Advanced Bathymetry Retrieval From Swell Patterns in High-Resolution SAR Images

Fernando Monteiro
Ph.D. Candidate, RSMAS-AMP

We present a depth retrieval technique based on active microwave imagery. The sea surface radar signature of interest in this work is the long surface wave field, which modulates the resonant Bragg waves, producing detectable wavelike patterns; our study area is Rottnest Island (Australia), a region where tidal-driven surface currents are negligible. As the long waves go under refraction as they approach the shore, a direct relation between their peak wavelength and the local absolute water depth can be established via the linear dispersion relationship. Previous bathymetry estimation techniques based on the same physical principle assumed a direct relation between the ocean wave and image spectra, without taking into account the dependence of the strength of the radar signature of ocean waves on peak wavenumber and wave direction relative to the radar look direction. In order to account for the wave imaging mechanisms when deriving the wave parameters for water depth estimates, we introduce an empirical, three-parameter wavelength modification factor array – as a function of SAR-derived peak wavelength, wave direction and spectral peakedness – in the water depth calculations and compare our results without and with the proposed approach. Our results show that the introduction of such a modification factor array leads to more accurate depth maps. We also apply our method – initially, without considering the wavelength modification array – in the Orkney Islands (Scotland) main tidal channel, where surface current data were retrieved by along-track interferometry techniques. We then evaluate bathymetry estimates in a region under the influence of strong currents.