North Atlantic Atmospheric Blocking and Atlantic Multidecadal Oscillation: Analysis through Reanalysis, Climate Models, and Datasets

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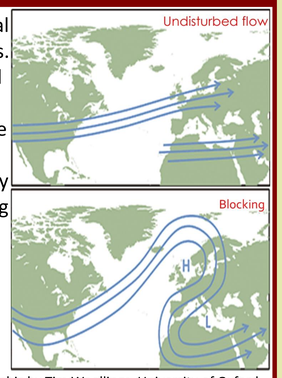
INTRODUCTION/OBJECTIVES

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. Influences that may amplify or weaken the frequency of blocking are still being investigated. One such potential influence 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 the model against observation in simulating the blocking and AMO.

METHODOLOGY

20th Century Reanalysis (20CR):
- Data from 1871-2011
- Assimilates only surface pressure historical observations

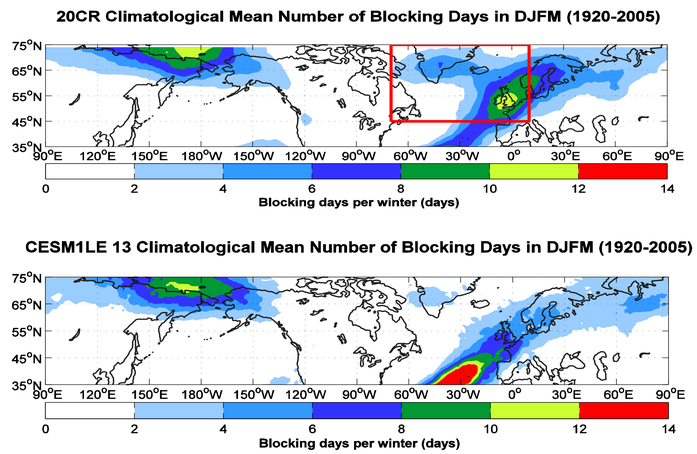
Hadley Global Sea Ice and Sea Surface Temperature (HADISST)
- Data from 1871-present

Community Earth System Model Large Ensemble (CESM1LE)
- 30 simulations with data from 1920-2005
- Share same radiative forcing (e.g. CO2)
- Slightly different atmospheric initial conditions in each simulation

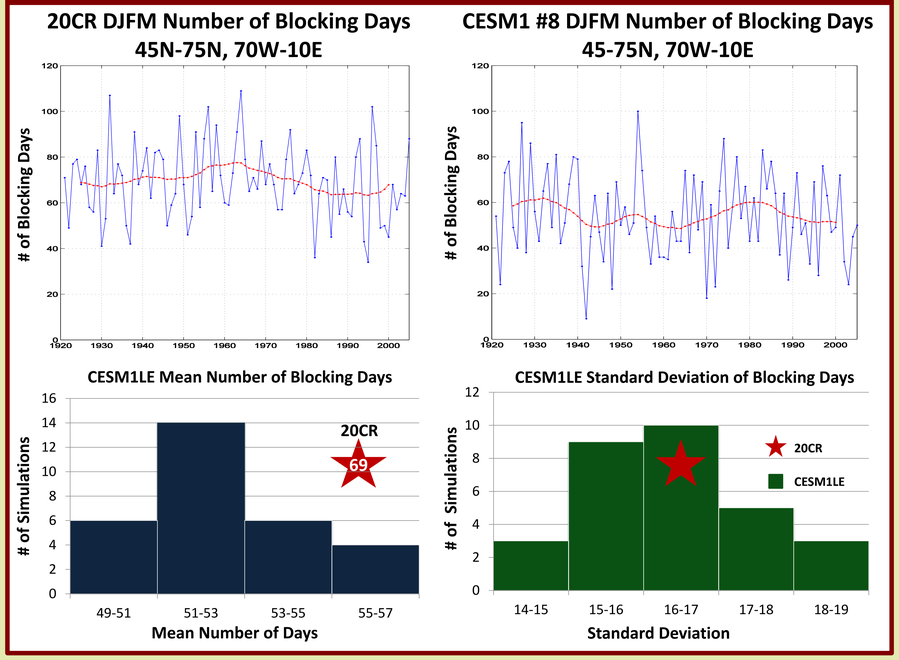
Number of Blocking Days (20CR vs. CESM1LE):
- Criterion: inverted meridional geopotential height at 500mb
- 5 consecutive days of inversion to be considered a "block"

AMO Index (HADISST vs. CESM1LE):
- Yearly weighted area-average SST over the North Altantic
- Calculated with and without global forcing

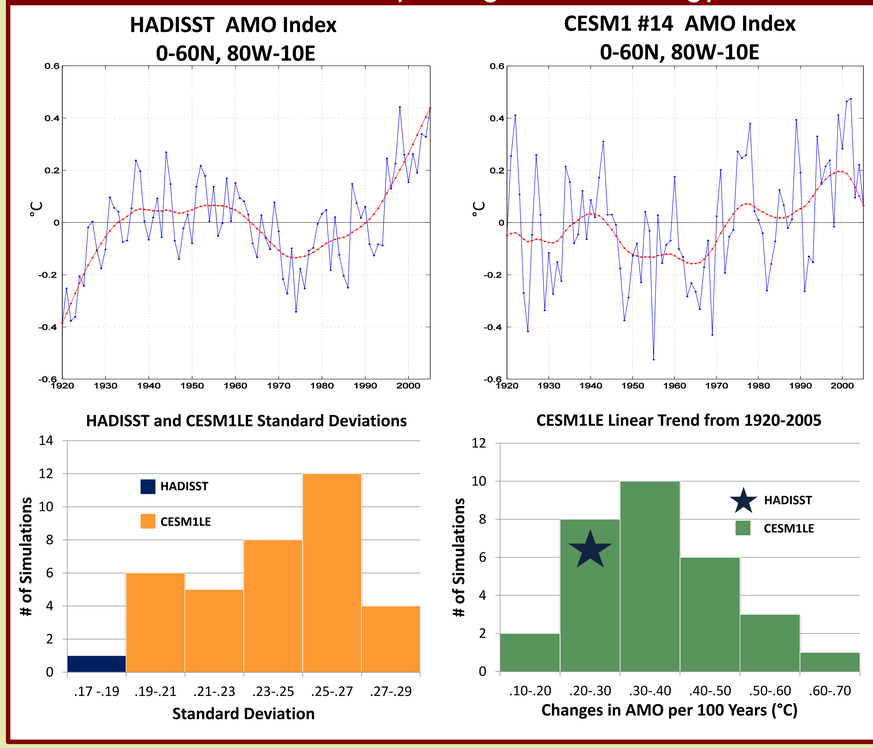
SPATIAL PATTERN OF BLOCKING



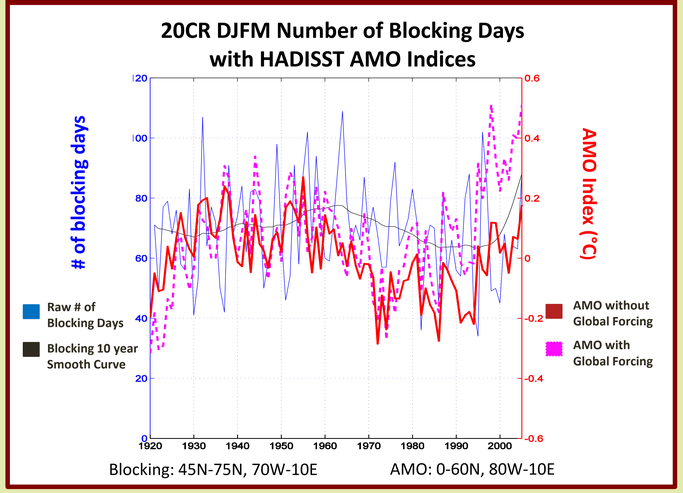
TIME SERIES OF BLOCKING



AMO INDEX (with global forcing)



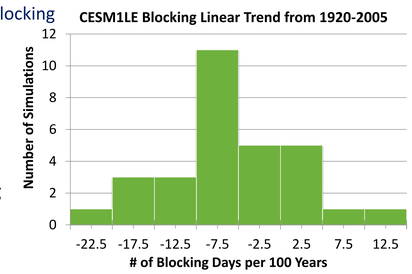
RELATIONSHIP OF AMO & BLOCKING



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 (with global forcing)**
  - Model amplitude 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 decadal variability with AMO and Blocking**



Future Work:
- **Correlation Coefficient**
- **Linear Trend of Blocking**
- **Summer Time Blocking**
- **Model Composites**

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REFERENCES

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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