EMS Annual Meeting Abstracts
Vol. 16, EMS2019-657, 2019

Assessing and understanding the sensitivity of the boreal winter extratropical atmospheric circulation to an abrupt CO_2 increase

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Understanding the Northern Hemisphere mid-latitudes atmospheric circulation response to the radiative changes induced by CO_2 forcing is complex due to the important internal variability in the mid and high latitudes. A modification of this circulation can influence the precipitation over Europe and North America and have significant impacts on population. Thus, it is of main interest to investigate the potential change in the eddy-driven jet and understand whether a latitudinal shift of the jet will occur or not in a warmer climate.
In this study, we investigate the boreal winter extratropical atmospheric circulation change in the new coupled model CNRM-CM6-1 developed at Météo-France and Cerfacs. The new model performs better in representing the atmospheric circulation compared to the previous version CNRM-CM5. In particular, the zonal wind biases are reduced and the climatology of blockings has been improved. Nevertheless, a zonal bias in the Northern Hemisphere atmospheric flow is still present, especially in the North Atlantic.
Looking at simulations in which CO_2 is quadrupled, CNRM-CM6-1 exhibits a stronger climate sensitivity compared to CNRM-CM5. The eddy-driven jet strengthens and shifts upward but no poleward shift is identified in boreal winter. Interestingly, a squeezing of the atmospheric variability is found at the east of the Atlantic. This response is then decomposed using amip-type simulations performed under the CFMIP (Cloud Feedback Model Intercomparison Project) protocol. The uniform SST warming is found to explain most of the total response, with relatively smaller contributions from CO_2 and SST pattern. Finally, to evaluate model uncertainties, the response in CMIP6 models is investigated.