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Impacts of the EA and SCA patterns on the 20th century NAO-winter precipitation relationship in Europe

Laia Comas-Bru and Frank McDermott
School of Geological Sciences. Science Education and Research Centre. University College Dublin, Belfield. Dublin 4. Ireland

Much of the 20th century multi-decadal variability in the NAO-winter precipitation relationship over the N. Atlantic / European sector can be ascribed to the combined effects of the North Atlantic Oscillation (NAO) and either the East Atlantic pattern (EA) or the Scandinavian pattern (SCA). The NAO, EA and SCA indices employed here are defined as the three leading vectors of the cross-correlation matrix calculated from monthly sea-level pressure anomalies for 138 complete winters from the 20CRv2 dataset (Compo et al., 2011). Winter precipitation data over Europe for the entire 20th century is derived from the high resolution CRU-TS3.1 climate dataset (Mitchell and Jones, 2005).

Here we document for the first time, that different NAO/EA and NAO/SCA combinations systematically influence winter precipitation conditions in Europe as a consequence of NAO dipole migrations. We find that the zero-correlated line of the NAO–winter precipitation relationship migrates southwards when the EA is in the opposite phase to the NAO. This can be related to a south-westwards migration of the NAO dipole under these conditions, as shown by teleconnectivity maps. Similarly, a clockwise movement of the NAO–winter climate correlated areas occurs when the phase of the SCA is opposite to that of the NAO, reflecting a clockwise movement of the NAO dipole under these conditions.

An important implication of these migrations is that they influence the spatial and temporal stationarity of climate-NAO relationships. As a result, the link between winter precipitation patterns and the NAO is not straightforward in some regions such as the southern UK, Ireland and France. For instance, much of the inter-annual variability in the N-S winter precipitation gradient in the UK, originally attributed to inter-annual and inter-decadal variability of the NAO, reflects the migration of the NAO dipole, linked to linear combinations of the NAO and the EA. Our results indicate that when the N-S winter precipitation gradient is accentuated by the occurrence of a positive EA during positive NAO winters, drier conditions than normal are found in the southern UK. This is consistent, for example, with the severe winter drought of 1976, when computed NAO and EA indices were both positive (0.97 and 1.87, respectively), illustrating the modulating effect of NAO/EA combinations on winter precipitation patterns in the southern UK.

References:

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