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ASSESSMENT OF WIND SHADOWS BEHIND OFFSHORE WIND PARKS WITH ANTENNA BEAM PATTERN COMPENSATED SENTINEL-1 DATA

Abstract

For decades, satellite microwave sensors have been successfully used to estimate ocean winds on the basis of specific Geophysical Model Functions that that interrelate the radar backscatter intensity to wind speed and direction. State-of-the-art spaceborne imaging SAR systems provide high resolution backscatter values and are thus capable of providing wind field data on a fine spatial grid. Wind properties derived from the Sentinel-1 A/B satellites on scales less than 100m while retaining a spatial coverage with a swath width of 250km provide new opportunities for applications particularly for offshore activities in coastal regions. One example is the ability to exactly measure extent and magnitude of the wind speed reduction in the wind shadow behind offshore wind parks. The data can either directly provide a better estimation for the expected power production of planned wind farms on the basis of long-term statistics or can be used indirectly as source to validate and improve numerical models trying to incorporate effects of existing wind turbine arrays. While the benefits of using SAR-based wind information are dominant, the data has drawbacks in term s of accuracy of the given wind speeds. A close inspection of the Sentinel-1 Interferometric Wide Swath (IW) mode data over the ocean reveals antenna beam patterns remaining in the calibrated and noise-corrected radar backscatter, resulting in discontinuous wind speed values across the beam boundaries. While of minor importance when calculating coarse wind fields of several kilometres resolution, high resolution wind fields as desired by offshore wind operators suffer from this uncertainty. A compensation for these errors contained in S-1 IW wind fields is believed to further increase the acceptance of SAR-bases wind data in both, industrial users of the data and the Numerical Weather Prediction (NWP) community for assimilation in met-ocean models. We present an analysis of the impact of this effect on estimated wind fields based on more than 8000 Sentinel acquisitions with level-2 OCN data available and compare to high resolution ECMWF model data. We propose a correction scheme to minimize the beam pattern impact and increase the overall accuracy of the SAR-based wind fields. We moreover show examples that illustrate the benefit of these wind data to asses wind shadows of offshore wind park in the German Bight.