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Title : **On the Benefits of Stack-Masking in Delay-Doppler Altimetry over Non-Homogeneous Surfaces**

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Key Words / Topic : delay-doppler, altimetry, empirical retracker, retracking, stack, sea ice, inland waters, non-homogeneous surfaces, scattering.

Satellites: CryoSat-2, Sentinel-3

Presentation Preference : Oral

Abstract: Radar altimetry over non homogeneous surfaces, such as inland waters, coastal zones and sea ice covered waters, requires a dedicated processing chain as of Level-2. The rationale is that calm waters (lakes, leads and some river sections) are specular scatterers while their natural surroundings are made of diffuse scatterers. The resulting echo returns are peaky. In many cases multi-peaks echoes are observed at the SARM / SARINM Stacks (and Waveforms).

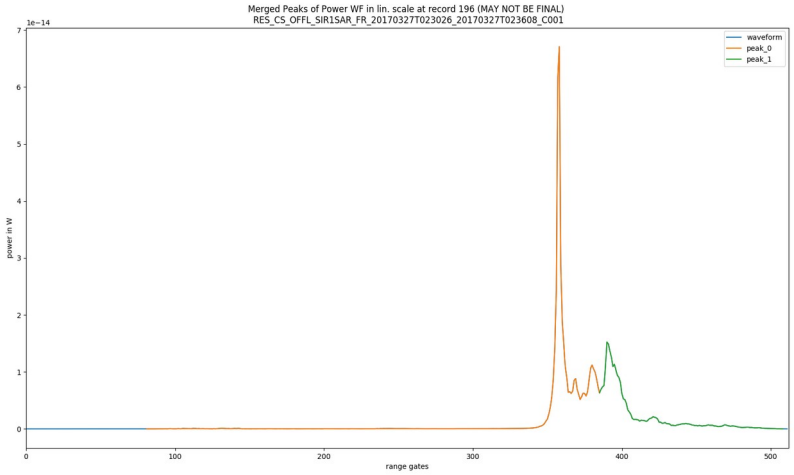
Some of these peaks are persistent over many Stack beams and can be considered as "signal" while others are spurious signatures that can be considered as "noise" or "ghost signals" that pop up through the antenna side-lobes. The unwanted signatures shall be filtered out prior to multi-looking otherwise a corrupted waveform will be passed to the retracker and this may cause a non negligible error on the estimated epoch.

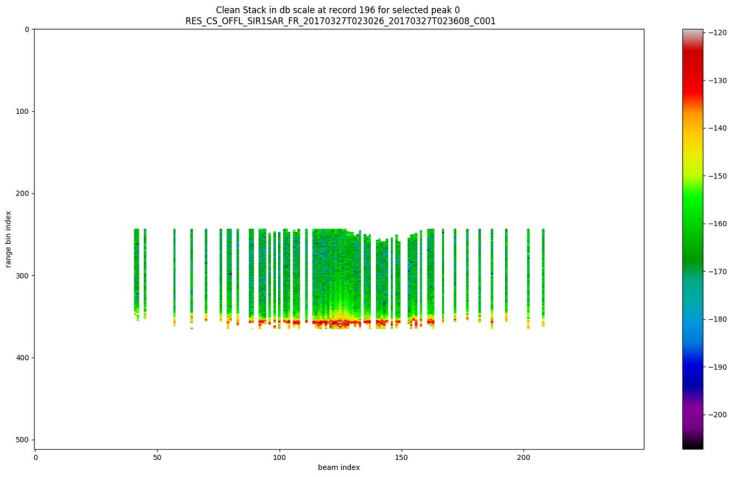
Beyond this, the main difficulty for a retracker over non homogeneous surfaces is inherent to the diversity and variety of the scenes. The shape of the waveforms, including the locations, widths and amplitude of the peaks can hardly be modeled as they depend on the unpredictable locations, roughnesses, areas and across track extents of the water surfaces within the altimeter footprint. A similar remark applies to the non-water surfaces which scattering properties depend on their locations within the footprint as well as their shapes, orientations and the type of materials they are made of. This is not really in favour of geophysical retrackers.

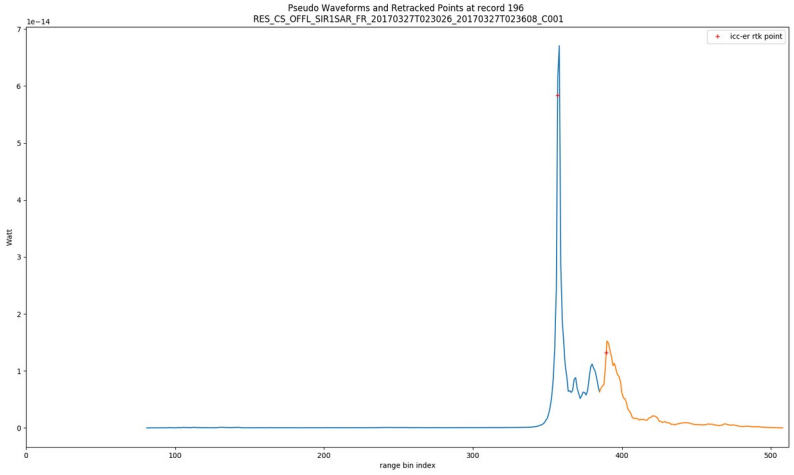
In the frame of three ESA contracts (SHAPE, Cryo-SEANICE and HydroCoastAL) ALONG-TRACK has designed and implemented a new empirical retracker called ICCER (Isolate Cleanse Classify - Empirical Retracker) that tackles these specific issues. The algorithm has been discussed in details at the CryoSat 10th Anniversary Science Conference (posters 10

and 158 from the same author). It can be summarized as follows:

- First process the beams individually in order to detect each of its peaks whatever its amplitude.
- Then keep the most powerful peaks and use some slope and roughness criteria to define their respective boundaries (merging the small adjacent peaks in the vicinity of the major ones) so that some continuous blocks of range gates can be isolated as "Pseudo Waveforms" : Fig 1,
- Analyse the whole Stack, looking for the major peaks of energy that are persistent across the beams and identify the "stable beams" for each stable peak,
- Cleanse the Stack by masking off the non stable beams : Fig. 2,
- Multi-Look, Classify and Threshold Retrack each Pseudo Waveform : Fig. 3 (the red crosses are the retracked points).







This robust multi-peaks empirical retracker can be used to densify measurements in SARINM while the first major peak only is needed in SARM altimetry. It can provide multiple classes per waveform. The retracker is also able to process waveforms only.

In this communication we illustrate, over several cases, the benefits of masking the Stacks before multi-looking. We do that by comparing the input and outputs of the ICCER when it processes the Stacks (L1BS products) and when it processes the Waveforms (L1B products), we also compare with other retrackers.