Recent trends in summer atmospheric circulation in North Atlantic/European region: is there a role for anthropogenic aerosols?

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The variability of the westerly jet stream and storm track is crucial for summer weather and climate in the North Atlantic/European region. Observations for recent decades show notable trends in the summer jet from 1970s to 2010s, characterized by an equatorward migration over the North Atlantic accompanied by a poleward migration and weakening of the Mediterranean jet over Europe. These changes in atmospheric circulation were associated with more cyclonic storms traveling across the UK into northern Europe, and fewer over the Mediterranean, leading to wet summers in northern Europe and dry summers in southern Europe.

In this study we investigate the potential drivers and processes that may have been responsible for the observed changes in summer atmospheric circulation, with a particular focus on the role of anthropogenic aerosols (AA). We conduct attribution experiments with an atmospheric general circulation model (AGCM) forced with observed changes in sea surface temperatures/sea ice extent (SST/SIE), greenhouse gas concentrations and AA precursor emissions. Comparison between the model results and observations strongly suggests that AA changes were likely the primary driver of the observed poleward migration and weakening of the Mediterranean jet, with changes in SST/SIE playing a secondary role. The simulated response shows good agreement with the observed changes in both magnitude and vertical structure, which suggests that common mechanisms - involving aerosol-radiation and aerosol-cloud interactions - are responsible. By contrast, changes in the North Atlantic jet are most strongly influenced in the model experiments by changes in Atlantic SST/SIE (which may themselves have been influenced by changes in AA). However, in this case there are significant differences between the model response and the observed changes; we argue these differences may be explained by biases in the model climatology.