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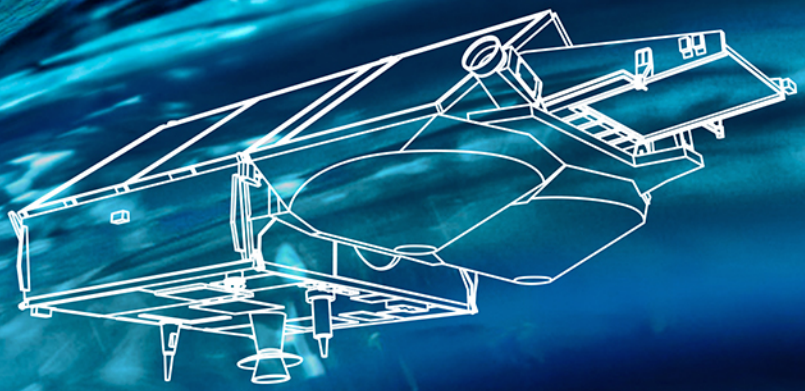
→ CRYOSAT PLUS FOR OCEANS

Applying CryoSat data to Ocean Studies



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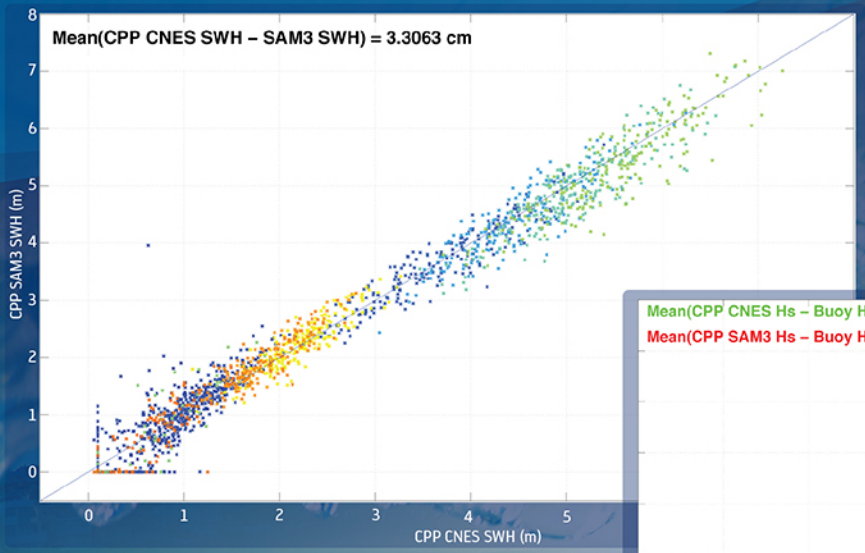
support to science element

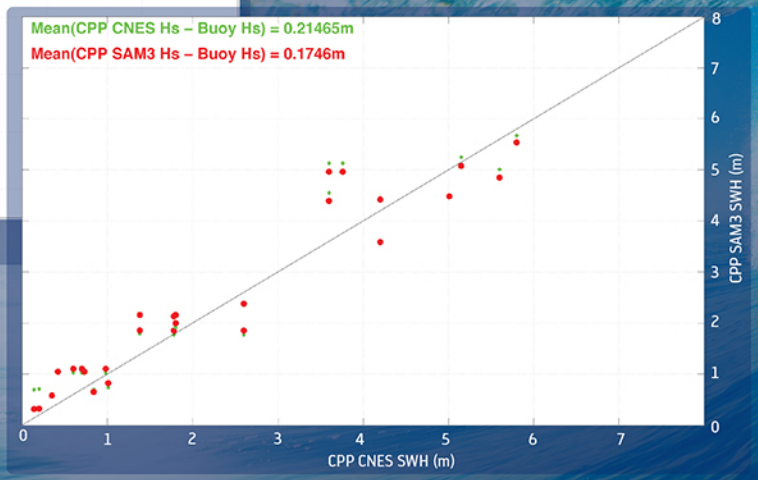
→ PRODUCT VALIDATION

The development and validation of algorithms and processing schemes for new ocean products, based on Cryosat-2 data is led by NOC.

Preliminary validation of SAMOSA3 echo model has been done against CNES CPP datasets and in-situ buoys (German Bight and North Atlantic near the UK).



Very good agreement between CNES CPP data and SAMOSA3 retracker outputs.
Excellent performance of SAR SWH against buoys, including at some very coastal sites (low sea states).



→ BENEFITS

The benefits of CP4O are twofold.

- CP4O products and studies will support the full exploitation of CryoSat-2 data over the oceans, so maximizing the value of this mission

- The development and evaluation of SAR mode processing schemes will be highly important for the exploitation of future missions which will also carry SAR enabled altimeters, including Sentinel-3 and Jason-CS.

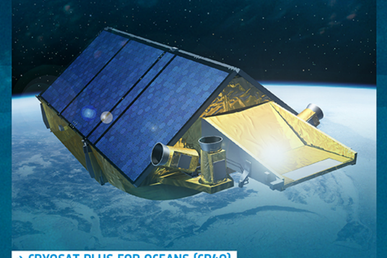
→ CP4O OUTPUTS

The CP4O will produce a number of outputs which will be of interest and available to the whole satellite oceanographic community.

- **User Requirements Survey**
- **State of the Art Report for SAR Altimetry**
- **Demonstration Products**
- **Impact Assessment**
- **Scientific Road Map and Recommendations**

→ CRYOSAT OFFERS IMPROVED OCEAN MEASUREMENTS

The ESA CryoSat-2 mission is the first space mission to carry a radar altimeter that can operate in Synthetic Aperture Radar (SAR) mode, as well as the more conventional Low Rate Mode (LRM), and also the SAR Interferometric mode (SARin). Although the prime objective of the CryoSat-2 mission is dedicated to monitoring land and marine ice, the SAR mode capability of the CryoSat-2 SIRAL altimeter offers significant potential benefits for ocean applications, based on expected performance enhancements which include improved range precision, finer along track spatial resolution, and an improved ability to provide measurements close to the coast.



→ CRYOSAT PLUS FOR OCEANS (CP4O)

The **Cryosat Plus for Oceans** (CP4O) project is supported by ESA under the Support To Science Element Programme. CP4O started in June 2012, and will continue to June 2014. The objectives of CP4O are:

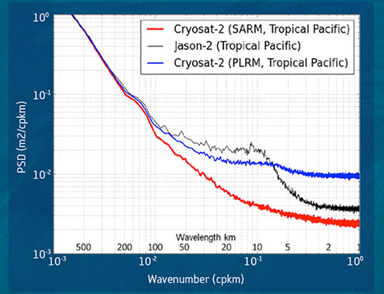
- to build a sound scientific basis for new scientific and operational applications of CryoSat-2 data over the open ocean, polar ocean coastal seas and for sea-floor mapping.
- to generate and evaluate new methods and products that will enable the full exploitation of the capabilities of the CryoSat-2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

→ CP4O OBJECTIVES

CP4O is investigating the potential for CryoSat-2 data to provide improved ocean measurements under four sub-themes: Open Ocean Altimetry, Coastal Zone Altimetry, Polar Ocean Altimetry, and Sea Floor Altimetry.

Open Ocean Altimetry

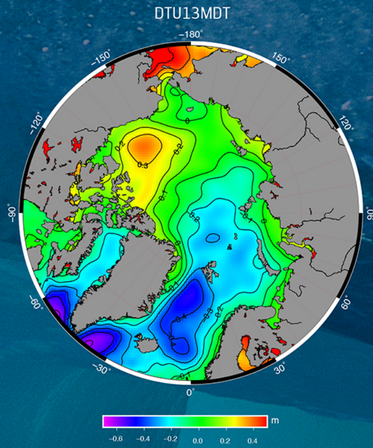
CP4O will develop products derived from Cryosat-2 SAR Mode data and investigate their capability to detect and map oceanographic features at shorter spatial scales than can be resolved by conventional Low Rate Mode altimetry (10-80km).
In addition schemes will be developed to convert SAR Full Bit Rate data to LRM data, with similar signal characteristics and so ensure continuity in ocean products generated from SAR and LRM source data. Improved Ocean products from Cryosat-2 LRM data will also be developed and evaluated.



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

Polar Ocean Altimetry

To develop and evaluate processing schemes applicable to sea-ice affected regions, so that Cryosat-2 SAR Mode data can be used to study large scale polar ocean signals and so make a significant new contribution to important applications:



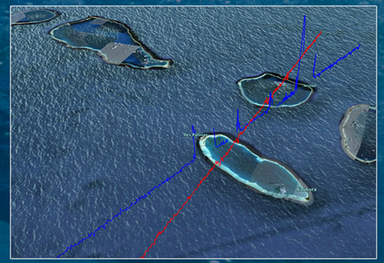
Cryosat-2 data provide important improvements to maps of Mean Dynamic Topography for the Arctic Ocean, and so support analysis of key ocean circulation features. Credits: DTU Space

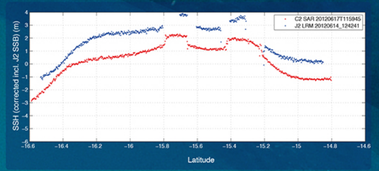
Sea-Floor Altimetry

The potential offered by the higher resolution and improved signal to noise ratio of Cryosat-2 SAR Mode data to resolve short-wavelength sea surface signals caused by sea-floor topography elements and to map uncharted sea-mounts and trenches.

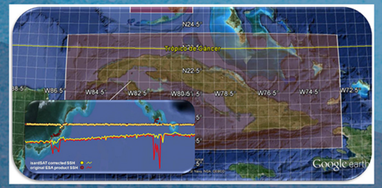
Coastal Zone Altimetry

The exploitation of Cryosat-2 SAR Mode data in the Coastal Ocean to demonstrate their finer spatial resolution, improved retrieval accuracy and lower sensitivity to land contamination, and so deliver high-quality altimeter measurements closer to the shore, to improve the estimation of coastal sea level changes, the detection of coastal features (coastal current jets, coastal wave set up, coastal tides) and the characterisation of inshore wave conditions.
The demonstration of the potential of Cryosat-2 SARIn mode data to help discriminate and mitigate land contamination signals from off-nadir land targets (e.g. steep cliffs) in SARin waveforms over coastal regions.





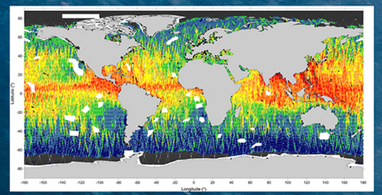
Good performances of Cryosat-2 SAR (red) data that continues to provide measurements across atolls in the Pacific, where conventional altimetry Jason-2 (blue) fails. Credits: NOC



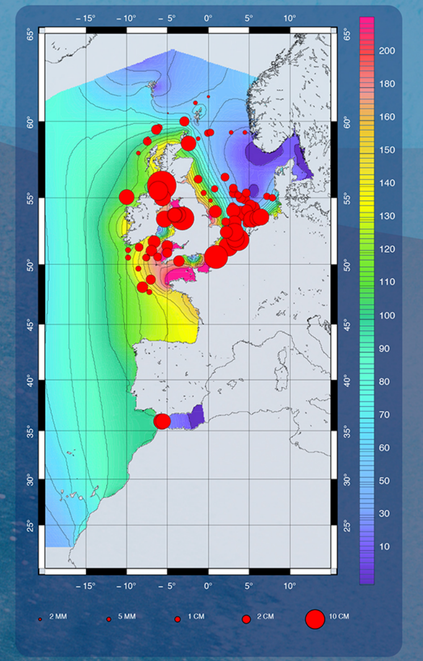
Examples of SARin data during transition from Coast to land. Reprocessing (yellow) can correct the initially processed data (red) which selects reflections from bright targets away from the sub-satellite track.
Credits: isardSAT

Geophysical Corrections

Improved Geophysical Corrections are needed to provide accurate range measurements, because Cryosat-2 does not carry a Microwave Radiometer to correct for water vapour path delay, and only operates at a single frequency (dual frequency allows a direct estimate of the ionospheric delay).



Wet Tropospheric correction (WTC) from DComb algorithm (in colour) estimated for CryoSat-2 Sub-cycle 16 by objective analysis using data from GNSS stations (black triangles), MWR images from Remote Sensing satellites and ERA Interim model. Zones where the WTC for this sub-cycle only rely on data from ERA are shown in grey; CryoSat-2 data unavailability is shown in white.
Credits: University of Porto



Amplitude of the M2 tidal wave from the COMAPI regional model (CNES project). The red dots superimposed are the vector differences between the model and tide gauge stations. The size of the dots is proportional to the misfit between the model and the observation. Credits: NOVELTIS

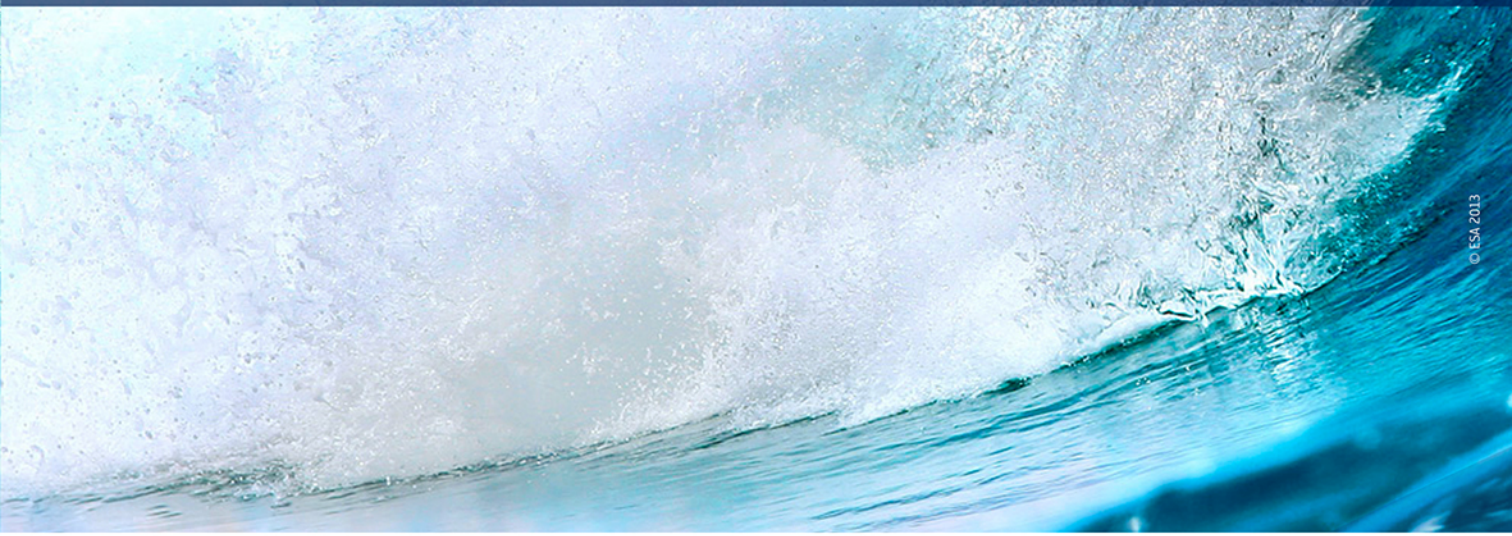
CP40 is lead by SatOC Ltd UK, the project team includes:

Collecte Localisation Satellites (Toulouse, France), **Denmark Technical University** (Copenhagen, Denmark), **isardSAT** (Barcelona, Spain), **National Oceanography Centre** (Southampton, UK), **Noveltis** (Toulouse, France), **Starlab** (Barcelona, Spain), **Technical University of Delft** (Delft, Netherlands), **The University of Porto** (Porto, Portugal).

Project Manager: **Dr. David Cotton** (SatOC, UK)

Project Scientific Officer: **Dr. Jérôme Benveniste** (ESA/ESRIN, Italy)

Project Scientific Support: **Salvatore Dinardo** (SERCO/ESRIN),
Bruno Lucas (DEIMOS/ESRIN)



www.satoc.eu/projects/CP40