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

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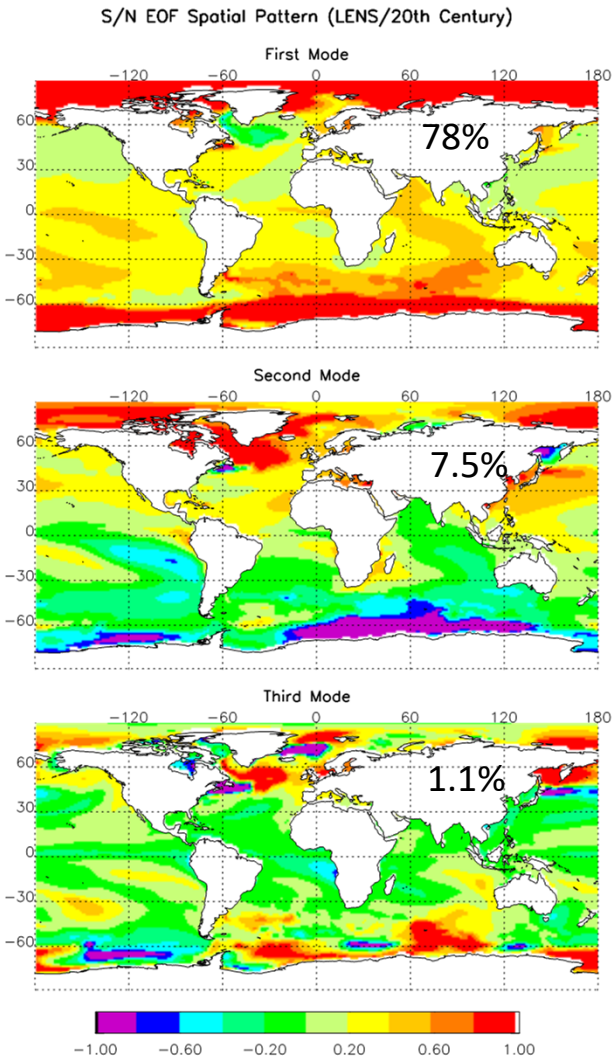
Motivation

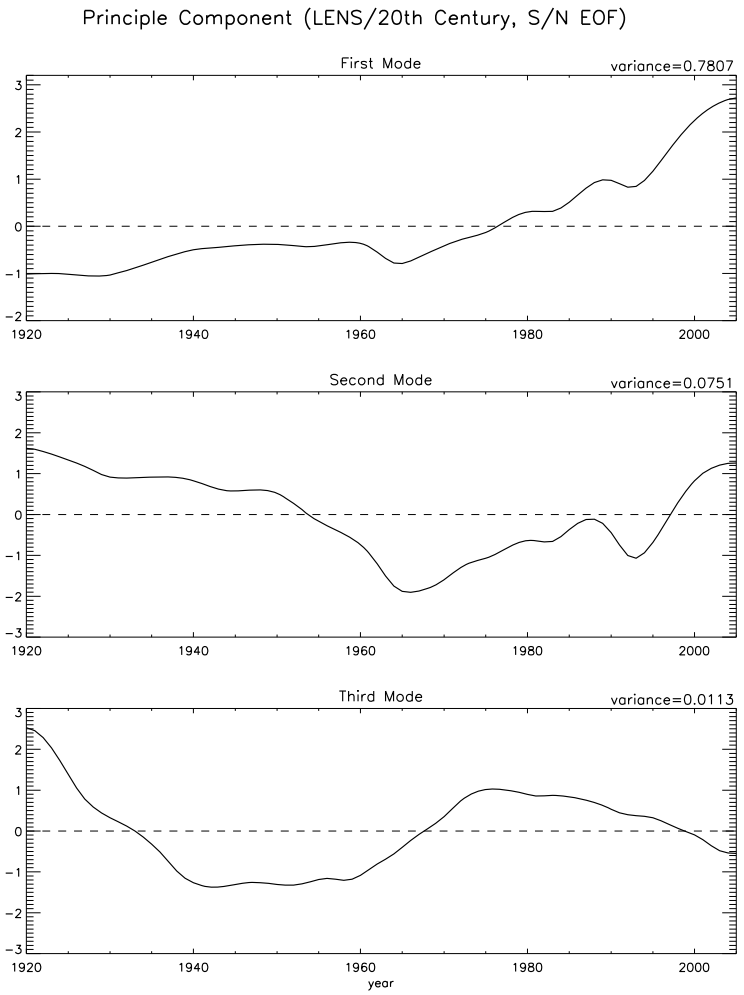
- Recent studies raised again the issue of whether the AMV during the instrumental period is largey forced by radiative forcing, particularly anthropogenic and volcanic aerosols
- What, if any, is the internally generated AMV and whether it is different from the forced North Atlantic SST variability?
- 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

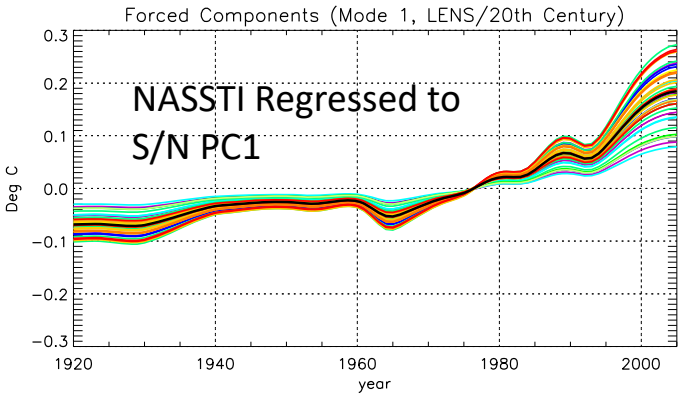
- Mode 1 – 78%, hemispheric symmetric warming
- Mode 2 – 7.5%, hemispheric asymmetric mode, reflecting more of the aerosol forcing?

Ting et al., 2009, 2011

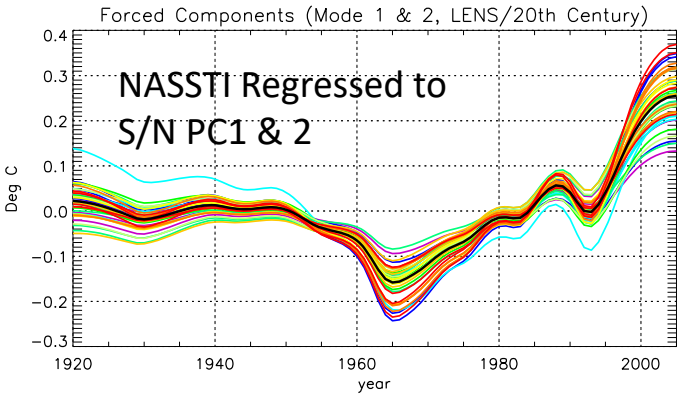


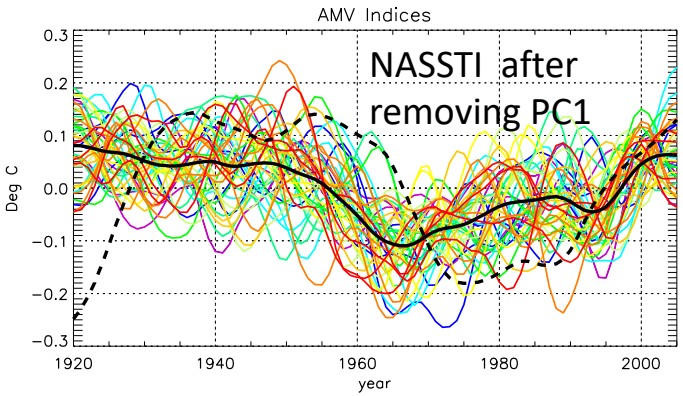


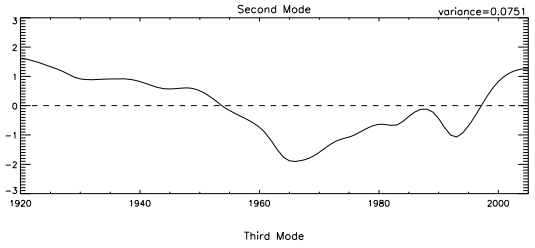
Forced and Unforced North Atlantic SST Index (NASSTI)

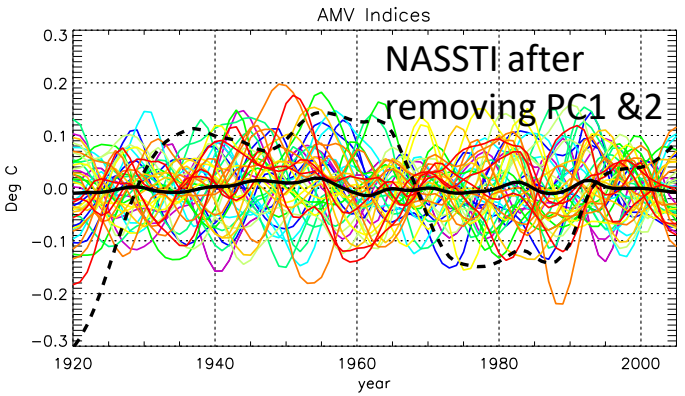


- Forced NASSTI variability can be largely removed with both modes 1&2 taken out
- AMV of individual ensemble member is not highly correlated with observations





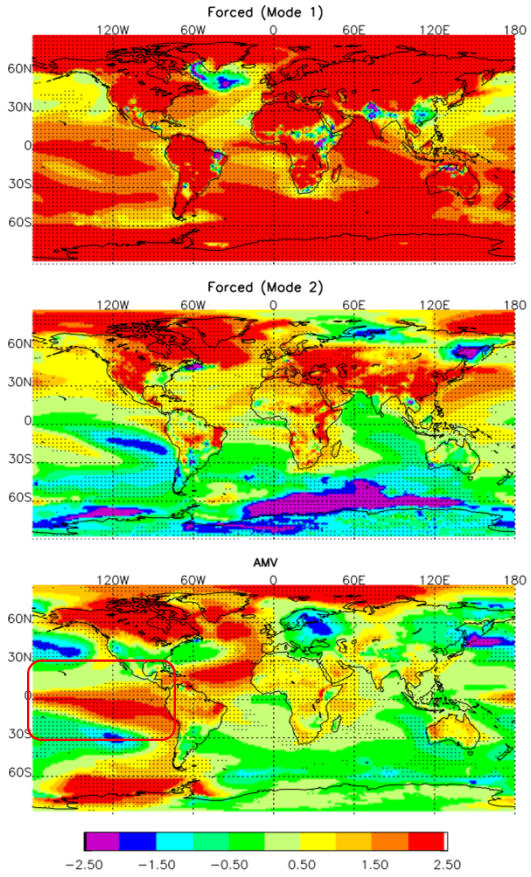




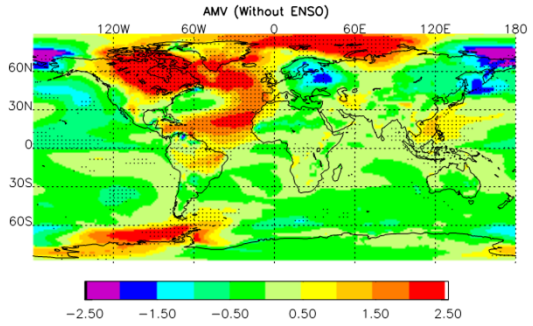
Dashed: observed Color: Individual ensemble member Solid Black: ensemble mean

Spatial Patterns of Forced Mode 1 &2 vs. AMV

Ts



AMV w/o ENSO



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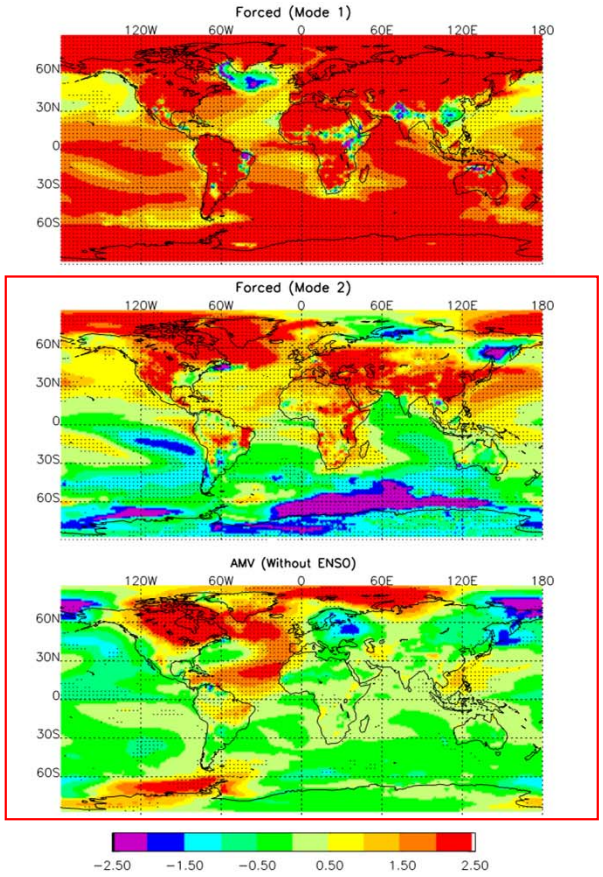
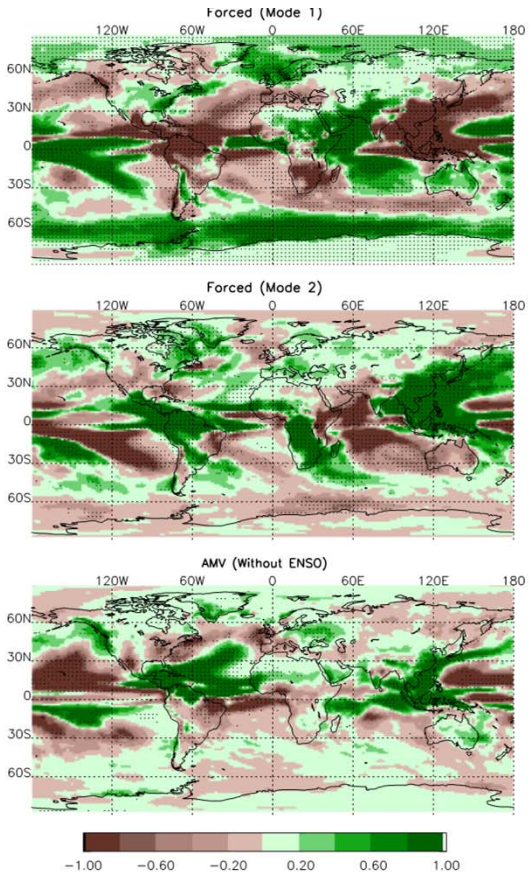
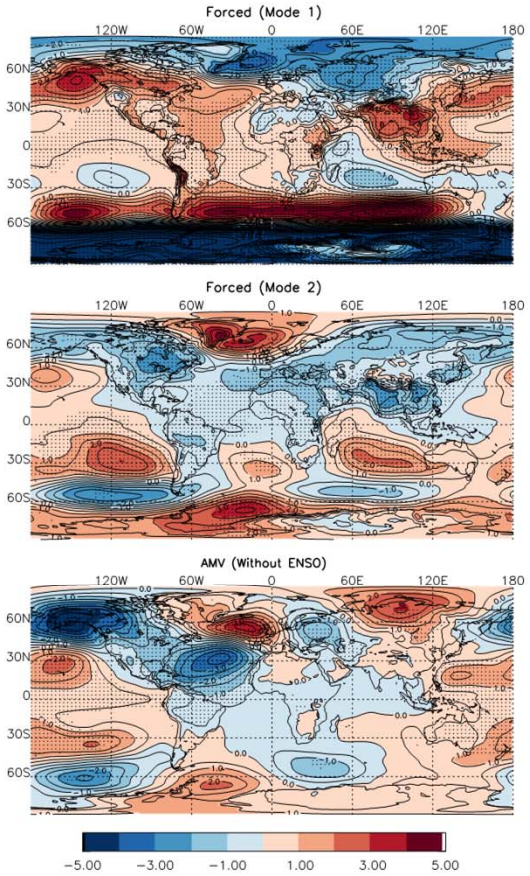


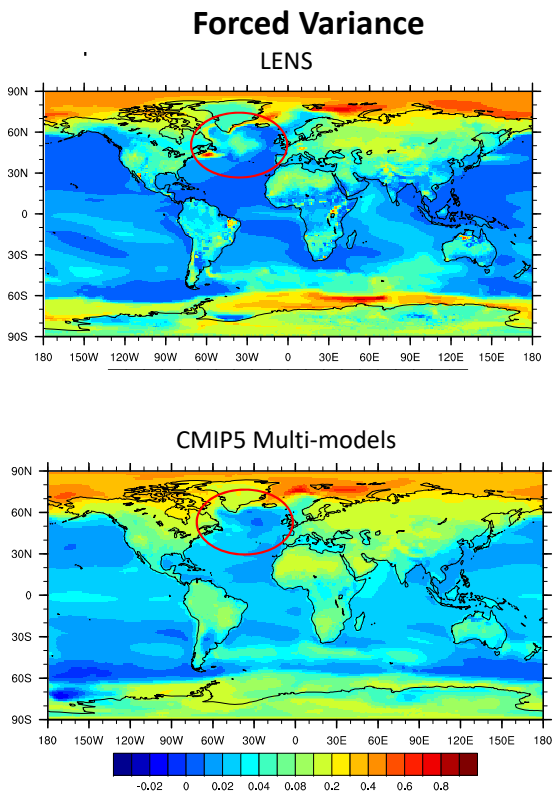
Precip

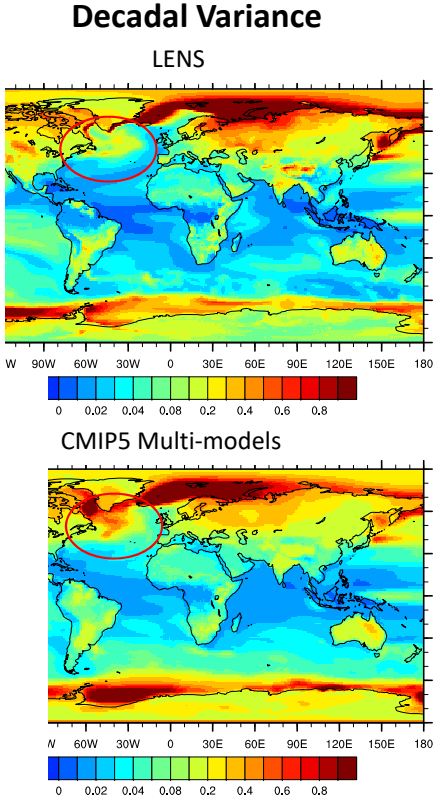


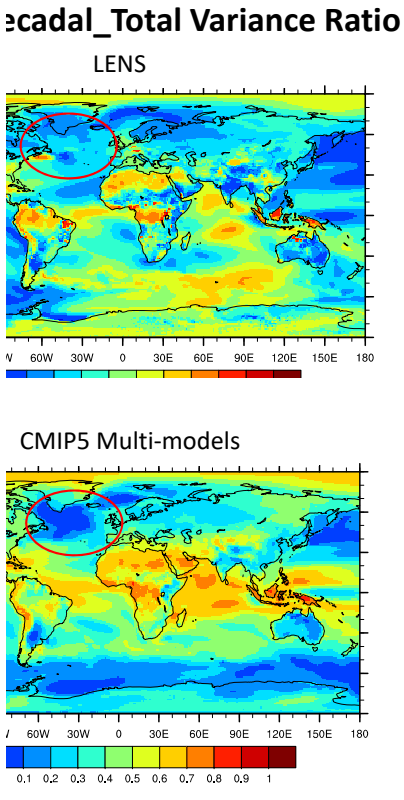
SLP



Forced versus Internal D estimated from LENS vs.







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.