

Satellite Synthetic Aperture Radar (ERS-2 SAR) validation study for offshore wind speed mapping

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Abstract

Satellite Synthetic Aperture Radar (SAR) from the ERS-2 satellite are computed into wind speed maps through the CMOD-IFR2 algorithm and wind direction through 2-dimensional Fast Fourier Transform. In-situ meteorological observations from a 62 m tall mast located 14 km offshore in the North Sea are used in the validation study. To ascertain a high degree of accuracy between the spatial wind speed observations from SAR to the time-series point measurements from the mast, a methodology of area-averaging through so-called footprint analysis is performed. It is demonstrated that a higher accuracy is obtained by the footprint method than by comparing single pixels to the in-situ data. The rmse is around 0.61 m s^{-1} between SAR and in-situ wind speed. For wind direction comparison the R^2 is 0.95. The physical principle in wind speed mapping from SAR is that the C-band (around 5 cm wave length) normalised backscatter coefficient is a function of the ocean surface roughness. The surface roughness is a function of the friction velocity and is usually modelled by the Charnock's relationship. This is based on the balance that exists between the surface wind speed and the capillary-short gravity wave spectrum of the sea surface. The SAR wind speed is retrieved at 10 m height. Marine features such as tidal height, sea currents and bathymetry are included in the investigation. A total of 20 ERS-2 SAR scenes are analysed. They cover offshore and onshore flow at different wind speed levels and stability regimes. The meteorological observations are collected by Techwise for Elsam (electrical utility), the owner of the world's largest offshore wind farm that is being erected 14-20 km west of Blåvandshuk in the North Sea (<http://www.hornsrev.dk>). A future aim of retrieving offshore wind speeds with high accuracy is to facilitate mapping of offshore wind resources for feasibility studies. A methodology of combining ERS SAR wind speed maps into a wind resource calculation programme (WAsP) is currently in development.

For further information <http://www.risoe.dk/vea-atu/remote/wemsar.htm>