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Climate response to a multidecadal warming and cooling of the north Atlantic ocean

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During the nineteenth and twentieth centuries there were marked variations on multidecadal timescales in the climate of both North America and western Europe. Prominent multidecadal variations were also observed in the North Atlantic Ocean during this period. Previous studies have suggested a link between these variations, in particular that the significant variations in rainfall and drought frequency observed in the continental US during this period may have been caused, in part, by multidecadal variations in Atlantic Sea Surface Temperatures associated with the Atlantic Multidecadal Oscillation.

Until recently the only evidence for such a link lay in observations which suggested correlation rather than causality. In order to examine the climate impacts of such multidecadal changes in the Atlantic Ocean we have carried out experiments in which an Atmosphere Global Circulation Model is forced with idealised multidecadal patterns of sea surface temperature.

We find, through quantitative comparisons between the model results and observations, that multidecadal variations in the Atlantic Ocean were an important driver of variations in the climate of both North America and western Europe during the twentieth century. The strongest response is found in boreal summer and is associated with suppressed precipitation and elevated temperatures over the lower latitude parts of North and South America. There are significant effects in other seasons across the region. For example, In August-September-October there is a significant reduction in the vertical shear in the main development region for Atlantic hurricanes.

Significant climate impacts are not restricted to the Atlantic basin, implying that the Atlantic Ocean could be an important driver of global decadal variability. We find

that the strongest remote impacts occur in the tropical Pacific region in JJA and SON. Surface anomalies in this region have the potential to excite coupled ocean-atmosphere feedbacks which are likely to play an important role in shaping the ultimate climate response.