

Development and Validation of New Advanced Ocean Altimetry Products From Cryosat-2 in Conventional and in SAR Mode



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PROJECT DESCRIPTION

BACKGROUND

- ESA's CryoSat-2 mission is the first to carry a radar altimeter that can operate in SAR mode (delay-Doppler).
- Although the primary aim is land and marine ice monitoring, the SAR mode capability of the Cryosat-2 SIRAL altimeter also offers potential benefits for ocean applications, particularly in the coastal zone;
- The “**Cryosat Plus for Oceans**” (CP4O) project is dedicated to the exploitation of Cryosat-2 data over the open and coastal ocean.
- It is supported by the ESA Support to Science Element (STSE) Programme and CNES, and brings together an expert European consortium, led by SatOC (UK).



OBJECTIVES & SUB-THEMES

The general objectives of the CP4O project are:

- To build a sound scientific basis for new scientific and operational applications of Cryosat-2 data over the open ocean, polar ocean, coastal seas and for sea-floor mapping.
- To generate and evaluate new methods and products that will enable the full exploitation of the capabilities of the Cryosat-2 SIRAL altimeter, and extend their application beyond the initial mission objectives.
- To ensure that the scientific return of the Cryosat-2 mission is maximised.

The specific themes that will be addressed by the project are:

- 1) Open Ocean Altimetry;
- 2) High Resolution Coastal Zone Altimetry;
- 3) High Resolution Polar Ocean Altimetry;
- 4) High Resolution Sea-Floor Bathymetry.



1. INITIAL WORK

Scientific Requirements

The first activity consolidated the preliminary scientific requirements for the four themes under investigation, and produced a list of scientific and operational requirements: **The Requirements Baseline**.

State of the Art Review

The next step provided an analysis of the State Of the Art including the status and quality of Cryosat-2 data, relevant algorithms and approaches for processing Low Rate Mode, SAR Mode and SARIN mode data, including so-called RDSAR, and waveform re-tracking. This activity produced a **Preliminary Analysis Report** and a **Development and Validation Plan**.

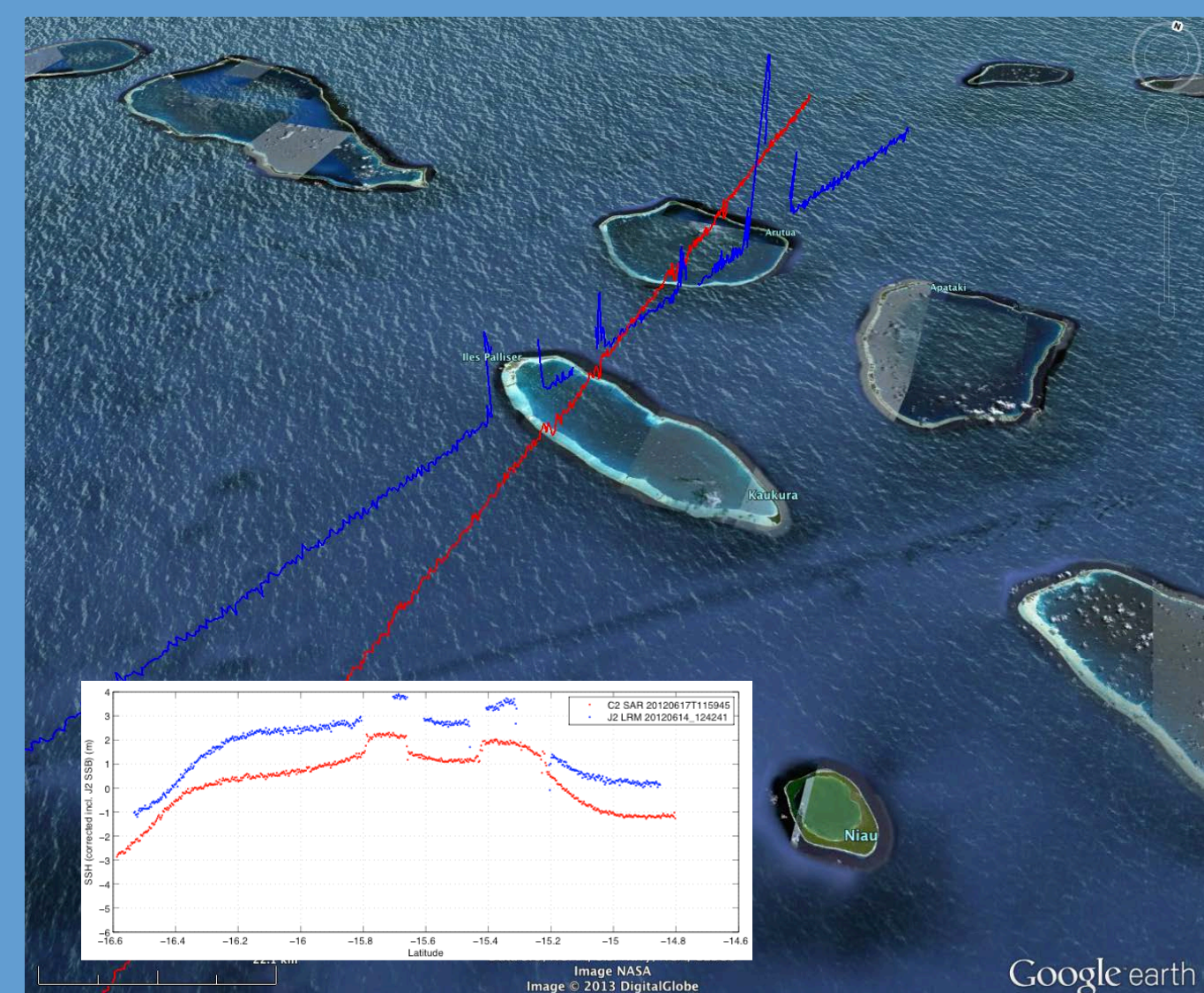


Figure 1: Cryosat-2 SAR (red) continues to provide measurements across atolls in the Pacific, where conventional altimetry (blue) fails. *Acknowledgement:* NOC

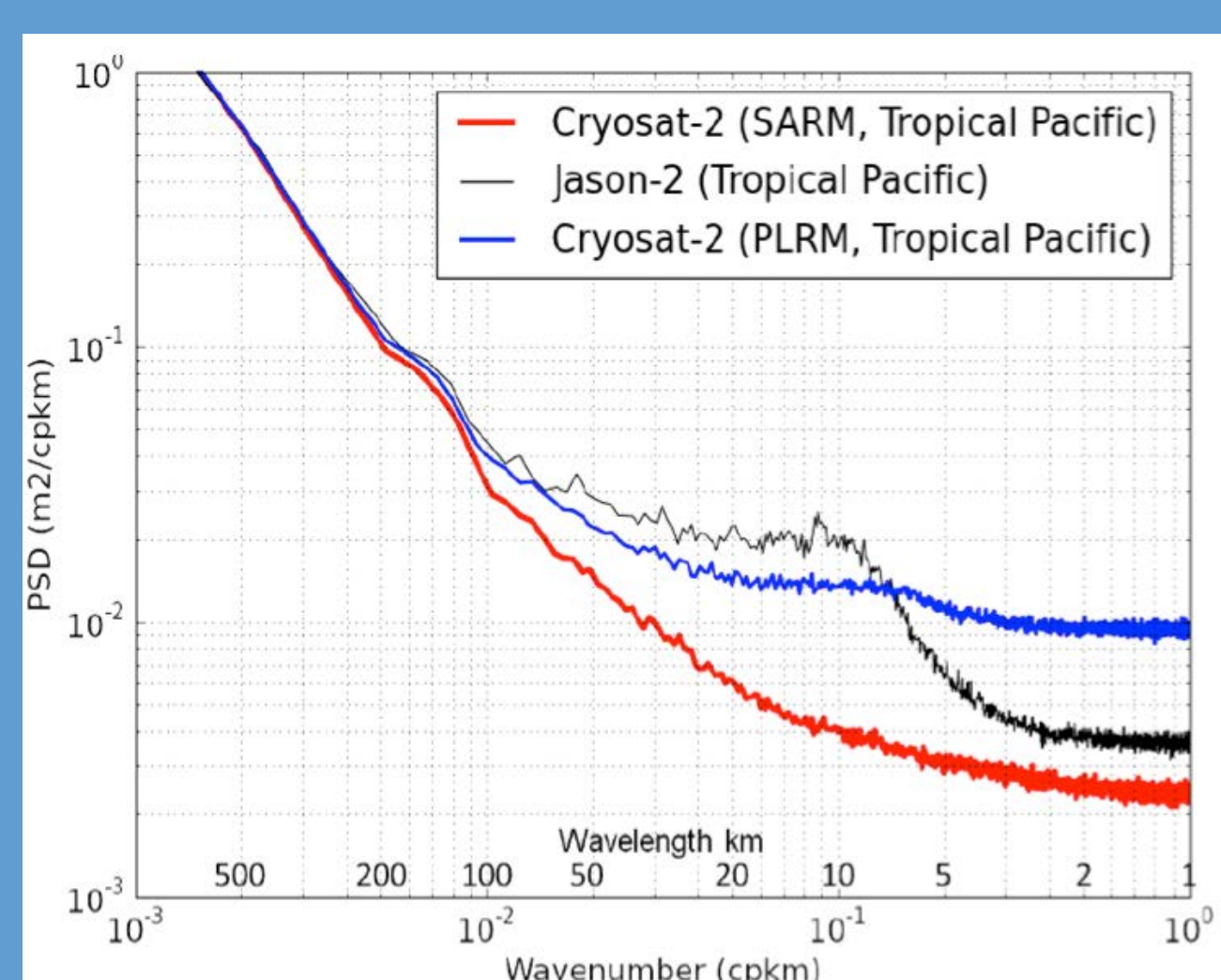


Figure 2: SAR mode (red) can resolve scales from 10-100km, not observable by conventional altimetry (Jason-2: Black, Cryosat-2 “Pseudo” LRM: blue) *Acknowledgement:* CNES/CLS

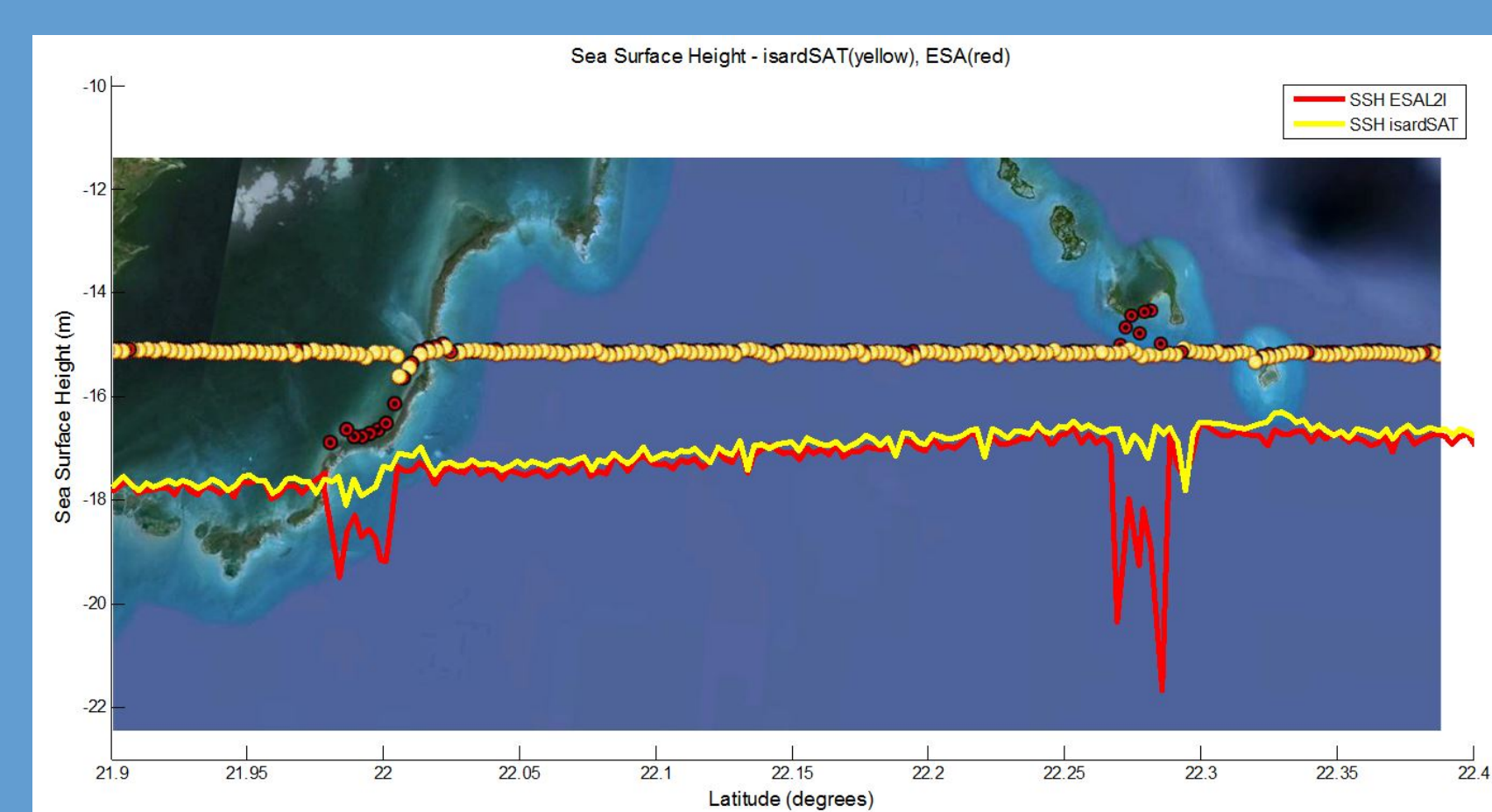


Figure 4: Examples of SARIN data during transition from Coast to land. Reprocessing (yellow) can correct the initially processed data (red) which selects reflections from bright targets away from the sub-satellite track. *Acknowledgement:* isardSAT

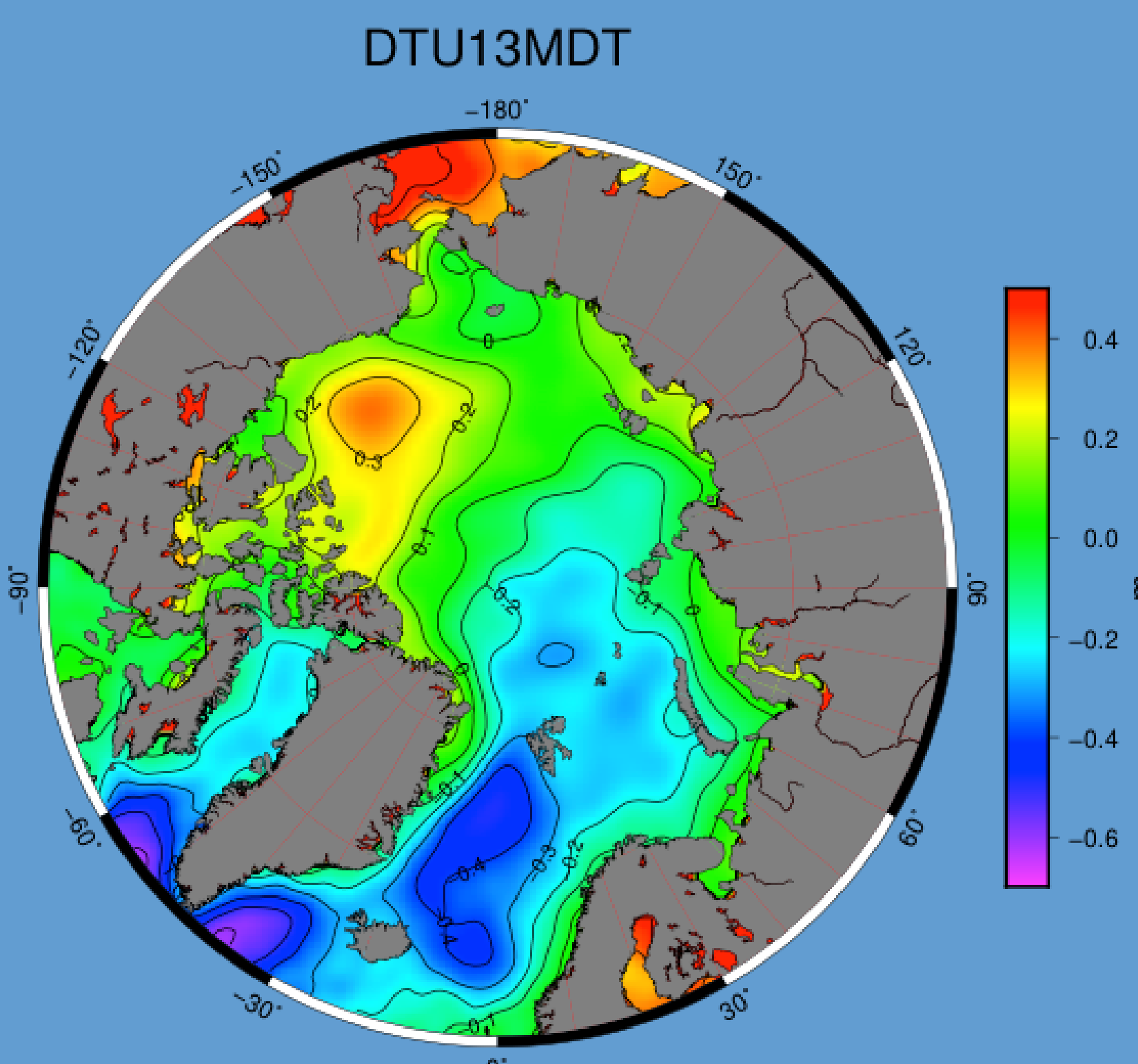


Figure 5: Cryosat-2 data provide important improvements to maps of Mean Dynamic Topography for the Arctic Ocean, and so support analysis of key ocean circulation features. *Acknowledgement:* DTU Space

2. PRODUCT DEVELOPMENT & VALIDATION

The heart of the Cryosat Plus for Oceans project is the development and validation of algorithms and processing schemes for new ocean products, based on Cryosat-2 data. This activity, led by the UK National Oceanography Centre, involves the creation of 7 new experimental altimeter data sets, and further data sets with new geophysical corrections, as follows (the lead partners are identified).

New Experimental Altimeter Data Sets

1. LRM for Open Ocean (TUDelft)
2. SAR for Open Ocean (Starlab, CLS)
3. SAR for Sea Floor Mapping (DTU Space)
4. SAR for Coastal Ocean (NOC)
5. SAR for Polar Ocean (DTU Space)
6. RDSAR for Open Ocean (CLS, TU Delft)
7. SARin for Coastal Ocean (isardSAT)

Improved Geophysical Corrections:

1. Wet troposphere correction (U Porto)
2. Ionospheric correction (Noveltis)
3. Regional tidal correction (Noveltis)

These experimental data sets will cover specific regions and time periods, The output of this activity will be **Algorithm Theoretical Basis Documents** and **Product Validation Reports** for each processing scheme.

The final results will be available in spring 2014, we present some initial results from the internal validation activities here.

Further Information is available on the projects website: www.satoc.eu/projects/CP4O

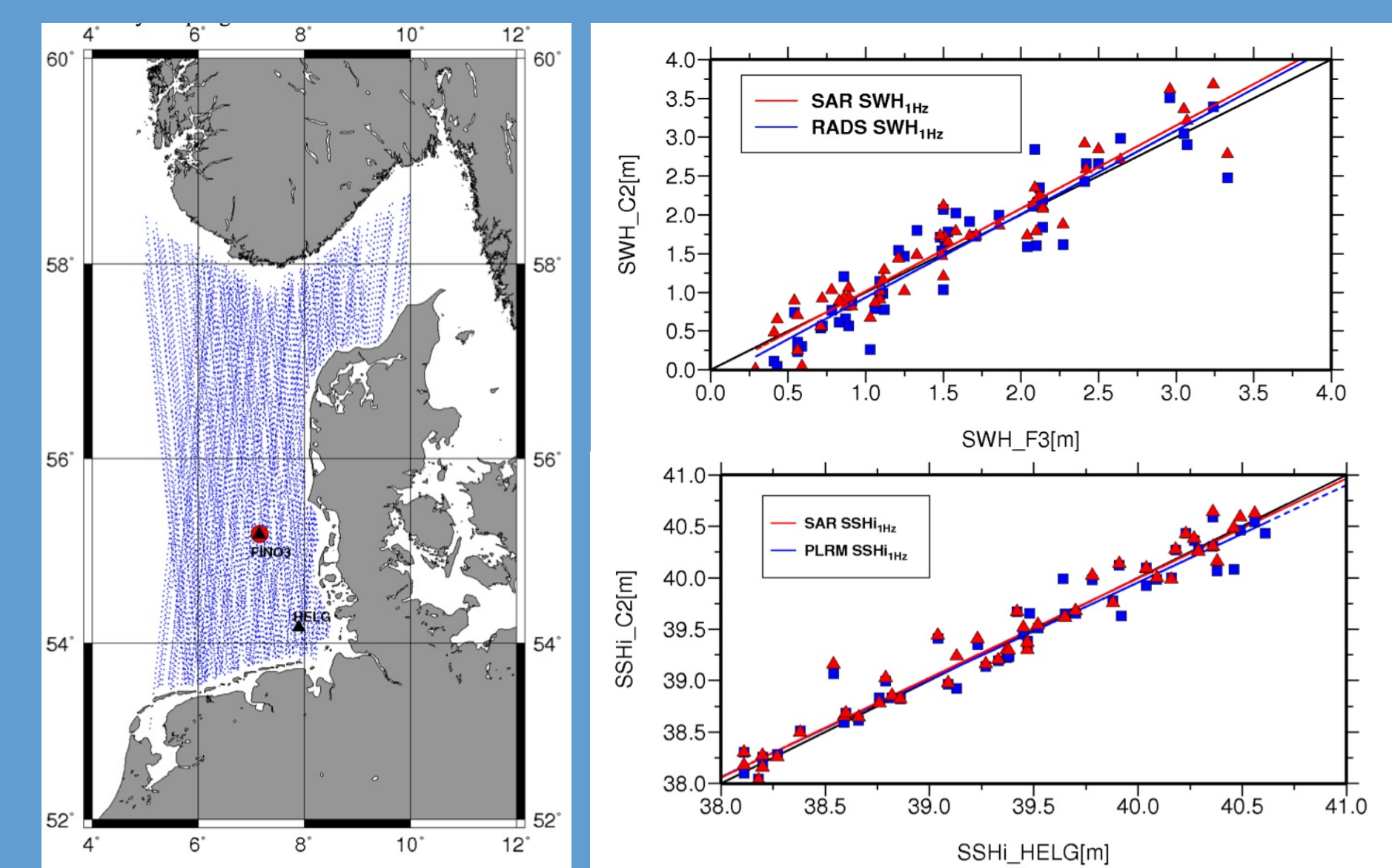


Figure 3: Validation of Cryosat-2 SAR mode data against in-situ data from the German Bight. The red triangles indicate SAR mode data processed with the SAMOSA-3 echo model, the blue squares RDSAR data from the RADS data base. *Acknowledgement:* ESA, TU Delft, and NOAA

3. IMPACT ASSESSMENT

Based on the processing schemes and experimental data sets validated in step 2, larger data sets will be generated and more widely evaluated, to analyse and quantify the impact and benefits of these new Cryosat-2 products.

The output will be an **Impact Assessment Report**, available early summer 2014

4. FUTURE EXPLOITATION – SCIENTIFIC ROAD MAP

Finally, the results of the Impact Assessment will be used to define an agreed **Scientific Roadmap** to ensure fullest possible exploitation of Cryosat-2 data over the oceans, and to support the transfer the results into scientific and operational activities.

5. FINAL WORDS

SAR mode altimetry offers an exciting opportunity to oceanographers, opening up a number of potential new applications, as well as significant improvements to well established products.

The ultimate aim of CP4O is to maximise the exploitation of Cryosat-2 data in oceanographic applications, and to build a sound scientific foundation for future satellite missions carrying SAR mode altimeters, starting with Sentinel-3.