Distinguishing Forced and Internal Multi-Decadal Variability in the North Atlantic using CESM LENS

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Motivation

- Recent studies raised again the issue of whether the AMV during the instrumental period is largely forced by radiative forcing, particularly anthropogenic and volcanic aerosols.
- What, if any, is the internally generated AMV and whether it is different from the forced North Atlantic SST variability?
- CESM LENS provide a unique opportunity to answer this question.
- We use S/N EOF analysis to identify the forced modes based on the single model LENS, as compared to the multi-model approach based on CMIP3 and 5 in earlier studies.
S/N EOF Analysis Performed on LENS Global SST

• Mode 1 – 78%, hemispheric symmetric warming
• Mode 2 – 7.5%, hemispheric asymmetric mode, reflecting more of the aerosol forcing?

Ting et al., 2009, 2011
Forced and Unforced North Atlantic SST Index (NASSTI)

- Forced NASSTI variability can be largely removed with both modes 1&2 taken out.
- AMV of individual ensemble member is not highly correlated with observations.

Dashed: observed       Color: Individual ensemble member       Solid Black: ensemble mean
Spatial Patterns of Forced Mode 1 & 2 vs. AMV

Ts

AMV w/o ENSO
Spatial Patterns of Forced Mode 1 & 2 vs. AMV w/o ENSO

Ts

Precip

SLP
Forced versus Internal Decadal Variability estimated from LENS vs. CMIP5 multi-models.

Forced Variance

Decadal Variance

Decadal_Total Variance Ratio

LENS

CMIP5 Multi-models
Summary

• With large ensembles, it is possible to identify multiple forced modes with distinct spatial characteristics.

• While the second forced mode, possibly forced by aerosols, shares some similarity to the internal multidecadal mode (AMV), the regional temperature and precipitation patterns associated with these are distinct.

• The CESM LENS show too strong a forced variance in the subpolar North Atlantic, as compared to the CMIP5 model ensembles.

• This points to the need for more large ensemble simulations using different models.