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Improved seasonal predictability of extra-tropical cyclones in a Two-Way Coupled Atmosphere Ocean Model

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The general bias of global atmosphere ocean models, and also of the MPI-ESM, is an under-representation of the high latitude cyclone activity and an overestimation of the mid latitude activity, thus representing the extra-tropical storm track too zonal. We present here the results of a newly developed two-way coupled (TWC) model system, which is able to eliminate this shortcoming to a large extent and simulate the mean location of the stormtrack more accurate. Beyond that, it also improves the predictability of extra-tropical cyclone track density and surface air temperature significantly in the first predicted winter over whole Europe.

The large scale dynamics in the form of extra-tropical cyclones are analyzed within a set of hindcasts performed with the two-way coupled model system. The regional model COSMO CLM is two-way coupled to the atmosphere of the global Max-Plack-Institute Earth System Model (MPI-ESM) and therefore integrates and exchanges the state of the atmosphere every 10 minutes (MPI-TWC-ESM). In the coupled source region (North Atlantic), mesoscale processes which are relevant for the formation and early-stage development of cyclones are expected to be better represented, and therefore influence the large scale dynamics of the target region (Europe).
The database covers 102 “uncoupled” years and 102 two-way coupled years of the recent climate. Results are validated against the ERA-Interim reanalysis. Despite from the climatological point of view, the design of this single model “ensemble“ allows for an analysis of the predictability of the first and second leadyears of the hindcasts.

As a first step to understand the improved predictability of cyclones, we will show a detailed analysis of climatologies for specific cyclone categories, sorted by season and region. Especially for cyclones affecting Europe, the TWC is capable to counteract the AOGCMs’ biasees in the North Atlantic. Also, cyclones which are generated in the Northern North Atlantic and the Labrador Sea are to an extraordinary extent underestimated in the MPI-ESM, for which in the latter region the TWC can balance this shortcoming. In the Northern Hemisphere annual mean statistics the TWC does not change the distribution of the strength of cyclones, but it changes the lifetime of cyclones.