Sentinel-3A for sea-ice and land ice

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Abstract

The secondary objective of the Sentinel-3 Surface Topography Mission is to provide surface elevation measurements over sea ice and land ice regions in continuity with CryoSat-2.

In order to assess the present data quality of the Sentinel-3A SRAL PDGS (Payload Ground Segment) products over sea ice and land ice, a processing of the S3A SRAL L1A products up to L2 has been carried out. The enhancements of this processing with respect the current PDGS processing baseline are:

- Double-Extension of the Radar Window
- Zero-Padding

The enhanced products will be cross-compared against the PDGS products in order to highlight the role and effect of the zero-padding for freeboard computation and of the radar window double-extension for the tracking of the land ice margins. A Cross-comparison against collocated CryoSat-2 products will be carried out. The final objective is to assess the add value brought by these two new processing options for potential implementation in the Sentinel-3 SRAL PDGS.

S3A PDGS Products over Sea Ice and Land Ice

- Sentinel-3A PDGS **marine** products are not yet consolidated over sea ice, discrepancies with respect the CryoSat-2 freeboard are observed and evolutions are planned.
- The discrepancy in the freeboard estimation between CryoSat-2 and Sentinel-3A may deal with the different L1b processing baseline between the two missions (as zero-padding not-applied in S3A PDGS)
- The Sentinel-3A PDGS **land** products are relatively good over the interiors of the Antarctic and Greenland.
- Despite the on board tracker working properly, during the L1b processing the waveform's leading edge is often lost or too shifted towards the end of the radar window over ice sheet margins.
- This manifests itself as a data gap at L2 over ice sheet margins.
- It has been already demonstrated that this can be amended by using an extended window at L1b processing and an evolution is planned

ZERO-PADDING

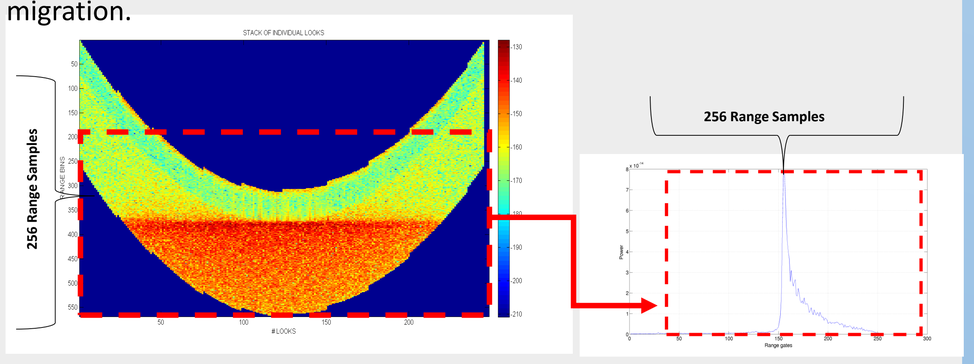
CryoSat-2 mission demonstrated the importance to oversample the specular return waveforms by zero-padding (Jensen's Echo Aliasing) over sea ice. Without zero padding, the radar echogram is visually affected by jitter noise rendering echoes "useless for sea ice freeboard" (Robert Cullen Poster at Living Planet 2010). The zero-padding was the major change from CryoSat-2 Baseline A to Baseline B.

Sara Fleury (Legos) in the CryoSeaNice project reported as well that without zero-padding the CryoSat-2 freeboard data distribution is not consistent with the one from in situ data. Once the zero-padding is introduced, the consistency between CryoSat-2 and in situ data is gained back.

Kevin Guerreiro (Legos) at last ISSI Sea Ice Meeting reported as well that the freeboard computed from the Sentinel-3 PDGS L1b (waveforms) is not consistent with the one computed from collocated CryoSat-2 PDGS L1b, even tough the same L2 processing was applied on both cases to compute freeboard. Hence, the main reason for the discrepancy has to be searched in the current Sentinel-3 L1b waveform and L1b processing.

EXTENDED WINDOW

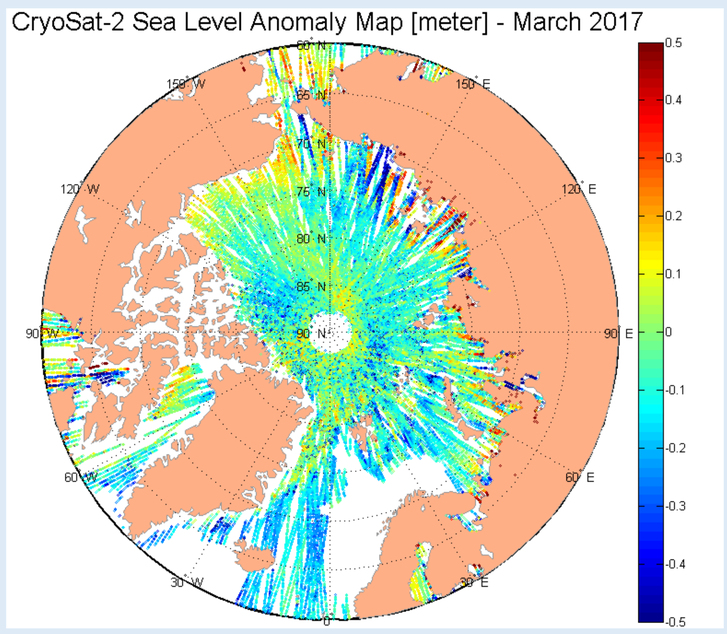
In order to better accommodate the possible variations of the overflown topography in the radar window, the stack can be subset into the final waveform with a extended radar window (256 range samples, counting from the stack's bottom, in place of 128 range samples) after the range cell migration.

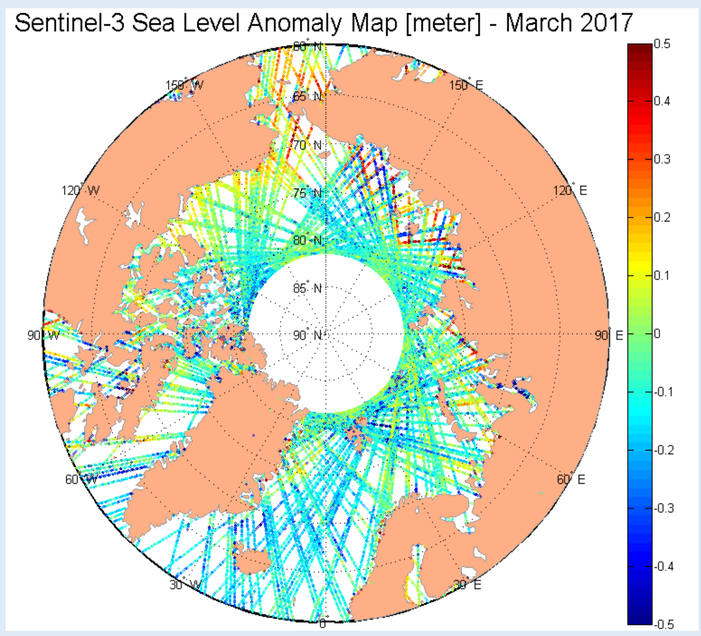


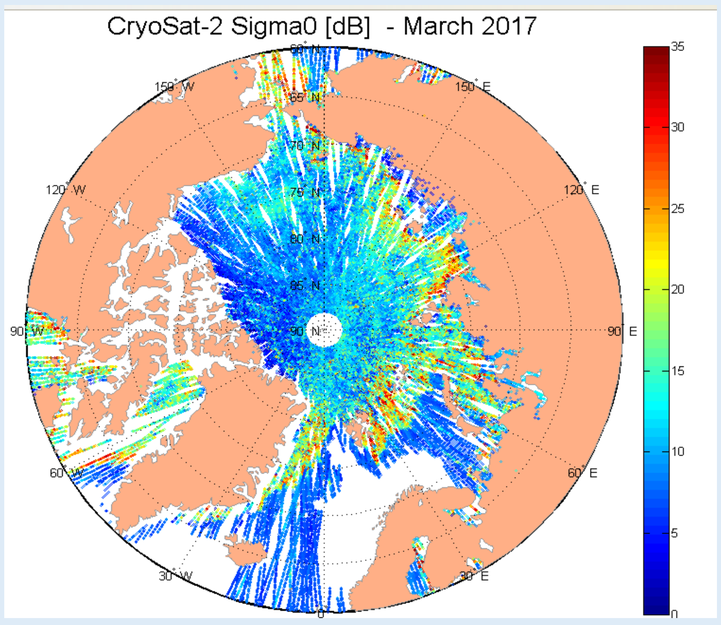
This technique is available since 2014 in the GPOD processing options.

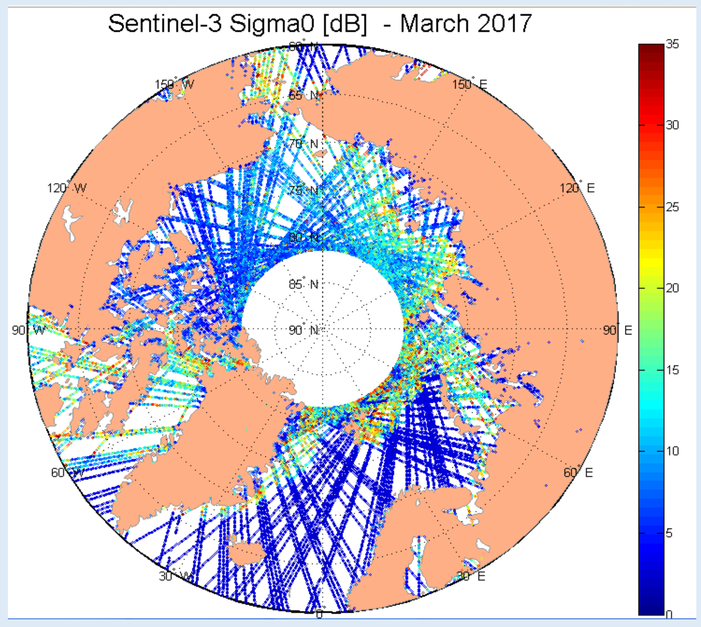
SEA ICE

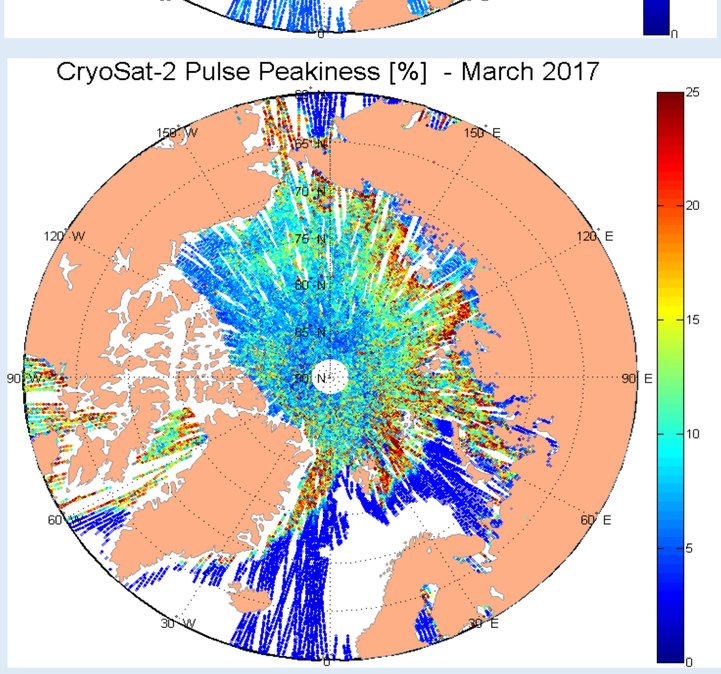
Sentinel-3A and CryoSat-2 data have been processed in GPOD from L1A products with the exactly same baseline (**zero-padding**, **No Hamming Window, extended window** and **SAMOSA+ retracking**). SSHA is with respect to DTU 15 Mean Sea Surface. Caveat: It was not possible to collect all the Sentinel-3 products in the selected time period (March 2017). Once CryoSat-2 and Sentinel-3 are processed with same baseline, the two missions look to return consistent results (SSHA, sigma0, Pulse Peakiness). Hence, the discrepancy in freeboard estimation between CryoSat-2 and Sentinel-3 might result from the fact that zero padding is done in the CryoSat-2 processing and not in the Sentinel-3 PDGS.

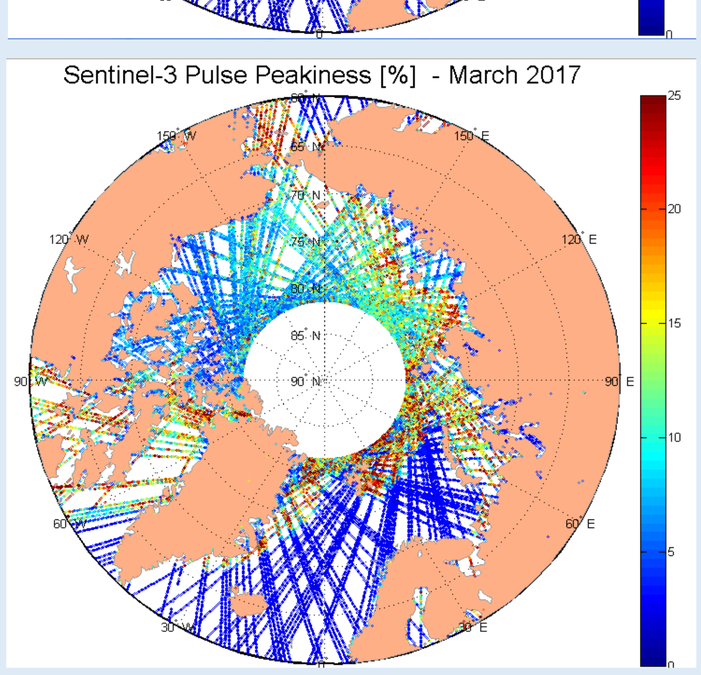


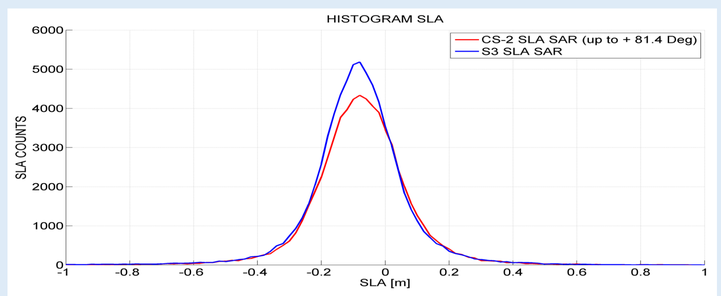


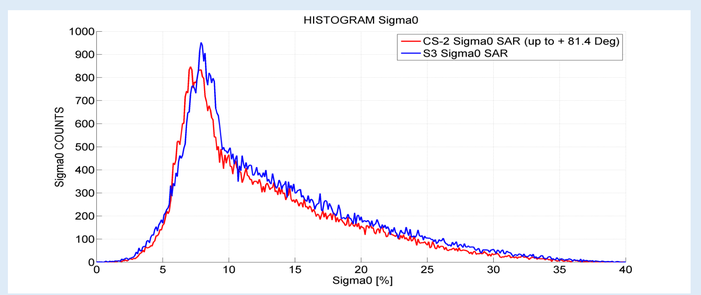












LAND ICE

In this box we show the radar echogram (waveforms range-aligned by tracker delay) of a S3A pass over Antarctic as in the L1b PDGS product (left picture) and as from GPOD L1b Processing (right picture, with double extended window). Clearly, the waveform alignment is erroneous in the PDGS case being the waveform shifted towards the bottom of the radar window (i.e. not placed around 44 range sample) and exhibiting a fictitious topography slope (encircled in red) after the abrupt transition from sea ice to land ice. In the GPOD radar echogram, the waveforms are correctly aligned and now the data gap is only limited to the very abrupt and steep transition between sea ice and land ice (tracker loss) of around 2.5 sec. In both the cases (GPOD and PDGS) the waveform alignment is correct over the land ice interiors.

In the picture on far right, we show the Sentinel-3A topography of Antarctic as computed by GPOD (March 2017) with extended window where is clear that the sensor is capable to retrieve valid topographic elevations over ice sheet margins. Caveat: It was not possible to collect all the Sentinel-3 products in the selected time period (March 2017).