Polarization Dependency in Sea Surface Doppler Frequency and its Application to Wind/Current Retrieval from Envisat ASAR Alt-Pol Data.

Ida Friestad Pedersen, Geir Engen,Harald Johnsen
Norut IT

ida.friestad.pedersen@itek.norut.no

It has previously been shown that the Doppler frequency anomaly in Synthetic Aperture Radar data is highly correlated to the wind field component along the radar line of sight. The anomaly arises because moving targets, such as the coherent backscattering elements riding on the ocean surface, produce Doppler shifts proportional to their relative velocities toward the receiving radar antenna. The motion of the ocean surface can be represented as a wave motion superimposed on a current U. For coastal areas, this anomaly may then just as likely be connected to the coastal current component than to the wind, or a mixture between wind field and surface current. The goal of this paper is to investigate the capabilities of dual polarization data to improve the wind/current retrieval based on Doppler measurements. The idea is that while the contribution from wind is polarization dependent, the contribution from a current is polarization independent provided that we neglect the nonlinear interactions between the small scale waves and the current. With this approximation, the HH-VV Doppler frequency difference will depend on the wave motion, but not on a steady current, and the focus of this paper is therefore to assess the performance of this Doppler frequency difference. A theoretical framework for using Doppler information from SAR measurements for wind/current retrieval is developed and applied to Envisat ASAR Alternating Polarization Mode data. The basis for the derivation has been the derivation of a general expression of the backscattering model source function, which includes wide range of incidence angles as well as the effect of surface curvature on polarization responses. Results showing the theoretical computed Doppler frequency difference at C-band between HH and VV polarization as a function of wind speed, wind direction and sea state for different incidence angles are presented. For a range wind of 7 m/s and an incidence angle of 30 deg, a Doppler frequency difference of 7 Hz is predicted. Comparison with Doppler frequency estimates from Envisat ASAR Alt-Pol data show good agreement, both for the absolute Doppler frequency and the HH-VV Doppler frequency difference.