Met Office
Hadley Centre

Skilful Seasonal Prediction of the NAO and surface climate

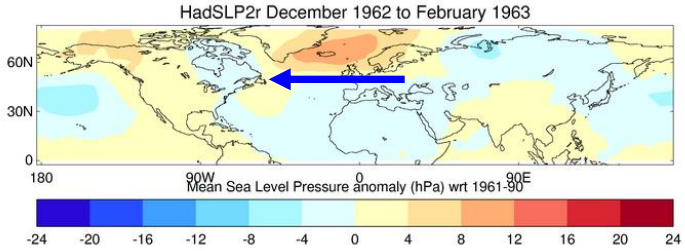
Met Office Global Seasonal Forecast System 5

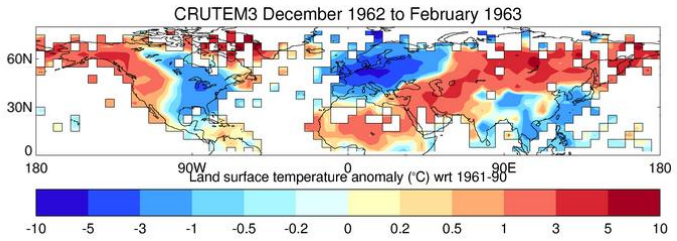
Adam Scaife

A. Arribas, E. Blockley, A. Brookshaw, R.T. Clark, N. Dunstone, R. Eade, D. Fereday, C.K. Folland, M. Gordon, L. Hermanson, J.R. Knight, D.J. Lea, C. MacLachlan, A. Maidens, M. Martin, A.K. Peterson, D. Smith, M. Vellinga, E. Wallace, J. Waters and A. Williams.

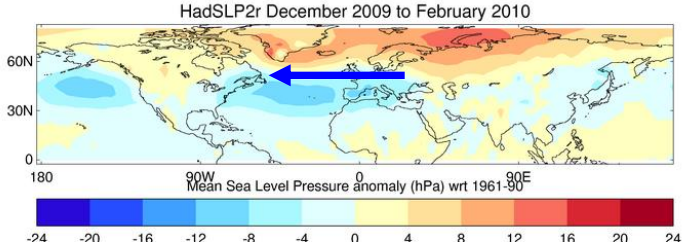
Winters depend on which way the wind blows (North Atlantic Oscillation)

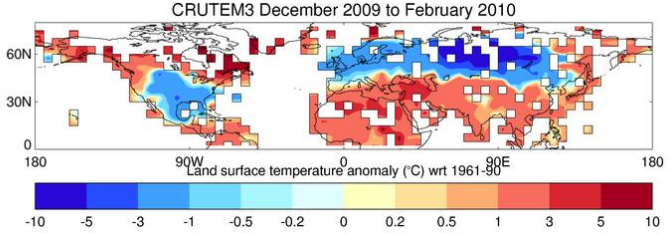
Winter 1962/63





Winter 2009/10



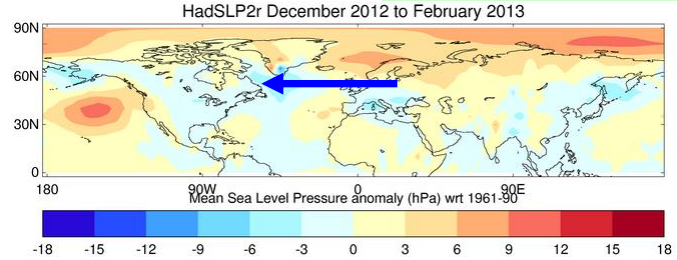


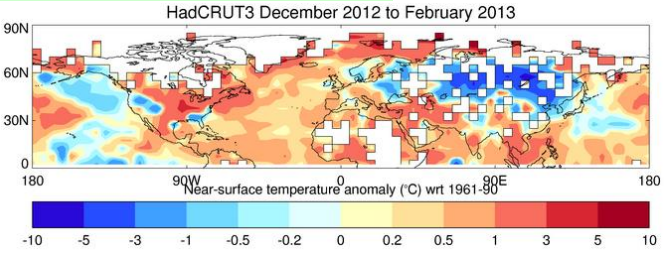
Weak P Gradient

Cold advection into Europe

Cold, calm and dry

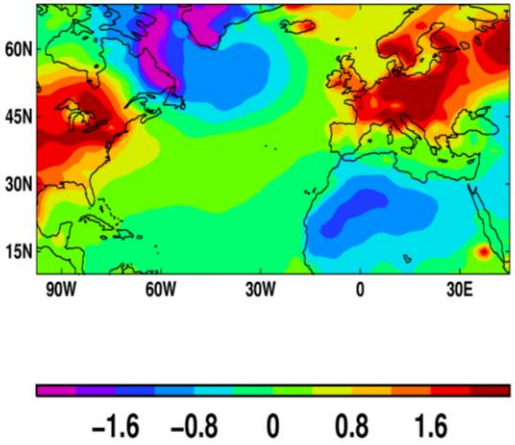
Winter 2012/13



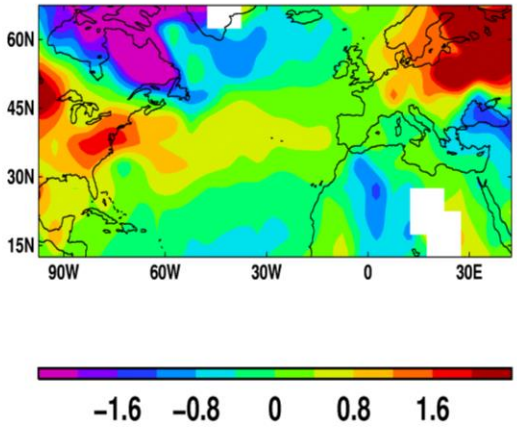


Decadal changes depend on the NAO…

Model Temperature



Observed Temperature



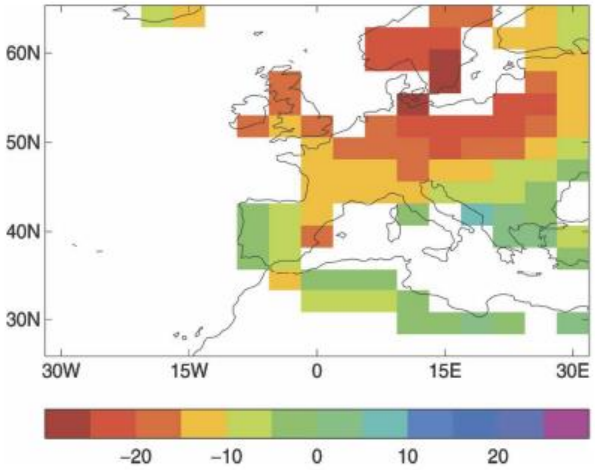
European winter T trend 1960s-90s

HadAM3 ctl 0.15K/decade

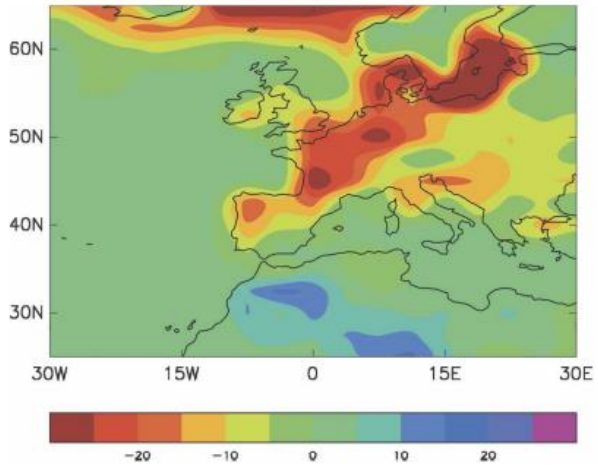
HadAM3 + NAO 0.59K/decade

Observations 0.53K/decade

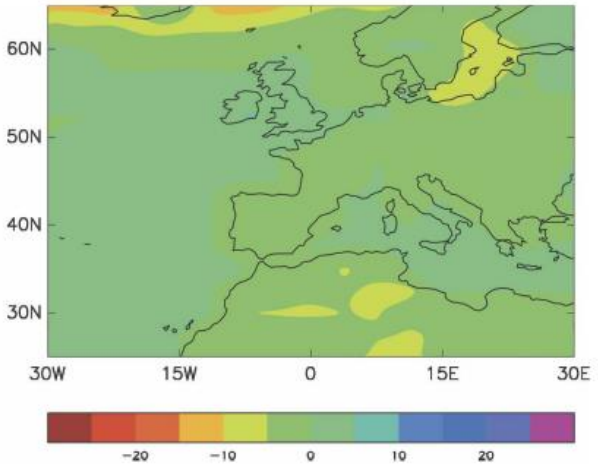
Observed Decrease in Frosts



Modelled decrease in Frosts



Without NAO change



Scaife et al, 2005, 2008

Met Office GloSea5

Global Seasonal Forecast System 5

Model: **HadGEM3H N216L85O(0.25)**

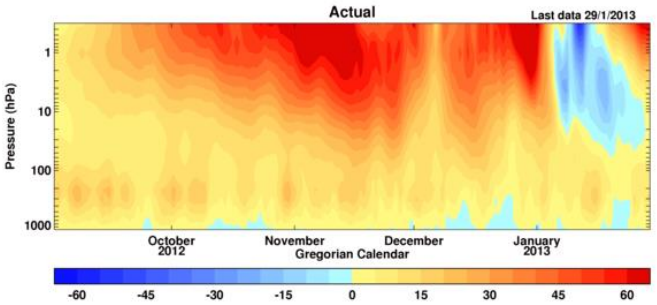
Initialisation: **NWP state + NEMOVAR + Sea Ice**

Winter Hindcasts: **24 members starting around 1 November**

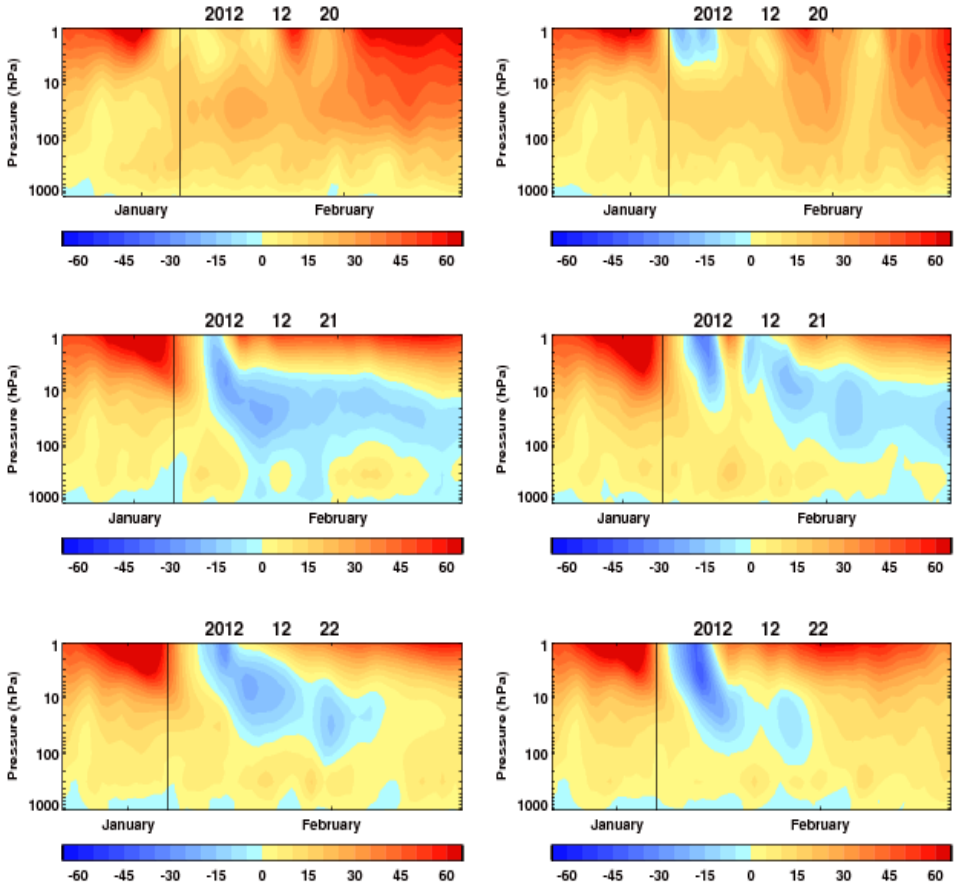
Designed for the job…

Sudden Stratospheric Warming Jan 2013

Obs

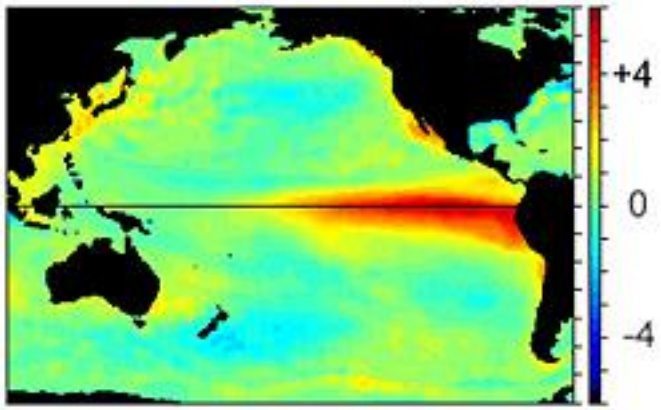


Fcast



Jan 2013 – SSW appearing in forecasts from 21st Dec
Operational forecasts from late Dec => increased risk of easterlies etc…

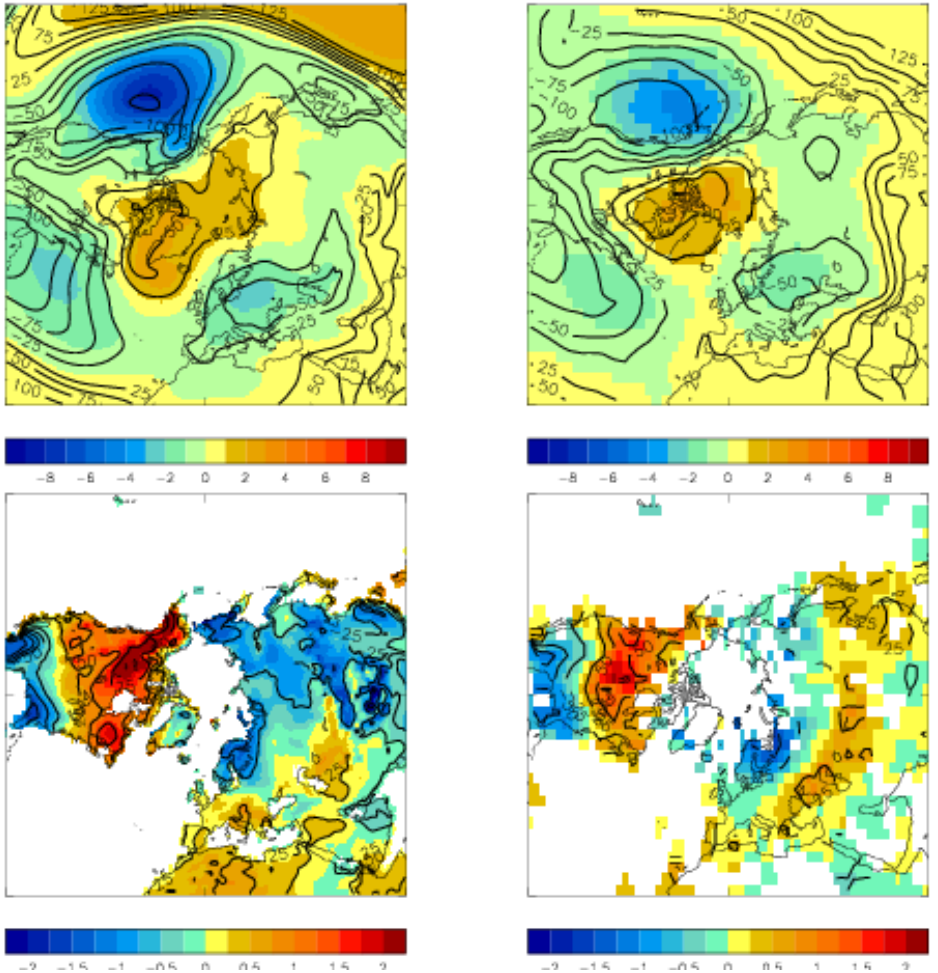
El Niño – Southern Oscillation



El Nino => easterly winds in UK

Occurred in 2009/10

Model **Observations**



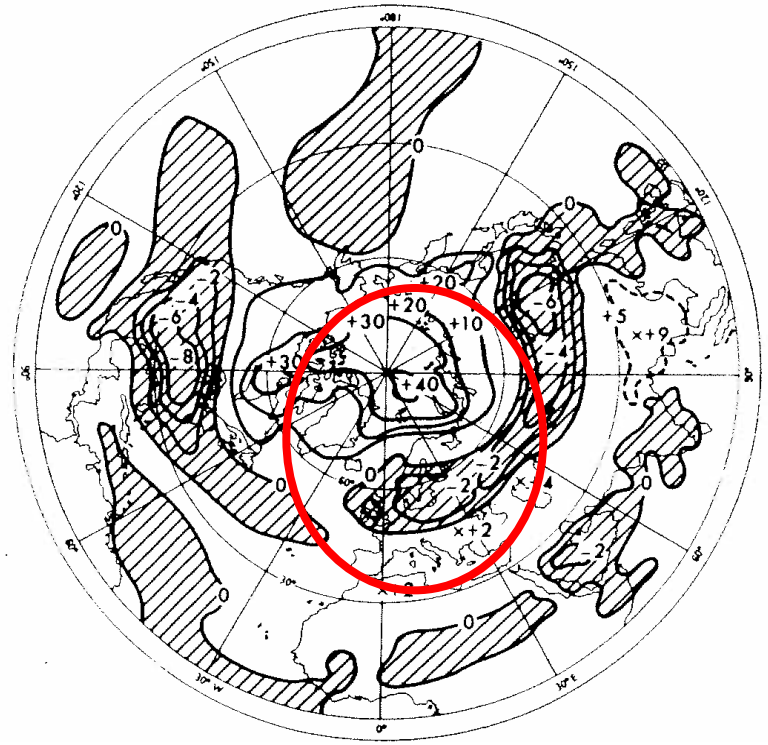
PMSL

Temp

Ineson and Scaife, Nat. Geosci., 2009

Arctic Sea Ice

Surface Temperature

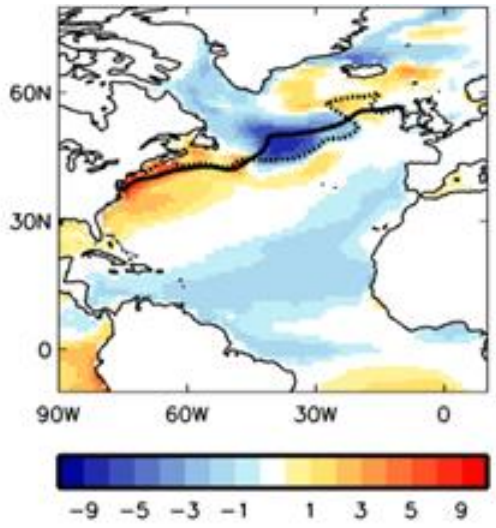


Newson, R.L., 1973. Response of a general circulation model of the atmosphere to removal of the Arctic ice-cap. Nature, 241, 39-40.

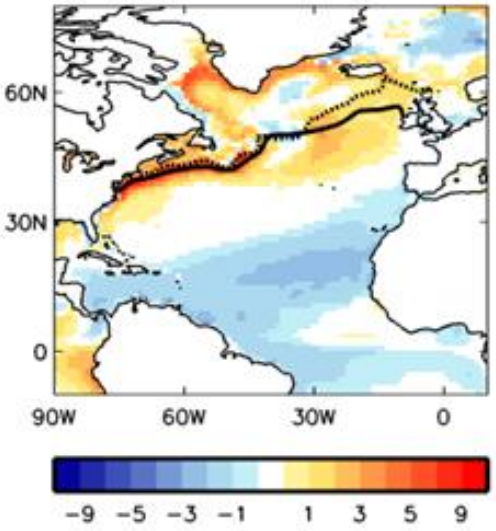
Atlantic Ocean

(Atlantic Blocking: an 'old chestnut' of climate modelling issues)

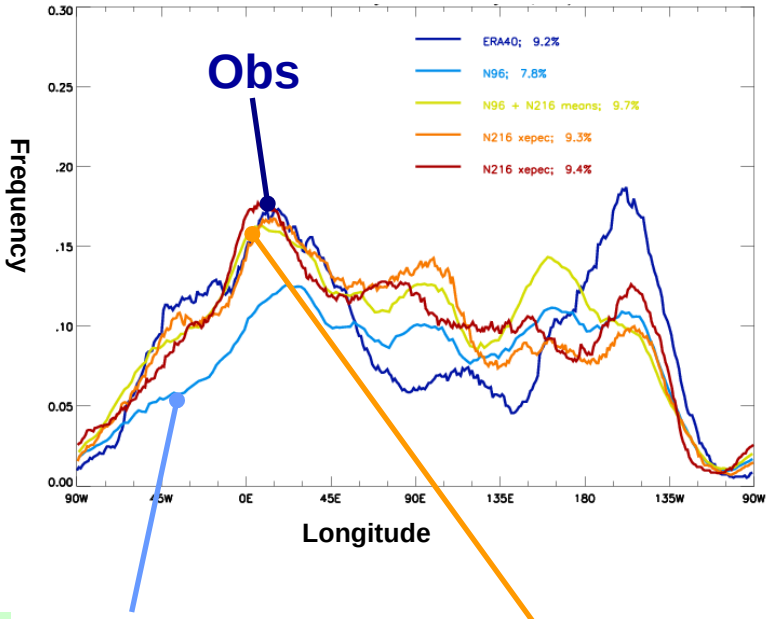
Low Res 1°



High Res 0.25°



Atlantic Blocking Frequency



Low Res Model

High Res Model

Cold winter bias (°C) in Gulf Stream

Occurs in standard seasonal forecast models

Small Gulf Stream bias in high res' Hadley Centre Model

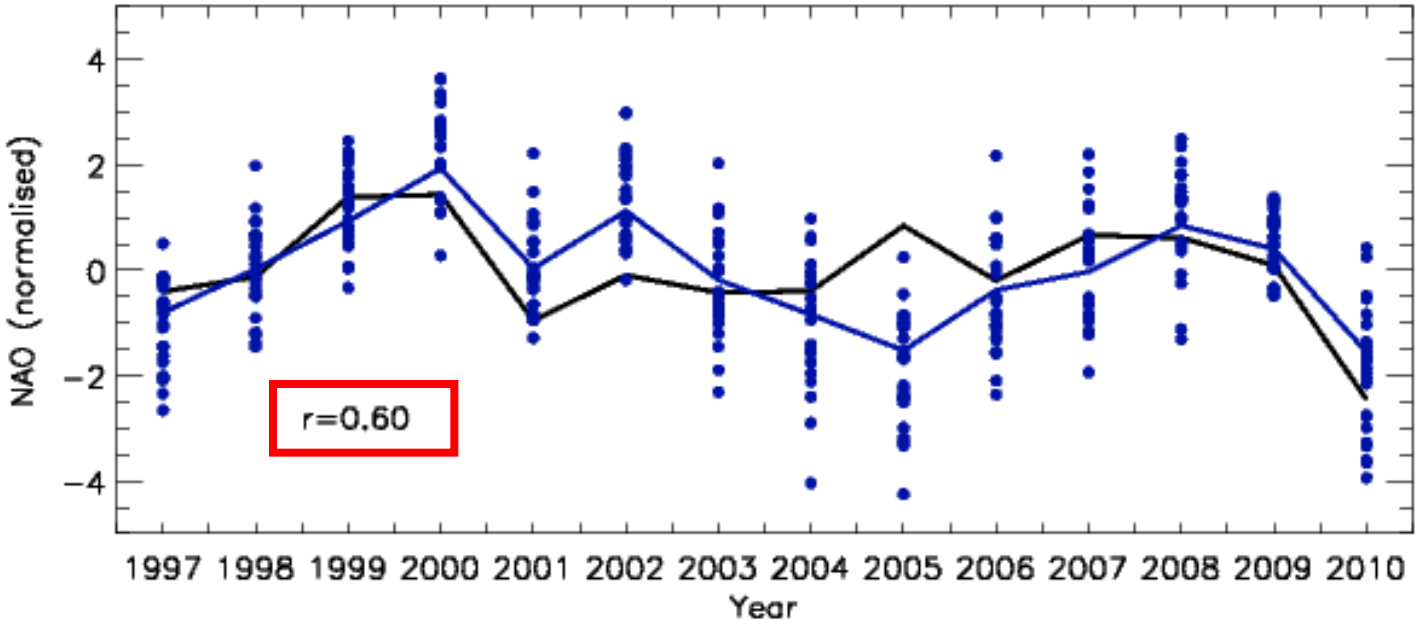
⇒ Good Blocking!

Scaife et al., GRL, 2011

Predictability of the NAO!

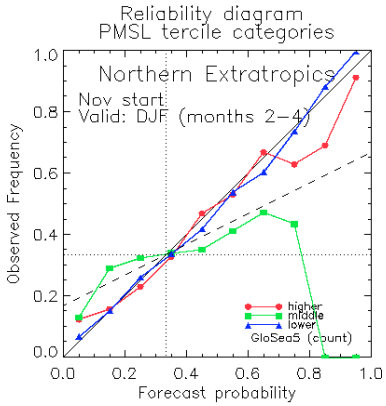
(and pretty reliable PMSL predictions)

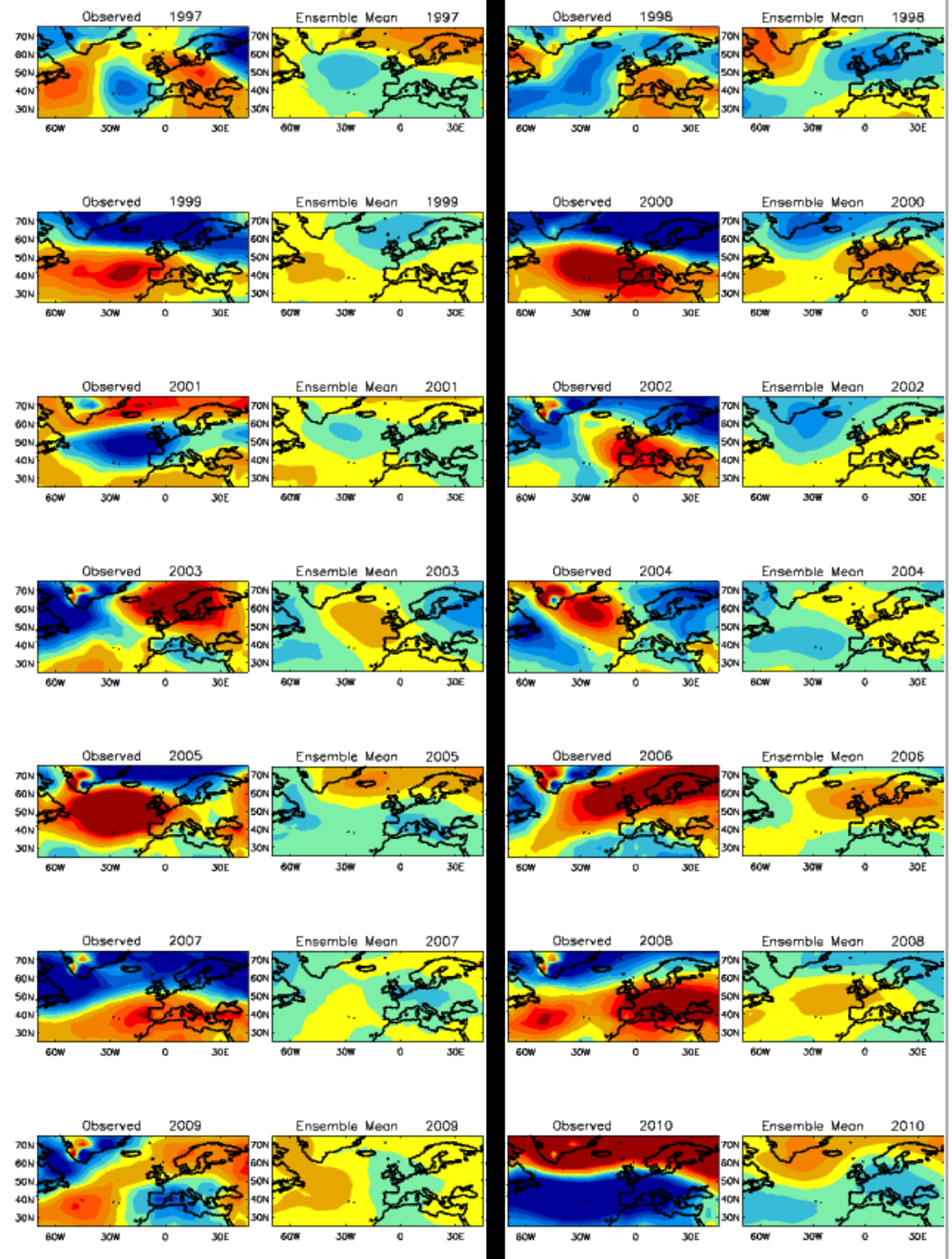
Retrospective winter forecasts



NAO skill r~0.6 (c.f. ECMWF 0.16, NCEP 0.25: not stat. sig.)

Significant at the 98% level





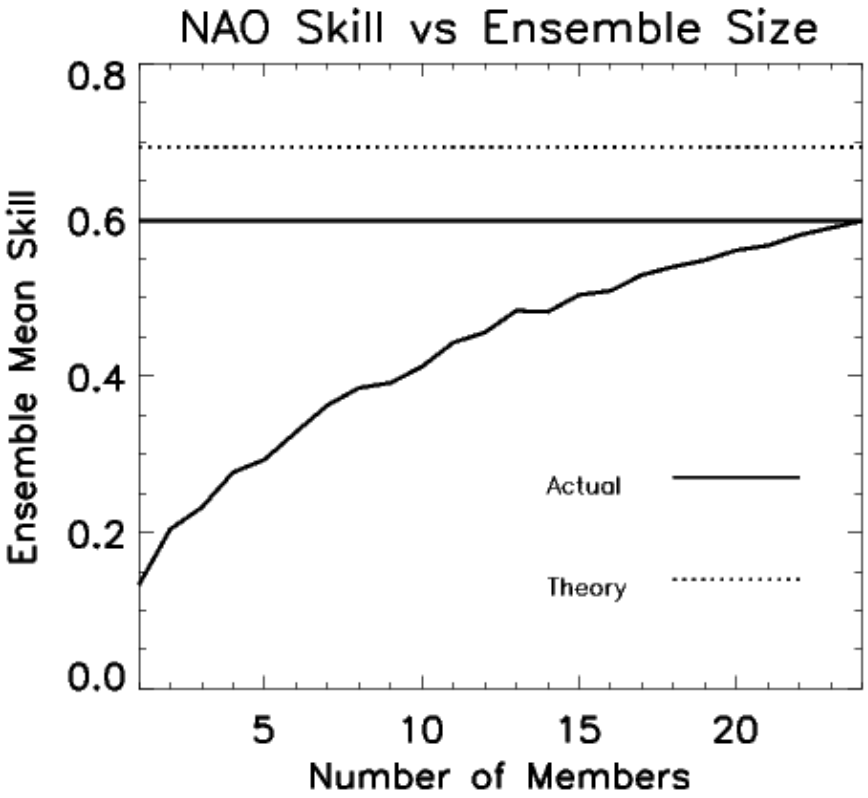
Individual winters

Very good agreement between pressure patterns in many individual years

Strength always underestimated

Isn't that to be expected?

Effect of ensemble size on skill

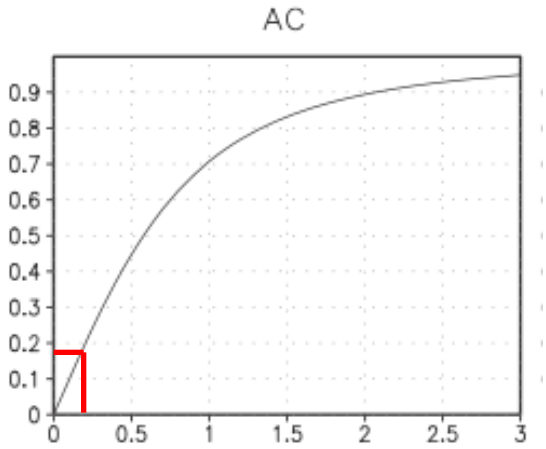


Increasing ensemble size increases signal-to-noise

Signal to noise is small ~0.2

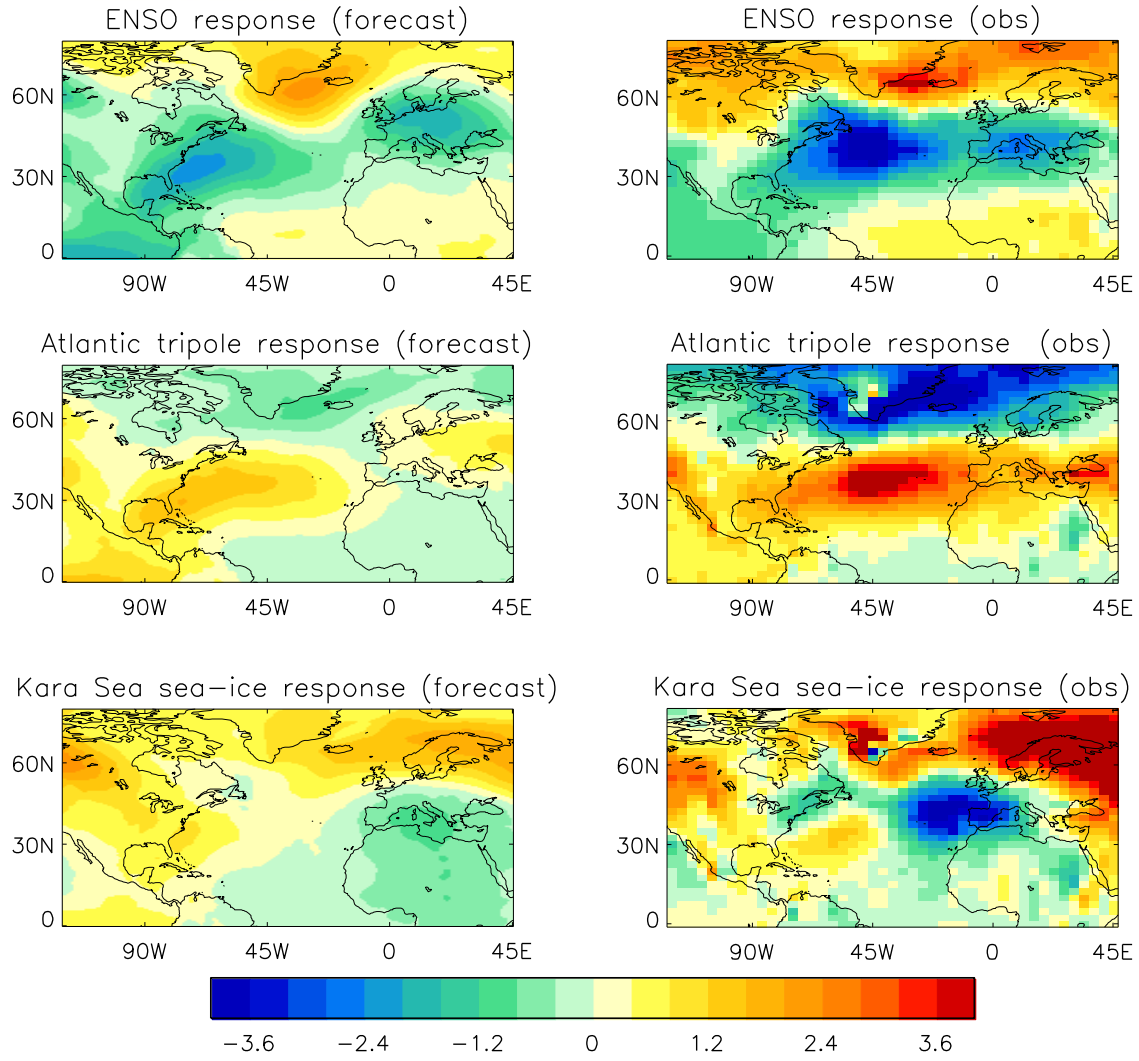
Approaching theoretical asymptote (Murphy, 1990)

0.7 is possible with this system!



Kumar 2009

Sources of predictability…



Strongest minus weakest cases for November predictors:

ENSO Niño3.4

Atlantic Tripole

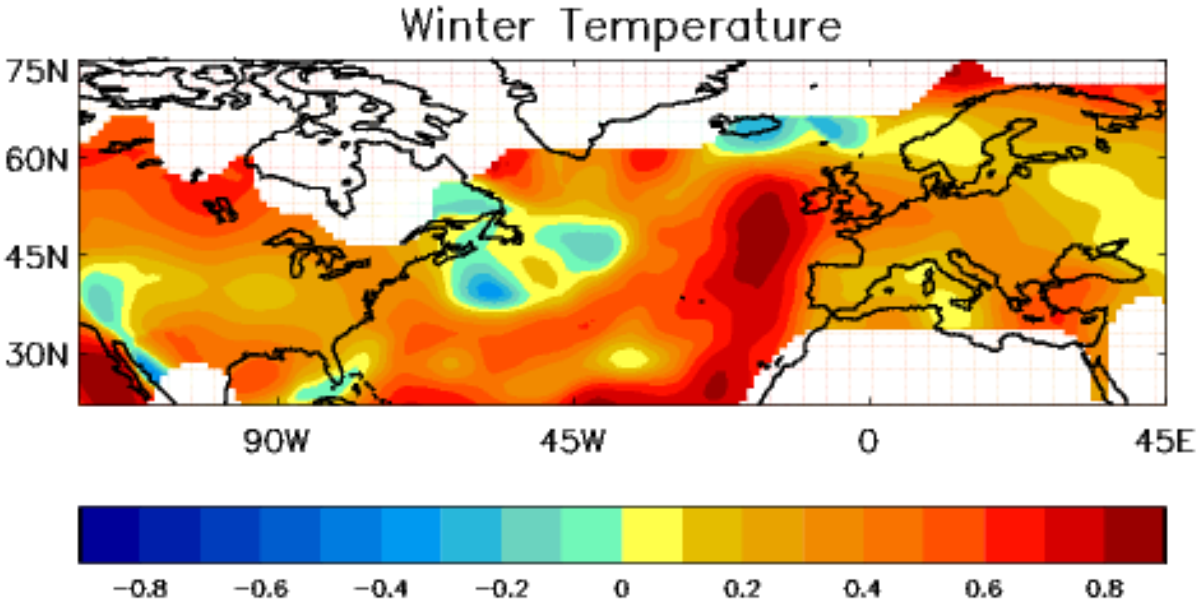
Kara sea-ice

Response is weaker in model than obs

Nevertheless…

Nick Dunstone

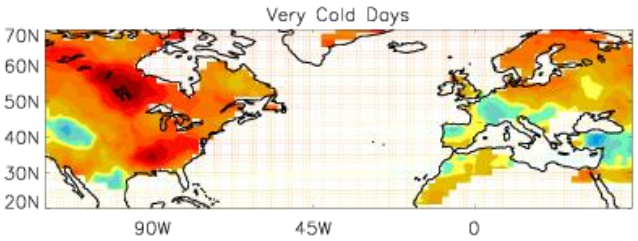
Skill in Winter Temperatures

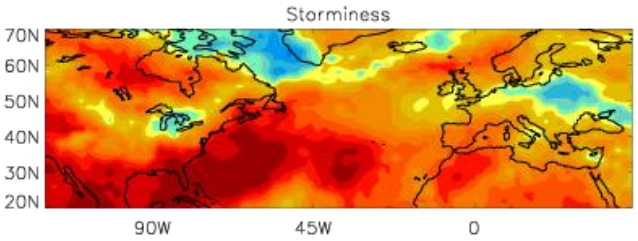


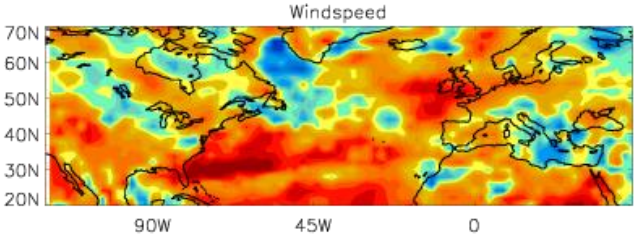
Skilful prediction of the NAO, gives skill in Europe and N America.

Emily Wallace

Daily extremes - impacts







Skilful prediction of the NAO

=> skill in winter extremes

Cold days (energy, transport..)

Storms (insurance…)

Windspeed (renewables) etc

Work now needed to create forecast products of societal value

Emily Wallace, Leon Hermanson & Robin Clarke

Summary of where we are:

Skilful **seasonal forecasts for Europe, N America and the NAO in winter!**

Predictability of the NAO/AO (corr > 0.6)

Low signal to noise

- **predictors weakly represented**
- **this needs to be accounted for *before* probabilistic assessment**

Several sources of skill including:

- **Sea Ice, Atlantic, ENSO – these 3 alone explain 50% of variance**
- **Implies need for interactive sea ice, good Atlantic and stratosphere**