An investigation of the ocean's role in Atlantic Multidecadal Variability





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Motivations: AMV forcing mechanism

60N

30N



ocean dynamics is a necessity



Slab ocean models reproduce the observed AMV SSTA \rightarrow ocean dynamics is **NOT** a necessity

Models "disagree" on what drives AMV

Study Goal: Evaluate the role of ocean in AMV based on available **observational** records



EA contributes to low frequency variability of AMV

Approach: Mixed layer heat balance



Assumptions:

- 1) Atmospheric forcing is a normally distributed white noise.
- 2) MLD variability and ocean dynamics are neglected to isolate the contribution of atmospheric noise to AMV.

Define e-folding time:
$$\tau^{-1} = \frac{\alpha}{\rho_o C_p^o h_m}$$

Results from idealized red-noise model

$$\frac{\partial T'_s}{\partial t} = -\tau^{-1}T'_s + N(0,\sigma^2)$$

 τ : e-folding time (derived from ICOADS) $\tau^{-1} = \frac{\alpha}{\rho_o C_p^o h_m}$ σ : standard deviation of atmospheric heating (derived from 20CR and NCEP/NCAR dataset)



Observed vs. **Modeled** SSTA variability



explained by the white noise of atmospheric forcing.

SSTA STD as a function of e-folding time & atmospheric forcing



Observed relationship b/w e-folding time & atmospheric forcing



Trade-off b/w e-folding time and atmospheric forcing and its implication for AMV SSTA



Discussion: Necessity of ocean dynamics



Ocean dynamics is needed for SSTA variability in the extratropical North Atlantic.

Conclusions

- The long persistence of AMV SSTA stems from the extratropics and is attributable to the deep MLD and weak damping.
- Atmospheric forcing can explain the SSTA variability in the tropical North Atlantic, but underestimates SSTA STD in the extratropics:
 - Red-noise model forced with observed atmospheric noise substantially explains 48% the SSTA STD in the extratropical North Atlantic.
 - the observed SSTA STD cannot be achieved with this model due to the trade-off between e-folding time and atmospheric heating rate.
 - Even with the inclusion of aerosol forcing and MLD variability, this 1-D model underestimates the SSTA variability in the extratropical North Atlantic.

Therefore, it appears that ocean dynamics is a necessity for AMV SSTA

THANK YOU!

