A Novel Sampling Method for Satellite-Based Offshore Wind Resource Estimation

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ABSTRACT

Synthetic aperture radar (SAR) measurements from satellites can be used to estimate the spatial wind speed variation offshore in great detail. The radar senses cm-scale roughness at the sea surface which can be translated to wind speed at the height 10 m using an empirical geophysical model function. A system has been set up at Risø DTU, the National Laboratory for Sustainable Energy in Denmark, for offshore wind retrievals from Envisat radar data.

If 70 or more overlapping satellite SAR scenes are available for a given area of interest it is possible to estimate the wind resource from the satellite samples. A major advantage of satellite-based offshore wind resource assessment is the spatial information gained at high resolution from the satellite imagery. Limitations include the low sampling rate and the fixed acquisition times of satellite data. A new satellite scene is typically available every 3-4 days over a given site of interest and the acquisition takes place in the morning and evening only.

At Risø DTU we have utilized our ever-growing collection of wind maps from Envisat to compute wind statistics for the North Sea and the Baltic Sea. The reliability and the spatial coverage of the satellite-based wind climatology have improved gradually as more data were collected. The satellite scenes have been treated as random samples and weighted equally in our previous analyses. Here we introduce a novel sampling strategy based on the wind class methodology that is normally applied in numerical modeling of wind resources. The method is applied within a wind and solar resource assessment study for the United Arab Emirates funded by Masdar and coordinated by the United Nations Environment Programme (UNEP).

Thirty years of NCEP/NCAR re-analysis data are used to define approximately 100 geostrophic wind classes. These wind classes show climatologically representative large-scale meteorological conditions for the region of interest. The wind classes are used to make the most representative selection of satellite images from the Envisat image catalogue. The frequency of occurrence of each wind class is used to weight the satellite-derived winds for the calculation of wind climatology. The applied selection and analysis method improves the reliability of wind climate estimates compared to random selection of images each given equal weighting.

SATellite WInd FIELDS

Map of the mean wind speed at 10 m over UAE based on satellite observations. The spatial resolution is 1 km. The contour plot below uses the same color scale.

Wind resources

Detailed wind resource maps can be produced from satellite SAR observations at an accuracy comparable with mesoscale modeling. The use of intelligent sampling, rather than random sampling, of satellite imagery leads to an improved accuracy at a lower cost, as fewer satellite images are needed.

CONCLUSIONS

We gratefully acknowledge Masdar’s support for this work. Satellite data are from the European Space Agency (ESA). Re-analysis data are provided by the National Centers for Environmental Prediction and the National Center for Atmospheric Research (NCEP/NCAR).