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Strong tropical cyclones in future in an enhanced resolution CMIP5 simulation

N. M. Rathmann (1), E. Kaas (1), and S. Yang (2)

(1) Niels Bohr Institute, University of Copenhagen, Denmark, (2) Danish Meteorological Institute, Danish Climate Centre, Copenhagen, Denmark

This study investigates the changes of characteristics of tropical cyclones (TCs) simulated by the EC-Earth CMIP5 experiments. The EC-Earth is a state-of-the-art global climate model system, consisting of the ECMWF's Integrated Forecast System (IFS) cycle 31r1 with modified convection scheme and a new land-surface scheme H-TESSEL, the NEMO version 2 and the LIM2 for the atmosphere, ocean and sea ice component. The EC-Earth model for CMIP5 experiments is configured at an enhanced atmospheric resolution of T159 (equivalent to 125 km x 125 km) and 62 vertical layers, and the ocean resolution at about 1° x 1° and 42 vertical layers. In order to assess the changes of TC characteristics in a warming climate, three time periods are considered, i.e. the early 20th century of 1901-1930 and the recent past of 1980-2008 in the historical simulation, and the projected near the end of the 21st century of 2070-2100 in the RCP4.5 and RCP8.5 scenario simulations. The experiment outputs of these three periods are processed and scanned for TC tracks using a customized tracking algorithm, which picks up several TC characteristics along the track. It is found that, whilst there is only a slight decrease in the global annual mean TC frequency, the number of high wind speed events associated with TCs increase markedly in the future.

To evaluate the extent that the TC characteristics are influenced by model resolution, a series of AMIP-type simulations using EC-Earth forced with sea surface temperatures and sea ice extents from ERA40/ERA-Interim for the period of 1979-2008 are carried out at the same resolution as in the CMIP5 simulations, and three very high horizontal resolutions of T319, T511 and T799 (equivalent to gridpoint resolutions of 60km x 60km, 40km x 40km and 25 km x 25 km, respectively). Performing the same TC tracking analysis for the four AMIP-type experiments reveals that coarse resolution results in reduced size and severely underestimates maximum wind speeds of simulated TCs. However, the geographical distributions, lifetimes and the seasonality of TCs are well captured at the enhanced resolution of T159. Furthermore, the characteristics of simulated TCs seem to converge at the two very high resolution simulations, implying that it may be unnecessary to run a climate model at a resolution higher then $\sim$ 40 km for getting a realistic TC climatology.