RGMA PI Meeting
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The Atlantic Multidecadal Oscillation: Key Drivers and Climate Impacts

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The goal of this project is to investigate the Atlantic multidecadal variability (AMV) using a hierarchical modeling framework to advance our process-level understanding on the respective roles of, and the feedback between, the key drivers of the AMV, and to examine the impact of the AMV, with a special emphasis on the possible augmentation of predictability the AMV may bring to the regional weather and climate of North America, Western Europe, and the Arctic.

Key Research Progresses in the past 2 yrs

Drivers

Hierarchical modeling

- Analytical stochastic model
- Slab ocean coupled CESM
- Column ocean coupled CESM
- Fully coupled CESM

Fresh water flux forcing and SSS

- Freshwater specification experiment
- SSS and SST reemergence from observation and simulations

Internal variability vs. external forcing

- Linear inverse modeling
- Linear response function
- Low-frequency component analysis

Impacts

AMV impact on the atmospheric blocking and NAO

- Mechanism
- Decadal predictability (CESM Decadal Prediction Large Ensemble)

Green's function q-flux perturbation experiments

- Linear vs. nonlinear responses to ocean heat flux forcing
- climate sensitivity

Multi-year predictability of the atmospheric blocking and NAO

Community Earth System Model-Decadal Prediction-Large Ensemble
(CESM-DP-LE; Yeager et al. 2018, BAMS)

- 40 ensemble members (round-off perturbation of atmospheric initial conditions)
- Initialized on each Nov. 1st for 1954-2015
- 122 month simulation for each start date and each ensemble member

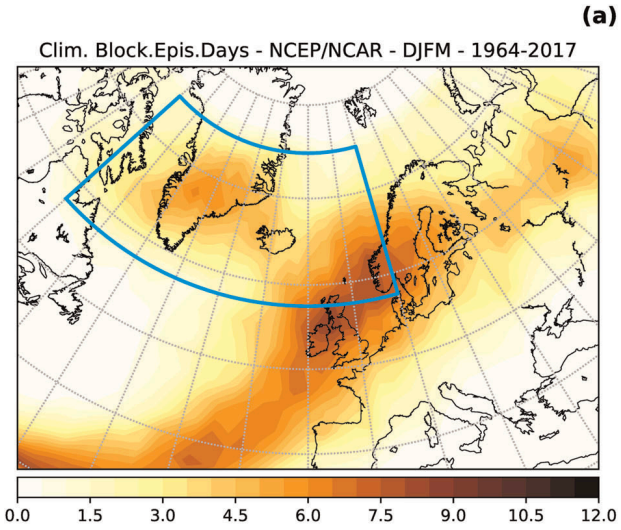
→ (retrospective) predictions with lead years 1 – 10

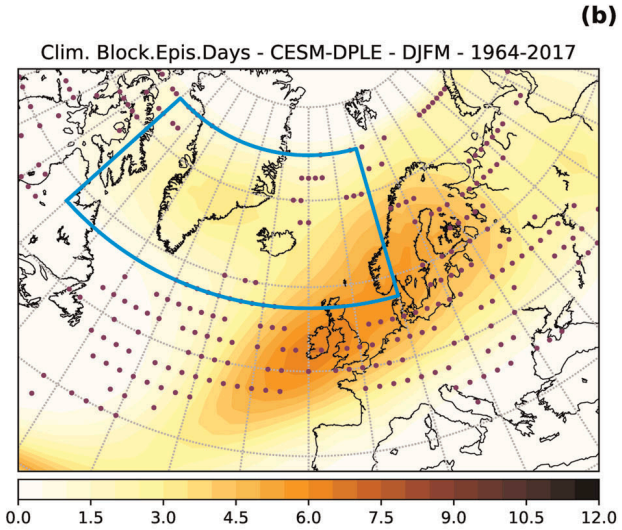
DJFM number of blocking days (1964-2017)

NCEP-NCAR R1

CESM-DP-LE

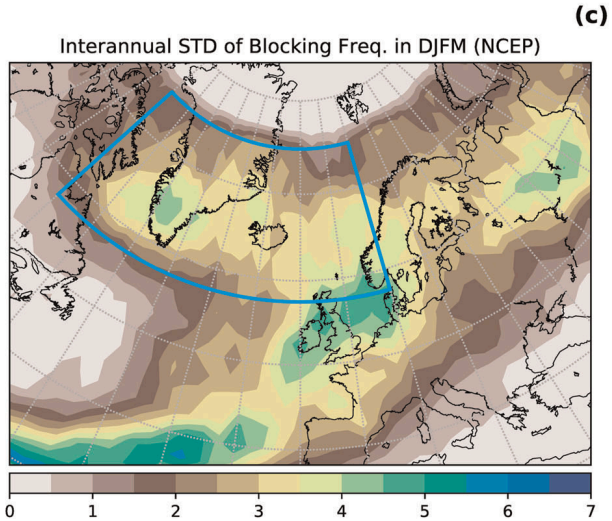
Climatological Mean

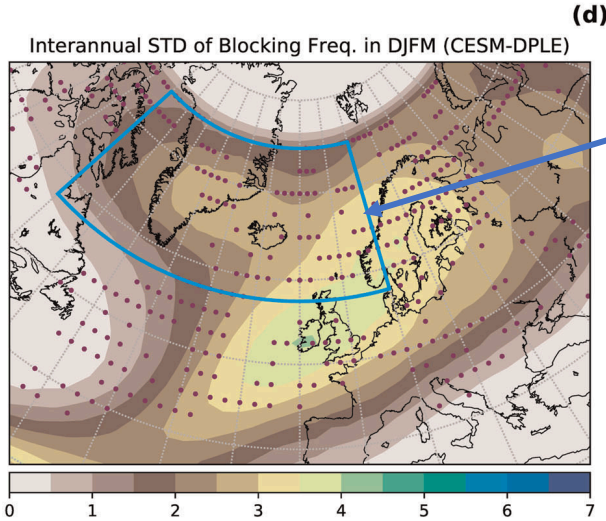




2-D blocking definition following Scherrer et al. (2006) using daily Z500

Interannual Standard Deviation





High Latitude Blocking

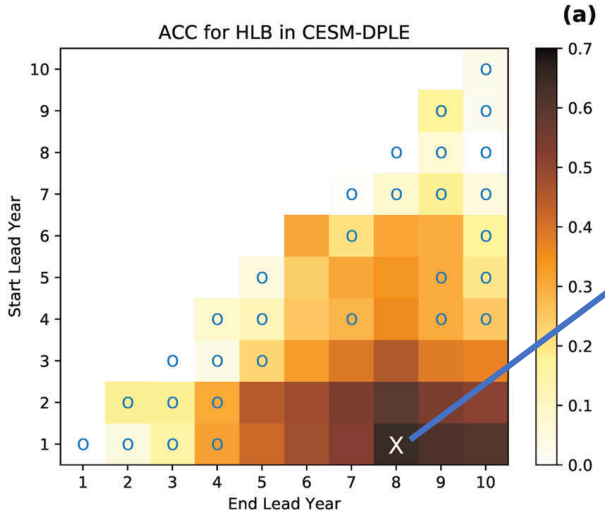
Significant prediction skill (ACC=~0.65) for lead years 2-8 yrs

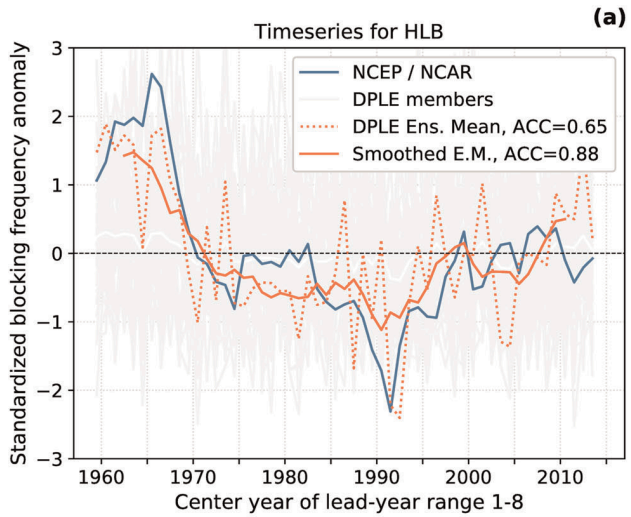
ACC

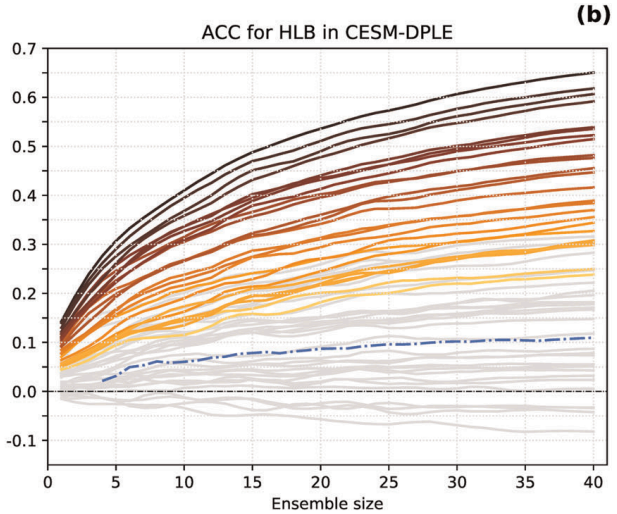
Time Series

ACC vs. ensemble size

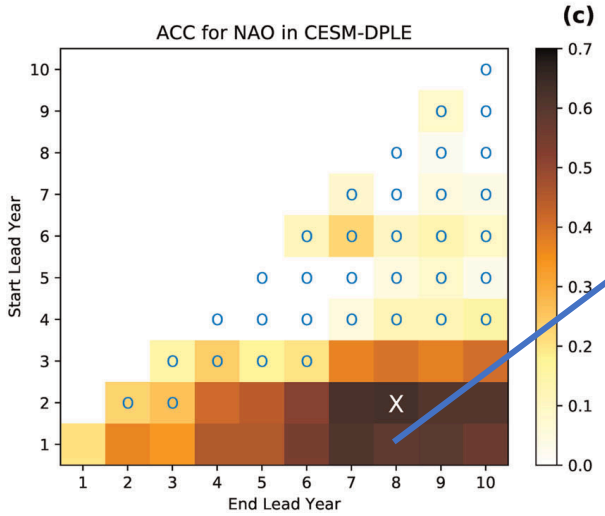
High Latitude Blocking

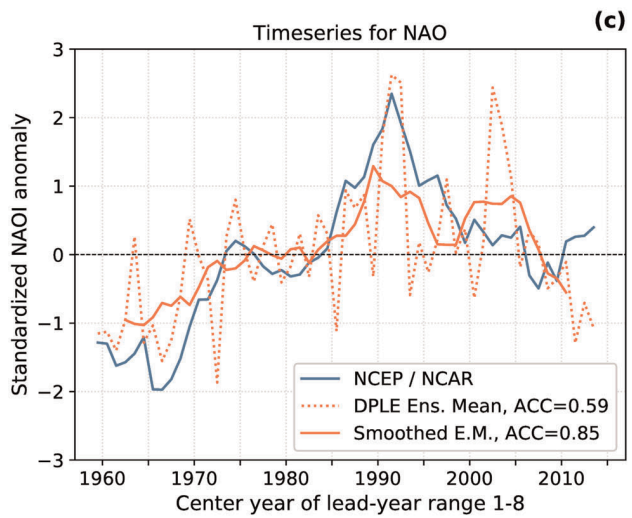


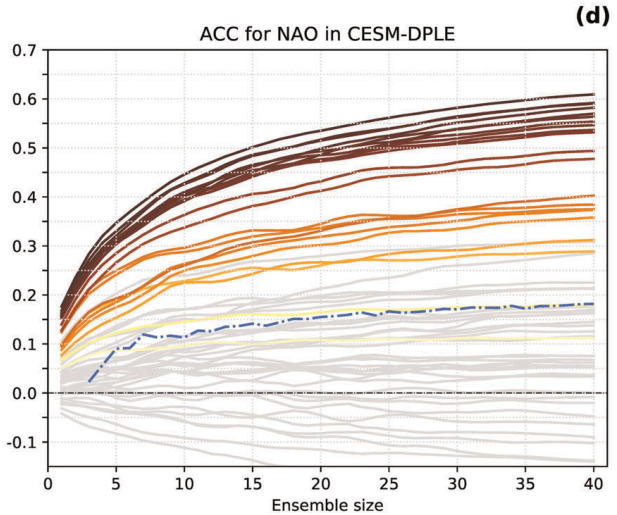




NAO



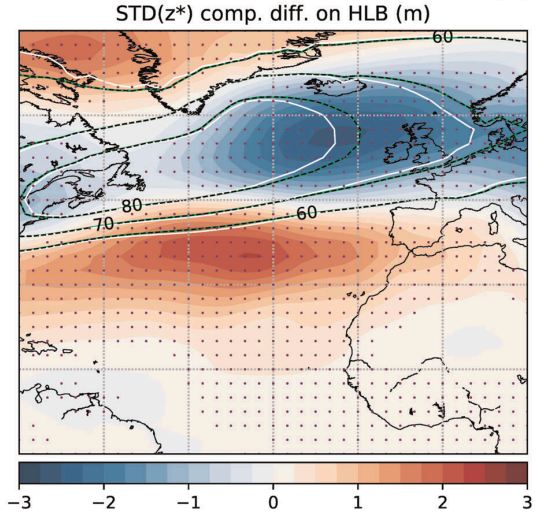




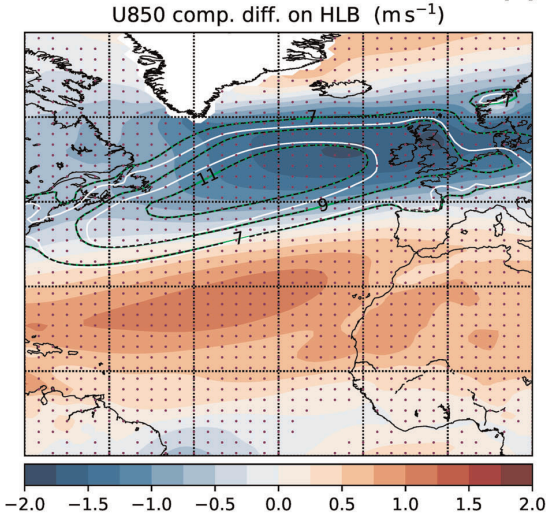
AMV ocean anomalies are the primary source of the predictability

Composite differences based on years with high (top 10%) and low (bottom 10%) ensemble-mean high-latitude blocking

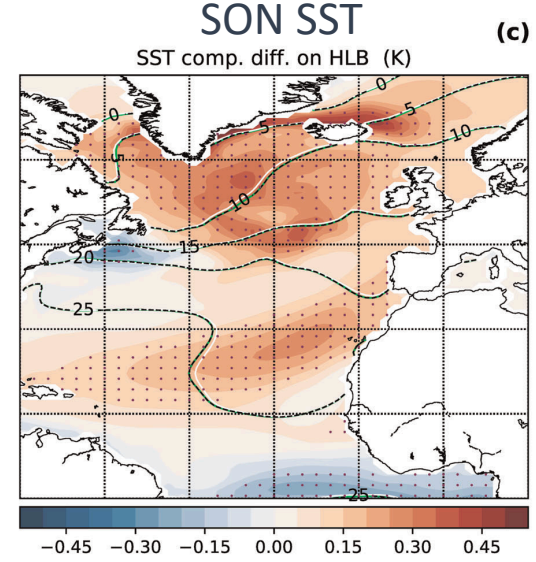
DJFM 500hPa storm track



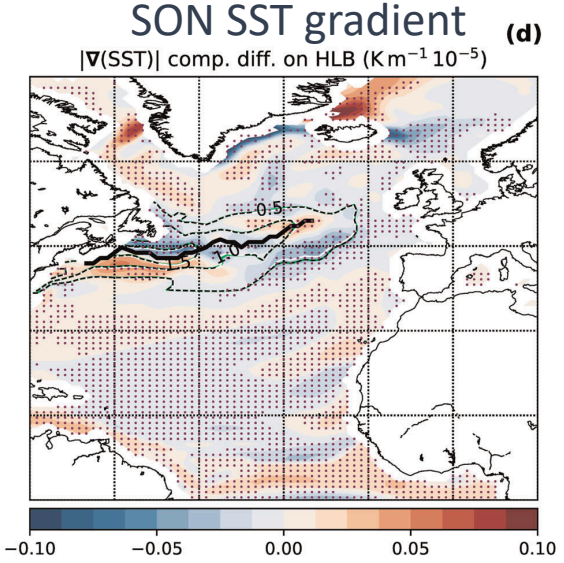
DJFM U850



SON SST



SON SST gradient



Athanasiadis, P., S. Yeager, Y.-O. Kwon, A. Bellucci, D.W. Smith, and S. Tibaldi, 2020: Decadal predictability of North Atlantic blocking and the NAO. *npj Climate and Atmospheric Science*, **3**, https://doi.org/10.1038/s41612-020-0120-6.

Kwon, Y.-O., H. Seo, C.C. Ummenhofer, and T.M. Joyce, 2020: Impact of Multidecadal Variability in Atlantic SST on Winter Atmospheric Blocking. *J. Climate*, **33**, 867-892, https://doi.org/10.1175/JCLI-D-19-0324.1.

Thank you!