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)
E3SMv1 Large Ensemble

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✔ Historical period: 1850-2015

21st century: 2016-2100 (SSP370)
Ensemble Initialization Strategy

Begin with existing low-res PI control: branch members from restarts
Initial conditions: selected by ocean basin state

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
0-300m ocean heat content, 1958-2005

Stevenson et al. (2021), in prep
Regression of TS (colors), SLP (contours) on NINO3.4 SSTA
20th century warming underestimated

Stevenson et al. (2021), in prep
Slower warming more pronounced over N. Pacific
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

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

Stevenson et al. (2021), in prep
Ensemble spread in FIRST MONTH

**E3SM**: regionally larger... sometimes

*Micro ensemble*: smallest spread

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

Stevenson et al. (2021), in prep
Ensemble spread in FIRST MONTH

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

Other macro ensembles: larger N. Atl. spread

Micro ensemble: smallest spread

Stevenson et al. (2021), in prep
Temporal evolution of ensemble spread: 60S-60N

Std. dev. of ocean heat content across ensemble members

Stevenson et al. (2021), in prep
Temporal evolution of ensemble spread: eastern Pacific

Std. dev. of ocean heat content across ensemble members

Stevenson et al. (2021), in prep
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??