Geophysical Research Abstracts
Vol. 16, EGU2014-14375, 2014
EGU General Assembly 2014

Generation of a wind and stability atlas for the optimized utilization of offshore wind resources in the North Sea Region

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The European Wind Energy Association expects 150 GW of installed wind capacity offshore in Europe by the year 2030. However, detailed knowledge on the atmospheric conditions offshore is still lacking. Satellite-based instruments can provide at spatial information on sea surface temperature and near-surface winds only at a low temporal resolution. Continuous in-situ observations providing vertical information on the marine boundary-layer have only been available from a handful of offshore met masts since roughly ten years, a time period too short to determine the long-term (climatological) wind resource.

The lack of spatially distributed, long-term measurements in offshore regions has led to the application of mesoscale models for the derivation of information on atmospheric conditions offshore. The technique of dynamical downscaling is used in order to derive information on the meso-gamma scale from reanalysis data on the meso-beta scale. The downscaled atmospheric data gives hints which sites might be especially interesting for wind energy. The attractiveness of a site cannot be determined from the mean wind speed alone. Other criteria such as the distribution of the wind speed or the atmospheric stability should be taken into account as well. Recent analysis of data from several offshore wind farms has shown the dependency of wind farm power outputs from atmospheric stability.

In the framework of the EU-funded research project ClusterDesign (www.cluster-design.eu) a wind and stability atlas (WASA) for the North Sea region based on dynamical downscaling of 21 years (1992-2012) of CFSR data with the mesoscale model WRF has been derived. Surface boundary conditions for offshore sites have been derived from the OSTIA SST data set. The WASA presented here has a spatial resolution of 2 km and is based on 10 minutes data. The WASA is a NetCDF-file that provides information on how often a combination of a certain wind speed, wind direction, air density, stability parameter and turbulence intensity occured at a specific location and a specific height during the period from 1992 to 2012. The WASA can easily be used to weight wake model simulations with different atmospheric input data. The aim is to improve the energy yields estimated by the wake models by improving the quality and complexity of the atmospheric input data used.

Prior to the simulation of the WASA, different WRF setups (e.g. PBL schemes) were evaluated based on simulation results for the whole year 2007. The results obtained with the different WRF setups were assessed by comparison of simulated wind speeds, wind directions, stability parameters and turbulence intensities with data from two offshore met masts. Two different methods to derive information on the turbulence intensity from WRF simulations were tested.

In this contribution the focus is on the results of the WRF simulations carried out in order to determine the final setup of the simulations for the WASA. Selected results from the WASA will also be presented. Moreover, we point out the value of the WASA by presenting results of energy yield simulations with the wake model FLaP driven by WASA data.