

Oceanic forcing of the wintertime North Atlantic Oscillation and European climate

M.J. Rodwell, D.P. Rowell, C.K.
Folland

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Presentation

- What is the NAO?
- NAO regional effects.
- Project and results.
- Draw some conclusions.
- Possible future work on the topic.

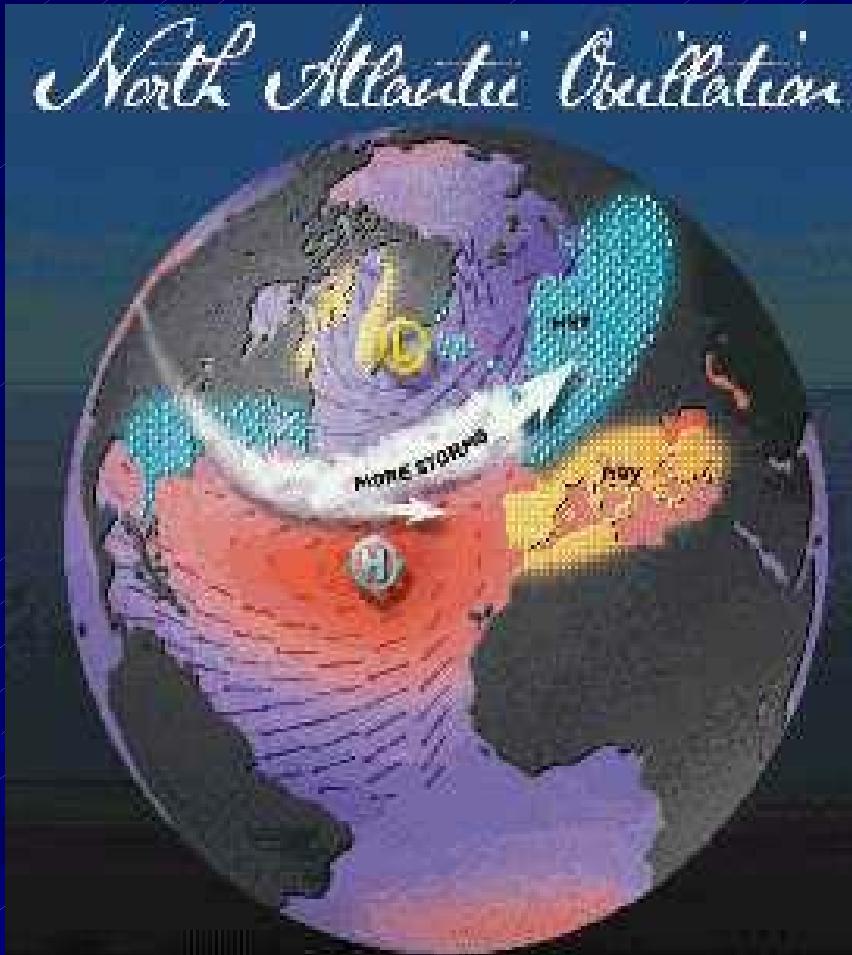
What is the North Atlantic Oscillation

- A see saw in atmospheric pressure which alternates between the poles and subtropics.
- A large scale mode of climate variability in the North Atlantic region.
- Pressure changes affect weather patterns in the East U.S. and Europe.
- The NAO is most noticeable in the winter (Nov-Apr).

History of the NAO

- The NAO response to surface air temperature has been known about since 1770. Scientists have studied this topic since the 1880's.

The positive phase

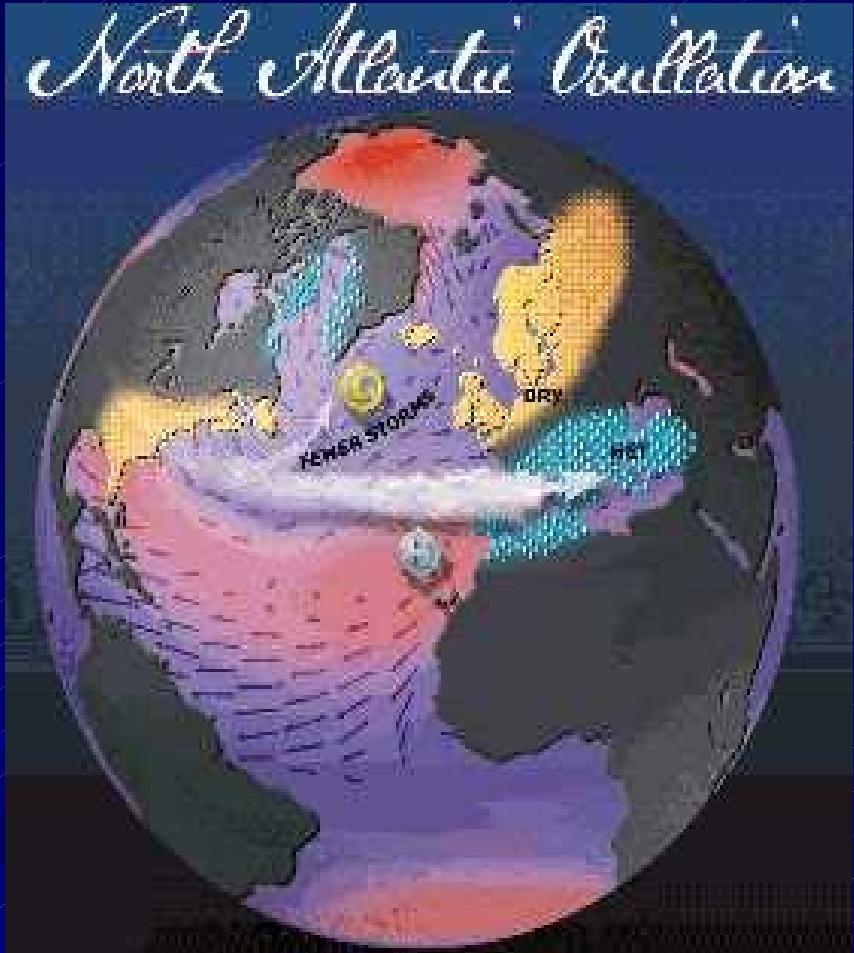


- Stronger subtropical high pressure. (Azores High).
- Stronger Icelandic low
- More and stronger winter storms on a further north storm track

Positive phase effects

- Warm and wet winters in Europe.
- Cold and dry winters in northern Canada and Greenland.
- Mild and wet winters in the U.S. East Coast.

The negative phase

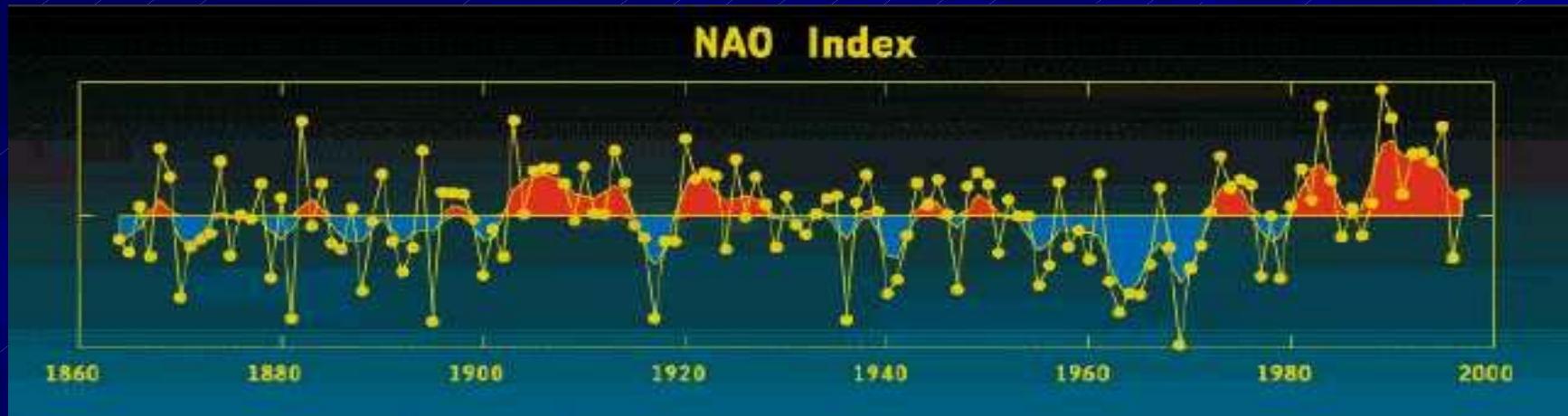


- Weak subtropical high
- Weak Icelandic low
- Results in fewer and weaker winter storms passing on a farther south more east-west track.

Negative phase effects

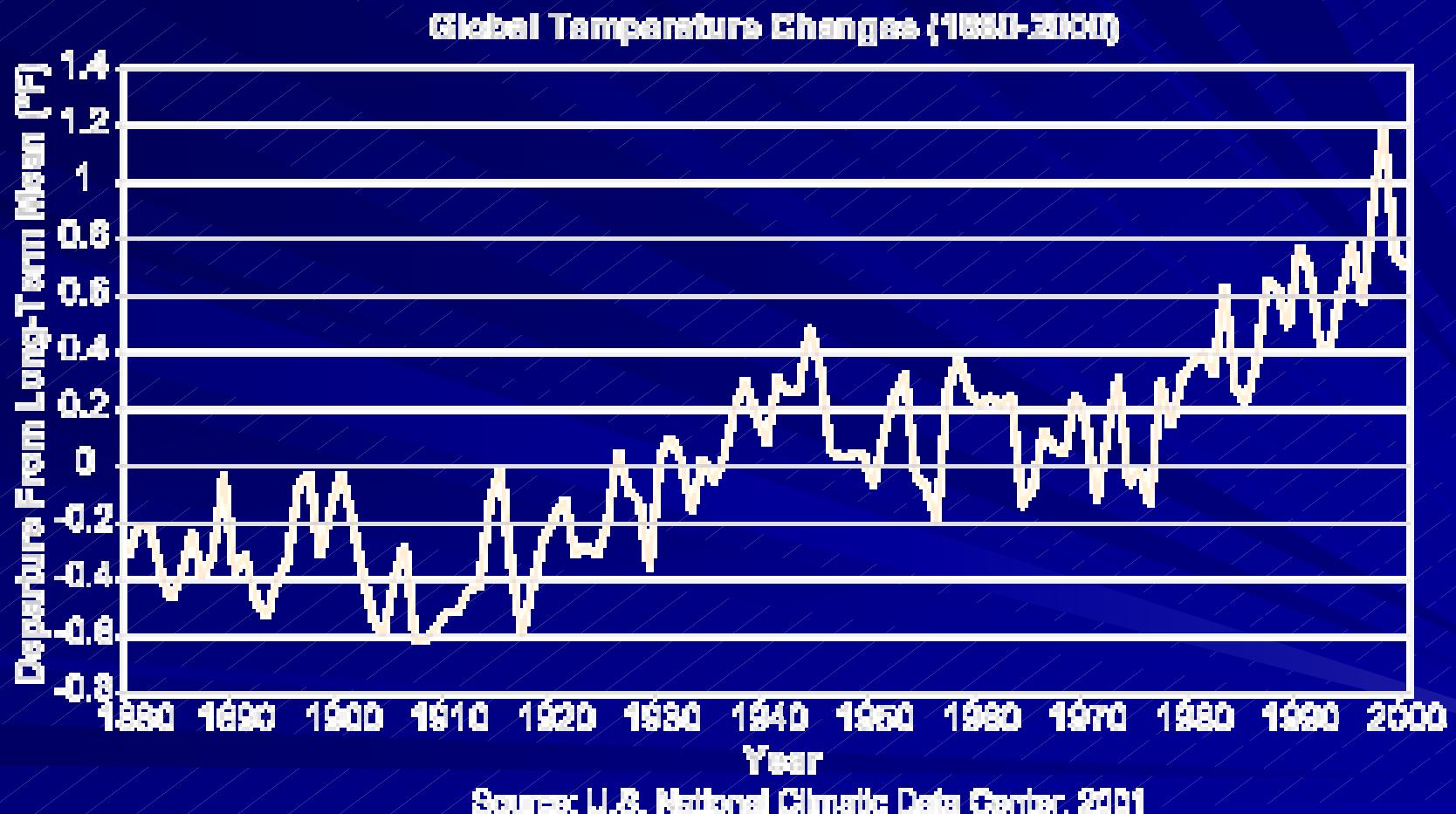
- Moist air in the Mediterranean.
- Cold air in northern Europe.
- Cold outbreaks in the U.S. east coast with snowy periods
- Greenland and northern Canada have a bit milder winters.

The North Atlantic Oscillation Index



- NAO index= $\text{SLP (Lisbon)} - \text{SLP (Stykkisholmur)}$
- Red- positive phase
- Blue- negative phase
- Decadal trends
- Is it linked to global warming?

Global Warming



Difference b/w - and + phase.

- Negative phase Dec-Feb, 1962-1969.
- Positive phase Dec-Feb, 1987-1994.
- P increased up to 30% in Britain and Scandinavia.
- Decreased by 50% in southern Spain, Italy, and Greece.
- Benefits can be gained, if skillful long range forecasts can be made.

Paper's Goal

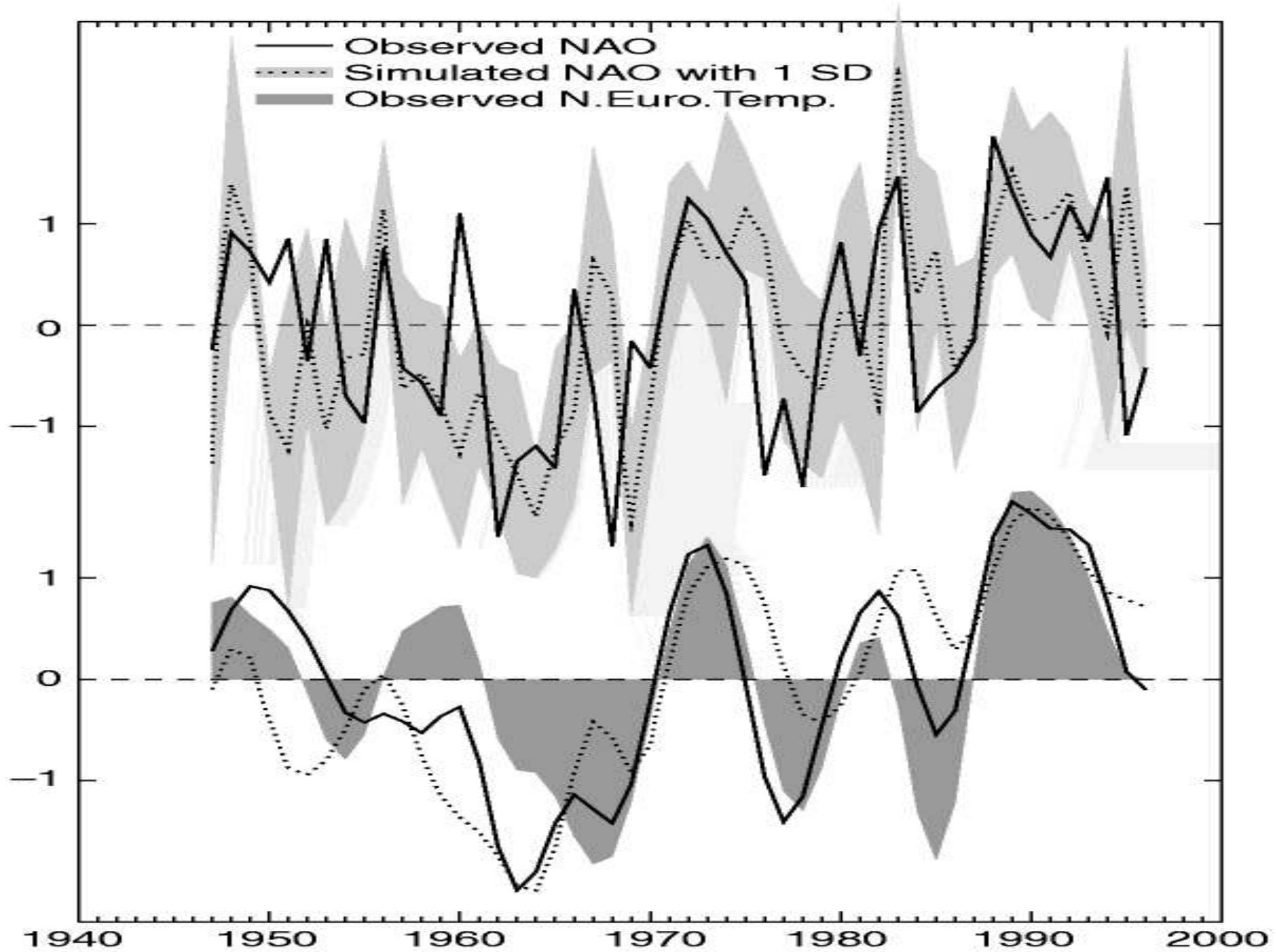
- Show fluctuations of SST and strength of NAO are related.
- Prove SST characteristics are communicated to the atmosphere by E, P, and atmospheric heating.
- Observational studies have shown that there may be significant predictability of mixed-layer oceanic temps in the North Atlantic at multiannual time scales.
- Show from the results NAO may be predictable.

Methodology

- Instruments:
- Global Atmospheric Model HadAM2b
- Horizontal grid 2.5×3.75 , 19 vertical levels.
- Sigma coordinates.
- Time step: 30 min.
- Incorporates prognostic cloud water and ice.
- Mass flux convection scheme.

Methodology

- Data:
- Model is forced with SST's and sea ice extents from GISST 3.0 data set.
- Ensemble of six 128 year simulations from 1870.
- Averages of the ensemble.
- Used data between 1947-1997.
- Focus on DJF season.

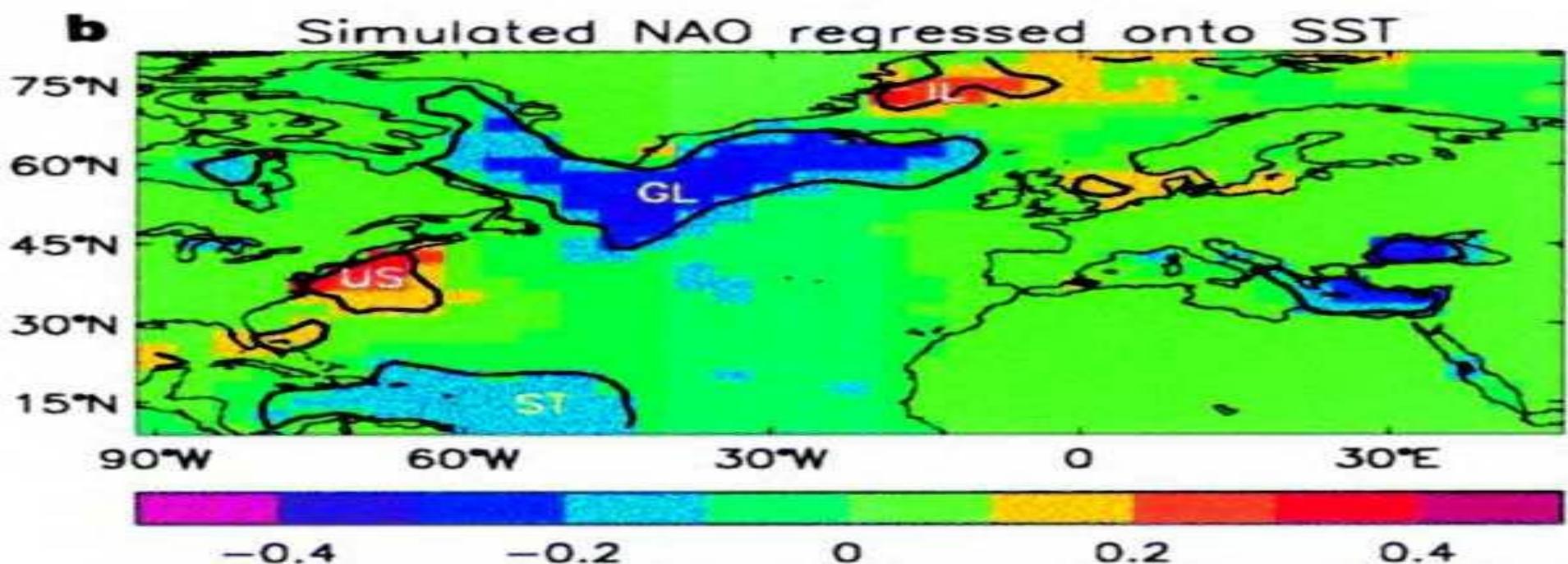
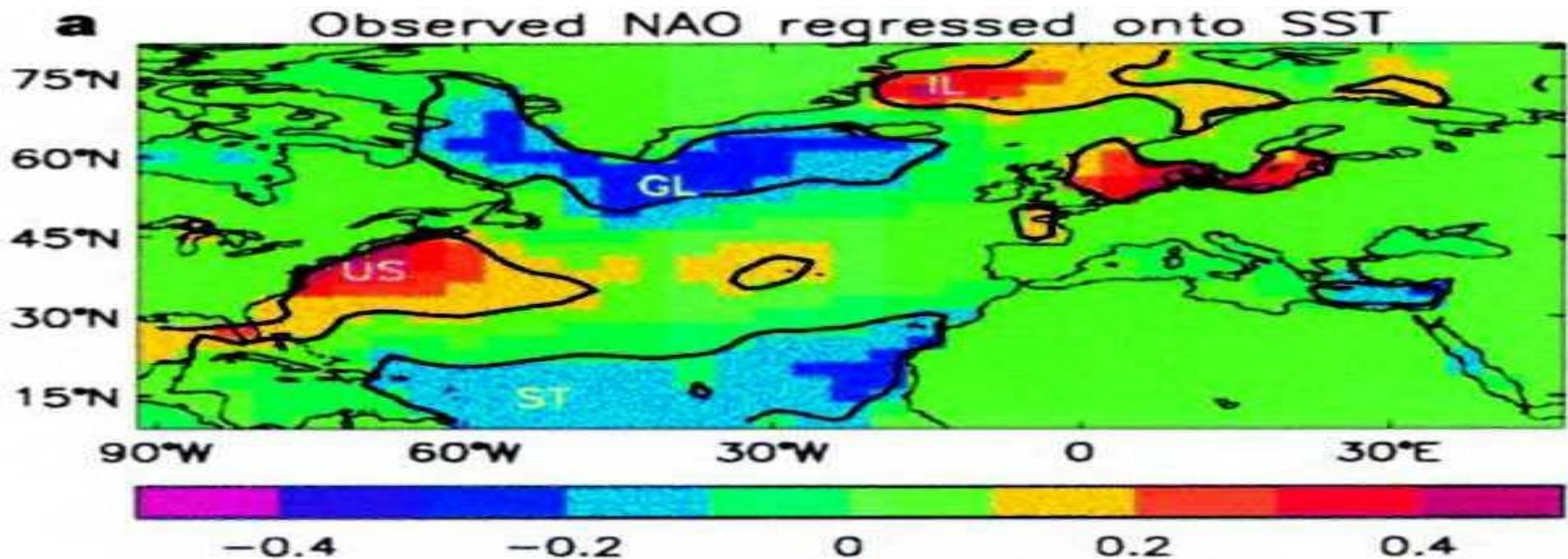


Model Verification- Unfiltered

- Model simulates the main features of the NAO index well.
- Correlation b/w simulated and observed is significant at the 98% level.
- Assuming SST is known, it may be possible to predict the correct sign 2 out of 3 years.
- Ensemble performs the best.

Model Verification-Filtered

- Time scales longer than 6.5 years.
- Correlation is significant at the 99.9% level
- Observed European sfc T and NAO index is highly correlated, model does not do as well.
- Note: The atmospheric model used does not have feedback into the ocean.
- Skill resides in prescribed SST and sea ice.

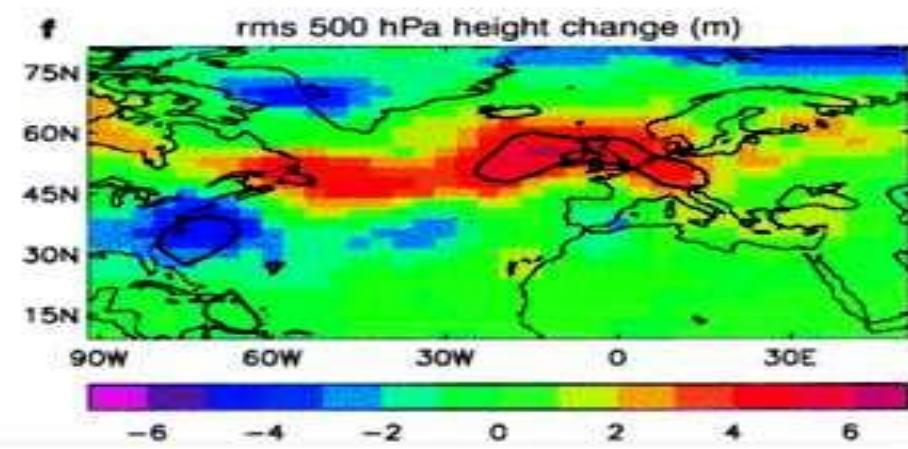
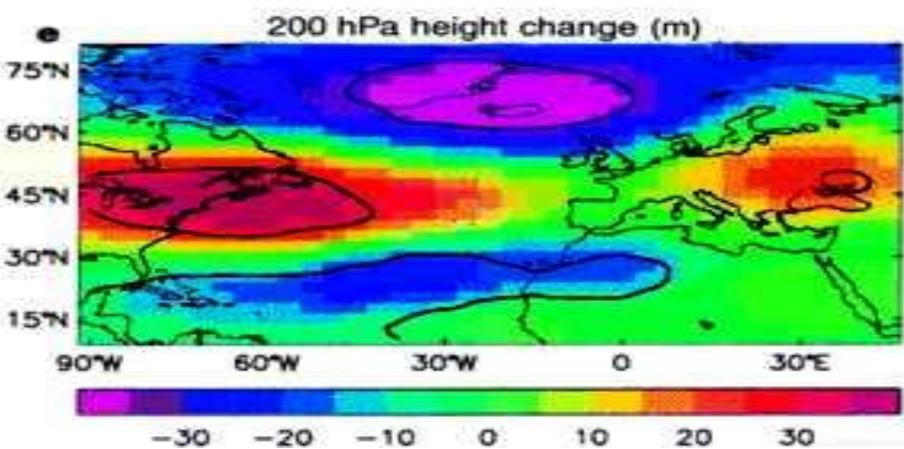
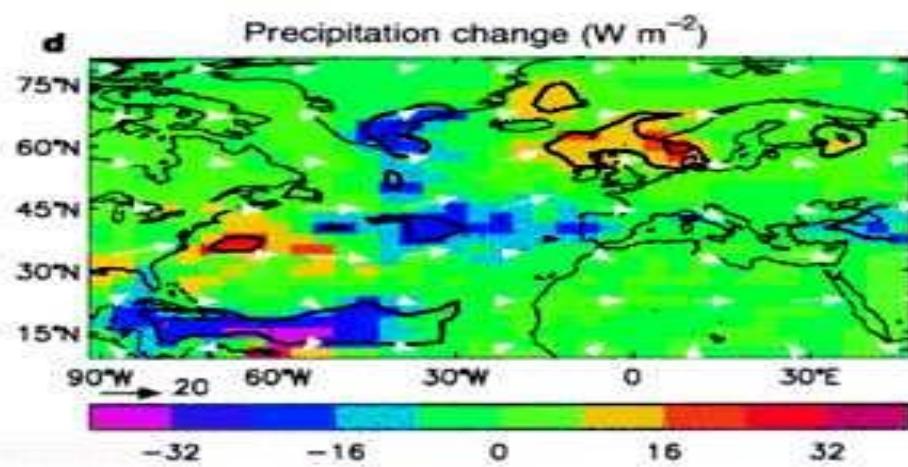
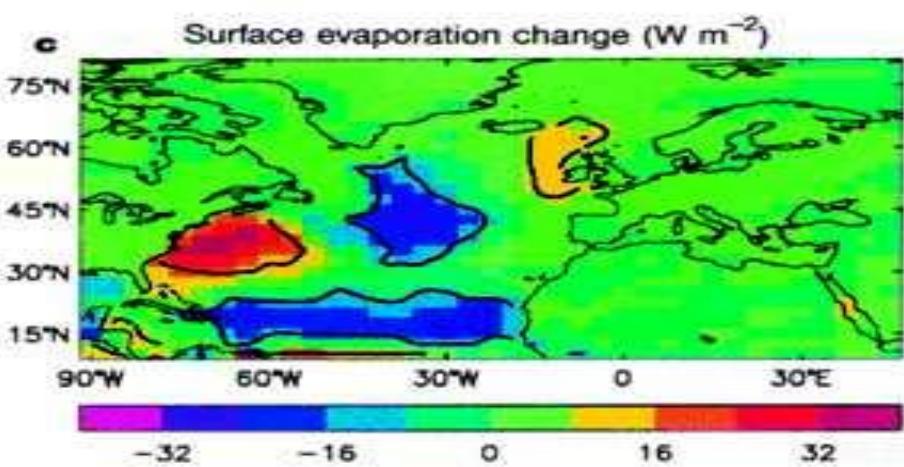
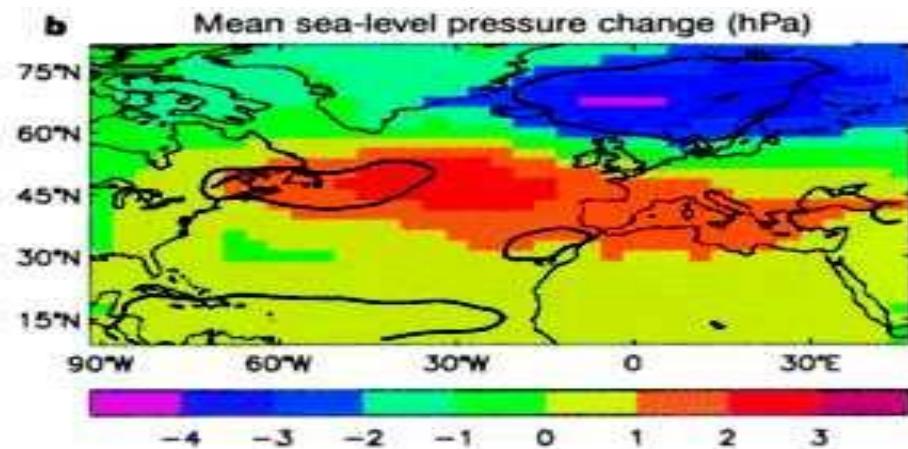
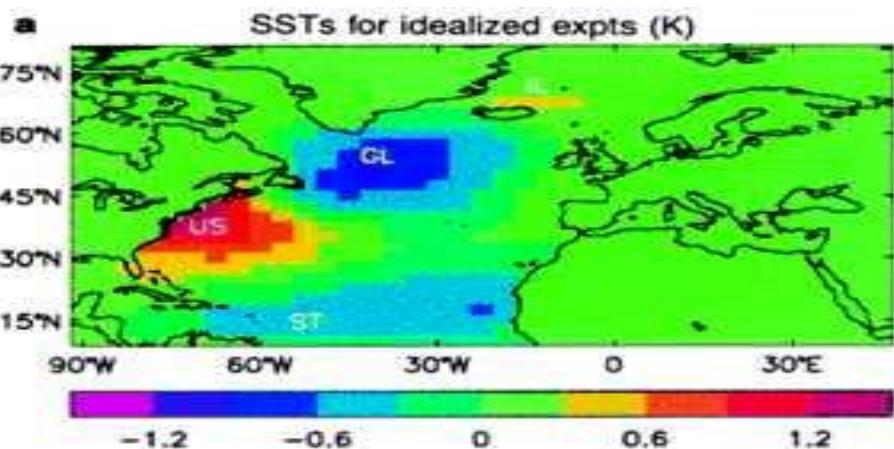


Regression of the observed unfiltered NAO index on to SST's

- Negative centers in (ST) and south of (GL) and positive centers off the US east coast agrees well with previous work done.
- Outside regions, not significant correlation.
- When the NAO is regressed onto winter MSLP outside of (NA) there is no statistical significance.

Regression of the model simulated NAO index on to SST's

- Similar pattern as the unfiltered observed.
This suggests ocean to atmosphere forcing is important at this time scale.
- Model correctly simulates the main mechanisms.
- Difference between figures is in the North Sea and Baltic may suggest atmosphere to ocean forcing is dominate there.



Analysis in the Ocean's Mixed Layer.

- E in fig c represents cooling of the ocean and damps the P-N SST anomalies (fig a).
- Positive feedback on SST involving E considered by Groztner and Latif does not occur in this model.
- Ekman Transport does provide a positive feedback to the P-N SST anomaly over almost the entire North Atlantic and for most of the year.

Conclusions

- Evidence has been provided that simulations of the NAO in the HadAM2b model are influenced by a pattern of North Atlantic SST variability.
- The use of an atmospheric model forced with imposed SST's was essential in establishing the chain of cause and effect from SST anomalies to the NAO.

Conclusions

- Previous authors (Saravanan) have suggested that extra tropical ocean sfc heat fluxes may be over estimated.
- The results imply that the extra tropical (as well as tropical) evaporative heat flux, and SST's beneath them, may be central to the skill of our simulation of the NAO.

Future Work

- Resolve the differences.
- Understand interannual and longer time scales predictability of SST pattern.
- Use fully coupled model, where synoptic and longer time scale forcing of the ocean by the atmosphere is included.

My Criticism

- NAO is predictable only if SST's are known.
- Most of the skill in the simulations is due to longer term decadal variations. The real challenge resides in forecasting the shorter term variations.