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Wind energy: Can we use regional reanalyses for yield reports?

Christopher Frank (1,2), Sabrina Wahl (1,3), Jan Keller (1,4), Bernhard Pospichal (2), Andreas Hense (3), and Susanne Crewell (2)

(1) Hans-Ertel_Centre for Weather Research, Climate Monitoring and Diagnostics, Germany, (2) Institute of Geophysics and Meteorology, University of Cologne, Germany, (3) Meteorological Institute, University Bonn, Germany, (4) Deutscher Wetterdienst, Offenbach, Germany

The yield report is the second step in the planning process of a wind turbine. While the first step is concerned with the identification of possible sites by taking into account infrastructure and other constraints such as nature reserves, the second step consists of the assessment of the long-term local wind conditions and the associated energy yield.

In order to get a reliable information on local wind conditions, tower measurements in two heights with one in at least 2/3 of hub-height performed over a minimum of one year are recommended. However, most yield reports are often based on multi-year measurements at 10 meters above ground which are extrapolated to hub-height.

This contribution assesses the usability of regional reanalyses for yield reports by comparing the quality of hub-height wind speed provided by regional reanalyses with the quality of extrapolated hub-height wind speed based on measurements. The reference is given by tower measurements at Cabauw, Hamburg and Lindenberg on all heights of interest.

Regional reanalyses under consideration are COSMO-REA6 (6 km horizontal resolution, 40 vertical layer) and COSMO-REA2 (2 km horizontal resolution, 50 vertical layer). Both have been developed within the Hans-Ertel Centre for Weather Research and are based on the German numerical weather prediction model COSMO. COSMO-REA6 covers the EURO-CORDEX region and COSMO-REA2 an extended COSMO-DE domain over central Europe. The coarser reanalysis is available from 1995 to 2015 and the finer from 2007 to 2013.

Since many different, and more or less complex extrapolation methods for hub-height wind are in use, we assess the quality of these methods, by investigating one rough and one more precise technique. The power law with constant exponent represents one of the most simplified extrapolation methods. The extrapolation method suggested by Smedman-Högström and Högström (1987) is one of the more complex ones considering atmospheric stability and surface roughness. Both methods are well established in wind engineering.

Considered theoretical hub-heights are 80 and 120 m. The extrapolated wind speed is based on (1) 10 m measurements and on (2) 2/3 of the hub-height measurements. A first assessment considers the marginal distributions. In a second step, annual and daily cycle of the different sources are investigated. Further, contingency tables provide a more detailed assessment of weaknesses and strengths of the different sources. Since the shape of wind profiles depend primarily on atmospheric stability, the performance is quantified for selected stability conditions.