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The benefit of wind atlases in wind energy and their verification

Julia Bethke, Jens Kampmeyer, and Heinz-Theo Mengelkamp
anemos GmbH, Germany (julia.bethke@anemos.de)

1 INTRODUCTION

Wind atlases such as reanalysis data and downscaled data sets are widely used in the wind energy sector, e.g. for long-term correlation of short-term measurements or initial site search. Due to the financial impact of statements derived from wind atlases, their verification is of high importance. Here, different wind atlases are verified in-depth with numerous certified high-quality mast measurements covering a broad range of heights up to 200 m. In contrast to the commonly used weather stations, high masts allow for an evaluation of vertical profiles and atmospheric stability.
The following questions will be addressed: What are wind atlases? How well are they performing? Which benefit do wind atlases have in wind energy?

2 APPROACH

The performance of commonly used reanalysis data, e.g. MERRA, ERA-Interim, and two data sets downscaled from MERRA reanalysis data is investigated. The first downscaled data set is derived by the mesoscale model MM5 and has a spatial and temporal resolution of 20 km and 10 min, respectively. The second downscaled data set is derived by the WRF model and has a spatial and temporal resolution of 3 km and 10 min, respectively.
Certified high-quality measurements of 45 met masts with 160 anemometers covering a range of complexity types, measurement heights between 30 m and 200 m and a time period of 2 years are compared to the wind atlases. Hourly values are analysed.

3 RESULTS

The correlation with hourly measurements of wind speed is very good for all data sets. Correlation increases with decreasing terrain complexity. Wind directions are also met very well by all data sets.
The frequency distributions of wind speed and therefore, the Weibull parameters are reproduced very well by the downscaled data sets for a broad range of velocities, however underestimating higher velocities. MERRA generally strongly overestimates wind speed.
Diurnal and annual cycles as well as vertical profiles are reproduced more accurately by the downscaled data sets than by reanalysis data. Thereby, the WRF based atlas performs best, especially in complex terrain and forest areas. One outstanding result is that the downscaled wind atlases are able to simulate the change of the vertical wind shear during the course of the day and thus, atmospheric stability quite well.
In general, the performance of all wind atlases weakens for areas with higher complexity and increased roughness (e.g. forests). For offshore sites an underestimation of the level of wind speed is observed.

4 CONCLUSION

Correlations with wind speed and wind direction are high, indicating that all wind atlases are suitable for long-term correlation. However, the downscaled data sets yield an overall better performance when it comes to detailed analysis. This suggests that they are more appropriate for applications where the absolute value is important, e.g. the initial estimation of the wind potential, energy loss calculations or the calculation of revenues regarding changing electricity rates. Thus, value is added by downscaling from reanalysis data. Furthermore, we see an improvement from MM5 to WRF and higher spatial resolutions, especially in complex terrain and forest areas.