Paper ID: 69823
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IAF EARTH OBSERVATION SYMPOSIUM (B1)
Interactive Presentations - IAF EARTH OBSERVATION SYMPOSIUM (IP)

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WHEAT CLUTTER MODEL FOR GEOSYNCHRONOUS SYNTHETIC APERTURE RADAR MISSIONS

Abstract

Clutter is general term for a radar signal coming from a target that is not the one of interest. Moving targets are smeared in azimuth direction in SAR images: if the target speeds are approximately constant during the integration time, the movement causes the azimuth shift and the targets appear in a different azimuth position. In fact, in Low Earth Orbit SAR (LEO-SAR) images we can compute the target radial velocities from the azimuth displacements, and vice versa. Conversely, in Geosynchronous SAR (GEOSAR) missions, important clutter can be caused by the often unsteady speed of the moving targets during the longer integration time, which can vary from minutes to hours.
This important clutter is also due to the low satellite azimuth speed, (satellite azimuth speed in geosynchronous orbit is much smaller than satellite azimuth speed in LEO), which gives an azimuth shift that can even be larger than the image extent (so a smeared strong target can hide a far weak target). This clutter reduces the effective signal to noise ratio of the image. In in order to estimate the truly achievable performance of a GEO-SAR mission, we need to include the clutter in our performance estimation. For example, the GEO-SAR mission Hydroterra (that has been selected by ESA for a feasibility study along with Harmony and Dedalus) could suffer from a severe clutter problem due to its orbit geometry. Nevertheless, such orbit has many advantages in terms of coverage and feasibility of the mission and this is the reason why it was selected. So, in order to truly estimate the performance, the clutter needs to be addressed and evaluated. However, the existing clutter models, such as the Billingsley Clutter Model, are not appropriate for modelling clutter in GEO-SAR missions because they have been developed for airborne SAR and for ground-based radar. In fact, they assume an elevation angle up to 10° while the elevation angle for Hydroterra would be between 20° and 70°. Using a database of wheat movement in blowing wind, we simulated the moving target signal and we modelled the coherent signal (the signal that appears in the target true position) and the incoherent signal (the signal that appears smeared in azimuth direction). We also integrated the wheat clutter model into a methodology to estimate the performance of the Hydroterra mission, such as the Signal to Clutter Ratio (SCR) and the Signal to Noise Ratio (SNR).