A regime view of the NAO and the effect of future climate change.
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The distribution of the daily wintertime North Atlantic Oscillation (NAO) index in the ERA-40 reanalysis has a significant negative skewness. Dynamical and statistical methods both suggest that this skewness reflects the presence of two distinct regimes which we refer to as 'Greenland Blocking' and 'Zonal Flow'. Most of the multi-year variability over the ERA-40 period is shown to arise from variations in the relative occurrence of the two regimes.

This is contrasted with the simulation of the NAO in 100-year control and double CO2 integrations of the Hadley Centre climate model HadCM3. In contrast to ERA-40, the daily NAO index in the control simulation is not significantly skewed. This adds to pre-existing concerns that climate models have serious deficiencies in their representation of NAO variability, and also suggests that these deficiencies may be linked to the difficulties which many models have in simulating blocking.

Intriguingly, the NAO index in the double CO2 integration does show significant skewness which is clearly associated with the same two regimes as seen in ERA-40. A physical mechanism for this change is given by consideration of the vertical structure of the zonal mean circulation change in model projections. This shows that the circulation response to increased CO2 does not project well onto the NAO or NAM (Northern Annular Mode) pattern, but is in fact dominated by the hydrostatic change associated with the spatial distribution of warming. In the mid-latitude mid-troposphere the warming pattern leads to increased cyclonic shear, which would be expected to favour the occurrence of the cyclonic wave-breaking events which lead to Greenland Blocking.