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Application of mesoscale models with wind farm parametrizations in eera-dtoc

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Introduction

Mesoscale models are suitable for simulating the flow field around large groups of wind-farms. Mesoscale model simulations have been used to investigate changes to atmospheric conditions caused by large wind-farms. Furthermore Jiminez (2014) estimated single turbine power productions for a large wind-farm. In the European Energy Research Alliance-Design Tools for Offshore wind-farm Cluster (EERA-DTOC), wind-farm parametrizations are validated against point and remote sensing measurements and are used to estimate the wind climate and resources. In this presentation we discuss the concepts of wind-farm parametrizations and give an overview of their applications and limitations, supported by in situ and Satellite data.

Approach

Single turbine wake effects remain unresolved in mesoscale models due to their coarse resolution and have therefore to be parametrized. Different approaches have been developed, including changed surface roughness and drag formulations. DTU Wind Energy uses in the EERA-DTOC project the Explicit Wake Parametrization (EWP) scheme which has been developed at DTU Wind Energy. It differs from previous approaches, in that it applies a spatial area averaged force to the grid-cell averaged model

equations, instead of a local drag force. This approach is implemented in the Weather Research and Forecast (WRF) model and it is used for the evaluation.

Main body of abstract

The EERA-DTOC project is a European Union FP-7 funded project. Its focus is on offshore wind farm design, mainly in the North Sea area. Its tool will be accessible for the wind industry. It assists wind-farm design by taking into consideration power production yield and electrical grid design among other aspects. It includes several turbine wake models, ranging from simple engineering models, linearized CDF models, up to complete CFD models as well as electrical grid models. Also mesoscale models are part of the DTOC tool. Mesoscale models are used to provide wind climates without and with the influence of neighbouring background wind-farms. The unperturbed and wind-farm perturbed wind speeds can be provided for any location in the form of generalized wind climate or time series.

Within the EERA-DTOC Tool every component has been evaluated against measurements. The wind-farm parametrization in the mesoscale model has been validated for the near and far wind-farm wake. For the near wake turbine SCADA data from the Rødsand wind-farm when it was in the wake of the nearby Nysted wind-farm has been used. For the far wind-farm wake Synthetic Aperture Radar (SAR) satellite images have been used for validation.

Conclusion

The EERA-DTOC Tool supplies a wide range of applications for the industry, relevant for offshore wind-farm design. The mesoscale model provides the wind climate for a user specified period with and without the influence of background wind farms defined by the user. In this way the tools can be used for resource assessment with an additional estimate of

the wind field perturbation from neighbouring wind-farms.

The evaluations shows the mesoscale model's ability to account for the observed dynamical properties of the wind-farm wake. These features are not modelled by conventional wake and CDF models.

Learning objectives

The introduction of the EERA-DTOC can be of significant benefit to the offshore wind industry. It will allow customers to design large offshore wind farm with current state of the art models. The models include electrical grid design tools, engineering, linearized and CFD wake models and mesoscale models with wind turbine parametrizations. This model chain provides a way to estimate time series, wind climates and the annual production for any given configuration of models.