Geophysical Research Abstracts
Vol. 18, EGU2016-16589-2, 2016
EGU General Assembly 2016

The influence of an atmospheric Two-Way coupled model system on the predictability of extratropical cyclones

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A 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 cyclone activity in the North Atlantic, thus representing the extra-tropical storm track too zonal. We will show, that this effect can be antagonized by applying an atmospheric Two-Way Coupling (TWC). In this study we present a newly developed Two-Way Coupled model system, which is based on the MPI-ESM, and show that it is able to capture the mean storm track location more accurate. It also influences the sub-decadal deterministic predictability of extra-tropical cyclones and shows significantly enhanced skill compared to the "uncoupled" MPI-ESM standalone system.

This study evaluates a set of hindcast experiments performed with said 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 (1960-2010). Results are validated against the ERA-Interim reanalysis. Besides 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 AOGCM's biases 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 "uncoupled" MPI-ESM - for 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 distribution of the lifetime of cyclones.