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

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The SCOOP Project

SCOOP (SAR Altimetry Coastal & Open Ocean Performance) is 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 Sets: The SCOOP Test data sets will be made available on request for international teams working in the same regions of interest (see panel below)

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.
- To develop and test modifications to the processing of the L1B and 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").

Coastal Zone Study

The aims of the coastal zone study are to:

- Characterise the expected performance of 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 and 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 on 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

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.

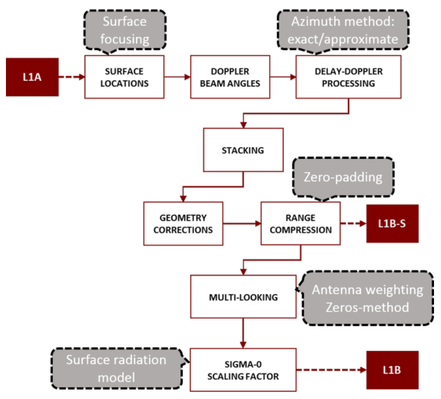

Figure 2: L1B processing flowchart. (Credit isardSAT)

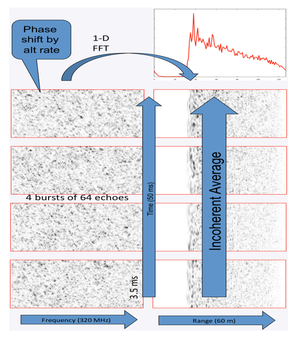

Figure 3: RDSAR Processing Steps (Credit TU Delft)

SCOOP Test Data Sets

The SCOOP studies are based 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 1).

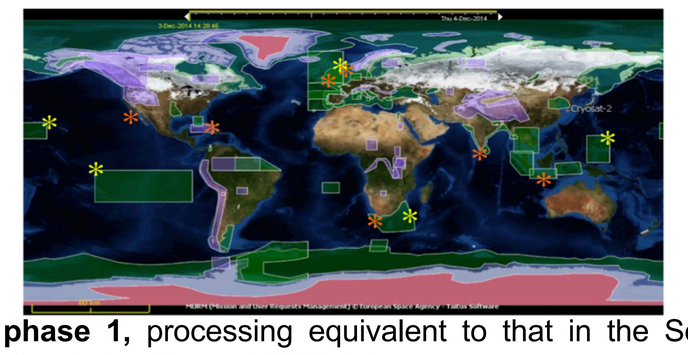

Figure 1: Regions included in the SCOOP study, based on a CryoSat SAR mode mask figure from ESA, with yellow indicating open ocean areas and orange coastal areas (note the Northeast Atlantic and Agulhas regions are assigned to both)

In **phase 1,** processing equivalent to that in the Sentinel-3 baseline will be applied to the Cryosat FBR data, summarised below:

Delay Doppler Processing (to L1B)

- No zero padding, no hamming windowing
- Cryosat calibrations applied according to Baseline-C
- Stack masking designed for Sentinel-6 applied. Equivalent to Sentinel-3 approach, where geometry corrections are separated in fine and coarse shifts.

Echo Modelling / Re-Tracking (to L2)

- Application of a Look-Up Table (LUT) for the selection of a variable Point Target Response (PTR) width as a function of SWH.
- Implementation of SAMOSA-2 Waveform model.
- Improved thermal noise estimation.

The Phase-1 Test Data Set is now available on request to scoop.info@esa.int

In **phase 2**, modified processing schemes will be applied to the same source data. Options that will be investigated include:

Delay Doppler Processing (to L1B)

- Zero padding, hamming (and other) windowing
- Stack Masking
- Surface focussing
- New approaches to stack processing

Echo Modelling / Re-Tracking (to L2)

- Coastal re-trackers (ALES approach, L1B stack geo-referencing)
- Stack data exploitation

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 Envisat, it is expected that both radiometers and the corresponding GPD+ WTC have similar performances in the open ocean but significantly better over the coast.

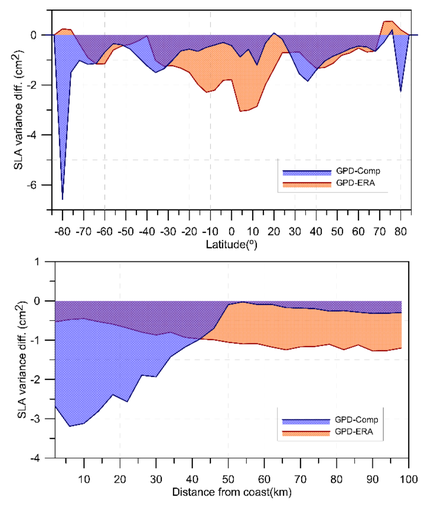

Figure 7: Variance difference between GPD+ and AVISO Composite WTC (blue) and with the ERA Interim model (orange), function of latitude (top) and distance from coast (bottom) (Credit U Porto)

Project Outcomes

The outcomes of the SCOOP project will include:

- Characterisation 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

www.satoc.eu/projects/SCOOP