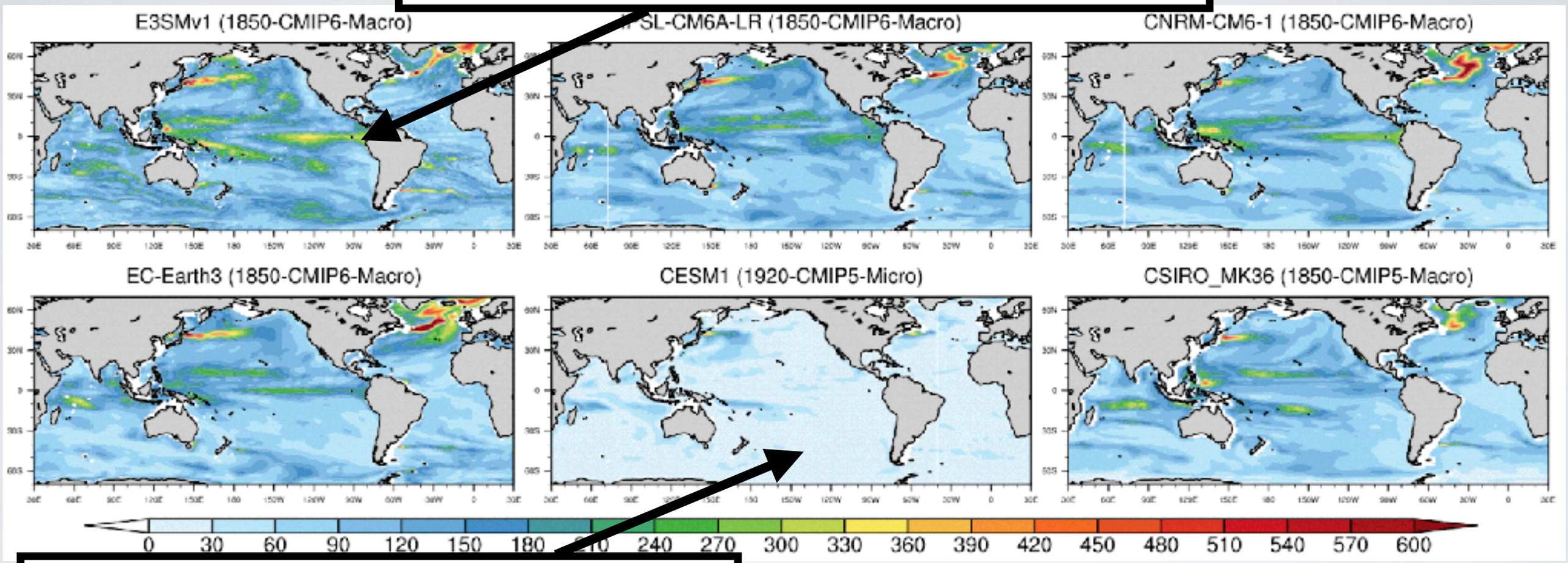


Stevenson et al. (2021), in prep

Std. dev. of ocean heat content across ensemble members (month 1 of simulation)

Ensemble spread in FIRST MONTH

E3SM: regionally larger… sometimes



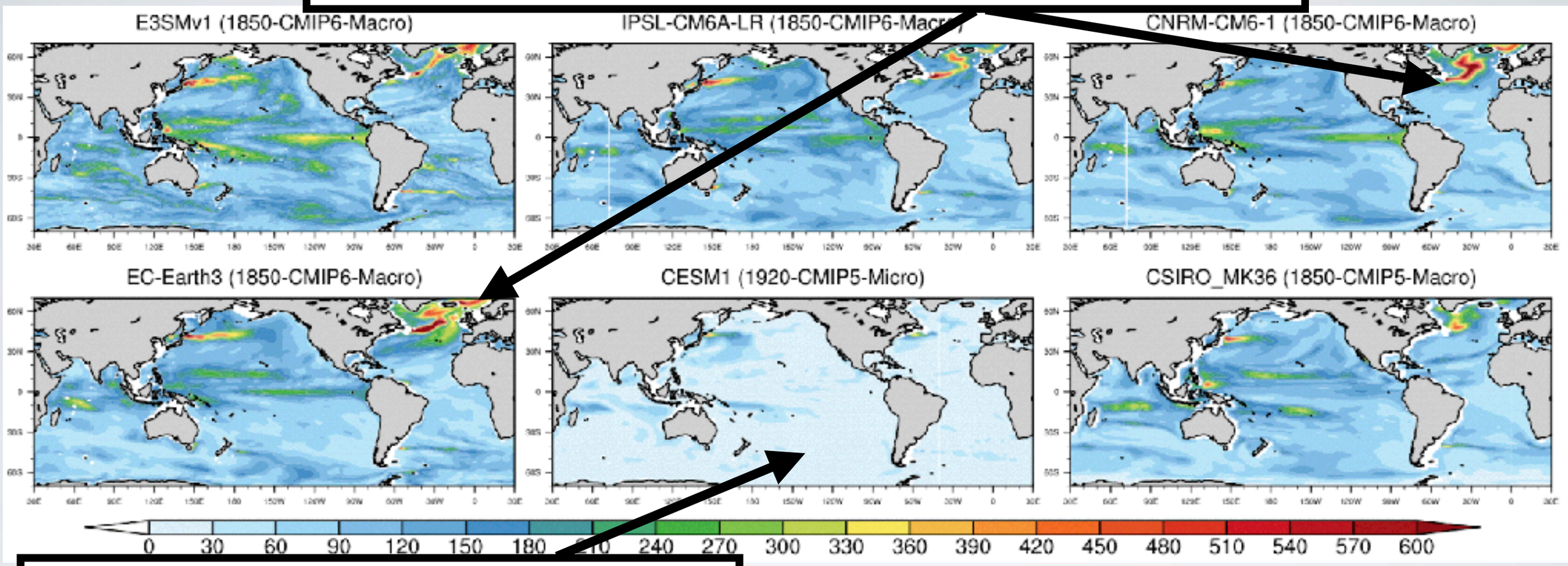
Micro ensemble: smallest spread

Stevenson et al. (2021), in prep

Std. dev. of ocean heat content across ensemble members (month 1 of simulation)

Ensemble spread in FIRST MONTH

Other macro ensembles: larger N. Atl. spread



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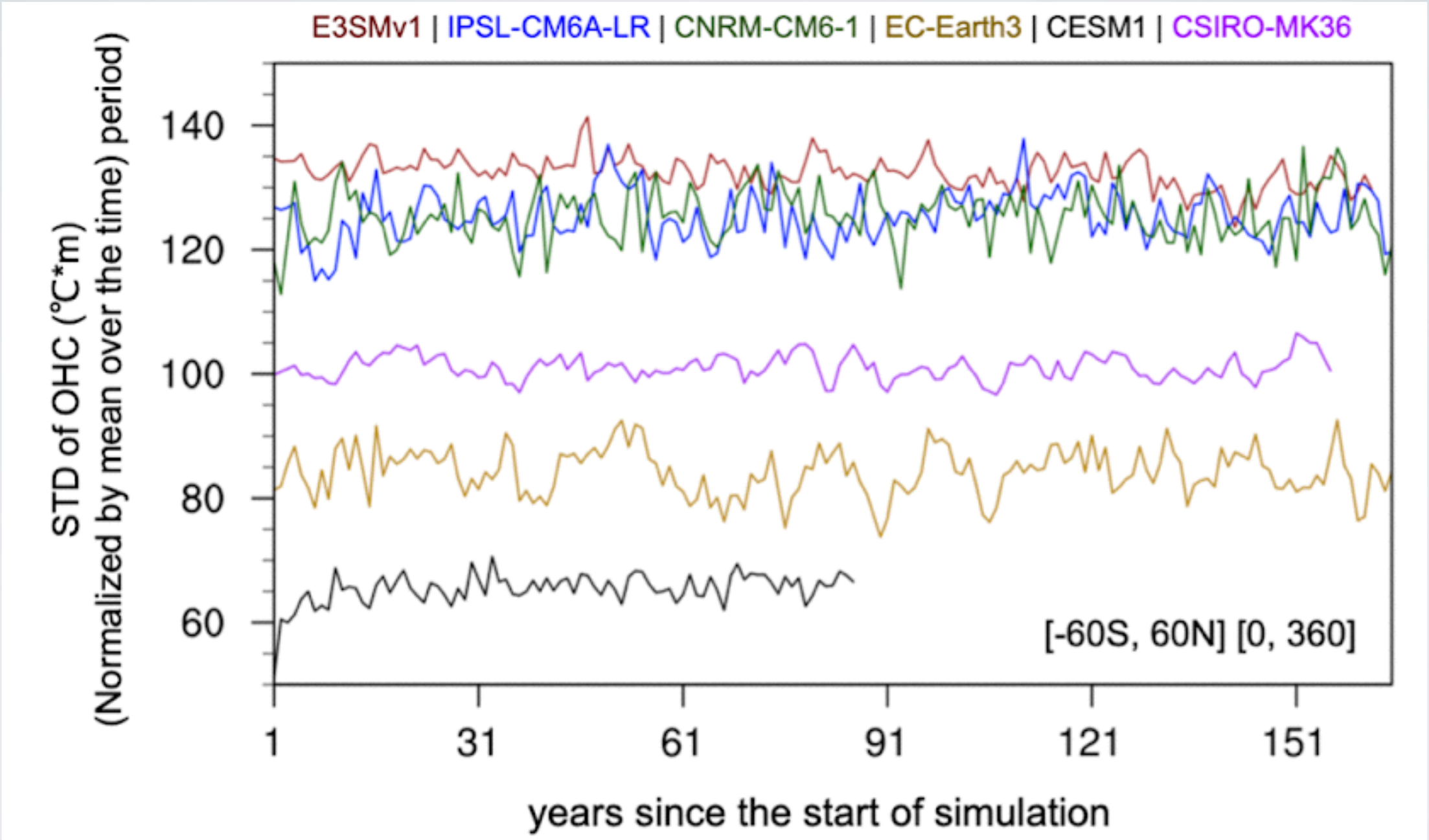
Temporal evolution of ensemble spread: 60S-60N



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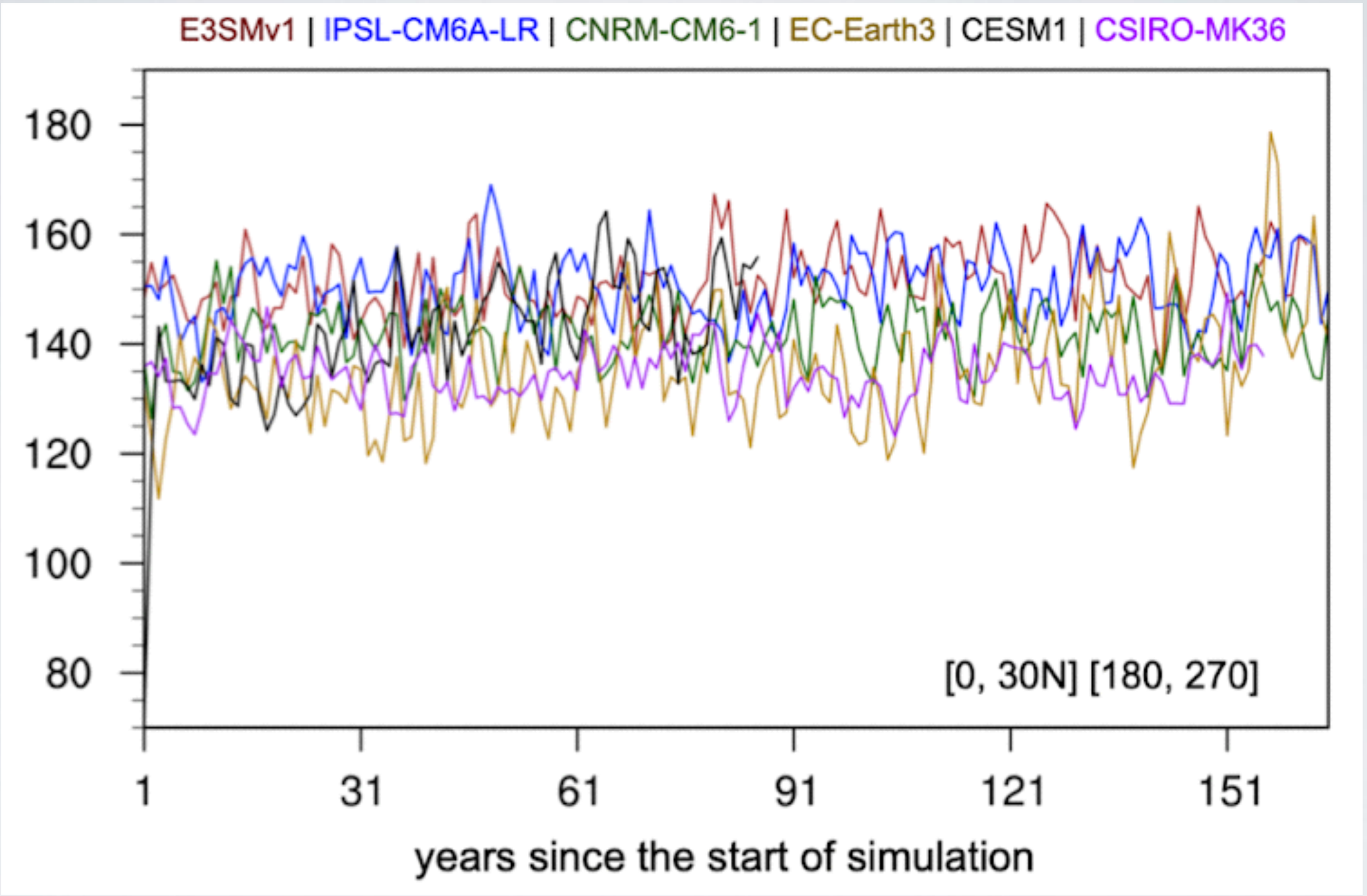
Std. dev. of ocean heat content across ensemble members

Temporal evolution of ensemble spread: eastern Pacific



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Std. dev. of ocean heat content across ensemble members

Conclusions

E3SMv1 Large Ensemble: a new resource for the DOE/modeling community (note: future simulations coming soon!)

E3SM simulates Pacific climate variability and mean ocean heat content well compared with observations

Temperature trends similar to CMIP6 simulations: underestimate of global-mean 20th c. trend, potentially important regional spatial structure

‘Optimal macro’ initialization method shows some indication of enhanced initial spread relative to other methods, but signal is small

Implications for future ensemble design: all macro methods created (mostly) equal??