Spatial and Seasonal Analysis of Surface Wave Dynamics on The Coastal Region Using Sentinel-1 SAR

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Abstract: The importance of reliable wave information is necessary to support anthropogenic activities and environmental monitoring on the coastal region. Generally, this requires continuous measurement of wave parameters such as significant wave height, wave period, and wave propagation direction throughout the year. To complement the traditional point-based instrument, medium-to-high resolution spaceborne instrument system could provide spatially efficient measurement. Through decade of algorithm development, publicly available system such as Sentinel-1 SAR is suitable and known to be able to perform this routine of estimating reliable wave parameters. In this paper, we tried to exploit the known capability of Sentinel-1 system with case study of Channel Islands of California, USA to observe the empirical coastal dynamics of the area using previously developed semi-empirical algorithm. Parameters estimated from the 2-dimensional wave spectra such as azimuth cut-off wavelength, preliminary wave propagation deviation from SAR range direction, and peak of dominant wavelength will become the part of the routines. We applied simple fuse of dual polarization and parameterized median filtering to improve the estimation of the significant wave height and other wave parameters. Spatial and seasonal pattern of the surface wave on coastal waters will be carefully observed. Due to the existence is small islands, diffraction and refraction phenomena could be generally imaged by the SAR. However, the reflection phenomenon is hardly seen due to the random change of surface roughness at the reflected area, resulting very low sigma-nought value. By processing one year of Sentinel-1A and 1B dataset, the RMSE of the significant wave height are found to be lower than 0.5m. Moreover, the seasonal analysis shows a reliable pattern when compared with the in-situ NDBC buoy measurements, although the full spectrum of the wave height could not be estimated due to the limitation of the satellite data stream.

Keywords: Significant Wave Height, Surface Wave Dynamics, Sentinel-1 SAR, Azimuth Cut-off Wavelength, Seasonal Analysis