An Atmospheric Bridge Between the Subpolar and Tropical Atlantic Regions: A Perplexing Asymmetric Teleconnection

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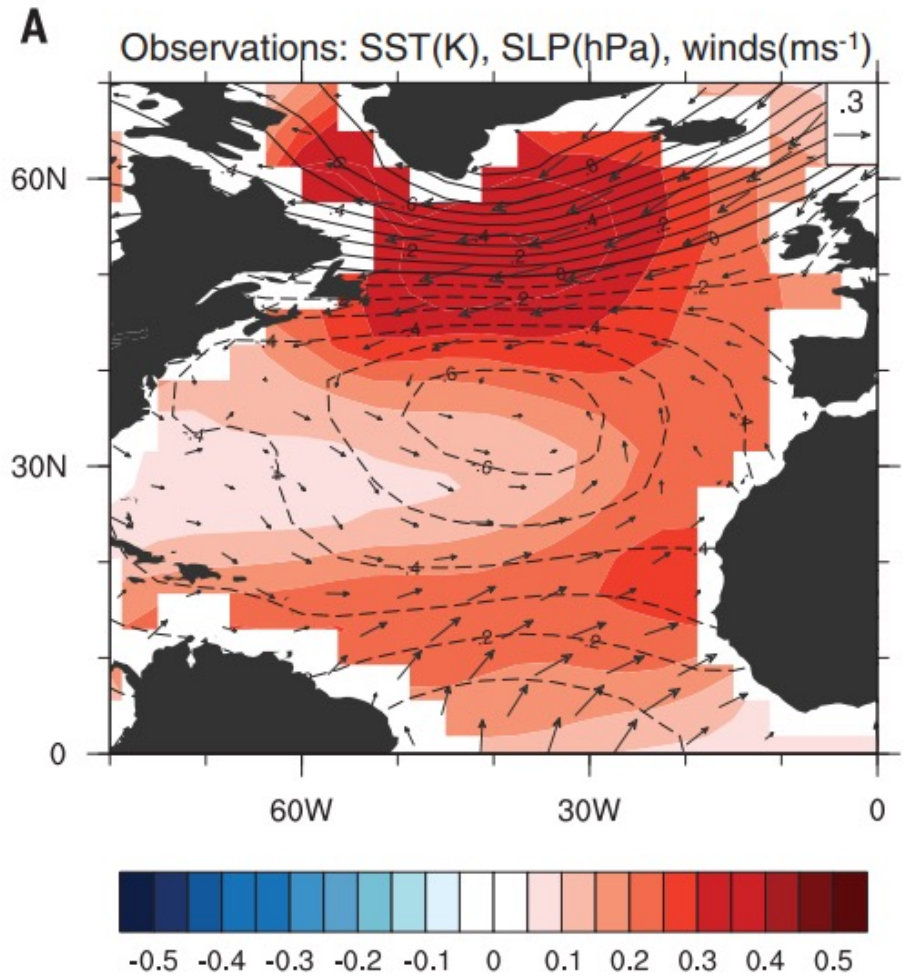
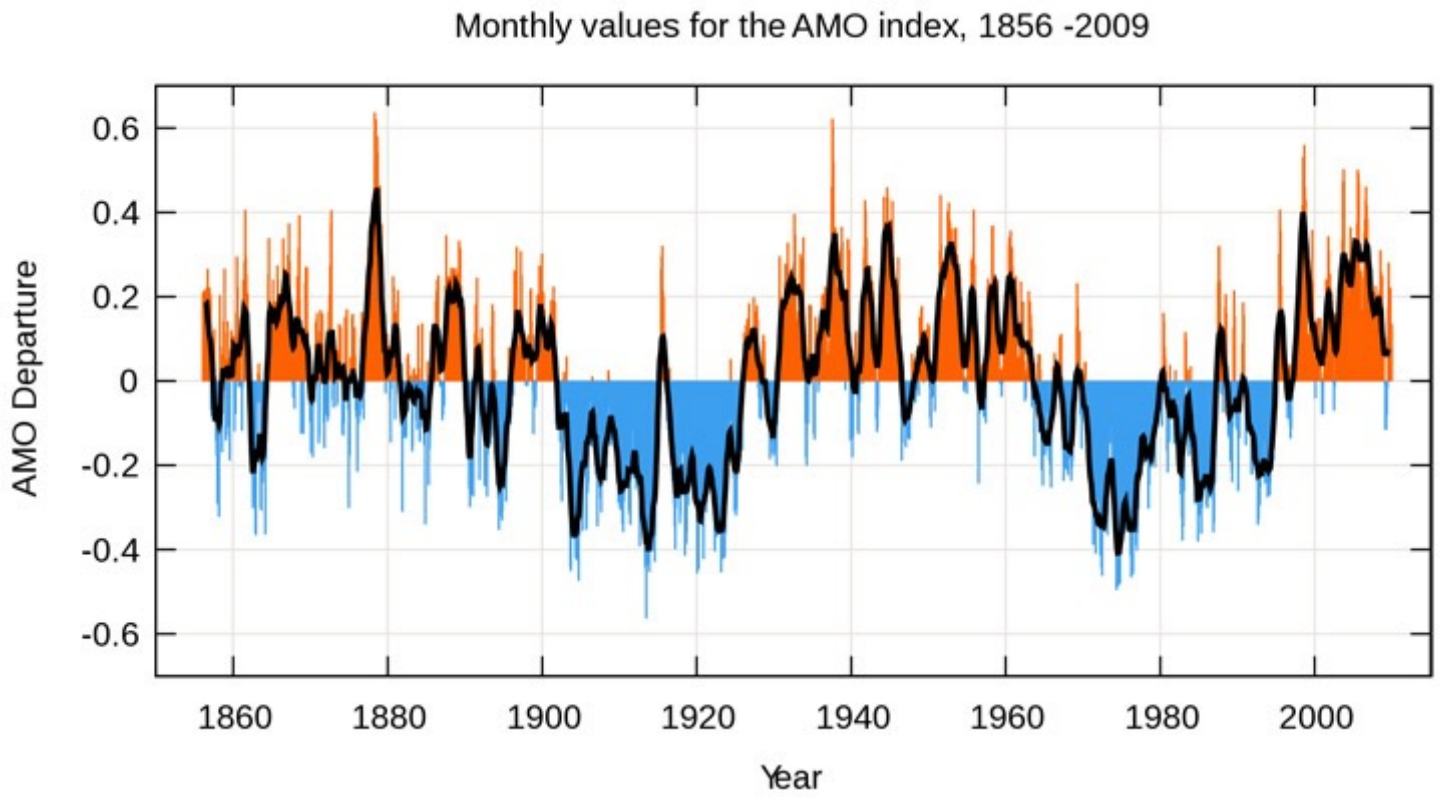
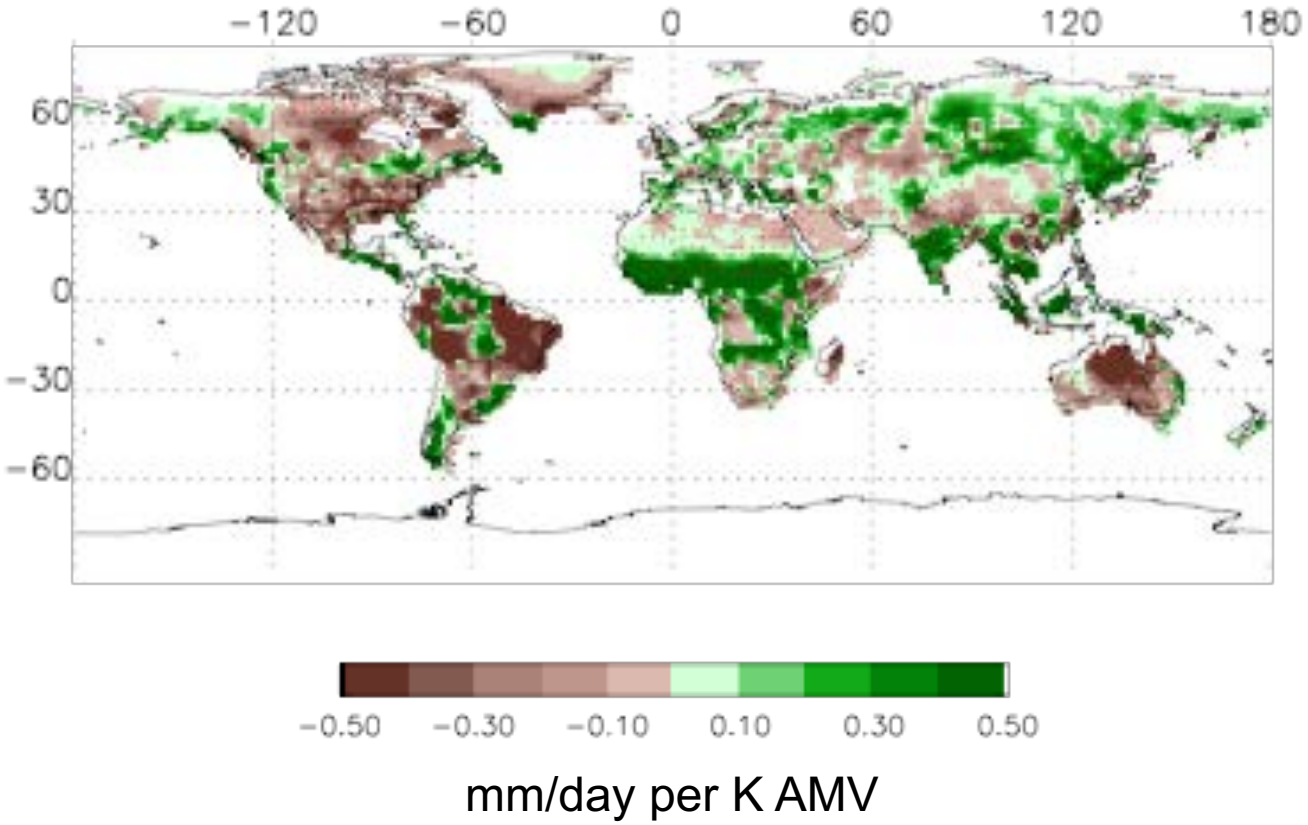
Atlantic Multidecadal Variability (AMV)





Clement et al. (2015)

Impacts of AMV

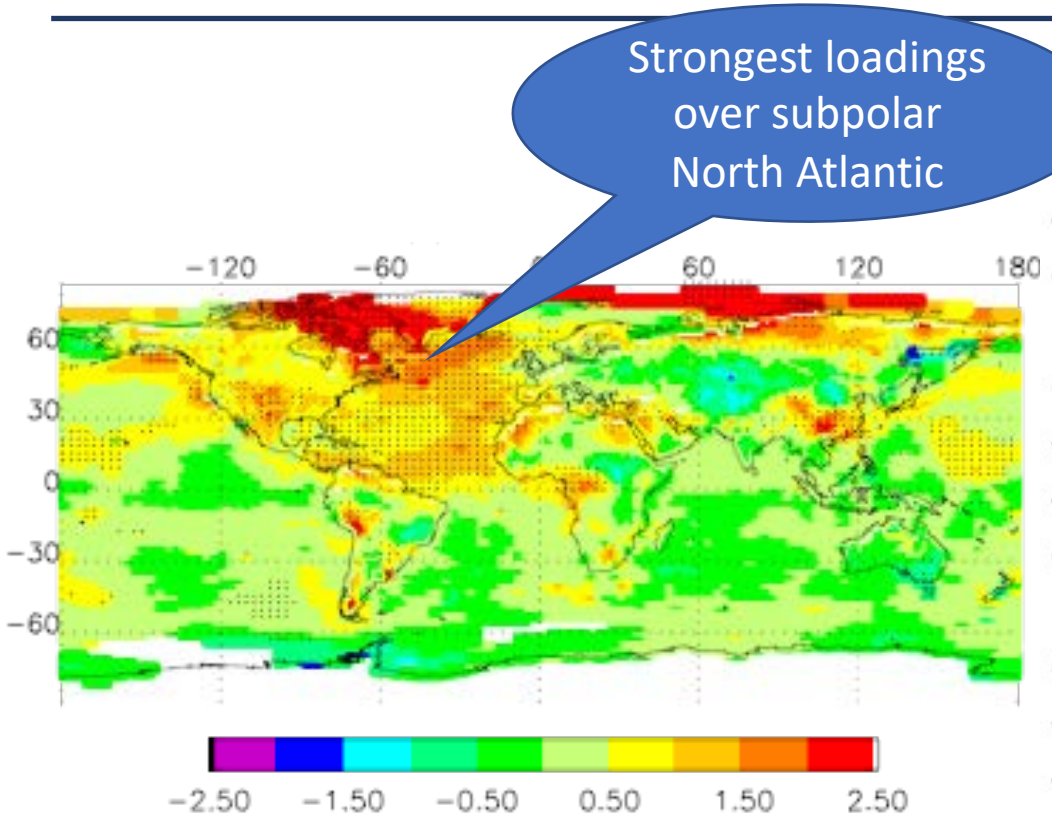


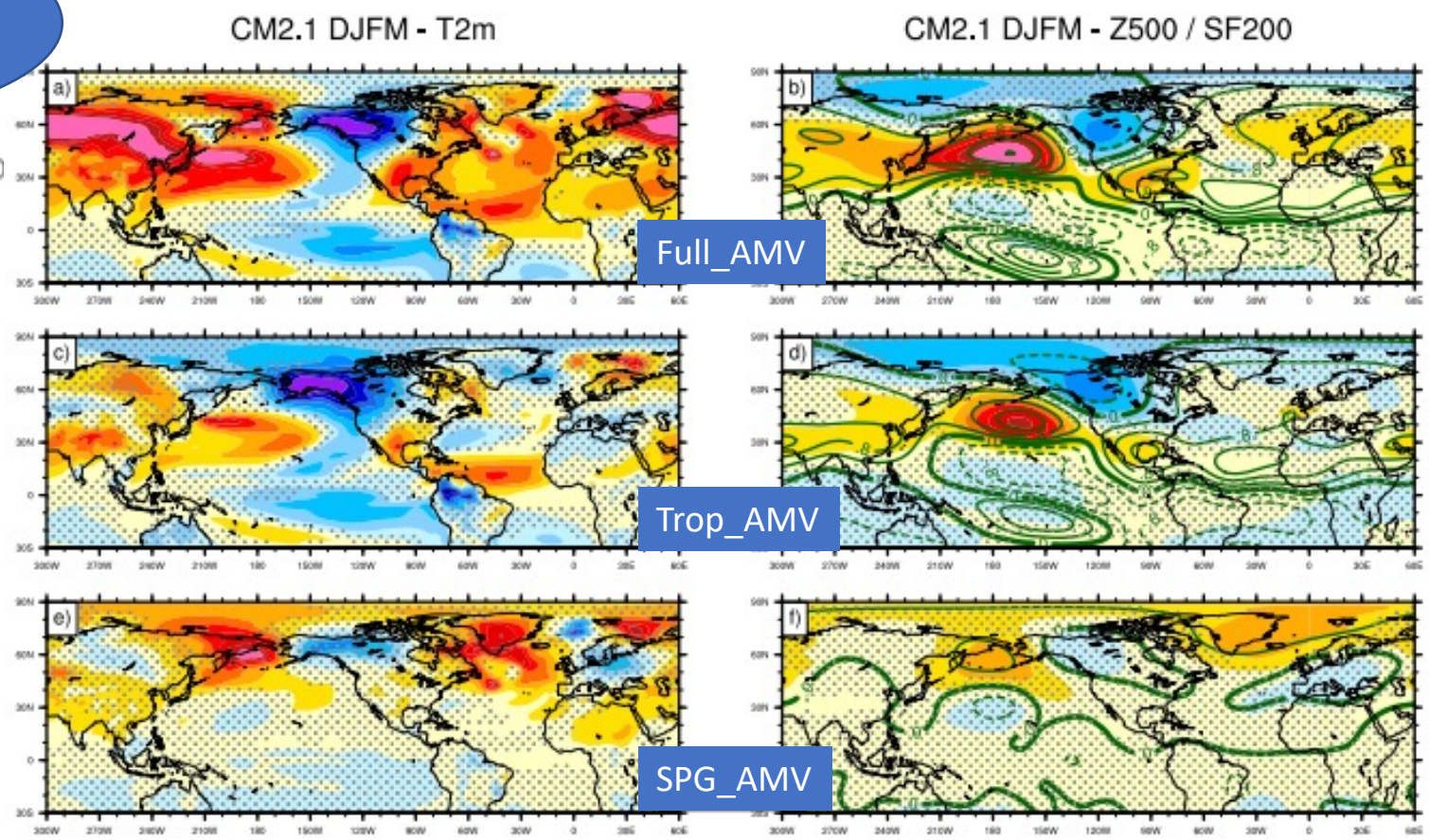
Affects

- North African monsoons
- North American droughts
- European temperature
- North Atlantic hurricanes

Ting et al. (2009)

Motivation





Tropical Atlantic Drives AMV Impacts!

Ting et al. (2009)

Ruprich-Robert et al. (2017)

Motivation

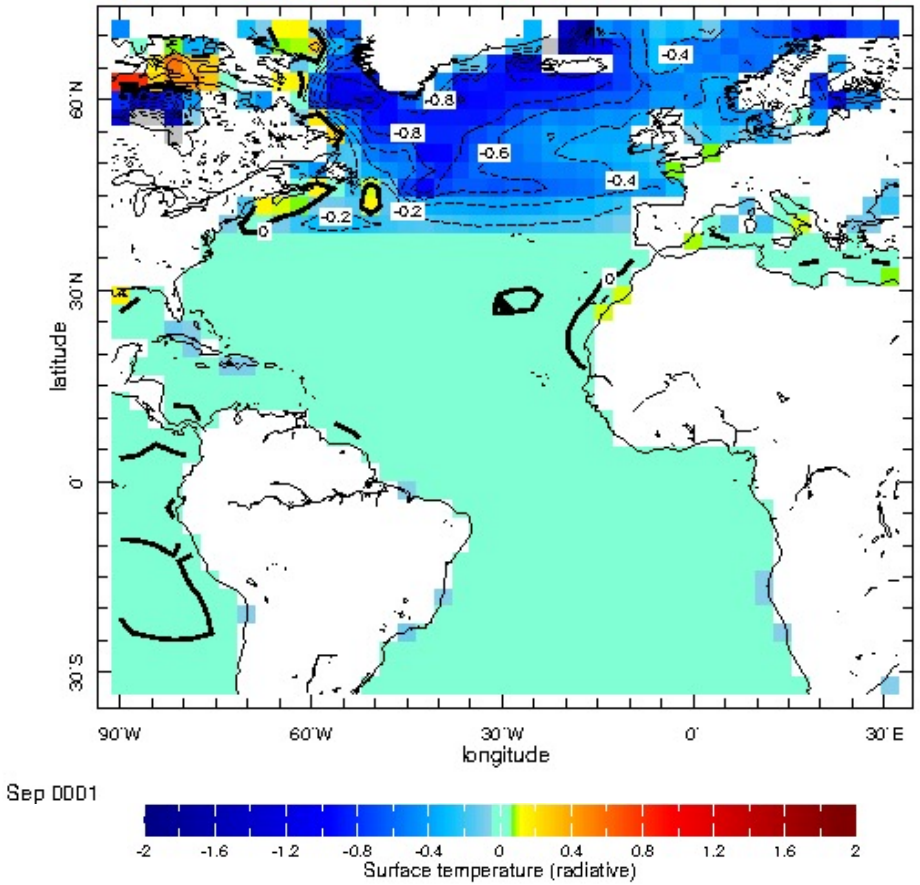
What are the atmospheric processes that communicate subpolar Atlantic SST change to the tropical North Atlantic?

We turn to idealized model experiments!

Methods: Idealized CAM5 experiments

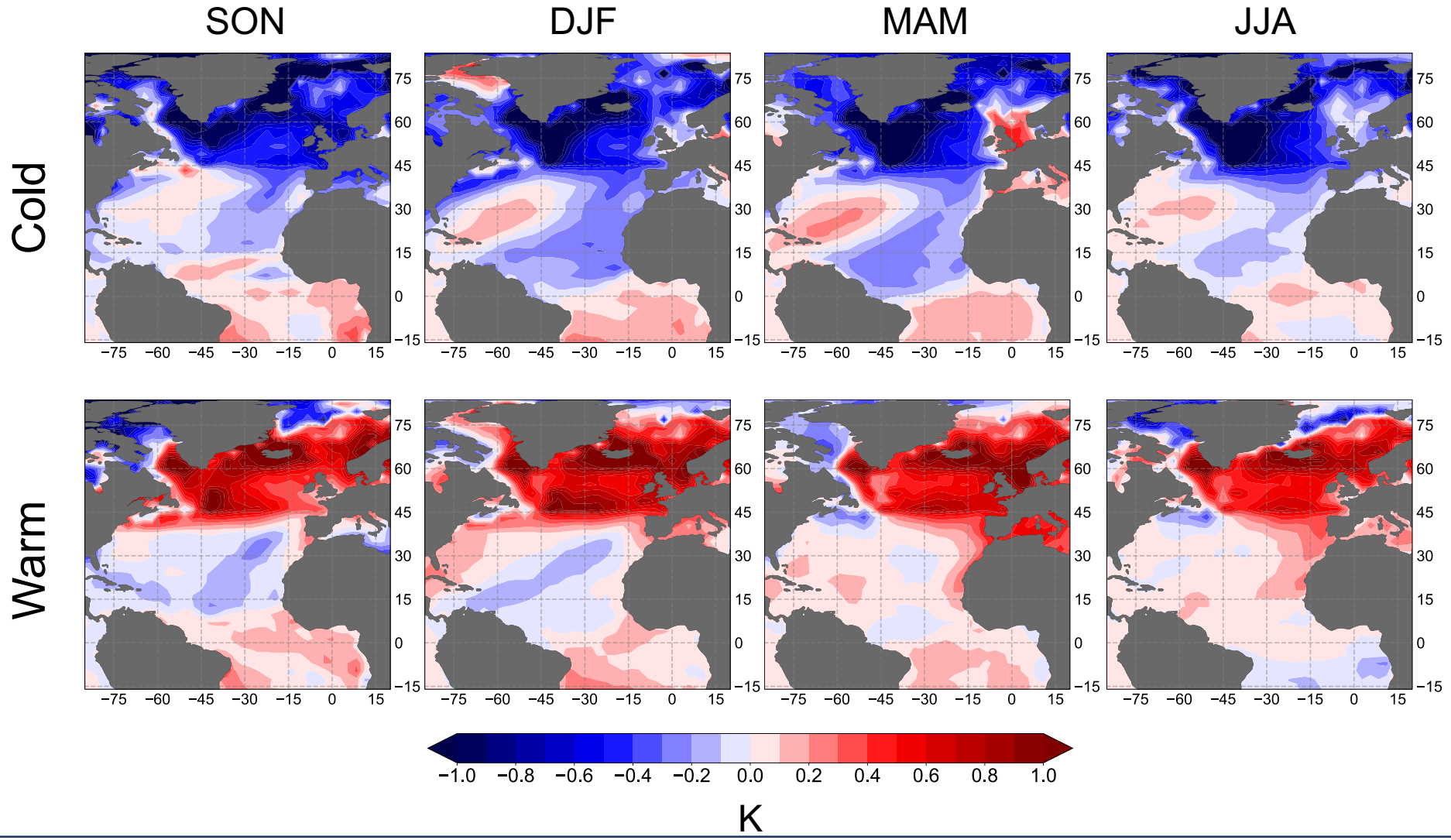
- Three 13-month, 60-member ensembles
  - 50-meter slab ocean over Atlantic (30ºS to 90ºN), Q-flux corrected to maintain observed monthly SST climatology (1970-2000)
  - Climatological SSTs elsewhere
- Apply warm, cold, and climatological AMV SSTs to subpolar North Atlantic!
  - 5x warm AMV pattern (“POS-ML”)
  - 5x cold AMV pattern (“NEG-ML)
  - climatology (“CLM-ML)

Forced SST Anomaly



Forcing Influence =
POS-ML/NEG-ML Ensemble Mean - CLM-ML Ensemble Mean

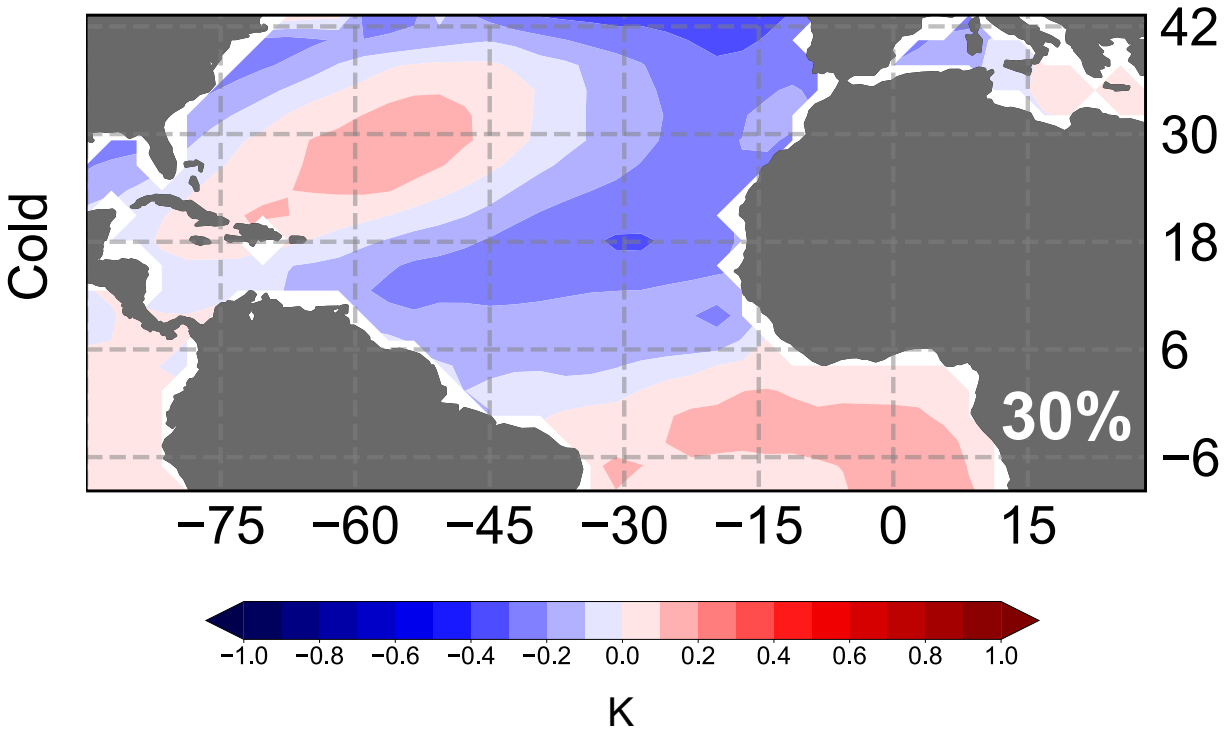
Warm and Cold Phases of AMV Are Asymmetric

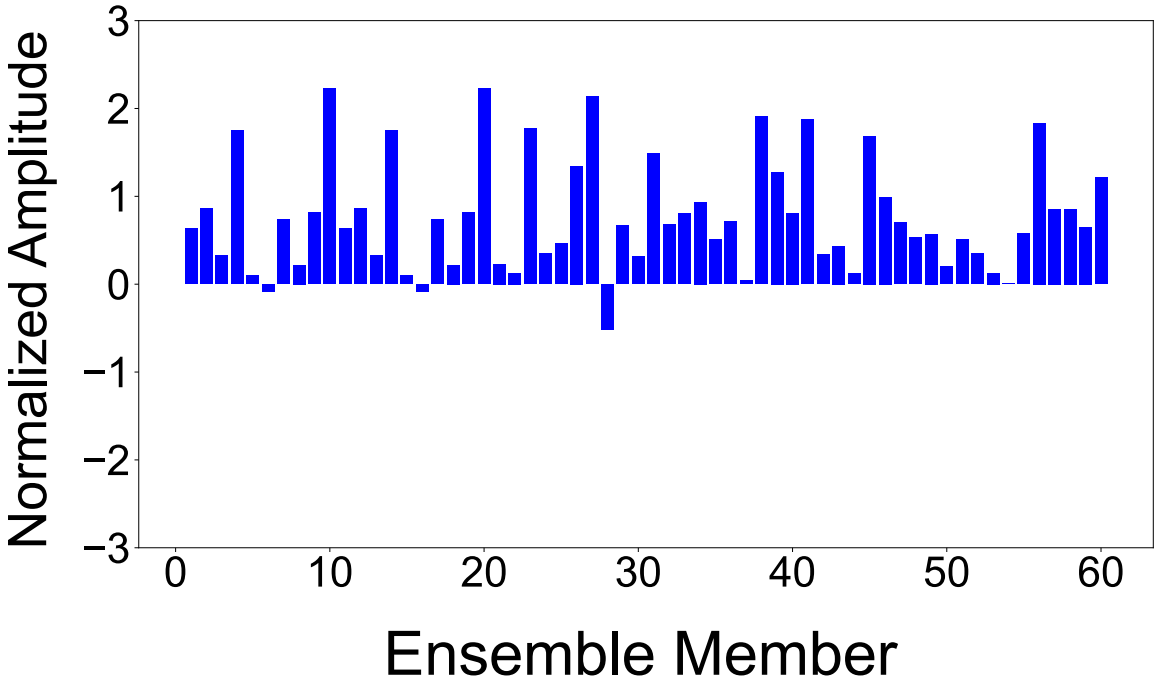


Baek et al. (2021), Geophysical Research Letters

How Robust Are These Results?

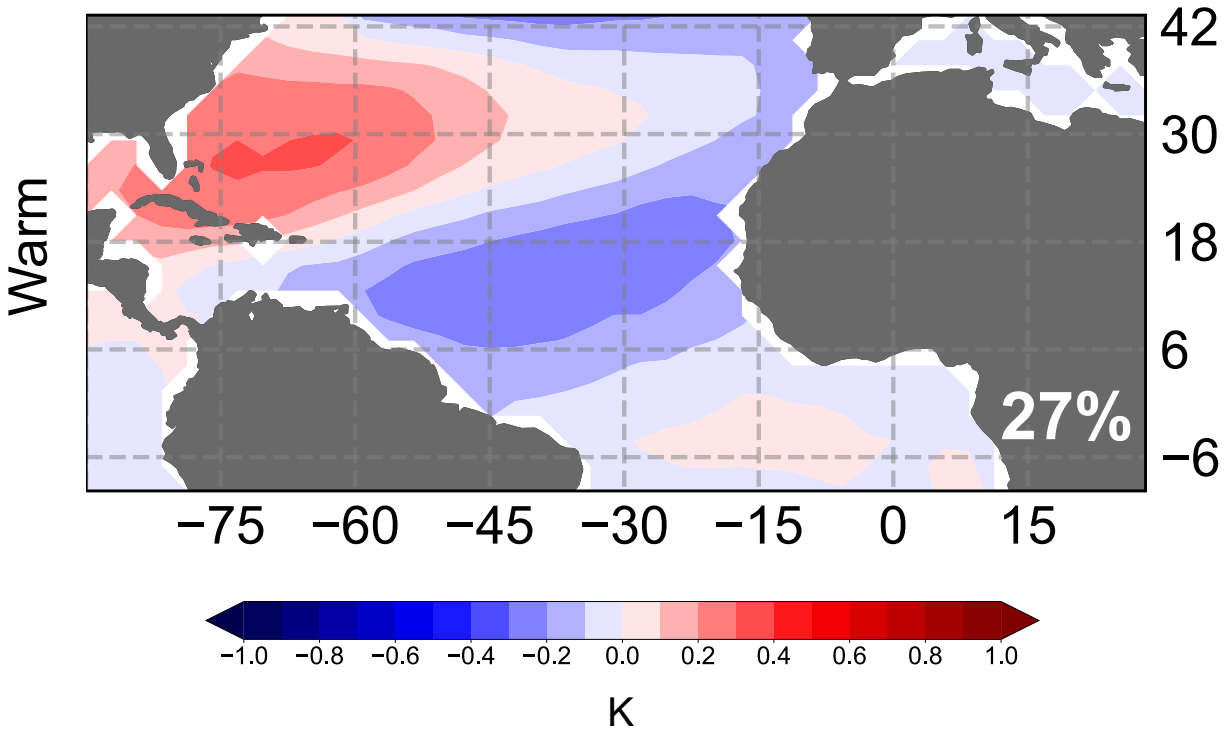
Pattern amplitude is steady and same sign across 60-members

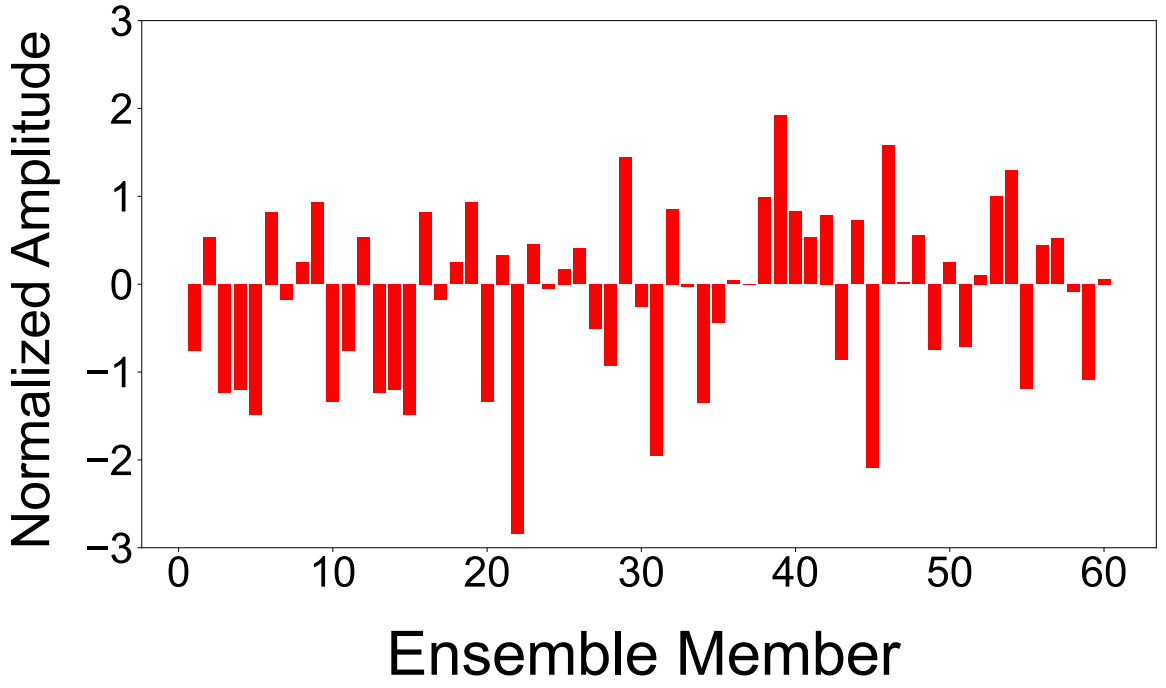




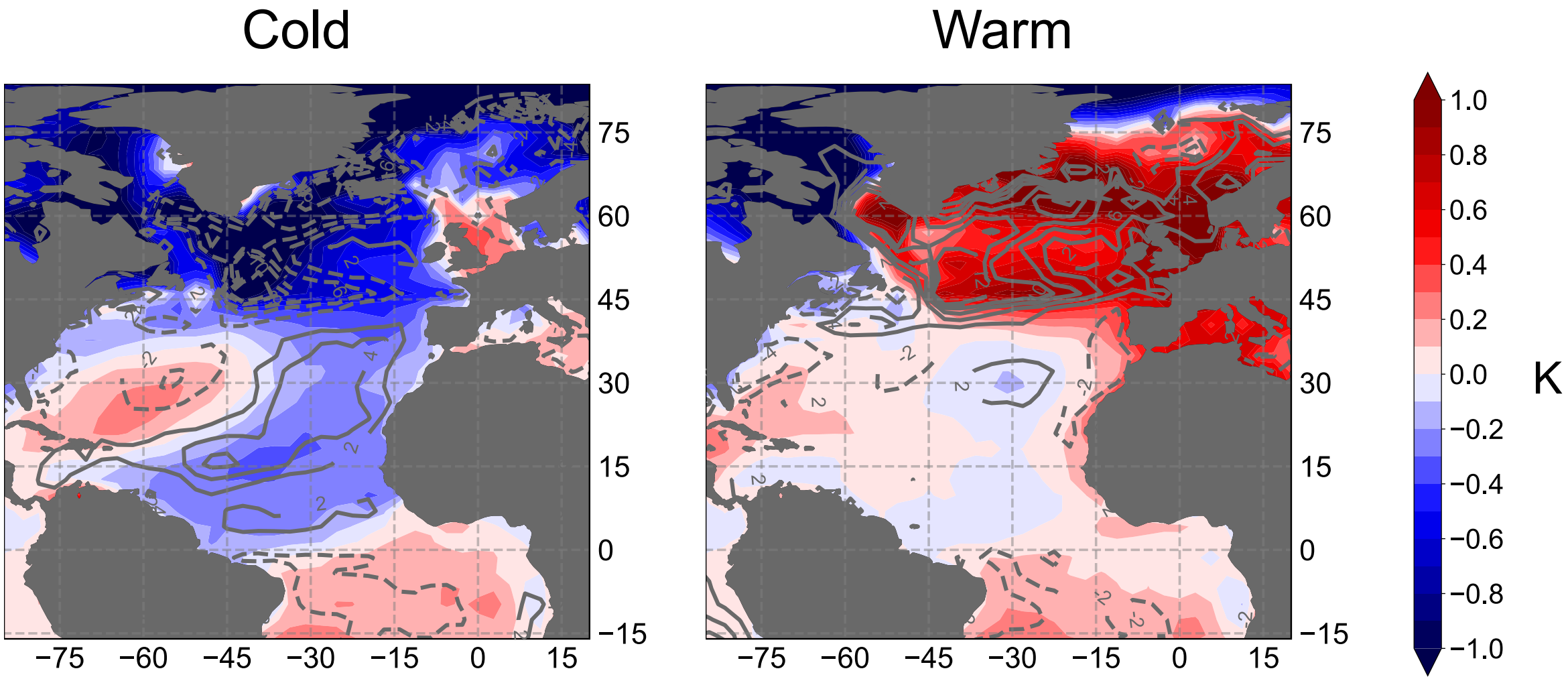
How Robust Are These Results?

Pattern amplitude fluctuates and changes sign across 60-members

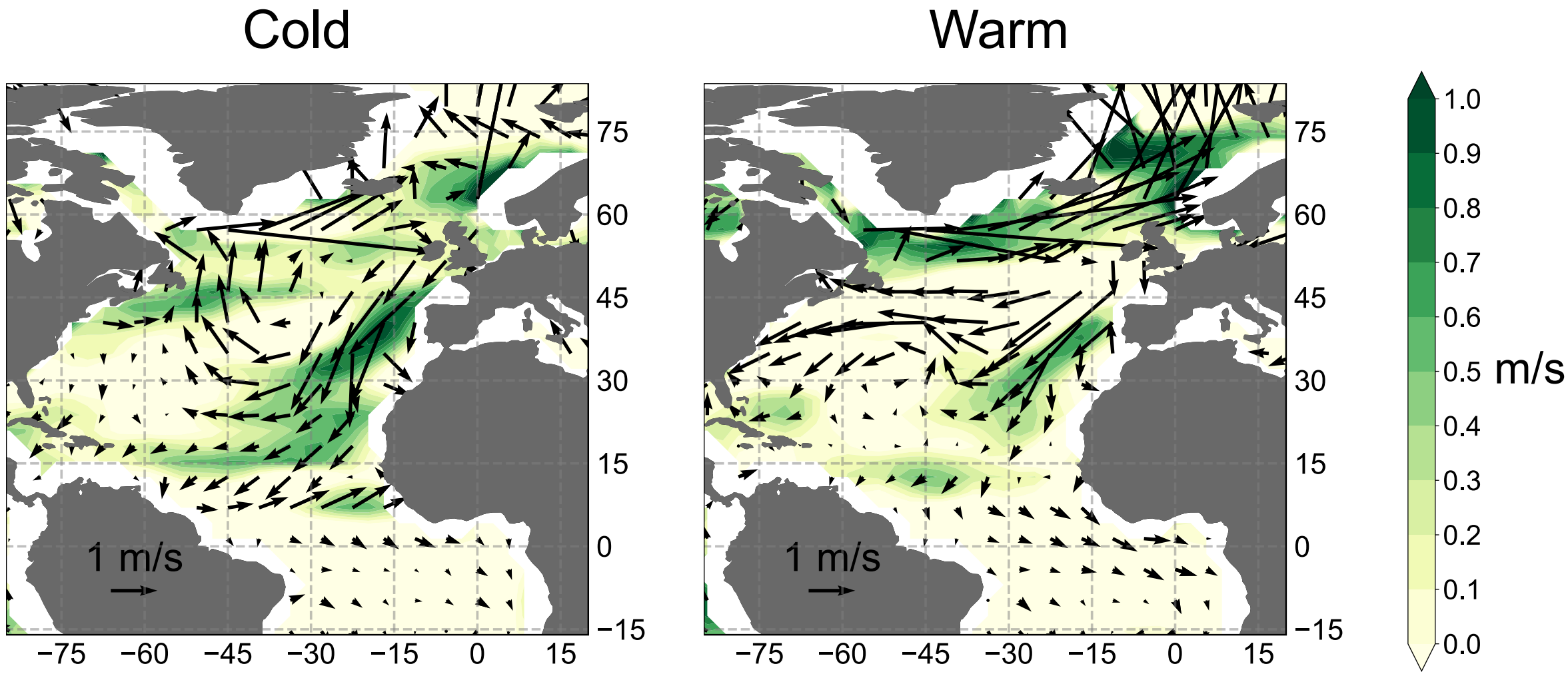




Mechanism

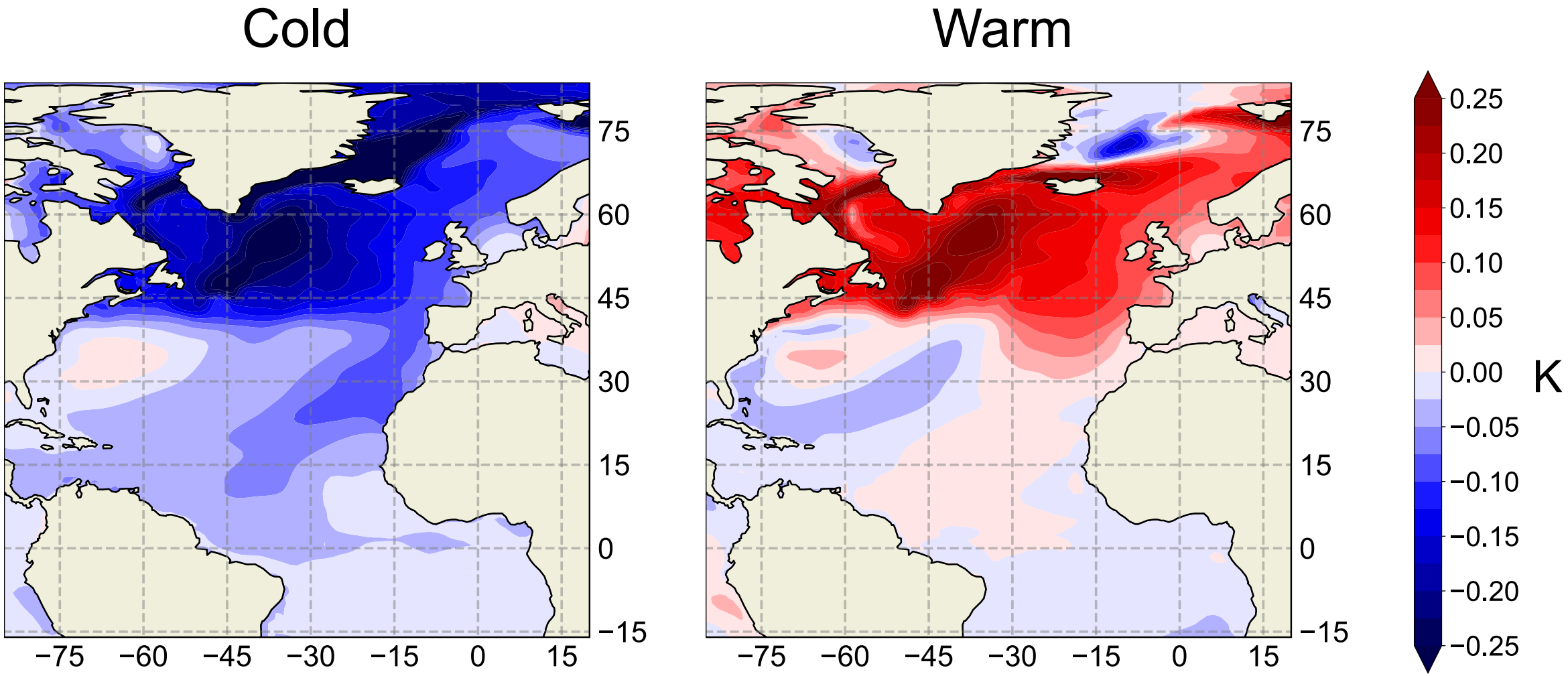

Cold
Warm
75
60
45
30
15
0
−15
−75
−60
−45
−30
−15
0
15
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
−0.8
−1.0
K

Mechanism

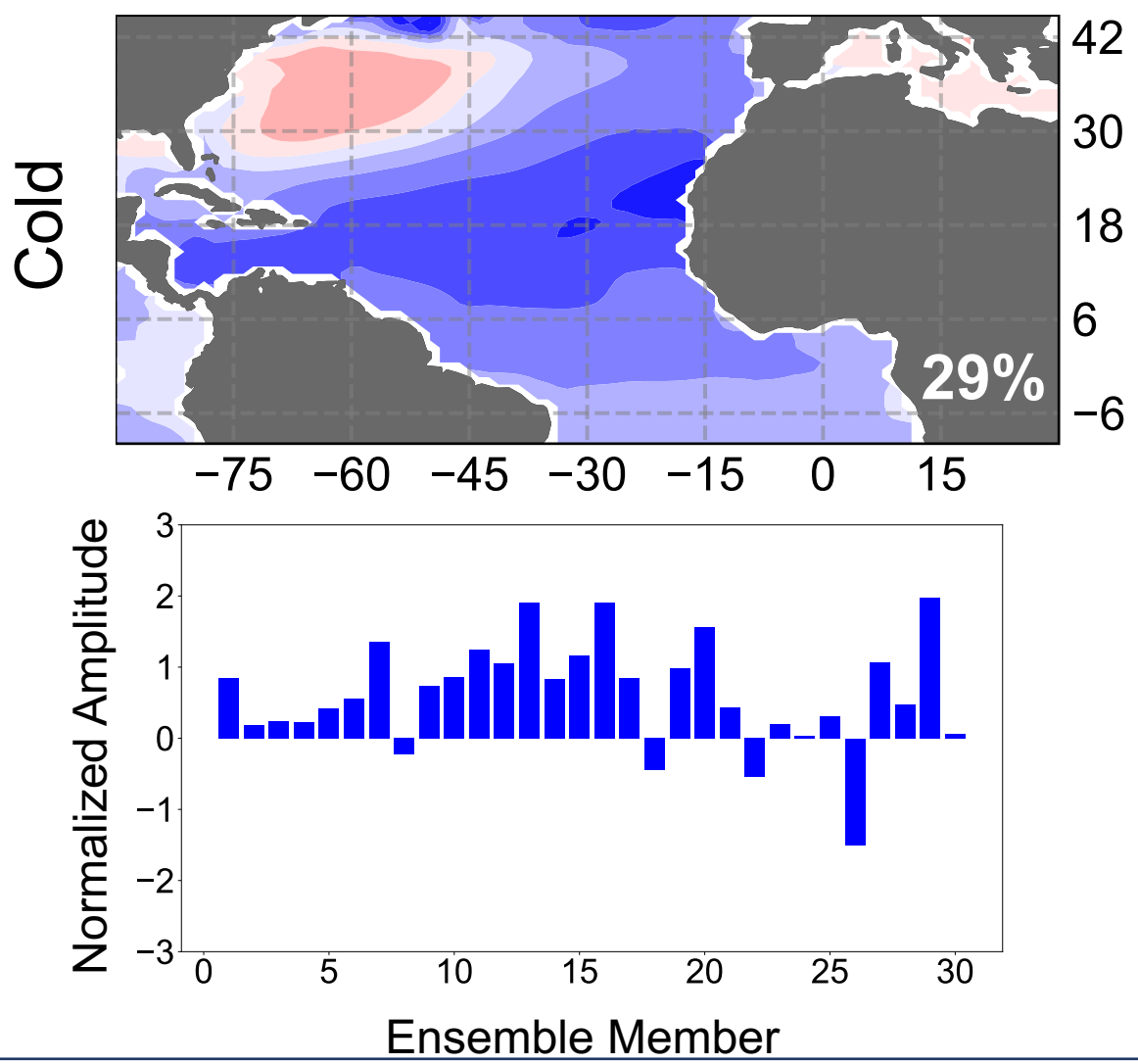

Cold
Warm
1 m/s
1 m/s
75
60
45
30
15
0
−15
−75
−60
−45
−30
−15
0
15
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
m/s

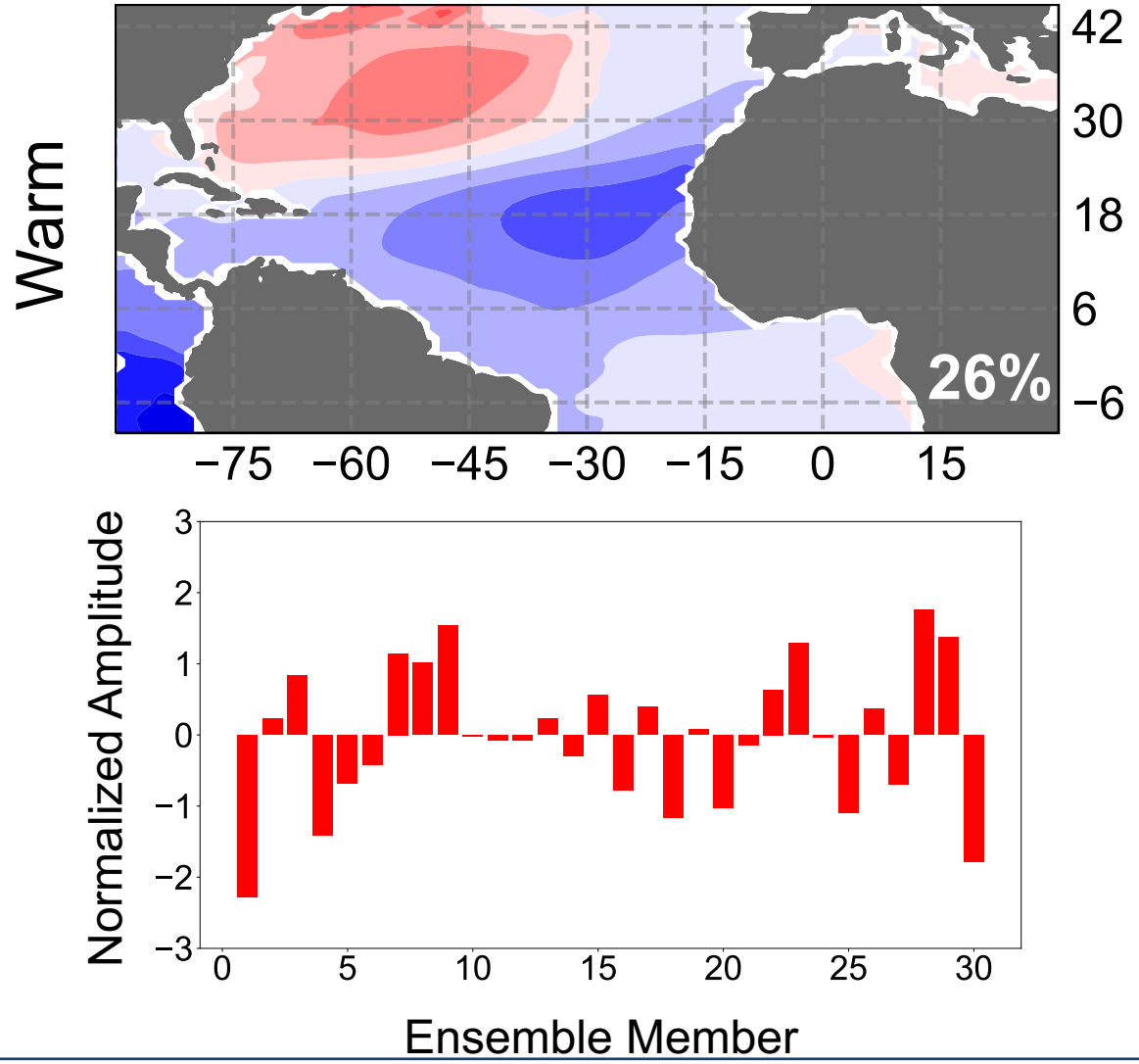
Does the Asymmetry Extend to Fully Coupled Models?

Parallel CESM1 experiments



Parallel CESM1 experiments





Conclusions

1. A fast, basin-wide atmospheric response to Atlantic subpolar gyre SST anomalies connects the subpolar and tropical Atlantic regions
2. This “atmospheric bridge” communicates, via wind-driven evaporative cooling, only cold subpolar Atlantic SSTs to the tropical Atlantic
3. The atmospheric bridge does not effectively communicate warm subpolar Atlantic SSTs, highlighting an important asymmetry of AMV