Spectral analysis of ENVISAT ASAR & QuikSCAT winds

Karagali, Ioanna; Larsén, Xiaoli Guo; Badger, Merete; Peña, Alfredo; Hasager, Charlotte Bay

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ESA Living Planet 2013 Abstract

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Title: Spectral properties of ENVISAT ASAR and QuikSCAT surface wind fields in the North Sea

Authors: Ioanna Karagali, Xiaoli Guo Larsén, Alfredo Peña, Merete Badger, Charlotte Bay Hasager

Observations of the oceanic surface wind field from satellites, typically from scatterometers or radars, are very useful for applications such as atmospheric and oceanic modelling, climate relate studies and recently for wind resource assessment offshore, where in situ measurements are difficult to obtain. The spectral properties of satellite wind fields are important if one needs to understand the nature of spatially coherent surface winds. They are also relevant for understanding the differences between in situ (temporal) and satellite (spatial) wind observations. In addition the spectral properties in the mesoscale range can be used as a measure of the accuracy in short-term forecasting and for estimating extreme winds.
Scatterometer wind fields from QuikSCAT are advantageous due to their global spatial and long temporal coverage and have a spatial resolution of 25~km.
Synthetic Aperture Radar (SAR) images are used in DTU Wind Energy to routinely perform wind field retrievals. These have a much higher spatial resolution of 600~m, but suffer from inconsistent time and space coverage.
Both QuikSCAT and ENVISAT ASAR products are currently used for offshore wind resource assessment in the Northern European Seas. QuikSCAT products have been used for spectral analysis and comparisons with Numerical Weather Prediction modelled wind fields. So far, the spectral properties of ASAR wind fields have not been explored. With its available high spatial resolution, ASAR provides the opportunity to study the spectral properties in the smaller scales.
Comparisons between QuikSCAT and ENVISAT ASAR wind fields are limited by differences in the resolution, spatial and temporal coverage and the approximately 5-hour time lag between overpass times. Spectral slopes and power are robust properties that highlight potential differences and the advantages and disadvantages of using the two different types of space-borne wind observations.

The present study aims at investigating the spectral properties of a gridded, QuikSCAT L3 product with a resolution of 25~km and ENVISAT ASAR wind fields of various spatial resolutions. The products are retrieved at DTU Wind Energy using the APL/NOAA (Applied Physics Laboratory/National Oceanic Atmospheric Administration) SAR Wind Retrieval System (ANSWRS) initiated with NOGAPS model wind directions. The software allows for the selection of the wind field resolution, by reducing the 150 m original resolution to any selected value. For the purposes of the present study, five different data sets have been created with resolutions of 600 m, 1.5 km, 3 km, 15 km and 25 km. Due to the inconsistent SAR coverage, a sub-domain of the North Sea is selected, where there is an overlap of 87 ENVISAT ASAR scenes. It is shown that the QuikSCAT

spectral dependency on wave number follows the theoretical $k^{-5/3}$ law in the mesoscale range, where the higher resolution SAR product slopes are smaller suggesting significantly more small scale variability. In addition, SAR spectral power levels increase as the resolution increases and maintain a high energy content even for length scales of 2 km, i.e. likely in the micro-mesoscale interaction range. No significant impact of the number of scenes on the spectral slopes is identified, for as many as 87 samples. There is a seasonal variation in the power content as well as a characteristic difference between the meridional and zonal spectral components. Seasonal sampling reduces the number of available wind fields to a maximum of 25 scenes and this reduced number impacts the computed spectral properties.