EMS Annual Meeting Abstracts
Vol. 15, EMS2018-310, 2018

Estimation of vertical wind gust profiles from regional reanalysis using extreme value theory

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Typically model forecasts and observations of wind gusts are provided for a standard measurement height of 10m above the surface. But for many applications wind gusts on higher levels are of high relevance, e.g. for the renewable energy sector wind gusts at hub height ($\sim$100m) are important. We present a statistical multivariate model approach for the estimation of vertical wind gust profiles from regional reanalysis data. Verifying observations are taken from measurements of a meteorological mast located in Hamburg, Germany. The Hamburg Weather Mast data comprise peak wind speed observations at six vertical levels between 10m and 280m for the time period from 2004 to 2014. We further dispose of 3-dimensional atmospheric data from the regional reanalysis COSMO-REA6. The COSMO reanalysis is a novel data set which covers Europe with a horizontal grid spacing of 6km for a time period of 21 years (1995 to 2015). The reanalysis output comprises about 150 variables (2D and 3D) with an hourly resolution.

Our statistical model comprises two steps: (i) First, the marginal distribution of the wind gusts at each vertical level is estimated conditionally on information from COSMO-REA6. To select the most informative variables we use the least absolute shrinkage and selection operator (LASSO). The conditional wind gust distribution is then a truncated generalized extreme value distribution with non-stationary parameters. (ii) In a second step, we investigate the dependence of the wind gusts for different heights using predictor-dependent extremal dependence functions. The most informative predictors from the reanalysis are the wind gusts in 10m, the absolute wind in different heights and the surface pressure tendency.