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Spectral verification of a mesoscale ensemble

C. Vincent (1), C. Draxl (1), G. Giebel (1), P. Pinson (2), C. Möhrlen (3), and J. Jørgensen (3)

(1) Risø DTU, Wind Energy Division, Roskilde, Denmark (gregor.giebel@risoe.dk), (2) Technical University of Denmark DTU, Informatics and Mathematical Modelling, Lyngby, Denmark, (3) Weprog Aps, Ebberup, Denmark

In this work, an adaptive spectral method is used to verify members of the Multi-Scheme Ensemble Prediction System (MSEPS), setup for the Horns Reef offshore wind farm near the Danish North Sea coast. All 75 ensemble members are run in the same model grid with a resolution of 5km. The members differ in their numerical formulation, mainly in the fast reacting processes in the atmosphere and in their initial conditions.

While numerical weather prediction (NWP) models are commonly used to forecast mean wind as an input to wind power prediction systems, this work is motivated by the premise that information about wind variability (as opposed to uncertainty) can also be extracted from NWP models. Forecasts of the risk of wind (and therefore power) variability are useful to wind farm operators because they indicate the likely back-up power requirements. Variability on these time scales is mostly caused by mesoscale phenomena, which should ideally be explicitly predictable by mesoscale models. A practical outcome of this work is conclusions regarding the scales which can be accurately predicted from a mesoscale model.

Since the forecast error is likely to consist of contributions from different scales of motion (such as the diurnal scale and the convective scale), verification of variability in the time domain is problematic because of the difficulty in separating contributions from these different scales. Here, an adaptive spectral method is used to first decompose the time-series into its constituent scales of oscillation, then the Hilbert transform is used to calculate the instantaneous frequencies and amplitudes of the components in a two step processes called the 'Hilbert-Huang Transform'. Verification using the Hilbert-Huang transform contrasts with spectral verification using the Fourier transform, which cannot give a well resolved representation of the instantaneous spectrum, and with parametric adaptive methods such as wavelet transforms which require choice of suitable wavelet functions.

Using the transformed time-series, a well resolved time-series of the total amplitude of all wind fluctuations within a given frequency range of interest is created. This methodology is exploited to directly verify the variability forecasts from the members of the MSEPS model on several temporal periods. The method verifies the amplitude but not the phase of the individual oscillations, and thereby avoids the commonly observed verification problem of high resolution forecasts with accurate but often slightly mis-timed features appearing to perform worse than low resolution forecasts that fail to forecast any sharply defined features.