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Development of a wind-gust model to estimate gust values and their return periods

Larisa Seregina, Rabea Haas, Kai Born, and Joaquim G. Pinto
University of Cologne, Institute for Geophysics and Meteorology, Cologne, Germany (rhaas@meteo.uni-koeln.de)

Spatially dense observations of gust speeds are necessary for the validation of climate models, but the observations are limited in space and time. The use of country specific thresholds for gust reports additionally reduces the availability of gust observations. This work presents an approach to help overcome problem. The first objective of this approach is the generation of synthetic gust velocities out of distribution parameters of wind velocities. With this aim, theoretical wind and gust distributions are estimated from ten years of hourly observations made at 123 synoptic weather stations provided by the German weather service (DWD). The approach consists of three steps. In the first step, an exposure correction is applied on the measurements of the mean wind velocity to reduce the influence of local urban and topographic effects. The second step consists of linear regressions applied on the parameters of the theoretical distribution of wind and gust velocities. The regression parameters gained by this procedure are used in the third step to set a transfer function to estimate distribution parameters of the gust velocity, which are applied afterwards to estimate gust velocities. The estimated distribution parameters are validated by the use of the so-called leave-one-out method. The estimated gusts can improve the accuracy of return periods at test sites with a lack of observations. The consideration of extreme value statistics enables to obtain return periods much longer that the nominal length of the original time series. Despite of uncertainties caused by the short length of the observational records, the method leads to satisfying results.