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Reconstruction of winter atmospheric teleconnections in the North Atlantic area during the Holocene using a gridded pollen-based temperature record.

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Understanding changes in atmospheric circulation is critical in forecasting future regional climate change, particularly in winter when circulation is strongest, and in the mid-latitudes where impacts are often largest. Atmospheric teleconnections such as the North Atlantic Oscillation (NAO) that are associated with particular circulation modes have a strong impact on surface temperatures, explaining up to ∼70% of winter temperature variability in some areas of Europe and North America. This strong and distinctive spatial impact on surface temperatures can in turn be used to reconstruct past changes in atmospheric pressure modes, particularly where large networks of climate archives can be utilized to investigate the distinctive spatial fingerprint associated with these modes at continental scales.

Here we use a quantitative and gridded winter temperature record derived from over 1400 pollen sites from across Europe and North America to investigate changes in the dominant circulation modes in the North Atlantic area during the Holocene. We established modern relationships between terrestrial surface temperature anomalies and teleconnection indices, and applied these relationships to our spatial-temporal palaeo-temperature field to directly reconstruct the changes in these indices throughout the Holocene. Our results support the idea that the NAO has been the main mode of variability in the North Atlantic region throughout much of the Holocene, with a more positive state than present during the early to mid-Holocene, consistent with previous studies. Importantly however, we also find that secondary modes, such as the East Atlantic (EA) pattern, have also played a significant role, with the EA being more negative than present in the early Holocene. The EA can be considered a variant of the NAO, and this particular finding may support the idea that the NAO is non-stationary and that the main pressure centers may have changed location through time. We evaluate our findings through comparison with independent terrestrial and marine records thought sensitive to these modes.