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Mesoscale modelling methodology based on nudging to increase accuracy in WRA

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Introduction

The offshore wind energy has recently become a rapidly growing renewable energy resource worldwide, with several offshore wind projects in development in different planning stages. Despite of this, a better understanding of the atmospheric interaction within the marine atmospheric boundary layer (MABL) is needed in order to contribute to a better energy capture and cost-effectiveness. Light has been thrown in observational nudging as it has recently become an innovative method to increase the accuracy of wind flow modelling. This particular study focuses on the observational nudging capability of Weather Research and Forecasting (WRF) and ways the uncertainty of wind flow modelling in the wind resource assessment (WRA) can be reduced. Finally, an alternative way to calculate the model uncertainty is pinpointed.

Approach

WRF mesoscale model will be nudged with observations from $FINO_3$ at three different heights. The model simulations with and without applying observational nudging will be verified against FINO1 measurement data at 100m. In order to evaluate the observational nudging capability of WRF two ways to derive the model uncertainty will be described: one global uncertainty and an uncertainty per wind speed bin derived using the recommended practice of the IEA in order to link the model uncertainty to a wind energy production uncertainty.

Main body of abstract

This study assesses the observational data assimilation capability of WRF model within the same vertical gridded atmospheric column. The principal aim is to investigate whether having observations up to one height could improve the simulation at a higher vertical level. The study will use objective analysis implementing a Cress-man scheme interpolation to interpolate the observation in time and in sp ace (keeping the horizontal component constant) to the gridded analysis. Then the WRF model core will incorporate the interpolated variables to the "first guess" to develop a nudged simulation. Consequently, WRF with and without applying observational nudging will be validated against the higher level of FINO1 met mast using verification statistical metrics such as root mean square error (RMSE), standard deviation of mean error (ME Std), mean error average (bias) and Pearson correlation coefficient (R). The respective process will be followed for different atmospheric stratification regimes in order to evaluate the sensibility of the method to the atmospheric stability. Finally, since wind speed does not have an equally distributed impact on the power yield, the uncertainty will be measured using two ways resulting in a global uncertainty and one per wind speed bin based on a wind turbine power curve in order to evaluate the WRF for the purposes of wind power generation.

Conclusion

This study shows the higher accuracy of the WRF model after nudging observational data. In a next step these results will be compared with traditional vertical extrapolation methods such as power and log laws. The larger picture of this work would be to nudge the observations from a short offshore metmast in order for the WRF to reconstruct accurately the entire wind profile of the atmosphere up to hub height. This is an important step in order to reduce the cost of offshore WRA.

Learning objectives

1. The audience will get a clear view of the added value of observational nudging;
2. An interesting way to calculate WRF uncertainty will be described, linking wind speed uncertainty to energy uncertainty.