Application of reanalysis datasets for calculating extreme wind climate

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Estimation of extreme wind statistics, in this case the 50-year wind, usually requires high quality wind measurement data, preferably for over a long period (over 10 years). It is often very difficult to find suitable measurements and therefore there is a strong motivation to develop methods based on reanalysis data plus mesoscale modeling to determine extreme wind climates.

In this presentation, two methods, which both use reanalysis datasets as their starting point, are described and their results summarized. The first method is a selective dynamical downscaling methodology, whereby storm episodes are simulated in the mesoscale model WRF. The second method is based on a statistical-dynamical downscaling methodology, whereby large scale wind maximum characteristics determined for an area of interest and the mesoscale model KAMM is used.

The selective dynamical downscaling method is developed to obtain the extreme wind atlases for large areas. This method is general, efficient and flexible. The method consists of three steps: identifying of storms for a particular area of interest, downscaling of the storms using the mesoscale modeling (WRF) and post-processing. The post-processing generalizes the winds from the mesoscale modeling to standard conditions, i.e. 10 m height over a flat homogeneous surface with roughness length of 5 cm. The generalized winds are then used to calculate the 50-year wind using the Annual Maximum Method for each mesoscale grid point.

The statistical-dynamical downscaling methodology is intended to be even more efficient than the selective dynamical downscaling method. For a particular area of interest, the annual maxima geostrophic wind at low level are determined for 12 direction sectors for 30 years from reanalysis data. This results in 360 extreme geostrophic winds. Each of these geostrophic winds is used as a stationary forcing in the KAMM mesoscale model. As in the first method, post-processing is used to generalize the surface winds from the mesoscale modeling. Then for each mesoscale model grid point the Annual Maximum Method is used to calculate the 50-year wind. To cover a larger area a method is developed to account for slight variation in the extreme geostrophic winds with location.

The generalization of the mesoscale winds through the post-processing provides a basis for data validation. This is because measurement derived extreme wind climates can also be generalized in the same way to give the extreme wind for the same conditions (i.e. over a flat homogeneous surface with roughness length of 5 cm). Thus the local effects of a measurement site's surface roughness length changes and orography can be removed (consider how extreme wind may be modified by orographic speed up at a hill top measurement site). The generalized extreme winds derived from mesoscale modeling and measurement can now be compared.

The generalization method also allows mesoscale model derived extreme wind statistics to be further downscaled through microscale modeling to determine local extreme wind climate at specific places. In this process microscale models are used to calculate the local effects at a site, which may significantly enhance or reduce the strength of the extreme winds.

The results for the two mesoscale downscaling methods are compared to measurements from two areas with different types of extreme wind climates. The results are promising.

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