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Modelling of long term wind resource assessment uncertainty using tall mast datasets

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Introduction

Long term resource estimates are usually validated using relatively short samples of wind speed or power production data. This research identifies and quantifies uncertainties in the long term resource assessment process using long term wind speed datasets from various tall masts around the globe, including masts in Germany, Belgium, Spain, the United States, Hungary, the offshore FINO 1 mast and others.

Method

Samples of a range of tall mast data are used as on-site measurements in resource assessment procedures. A variety of generic and in-house extrapolation methods are applied in combination with a range of reanalysis datasets and nearby meteorological station data. The reconstructed long term yield for each calculation is compared to remainder of the mast dataset and the errors are quantified.

Uncertainties are assessed according to availability of data, data granularity, length of the overlapping period and the long term reference source used. Climate variability is quantified by using different periods of the tall mast data as the on-site data in the MCP procedures. Multivariate analysis using a selection of the available tall mast datasets yields a methodology by which uncertainty on the long term resource estimates can be determined analytically using a limited range of site-specific factors. The resulting relationships are tested against out of sample masts.

Results

Model construction

Results show that generally Merra at 50 m is the most reliable reference source and that the high time resolution is not the main cause of the improved performance of Merra 50 m compared to other reference data sources. 3E's residual resampling method gives the lowest RMSE over all datasets, but is more sensitive to shorter overlap periods compared to other resampling techniques. Results also indicate that there is a strong and significant relationship between the inverse of the site overlap period and the RMSE of the reconstruction. The advantage of a longer site overlap quickly becomes marginal, typically between 1 and 2 years of overlap.

Model testing

Uncertainty model predictions against out of sample data reveal a very strong fit. This uncertainty model can be used with confidence to define the uncertainty surrounding any long term yield estimate. Long term yield estimates from around the globe are compared, revealing fair to good agreement with wind atlas estimates.