North Atlantic Oscillation Forecast for Winter 2005/6

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Forecast Summary

The North Atlantic Oscillation is forecast to be slightly below-norm during the coming winter (1st December 2005 - 28th February 2006).

The North Atlantic Oscillation (NAO) is the dominant influence on winter climate variability over the North Atlantic, Europe and eastern North America. Our NAO forecast for winter 2005/6 indicates a below-norm NAO is three times more likely than an above-norm NAO. To place this in context, eleven other winters since 1972/3 have recorded an NAO more negative than our forecast for 2005/6, the last such instance being the winter of 2003/4. The forecast spans the period from 1st December 2005 to the 28th February 2006. The prediction is made using an ensemble of two separate forecasts made with prior June/July northern hemisphere subpolar surface air temperature and prior June/July northern hemisphere snow cover (*Saunders et al., 2003*). This multi-model anticipates whether the winter NAO will be above or below the median - for a range of NAO indices - in 67%-82% of the winters during the 1972/3-2004/5 period of reliable snow cover monitoring. Deterministic and tercile probability forecasts for three leading NAO indices for winter 2005/6 are given below.

1. Winter 2005/6 NAO Forecast

NAO Index	Climate Norm ± SD (1972/3 - 2004/5)	Forecast ± FE 2005/6	Hindcast Skill (%) (1972/3 - 2004/5)
NAO Index 1	0.58 ± 1.32	-0.12 ± 1.01	42
NAO Index 2	0.28 ± 0.65	0.07 ± 0.55	28
NAO Index 3	0.36 ± 1.17	0.02 ± 0.96	32

NAO Index 1 is forecast to be below average (lower tercile) to 55% probability, near-average (middle tercile) to 34% probability and above average (upper tercile) to only 10% probability (see Figure 1). NAO Index 2 is forecast to be below average to 45% probability, near-average to 36% probability and above average to 19% probability. NAO Index 3 is forecast to be below average to 44% probability, near-average to 38% probability and above average to 19% probability.

Key: NAO Index 1 = Mean sea level pressure difference between Iceland and Gibralter compiled by the Climate Research Unit (http://www.cru.uea.ac.uk/~timo/projpages/nao_update.htm).

NAO Index 2 = NAO teleconnection index from the US Climate Prediction Center. (http://www.cpc.ncep.noaa.gov/products/precip/CWlink/pna/nao_index.html).

NAO Index 3 = Leading principal component of North Atlantic (20^{o}N-70^{o}N, 40^{o}E-90^{o}W) mean sea level pressure compiled by Dr Jim Hurrell (http://www.cgd.ucar.edu/

		~jhurrell/nao.pc.other.html#djfseas).
Forecast Error (FE)	=	Standard deviation of errors from cross-validated hindcasts 1972/3-2004/5 made with 5-year block removal.
Hindcast Skill	=	Percentage improvement in mean square error over the 1972/3-2004/5 33-year climate norm from cross-validated hindcasts 1972/3-2004/5 made with 5-year block removal.
Tercile	=	Data groupings of equal (33.3%) probability corresponding to the upper, middle and lower one-third of values historically (1972/3-2004/5).
Upper tercile	=	NAO value greater than 1.15 (Index 1), 0.56 (Index 2) and 0.87 (Index 3).
Middle tercile	=	NAO value between 0.01 and 1.15 (Index 1), 0.00 and 0.56 (Index 2) and -0.14 and 0.87 (Index 3).
Lower tercile	=	NAO index value less than 0.01 (Index 1), 0.00 (Index 2) and -0.14 (Index 3).

Our forecast for NAO Index 1 for winter 2005/6 is shown in terms of probability of exceedance in Figure 1. The plot indicates that for winter 2005/6 the NAO Index 1 is five times more likely to lie in the below-average climate-norm tercile than in the above-average tercile. Taking the three NAO indices together the 2005/6 NAO is three times more likely to lie in the below-average tercile than in the above-average tercile.

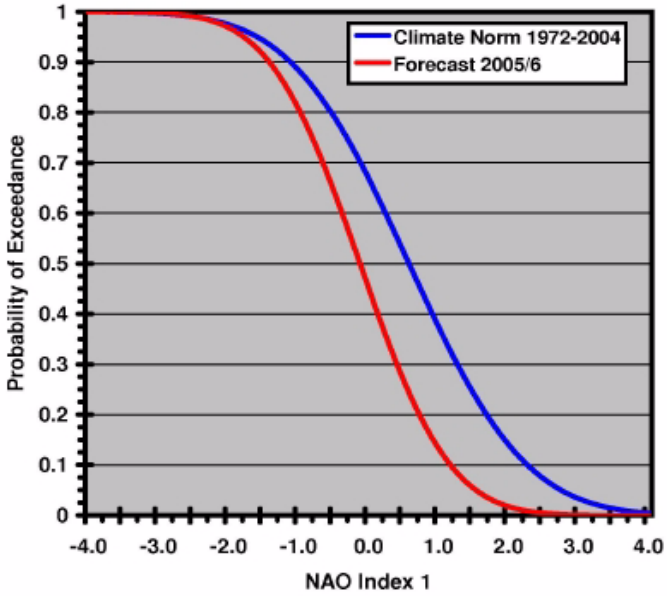

Figure 1. Probability of exceedence plot for NAO Index 1 comparing winter forecast for 2005/6 and 1972/3-2004/5 climatology.

2. The NAO Forecast Model

The winter NAO forecast is an ensemble of two separate NAO forecasts made with (1) prior June/July northern hemisphere subpolar zonal surface air temperature differences and (2) prior June/July northern hemisphere snow cover (*Saunders et al., 2003*). Figure 2 shows the strength of the recent link between these two predictors and three leading winter NAO indices. The link is significant to 0.01 after correction for time series serial correlation. The link between subpolar zonal surface air temperature difference and various winter NAO indices is also significant to 0.01 over longer (~100 year) timescales (*Fletcher and Saunders, 2005*).

Here the models are constructed and the hindcast skill assessed using detrended time series, thereby ensuring that trends have no influence on either the model development or the skill.

Cross-validation is performed with 5-year block removal to minimise the influence of serial correlation on skill. For hindcasts with detrended data the multi-model anticipates whether the winter NAO will be above or below the median in 82% of winters (NAO Index 1), 69% of winters (NAO Index 2) and in 67% of winters (NAO Index 3) 1972/3-2004/5. For a tercile probability forecast the multi-model predicts the highest probability in the correct tercile in 52% of winters (NAO Index 1), 42% of winters (NAO Index 2) and in 55% of winters (NAO Index 3) 1972/3-2004/5. This compares to 39%, 36% and 45% respectively if we were to always predict an above average NAO index.

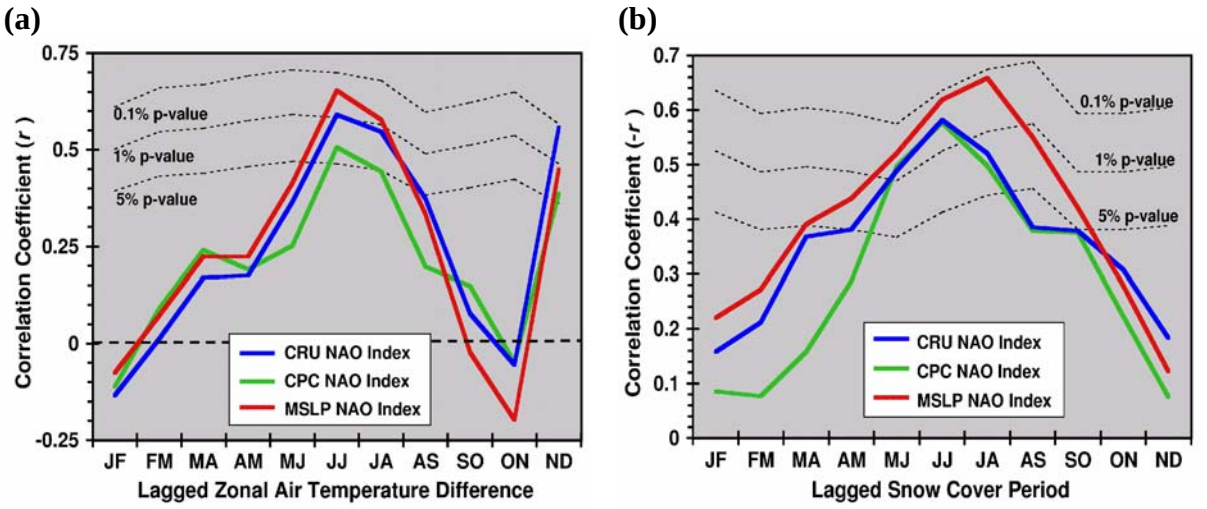

Figure 2. The link between lagged northern hemisphere (a) subpolar zonal surface air temperature difference and the upcoming winter NAO 1972/3-2001/2, and (b) snow cover and the upcoming winter NAO 1972/3-2001/2. The plots display correlations between lagged bi-monthly values of each parameter and the three upcoming winter NAO_{DJF} indices forecast in this document. All correlations are computed from detrended time series. Dashed lines display the confidence levels of non-zero correlation between the subpolar zonal surface air temperature difference (a) and snow extent (b) and the MSLP NAO_{DJF} index assessed using a 2-tailed Students *t*-test after correction for autocorrelation with lags out to 15 years included. (Figure adapted from *Saunders et al., 2003*).

3. Further Information

Further details on the relationship between summer northern hemisphere subpolar zonal air temperature differences, snow cover and the winter NAO may be found in the following papers available from http://forecast.mssl.ucl.ac.uk/publ.html:

Fletcher, C. G. and M. A. Saunders, A comparison of winter North Atlantic Oscillation hindcast models, *J Climate*, submitted 2005.

Saunders, M. A., B. Qian and B. Lloyd-Hughes, Summer snow extent heralding of the winter North Atlantic Oscillation, *Geophys. Res. Lett.*, **30**(7), 1378, doi:10.1029/2002GL016832, 2003. (Highlighted by *Geophys. Res. Lett.* and the subject of a News Story in *Science*: Kerr, R. A., WEATHER FORECASTING: Can Northern Snow Foretell Next Winter's Weather?, *Science*, **300**, 1865-1866, 2003).