Offshore vertical wind shear: Final report on NORSEWInD’s work task 3.1 - DTU Orbit (28/12/2018)

This document reports on the analysis performed by the work task 3.1 of the EU NORSEWInD project and includes the following deliverables:

3.2 Calculated vertical wind shears
3.3 Multi-variational correlation analysis
3.4 NWP data for wind shear model
3.5 Vertical extrapolation methodology
3.6 Results input into satellite maps

The nature of the offshore vertical wind shear is investigated using acquired data from the NORSEWInD network of mast and wind lidar stations. The importance of the knowledge of the vertical wind speed profile and wind shear is first illustrated for the evaluation of power outputs. Background related to the parametrization of the vertical wind speed profile and the behavior of the vertical wind shear in and beyond the atmospheric surface layer is presented together with the application of the long-term atmospheric stability parameters for the analysis of the long-term vertical wind speed profile. Observed vertical wind shears are illustrated for all NORSEWInD wind lidar and meteorological stations in terms of wind shear roses, distributions, and diurnal and monthly evolutions. A multi-variational correlation analysis is performed to study the vertical wind shear dependency on fetch, mean wind speed, seasonality and atmospheric stability. Numerical weather prediction data from the advanced weather research and forecasting (WRF) model is used to 1) Evaluate the ability of the model for the prediction of winds, temperatures and turbulent fluxes to be used for the extrapolation of wind speeds in the surface layer and 2) Construct a basis for the analysis of the long-term vertical wind speed profile and wind shear. A vertical extrapolation methodology for offshore wind resources is also presented based on different methods including profile methods, bulk and gradient Richardson numbers and long-term analysis of the atmospheric stability conditions. Finally, we propose alternatives for the extrapolation of surface winds typically from satellite retrievals and evaluate the effect of such methodologies on the wind speed, power density and vertical wind shear based on data from an offshore tall meteorological mast, where measures of the atmospheric stability can be performed based on observations and WRF outputs.

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