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Directional statistical analysis for the wind resource evaluation

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The wind resource evaluation and the characterization of the wind resource availability in an area of interest is crucial in determining the feasibility of wind energy development. The lack of observational data available in some areas can be complemented by analyzing the wind field through a dynamical downscaling approach. Nevertheless, the reliability of the simulated wind field has to be evaluated by comparing with observations. Within this kind of assessment, the analysis of the wind direction is not as straightforward as in the case of the wind speed because the direction is a circular variable, i.e. it varies between 0º and 360º but it wraps around 0. Usually, the wind speed and wind direction are decomposed into their easterly and northerly components and thus, the analysis of circular variables is avoided and the wind field is studied by using scalar statistical methods.

An analysis of the wind direction using scalar (components) and directional statistics (angles) is presented. Both methodologies are equally valid and provide complementary information about the wind field. This work is part of the wind resource evaluation over Turkey carried out by comparing observations and a high resolution simulation of the wind field over the region. The simulation has been performed with the fifth-generation Penn State/NCAR mesoscale model (MM5) for a period of ten years and 10 km as horizontal resolution. The available data at 133 sites homogeneously distributed over the region consist of instantaneous measurements (6 and 3-hourly, hourly, 20 and 10-minutes reports) of wind module and direction at the surface (10 m above ground level). A basic quality control has been applied to the observations in order to avoid possible problems in the comparison with the simulated wind field.