Abstract No.

Calculation of a global atlas of expected wind turbine design class

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The GASP project develops the first 'Global Atlas of Siting Parameters' in high spatial resolution (250m). Here we present the work in GASP to establish a global atlas of expected wind turbine design classes. This atlas will benefit authorities and the industry broadly as a first-line estimate of turbine design class for very fast initial decision making when prospecting sites in new regions.

GASP builds upon the existing wind resource map in the Global Wind Atlas and extends it with additional important site parameters. The combined set of site parameters in GASP form the required input to determine the structural loads which decide if a wind turbine design class is suitable for a prospect site.

As part of GASP we also demonstrate how the accuracy of the site parameters can be significantly improved regionally by calibrating the model with scattered wind measurements. The regional calibration employs a heteroscedastic Gaussian Process Regression (GPR) machine learning method and is demonstrated for the entire country of Sweden. Calibration results are promising using geospatial predictors derived from recent regional and global databases.

Wind turbine design classes are defined in the IEC61400-1 ed. 4 standard (IEC., 2019) which lists their design requirements. The standard also defines the required set of site parameters for assessment of the suitability of a given design class at a prospect site. These parameters include wind speed distribution, turbulence, wind shear, flow inclination and air density, as well as assessment of the terrain complexity and 50-year extreme wind speed.

In site suitability assessment the set of site parameters is input to load calculations for each turbine component, and the resulting loads are then compared to the design loads for the relevant design class. Design loads are obtained using the design climate defined for each design class in the standard (IEC., 2019). In GASP we predict the structural loads for 10^{12} different site locations using the fast and accurate response surface method 'Load Response' described in (Toft et al., 2016) and implemented on EMD's 5000+ core HPC cluster. Representative generic response models are established using three reference turbine models whose aeroelastic design is available in the public domain, as e.g. the NREL 5MW (Jonkman et al., 2009).

Most wind turbines are installed in a park layout where each wind turbine sheds wake on its neighbouring turbines, thereby increasing the level of turbulence. To realistically account for wake effects we adopt a standard grid layout with a spacing of 5 rotor diameters (RD) between turbines in the main wind direction and 3 RD orthogonal to this. This allows for calculation of an atlas of expected design class both with and without wake effects.

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Web: http://www.scisertec.de

By April 2021 the GASP maps of resource, site parameters and expected turbine design classes will be freely available from the website windprospecting.com. The data will also be available within the standard desktop softwares windPRO and WAsP, and lastly for direct machine access via a REST-based API service (‘EMD-API’) suitable for integration, big-data and machine learning applications.

Keywords: ”Global atlas ” ”Siting parameters ” ”Design class ” ”Site suitability ” ”Response model ”

Images:
Link: https://s3-eu-west-1.amazonaws.com/static.vcongress.de/cms/forwind/paper/777b286c-eb68-412d-9d6e-83eac6b437e2.png
Description: Preliminary illustration of expected design classes for a region around Denmark. Taken from a development version of windprospecting.com.

References:
IEC. (2019) 'International Standard IEC 61400-1 ed. 4, "Wind Turbines - Part 1: Design Requirements".'
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