North Atlantic Atmospheric Blocking and Atlantic Multidecadal Oscillation in CESM1 Large Ensemble Simulations

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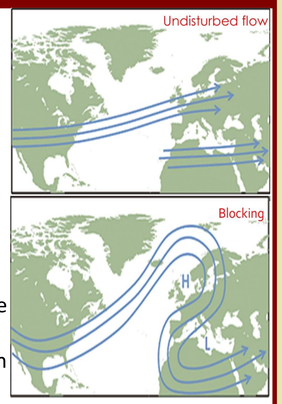
INTRODUCTION/OBJECTIVES

Atmospheric blocking in the North Atlantic alters normal climates across Europe and Russia by shifting storm tracks. Typically associated with an anticyclone, the normal zonal wind pattern known as the jet stream deviates and its westerly winds reroute north and south of the anticyclone (as shown on the right). This results in anomalous temperature and precipitation events. Factors that may amplify or weaken the frequency of blocking are still being investigated. One such potential factor is sea surface temperature. Häkkinen et. al (2011) speculate that the Atlantic Multidecadal Oscillation (AMO), which characterizes the natural variability of SST in the North Atlantic, may play a role in variability of blocking. In this work, we investigate this relationship.



Graphic by Tim Woollings, University of Oxford
Woollings (2011)

Objectives:

1) Investigate the relationship between blocking and AMO on decadal time scales.

2) Assess a climate model against observation in simulating the blocking and AMO.

DATA AND METHODS

20th Century Reanalysis (20CR): Z500 (1871-2005)

Hadley Global Sea Ice and Sea Surface Temperature (HADISST): 1871-2005

Community Earth System Model Large Ensemble (CESM1LE): 1920-2005

- 30 simulations with the same radiative forcing (e.g. C02) but slightly different atmospheric initial conditions in each simulation.

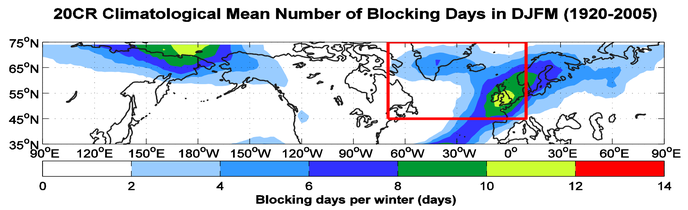
Number of Blocking Days (20CR vs. CESM1LE):

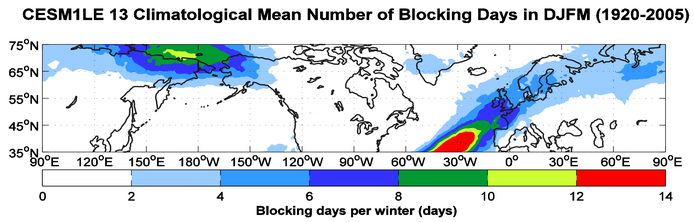
- Criterion: inverted meridional geopotential height at 500hPa
- 5 consecutive days of inversion to be considered a "block"

AMO Index (HADISST vs. CESM1LE):

- Yearly weighted area-average SST over the North Atlantic
- Calculated with and without global mean SST included

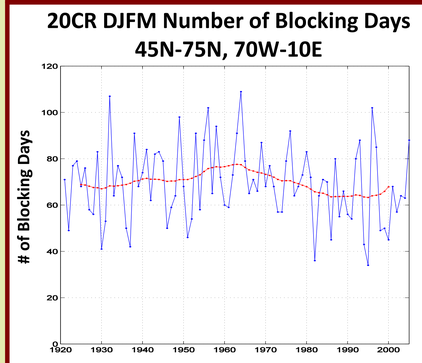
SPATIAL PATTERN OF BLOCKING

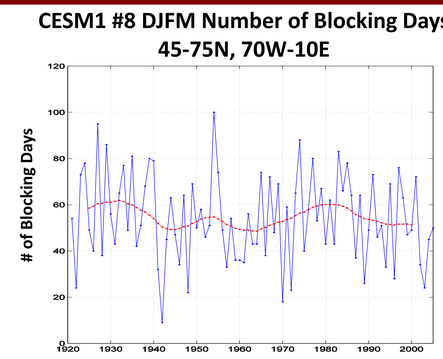


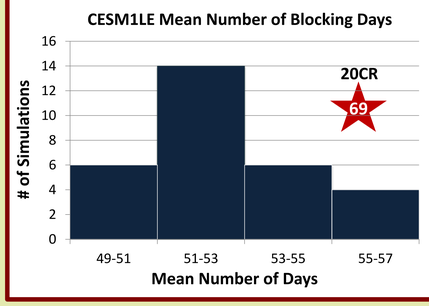


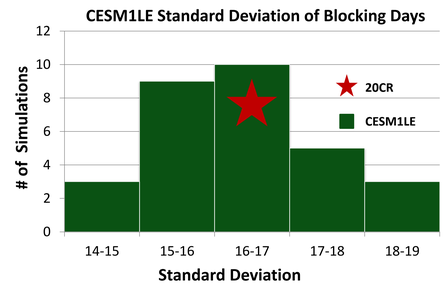
Typical Pattern for all the 30 CESM1LE simulations

TIME SERIES OF BLOCKING

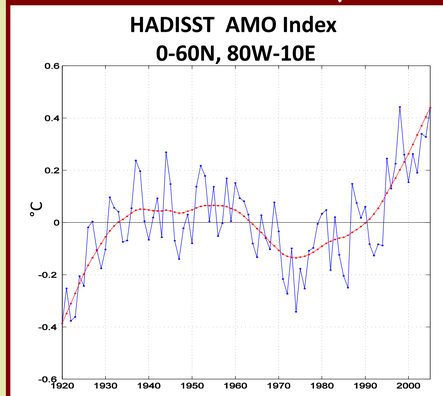


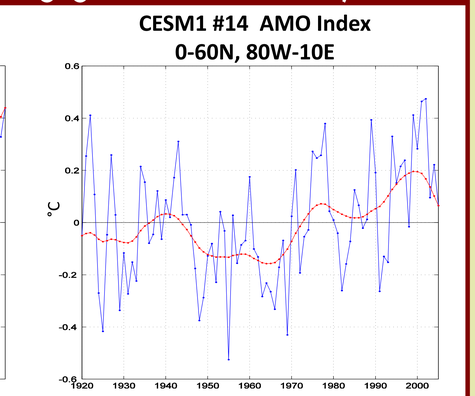


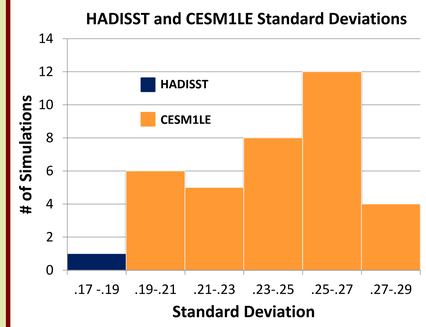


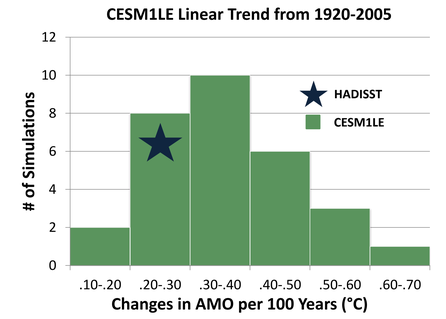


AMO INDEX (including global mean SST)

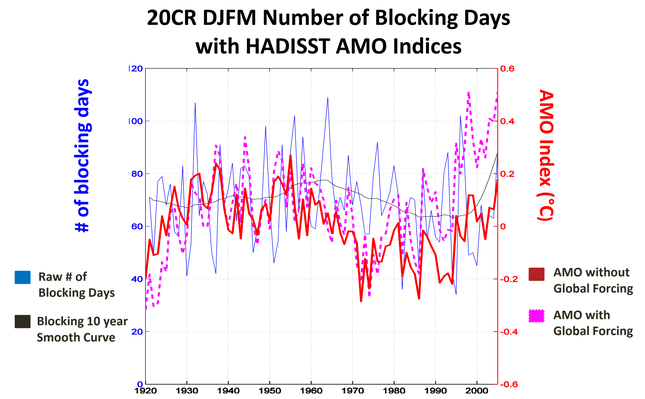








RELATIONSHIP OF AMO & BLOCKING



Blocking: 45N-75N, 70W-10E AMO: 0-60N, 80W-10E

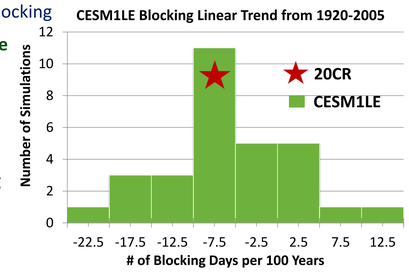
Correlation Coefficient with no AMO lead: .3535

Correlation Coefficient with 6 year AMO lead: .5652

CONCLUSIONS

- **Spatial Pattern of Blocking**
  - Southern maximum in model and no blocking in Greenland vs. observations.
- **Time Series of Blocking**
  - Standard deviation is comparable
  - Model underestimates mean number of blocking days
- **AMO Index (including global mean SST)**
  - Model amplitude is similar to observations but year-to-year variability greater than observations
- **Relationship of AMO and Blocking**
  - **Some qualitative correlation is suggested between AMO and Blocking**
  - Time lag: AMO leads the Blocking

Model does show qualitative and quantitative decadal variability with AMO and Blocking



Future Work:

- **Linear Trend of Blocking**
- **Summer Time Blocking**
- **Model Composite of Spatial Blocking**

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Häkkinen S, P.B. Rhines, and D. L. Worthen, 2011: Atmospheric Blocking and Atlantic Multidecadal Ocean Variability. Science, **334**, 655-659

Woollings (2011). Ocean effects of blocking, Science, **334**, 612-613. A perspective on the recent paper by Hakkinen et al.

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