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Large-scale temperature gradients and the extratropical storm track responses in CMIP5

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There is a large spread in the projected climate change responses of the extratropical storm tracks in the CMIP5 multi-model ensemble, particularly over the North Atlantic and Europe in winter. This is in part due to our limited understanding of the processes that drive changes in storm track dynamics globally, and in part due to the particular configuration of the North Atlantic jet streams which render them particularly sensitive to forcing. One key question is the relative role that changes in the upper- and lower-tropospheric temperature gradients play in shaping changes in baroclinicity and the storm track responses, compared to the role of more local processes such as changes in sea-surface temperatures, sea ice and land-sea temperature contrasts.

In this study the range of late 21st century extratropical storm track responses in the CMIP5 multi-model ensemble is analysed in terms of the equator-to-pole temperature differences. In the southern hemisphere there are large regions where the responses of both the upper- and lower-tropospheric zonal-mean temperature differences explain between 30%-60% of the inter-model variance of the storm track responses. In the northern hemisphere in winter the fraction of inter-model variance of the storm track responses explained by the zonal-mean temperature differences is small; however, in that case using the equator-to-pole temperature differences calculated just over the Atlantic basin explains over 50% of the variance in the North Atlantic region. These results suggest that there is potential to reduce the spread of the projected storm track responses by constraining the relative climate sensitivities of the tropical and polar regions.