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A multi-model perspective on the future changes of North Atlantic and European cyclones

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The future response of North Atlantic cyclones to climate change and its socio-economic impact on Europe is very uncertain. Previous studies do not agree on whether extratropical cyclones will intensify in a warmer world, and climate models are traditionally affected by biases in simulating the North Atlantic climate which might affect the confidence in their projections. Here we address such model uncertainty by providing a multi-model systematic assessment of the biases and of the future responses of North Atlantic cyclones in 20 CMIP5 models. The number and the dynamical intensity of cyclones - measured as T42 vorticity and wind speed at 850mb - are separately quantified by applying a cyclone tracking algorithm. Due to data unavailability, this approach has not been adopted in previous multi-model assessments.

We find that CMIP5 models have systematic biases in both the spatial distribution and the dynamical intensity of cyclones. However, in spite of these biases, CMIP5 models show broad consensus on the future changes in North Atlantic cyclones, as revealed by comparing the RCP4.5 (2070-2099) and the HISTORICAL (1976-2005) simulations. For instance, CMIP5 models agree in indicating a decrease in the dynamical intensity of cyclones in winter (DJF). However, the stormtrack becomes more zonal and extended into Europe so that a slight increase in the cyclone intensity is locally found in Northern France and Germany. In summer (JJA), models agree in indicating a reduction in cyclone number and intensity on the southern flank of the North Atlantic stormtrack. The difference between the DJF and JJA responses is interpreted in relation with the changes in the large scale baroclincity, and particularly that driven by Arctic surface temperature change. The impact of the model biases on the future projections are analysed and discussed.