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Response of the midlatitude jets and of their variability to increased greenhouse gases in the CMIP5 models

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This work documents how the midlatitude, eddy-driven jets respond to climate change using output from 72 model integrations run for the Coupled Model Intercomparison Project, Phase 5 (CMIP5). We consider separately the North Atlantic, the North Pacific and the Southern Hemisphere jets. Unlike previous studies, we do not limit our analysis to annual mean changes in the latitude and speed of the jets only, but also explore how the daily variability of each jet changes with increased greenhouse gases. Given the direct connection between synoptic activity and the location of the eddy-driven jet, changes in jet variability directly relate to the changes in the future storm tracks.

We find that all jets migrate poleward with climate change: the Southern Hemisphere jet shifts poleward by 2 degrees of latitude between the Historical period and the end of the 21st century in the RCP8.5 scenario, whereas the Northern Hemisphere jets shift by only 1 degree. The speed of the Southern Hemisphere jet also increases markedly (by 1.2 m/s between 850-700 hPa), while the speed remains nearly constant for both jets in the Northern Hemisphere. The seasonality of the jet shifts will also be addressed, whereby the largest poleward jet shift occurs in the autumn of each hemisphere (i.e. MAM for the Southern Hemisphere jet, and SON for the North Atlantic and North Pacific jets).

We find that the structure of the daily jet variability is a strong function of the jet position in all three sectors of the globe. For the Southern Hemisphere and the North Atlantic jets, the variability becomes less of a north-south wobbling (i.e. an 'annular mode') with a poleward shift of the jet. In contrast, for the North Pacific jet, the variability becomes less of a pulsing and more of a north-south wobbling. In spite of these differences, we are able find a mechanism (based on Rossby wave breaking) that is able to explain many of the changes in jet variability within a single theoretical framework.