SCOOP: Evaluating the Performance of Sentinel-3 SRAL SAR Altimetry in the Coastal and Open Ocean, and developing improved retrieval methods

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The Sentinel-3 Mission

- The ESA Sentinel-3A satellite was launched on 16th February 2016, and carries a suite of instrumentation to carry out remote sensing monitoring of the ocean and land. The payload includes a synthetic aperture radar (SAR) altimeter which will be the first satellite altimeter to provide 100% coverage of the ocean in SAR mode.

- The Sentinel-3A Synthetic Aperture Radar Altimeter (SRAL) is based on the heritage from CryoSat-2, but will be complemented by a Microwave Radiometer (MWR) to provide a wet troposphere correction, and will operate at Ku and C-Band to provide an accurate along track ionospheric correction. Together, this instrument package will allow accurate measurements of sea surface height over the ocean, as well as measurements of significant wave height and surface wind speed.

SAR Altimeter Data Processing

SCOOP will be implementing, and testing, modifications to three separate aspects of SAR altimeter processing:

•L1A to L1B (Delay-Doppler processing)
This stage (Figure 1) includes the processing steps from the received waveforms, to build the Delay-Doppler Beams Stack (L1B-S), and then the multi-looked SAR Echo (L1B).

•L1B to L2 SAR product (echo modelling and re-tracking)
In this stage the multi-looked SAR echo is fitted to a model echo waveform and “re-tracked” to derive ocean geophysical parameters (range, significant wave height, backscatter).

•L1A to RDSAR product
The so-called “RDSAR” product is the equivalent of the Low Rate Mode (LRM) product produced by previous altimeter missions. It is generated to provide continuity with historic data sets.

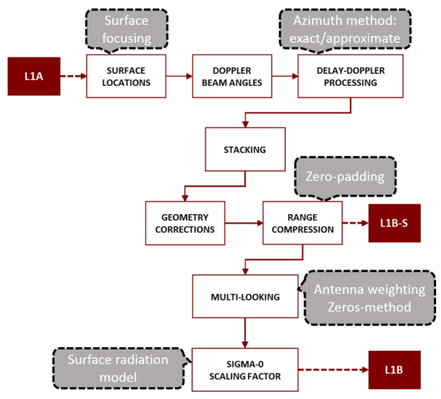

Figure 1: L1B processing flowchart. (Credits isardSAT)

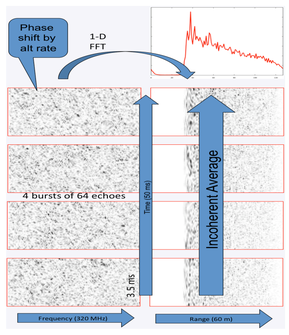

Figure 2: RDSAR Processing Steps (Credit TU Delft)

Open Ocean Study

The aims of the open ocean study are:

- To characterise the expected performance of Sentinel-3 SRAL data in the open ocean (Figure 4).
- To develop and test modifications to the processing of the L1B-S product, and improvements in the re-tracking of the SAR echo to generate the L2 product.
- Evaluate the performance of products generated by this modified processing chain and make recommendations.
- To carry out a study into the dependency of SAR altimeter data on swell.
- To propose a solution to be applied to Sentinel-3 for an open ocean SAR mode Sea State Bias correction, building on findings from a EUMETSAT funded study (EUMITS ITT No.14/209556 "Jason-CS SAR Mode Sea State Bias Study”).

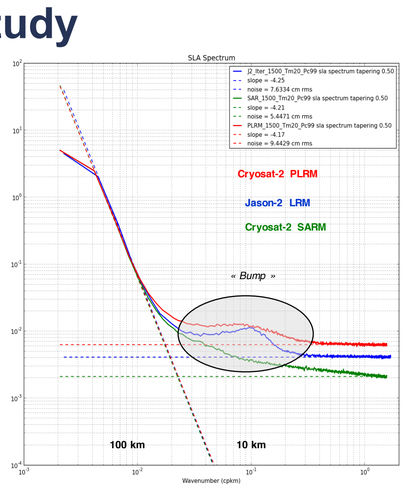

Figure 4: Examples of SSH Spectra from different altimeters, demonstrating the ability to resolve small scale ocean features (Credit CLS)

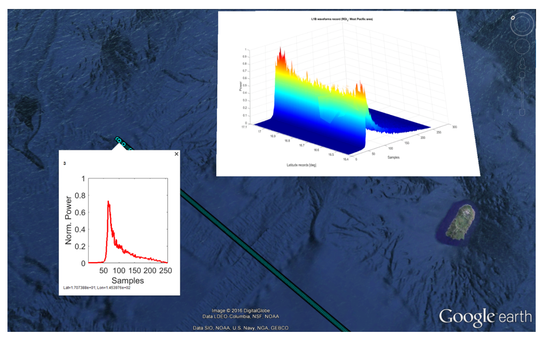

Figure 5: SAR Altimeter processing: CryoSat-2 ground track and L1B Waveform Records for a pass over the Western Pacific (Credit isardSAT)

Project Outcomes

The outcomes of the SCOOP project will include:

- Characterization of the expected performance of Sentinel-3 SRAL SAR mode altimeter products, in the coastal zone and open-ocean.
- An evaluation, and clear description of, enhancements to the Sentinel-3 SRAL processing in terms of their ability to provide improved measurements over the open ocean and in the coastal zone.
- The provision of clear technical information of Sentinel-3 SRAL SAR products and their processing, supporting correct interpretation and application by the user community
- A Scientific Road Map including recommendations for further developments, implementations and research for Sentinel-3 SRAL SAR data

The SCOOP Project

SCOOP (SAR Altimetry Coastal & Open Ocean Performance) is a project funded under the ESA SEOM (Scientific Exploitation of Operational Missions) Programme to answer the questions:

- *What performance can we expect from Sentinel-3 SRAL data over the open ocean and coastal zone?*
- *Can we enhance this performance with improved processing schemes?*

Phase 1 : Evaluating the Expected Performance of Sentinel-3 SRAL

In Phase 1 the expected performance of the SRAL altimeter on Sentinel-3, will be evaluated within the SCOOP open ocean and coastal zone studies, based on the assessment of a 2-year test data set (see below).

Phase 2: Implementing/assessing SRAL processing enhancements.

In SCOOP Phase 2, a number of possible improvements to the SAR processing algorithms will be implemented and a second test data set generated. This new data set will be assessed to identify and validate any improvements in performance, again within the SCOOP open ocean and coastal zone studies.

Scoop Test Data set

The initial SCOOP studies will be carried out on a 2-year test data set derived from CryoSat-2 FBR data, with Sentinel-3 SRAL equivalent processing, produced for 10 regions across the global oceans (Figure 3).
In phase 2, modified processing schemes will be applied to the same source data

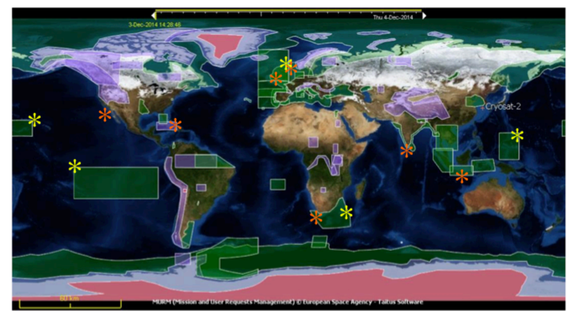

Figure 3: Regions included in the SCOOP study, based on a CryoSat SAR mode mask figure from ESA, with yellow indicating open ocean areas and orange coastal areas (note the Northeast Atlantic and Agulhas regions are assigned to both)

Coastal Zone Study

The aims of the coastal zone study are to:

- Characterise the performance of expected performance on Sentinel-3 SRAL data in the coastal zone, including a specific regional study in the German Bight and a study of the impact of swell on the US West Coast . (Figure 6)
- Develop, test and implement modifications to the processing of the L1B-S product (e.g. zero-padding, burst weighting window, higher posting rate).
- Evaluate the performance of products generated by this modified processing chain and make recommendations with regard to future implementation
- Develop techniques to identify and discriminate against the impact of land contamination of the nadir ocean echo.
- Develop, test and implement coastal re-trackers for Sentinel-3 SAR and RDSAR data
- Investigate how the orientation of the ground track with respect to the coastline, and the proximity of the land affect performance.

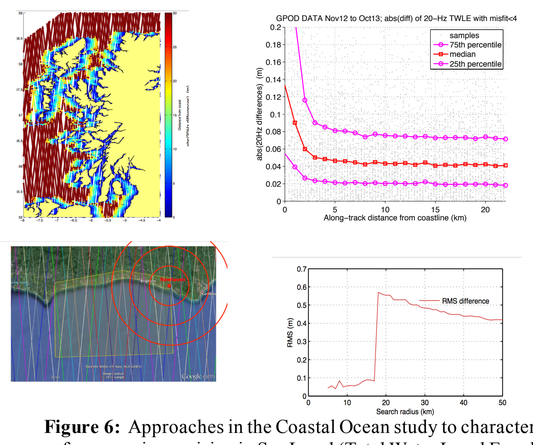

Figure 6: Approaches in the Coastal Ocean study to characterize performance in precision in Sea Level (Total Water Level Envelope – TWLE) retrieval close to the coast (top), and (bottom) comparison of satellite retrieved TWLE against Tide Gauge Data. Credits NOC

Wet Troposphere Modelling

SCOOP will produce an enhanced wet tropospheric correction (WTC) for Sentinel-3, over the open and coastal ocean.

The algorithms are based on the GNSS-derived Path Delay Plus (GPD+) methodology developed by U Porto in the scope of previous ESA projects (COASTALT, CP4O and SL_cci).

Figure 7 illustrates the performance of the GPD+WTC for Envisat. Since Sentinel-3 possesses a two-channel on-board MWR, similar to that of Envisat, it is expected that both radiometers and the corresponding GPD+ WTC have similar performances in the open ocean but significant better over the coast.

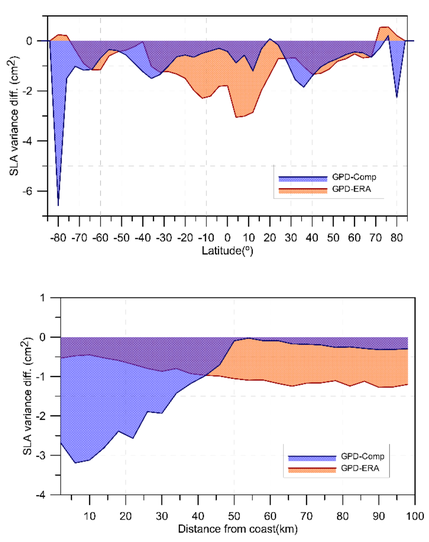

Figure 7: Variance difference between GPD+ and AVISO Composite WTC (blue) and with the ERA Interim model (orange), function of latitude (top) and distance from coast (bottom). Credits U Porto

For further information scan this QR code, or go to : http://bit.ly/1SnfMkB

Also see www.satoc.eu/projects/SCOOP