Towards a generalization procedure for WRF mesoscale wind climatologies

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Publication date:
2013

Citation (APA):
Abstract

We present a method for generalizing wind climatologies generated from mesoscale model output (e.g. the Weather, Research and Forecasting (WRF) model.) The generalization procedure is based on Wind Atlas framework of WASP and KAMM/WASP, and been extensively in wind resources assessment in DTU Wind Energy for many years (Mortensen et al 2005, Badger et al 2010). The method is verified by two distinct sets of WRF simulations: A single WRF wind atlas over Denmark, and a series of WRF simulations with the Vortex MAPS system with 29 sites in many wind climate regimes.

Comparison is made between generalized wind climatologies estimated by the mesoscale model WASP and the methodology presented here. For the Danish wind measurements the mean absolute error in the 'raw' wind speeds is 9.2%, while the mean absolute error in the generalized wind speeds is 4.1%. The generalization procedure has been installed and automated in the Vortex downscaling chain for the MAPS calculation, which are computed at 3 km horizontal resolution grid. For the MAPS-derived wind speeds the mean absolute error in the 'raw' wind speeds is 17.3%, while the mean absolute error in the generalized winds is 10.7%.

Motivation

Because wind climatologies extracted from a mesoscale model simulation are spatially averaged values representative for the area of the grid box size (see Figure below), usually of orders of km, they should not be directly compared to spatially averaged values representative for the area of the grid box size (see...)

Method

A diagram of the procedure used to generalize winds derived from the output of mesoscale models is shown above. Time series of wind speed and direction are computed from the WRF model output at a set of standard heights (e.g. 10, 25, 50, 100 and 200 m AGL) are generalized to a standard set of roughnesses (z0=0.0002, 0.03, 0.1, 0.4, 1.5 m)

The generalization is based on removing the speed-up effects due to mesoscale orography (e.g. speed-up at hills) and roughness change (e.g. the effects of the internal boundary layer along the coastline) and the upstream reference roughness for each sector surrounding the mesoscale model grid point.