Multi-polarization SAR ship detection: a fair comparison using the TanDEM-X pursuit monostatic mode

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ABSTRACT

This study aims at contrasting full-polarimetric (FP) SAR with single-polarimetric (SP) SAR for ship detection purposes. In fact, although the importance of FP SAR observations is nowadays well established in many Earth Observation applications, including maritime surveillance, it is also well-known that the major drawbacks that limit the use of FP SAR in maritime applications (like oil and ship detection) are the reduced swath width and azimuth resolution.

Within this context, several polarimetric ship detectors have been developed and all of them share the common result that FP data result in a remarkable increasing of observation performance (both in terms of detection and missed target rates). However, a fair inter-comparison between FP and SP detectors is still a challenge. In fact, the performances of PolSAR detectors can only be directly compared with the ones obtained using one of the channels, e.g. the HH channel in case of ship. This comparison strategy is quite fair and it is preferred over the repeat pass method as for satellite acquisitions the unavoidable time lag between data-takes introduce differences that are not easy to discard, e.g. different wind and sea state conditions. It is obvious that the “repeat pass” comparison strategy would be fairer if the two acquisitions were simultaneous (or close to be simultaneous) and made by two twin sensors.

In this sense and for the purposes of this study, we have exploited the pursuit monostatic configuration of the TanDEM-X constellation jointly with the planned science phase acquisitions campaign to set up a scenario that consists of the satellite duo (TerraSAR-X and TanDEM-X) that was able to collect (almost simultaneously, i.e.; the twin satellites are flying in two orbits separated of circa 76km) pairs of independent X-band SAR measurements using the standard single receiving antenna mode (SRA) and the experimental dual receive antenna mode (DRA). The former allows collecting data in either SP or dual-polarization coherent mode; while the latter provides FP measurements. Under this configuration, two exceptional coordinated TerraSAR-X/TanDEM-X data-takes were collected in Gulf of Mexico where the scene, which includes both ships and oil rigs, was observed in a single-pol (HH) and FP configuration.

Experiments undertaken on this data set clearly demonstrate that, although FB SAR observations are characterized by a coarser azimuth spatial resolution (doubled with respect to SP observations), FP detection performance is significantly better than SP one when FP information is properly exploited (i.e. both amplitudes and the inter-channel phases must be exploited).