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Diagnosis of spatial distribution and severity of mid-latitude storms in an ensemble of European AOGCMs under anthropogenic climate change

G.C. Leckebusch (1), M. Donat (1), D. Renggli (1), U. Ulbrich (1), and J.G. Pinto (2)

(1) Freie Universität Berlin, Institut für Meteorologie, Berlin, Germany (gcl@met.fu-berlin.de, +49 (0)30 838-71107), (2) Universität zu Köln, Institut für Geophysik und Meteorologie, Köln, Germany

Large structural damages and financial losses are caused by severe extra tropical cyclone systems of the mid-latitudes. Although in the decades from 1960 to the mid-90s a significant increase in the number of severe storms in the North-Atlantic / European region is undouptful, no clear attribution to anthropogenic climate change could be depicted. Nevertheless, the importance of such meteorological high impact phenomenon, underlines the necessity to estimate potential future developments and occurrence of storms over the Northeast Atlantic and Europe.

This study investigates the occurrence of mid-latitude cyclones and wind storms under anthropogenic climate change (ACC, IPCC SRES A1B) conditions from a multi-model perspective and aims at a robust diagnostic of the future occurrence of extreme cyclones under ACC based on an ensemble of state-of-the-art global atmosphere-ocean circulation models and at deducing measures of uncertainties of these ACC signals.

Two different investigation techniques are applied. Firstly, an objective cyclone identification and tracking method based on mean sea level pressure, and secondly, an impact based severity measure incorporating the daily maximum wind speed. Thus, a measure more related to the dynamic development features, as well as a proxy for the severity of impacts is used to ensure the relevance of the deduced results for the larger stakeholder community as e.g. reinsurance companies. The model results are validated with ECMWF-reanalysis data (ERA40).

In an ensemble mean perspective the overall number of cyclone systems in the A1B scenario is decreased, physically consistent with a reduced low-tropospheric mean baroclinicity due to a larger zonal mean temperature increase in polar regions than in mid- to low-latitudes. For extreme cyclones, however, two hotspots of increased activity are revealed by the ensemble mean: one over the Northeast-Pacific, and another over the Northeast-Atlantic. Allthough model-to-model variability of this ACC signal is high, a weighting with the model quality, increases the statistical significance of the increased number of cyclone tracks over the Northeast-Atlantic near to the British Isles. In parallel, the impact based storm severity measure (SSI) shows results in a uniform manner.