Geophysical Research Abstracts
Vol. 18, EGU2016-17036, 2016
EGU General Assembly 2016

A statistical model for Windstorm Variability over the British Isles based on Large-scale Atmospheric and Oceanic Mechanisms

Nicolas Kirchner-Bossi (1), Daniel J Befort (1), Simon B Wild (1), Uwe Ulbrich (2), and Gregor C Leckebusch (1)

(1) School of Geography, Earth and Environmental Sciences, University of Birmingham, United Kingdom, (2) Institut für Meteorologie, Freie Universität Berlin

Time-clustered winter storms are responsible for a majority of the wind-induced losses in Europe. Over last years, different atmospheric and oceanic large-scale mechanisms as the North Atlantic Oscillation (NAO) or the Meridional Overturning Circulation (MOC) have been proven to drive some significant portion of the windstorm variability over Europe. In this work we systematically investigate the influence of different large-scale natural variability modes: more than 20 indices related to those mechanisms with proven or potential influence on the windstorm frequency variability over Europe —mostly SST- or pressure-based— are derived by means of ECMWF ERA-20C reanalysis during the last century (1902-2009), and compared to the windstorm variability for the European winter (DJF). Windstorms are defined and tracked as in Leckebusch et al. (2008). The derived indices are then employed to develop a statistical procedure including a stepwise Multiple Linear Regression (MLR) and an Artificial Neural Network (ANN), aiming to hindcast the inter-annual (DJF) regional windstorm frequency variability in a case study for the British Isles.

This case study reveals 13 indices with a statistically significant coupling with seasonal windstorm counts. The Scandinavian Pattern (SCA) showed the strongest correlation (0.61), followed by the NAO (0.48) and the Polar/Eurasia Pattern (0.46).

The obtained indices (standard-normalised) are selected as predictors for a windstorm variability hindcast model applied for the British Isles. First, a stepwise linear regression is performed, to identify which mechanisms can explain windstorm variability best. Finally, the indices retained by the stepwise regression are used to develop a multlayer perceptron-based ANN that hindcasted seasonal windstorm frequency and clustering.

Eight indices (SCA, NAO, EA, PDO, W.NAtl.SST, AMO (unsmoothed), EA/WR and Trop.N.Atl SST) are retained by the stepwise regression. Among them, SCA showed the highest linear coefficient, followed by SST in western Atlantic, AMO and NAO. The explanatory regression model (considering all time steps) provided a Coefficient of Determination (R^2) of 0.75. A predictive version of the linear model applying a leave-one-out cross-validation (LOOCV) shows an R^2 of 0.56 and a relative RMSE of 4.67 counts/season.

An ANN-based nonlinear hindcast model for the seasonal windstorm frequency is developed with the aim to improve the stepwise hindcast ability and thus better predict a time-clustered season over the case study. A 7 node-hidden layer perceptron is set, and the LOOCV procedure reveals a R^2 of 0.71. In comparison to the stepwise MLR the RMSE is reduced a 20%.

This work shows that for the British Isles case study, most of the interannual variability can be explained by certain large-scale mechanisms, considering also nonlinear effects (ANN). This allows to discern a time-clustered season from a non-clustered one —a key issue for applications e.g., in the (re)insurance industry.