SEA-CLUTTER ANALYSIS AT MULTIPLE WAVELENGTHS (L,C,X) FOR TARGET-CLUTTER CONTRAST ASSESSMENT IN LITTORAL WATERS

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1. ABSTRACT

Radar sea-clutter and target identification in clutter of varied characteristics and strength has been a subject of on-going research with established statistical models and recently physical models being more powerful based on advances in computer graphics based approaches. In the steady state of oceans these models perform adequately but have short comings when applied to littoral water where wave refractions occur, there are more breaking waves and underwater topography affects the surface waves. The observation of these effects at different wavelengths and different sea-states is now feasible through the availability of multi-polarimetric spaceborne sensors in L, C and X bands, namely ALOS-PALSAR, RadarSAT-2 and TerraSAR-X. The appearance of the sea-clutter, surface waves and swells varies at the different wavelengths in terms of the scale of the waves seen. L-band captures long wavelength swell, where X-band has higher return from small eddies and breaking waves. In term of target clutter contrast smaller targets are visible at X-band , at the same time the sea clutter strength is higher making target detection difficult.

This study is aimed at quantifying the statistics and nature of sea-clutter as seen from spaceborne platforms and assessing the target-clutter contrast in the Adelaide harbor area of South Australia. To this end a series of images in mixture of polarizations were collected from the above mentioned SAR sensor over this area in typical wide area surveillance mode - ScanSAR single polarization images from TerraSAR-X, Dual-Polarization Wide Beam images from RadarSAT-2 and Full and Dual Polarization images from ALOS-PALSAR. Synchronized with the acquisitions (dawn/dusk orbit of SAR satellites) video over flights with a low light camera were performed to record the sea-state. AIS data was collected for the information on the larges vessels and meteorological buoy readings for surface wind, wave height and swell were noted.

The analysis reveal for automated ship detection purposes using standard CFAR based techniques, X-band has much lower target clutter contrast and needs higher thresholds for acceptable false alarm rates, but this also lowers the probability of detection of smaller boats of around 10m which are visible. The clutter statistics at X-band vary greatly with look angle, steeper angle have much stronger clutter signature compare to shallower ones. At L-band the clutter is greatly suppressed and polarimetric decompositions indicate dominant surface scattering from the ocean, targets are less distinct and smaller targets are not visible, overall the target clutter contrast is actually reduced below that at X-band. At C-band the clutter statistics have well known characteristics in HH and VV polarization from previous satellite mission, the goal here was to study the clutter statistics comparatively between the co-polar and cross-polar returns. Radarsat-2 HH/HV mode was used for this purpose, HV clutter statistics was found to vary greatly due to small look angle differences within the scene. Overall the clutter-target contrast decreased with increasing look angle, where as in the HH polarization the clutter target contrast increased with increasing look angle, though not as strongly. The overall target-clutter contrast at C-band was better than at X-band or L-band.