Abstract No.

Calculation of global atlases of extreme wind and turbulence

Xiaoli Larsén[1,*], *Neil Davis*[1], *Ásta Hannesdóttir*[1], *Mark Kelly*[1], *Bjarke Olsen*[1], *Rogier Floors*[1], *Marc Imberger*[1], *Lasse Svenningsen*[2], and *René Slot*[2]

[1]Technical University of Denmark
[2]EMD International A/S
*Presenting author

The GASP (Global Atlas for Siting Parameters) project targets at reducing the levelized cost of wind energy by calculating global data for siting parameters, including the extreme wind and turbulence intensity. Such estimations are needed in order to avoid placing turbines in dangerous wind environment, but at the same time not to be over-designed, so that they can be safely harvesting largest possible wind energy.

When calculating the 50-year wind, in the GASP project, we downscale 32 years of Climate Forecast Reanalysis System (CFSR) data from 1 h and 40 km resolution to 10 min and 250 m. The temporal downscaling uses the spectral correction method developed at DTU (Larsén et al. 2011). This method adds in the missing wind variability to the coarse resolution model time series for relevant frequency range through a mesoscale spectral model. The spatial downscaling uses the microscale Linear Computational Model (LINCOM) flow model to account for the local conditions (Mann et al. 2000).

When calculating the turbulence, an ensemble of models are used. It includes the use of the Kaimal model (Kaimal et al. 1994) and TKE-budget based models (Kelly et al. 2014). Turbulence intensity and coefficients of its distribution with wind speed are obtained. This will be further used for assessing wind turbine classes.

Extreme winds in tropical-cyclone-affected areas are calculated with additional calibration of the best track data. The best track data are used to adjust the algorithms for the spectral correction method.

We use the SRTM 3 arc-sec/Viewfinder dataset for orography and the ESA CCI-LC 2015 land cover data for roughness length over land grids. Over water, the roughness length is calculated using the drag law from Zijlema and van der Westhuysen (2005).

The GASP outputs are prepared on a global latitude-longitude grid with a 250 m spatial resolution, for three heights of 50, 100 and 150 m. Figure 1 shows an example of the outputs: the global distribution of the 50-year wind at 100 m at a spatial resolution of 250 m. We have values over the whole water area, though in Figure 1 only water areas 250 km from the shoreline are shown.

We chose the CFSR data for the calculation of the extreme wind, as it outperforms the other reanalysis products ERA5, CFDDA and MERRA data for Europe as well as South Africa where measurements are used for the validation.

Current industrial methods suffers from missing measurements for both calculating extreme wind and turbulence. They also suffer from inadequate use of coarse resolution model data and inadequate turbulence modeling approaches with detailed surface data. This work provides

knowledge, methods and data, to fill these gaps. For the first time, a global siting parameters are provided at a high resolution of 250 m. The open access of the data makes it possible, for the first time, for any industry unit to assess parameters related to the cost in terms of turbine siting and design class related to energy planning, over the globe.

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Images:
Link: https://s3-eu-west-1.amazonaws.com/static.vcongress.de/cms/forwind/paper/573698ae-3733-4db1-9749-7f83bebf8803.png
Description: Global distribution of the 50-year wind at 100 m at a spatial resolution of 250 m, including water areas 250 km from shoreline. The legend shows the color scale for winds from close to zero to 50 m/s.

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