Wave-current interactions: a new view of how surface currents influence wave properties using CFOSAT-SWIM data

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Résumé

Ocean measurements and advances in ocean numerical modelling have revealed the strong dynamics of ocean surface currents with the ubiquitous presence of eddies, filaments and fronts. Recent studies had shown the importance of small-
scales surface oceanic features in shaping the spatial patterns of wind-wave properties, particularly in mesoscale boundary currents as in the Agulhas current or in the Gulf Stream. High resolution wave height altimeter data provide a a clear and systematic evidence for large wave height changes caused by wave refraction over currents at scales 20 to 200 km, and optical imagery from Sentinel 2 has also led to anecdotal evidence (in cloud free conditions) of wave spectra modification by the current field. Here we use the Ku-Band SWIM spectrometer (onboard CFOSAT) to diagnose both on waves directions and wavelengths, in the region of the Agulhas current. We find that that the combination of SWIM off-nadir beams from 2 to 10◦ incidence, gives a detailed measurement of wave transformation in the current as at scales of the order of 20 km, which is the typical separation of the different beams looking in the same azimuth. Besides the wave height enhancement across the Agulhas front that is captured by SWIM nadir beam, a turn in wave direction (attributed to wave refraction over the current) and frequency Doppler shift are also measured in the off-nadir beams. The SWIM measurements of surface current influences on waves properties thus give a quantitative measurement of the non local effect of surface currents on waves height variability, associated with the necessary details in the shape of the wave spectrum that are needed to analyze these effects, which cannot be done from nadir data alone. In particular we expect that directional spreading is an important controlling factor in the amplitude of wave height changes as waves travel over varying currents. These measurement provide inderect evidence for the current strength and its gradients. We also find that the SWIM sampling is not ideal for retrieving complex spatial variations in the sea state at scales under the Level 2 spectrum product resolution (80 km). Different machine learning techniques are proposed to fill in the measurements of spectrum for spatial positions and viewing azimuths for which no data is retrieved.

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