

## Seasonal forecasts of the exceptional boreal winters of 2009/10 and 2010/11

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The northern hemisphere winters of 2009/10 and 2010/11 were exceptional, with extremes of both atmospheric circulation and temperature. This presentation examines the causes and predictability of these extreme winters within the UK Met Office seasonal forecast system GloSea4. In winter 2009/10 the North Atlantic Oscillation (NAO) index was the lowest on record for over a century, contributing to cold conditions over large areas of Eurasia and North America. The then-operational version of GloSea4 used a "low top" model and successfully predicted a negative NAO in forecasts produced in September-November 2009. GloSea4 was later changed to use a "high top" model, which better simulates sudden stratospheric warmings. These events are shown to play an influential role in surface conditions, producing a stronger sea level pressure signal in the "high top" model and further improving retrospective predictions of the 2009/10 winter.

Early winter 2010/11 also saw record-breaking cold anomalies over much of northern Europe, once again associated with a very negative NAO index. The negative winter NAO signal was forecast with near unanimity by the 11 WMO Global Producing Centres (including GloSea4) in September. Different potential mechanisms have been identified as driving the NAO, including El Nino-Southern Oscillation teleconnections, autumn Eurasian snow cover, Arctic ice extent and North Atlantic sea surface temperature (SST) anomalies. The representation of these mechanisms in GloSea4 is assessed using hindcasts for the period 1989-2009. The November 2010 forecast for December is examined using ensembles of atmosphere only runs, forced with SST fields as forecast in November 2010. We relax possible forcings (the strong La Niña in November 2010, the Arctic ice field, and the North Atlantic SST tripole) back to climatology to see which forcings produce the cold signal over Europe in December, and conclude that the main driver was the North Atlantic SST tripole.