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The impact of increased greenhouse forcing on the cyclones of the Atlantic and Mediterranean regions in CMIP5 models

Giuseppe Zappa[†]; Len Shaffrey; Kevin Hodges
[†] University of Reading, United Kingdom
Leading author: g.zappa@reading.ac.uk

The impact of climate change on the extratropical cyclones of the Atlantic and Mediterranean regions is investigated by examining the simulations for the current and future climates from models participating in the CMIP5 project. By inspecting the six hourly model output, cyclones are here identified as relative maxima in the 850mb vorticity, and tracked using an objective feature tracking algorithm. Stormtrack statistics are then computed by aggregating properties of the ensemble of tracks, so that changes in the spatial distribution and in the intensity of the cyclone activity can be separately quantified. The matter is of interest because of the socio-economic importance of cyclones in the region and because previous works on the topic has resulted in contrasting conclusions. In particular, little agreement is found about how the intensity and the frequency of occurrence of strong extratropical cyclones will change under increasing greenhouse gases. The contrasting nature of these results is believed to be partially due to the adoption of different cyclone identification criteria. Moreover, large uncertainties still affect how the location of the Atlantic stormtrack could be displaced in a warmer world. This work aims to use the same feature tracking method over a variety of state of the art climate models, so that a substantial advance in addressing these unresolved issues is provided. For each CMIP5 model, the difference in the spatial distribution of the average cyclone intensity, and in the track, genesis and lysis densities between the RCP4.5 (2070-2099) run and the historical (1976-2005) run is computed. Data from all the available ensembles are used to increase the robustness of the climate change signal when comparing with natural variability. The intensity distribution of the ensemble of cyclones in the stormtracks is further investigated by examining the probability density function (PDF) of the maximum along-track cyclone wind speed and precipitation rate. Changes in the average and in the extremes of cyclone intensities are both inferred from the PDFs. Particular attention is placed in quantifying the spread of the climate change signal in the CMIP5 ensemble, and in the subset of CMIP5 models that gives a more realistic simulation of the cyclones observed in the current climate. The statistics are computed and separately presented for the four seasons.