RECOMMENDATIONS FOR THE FUTURE

COASTALT
www.coastalt.eu

Processors and retracking

- further work is needed on the coastal retrackers, both theoretical and in terms of optimization and intercalibration.
- innovative retrackers using information in adjacent waveforms need further R&D to move from concepts to simulations and eventually comparison with real data.
- to facilitate the work of developers, testers, and the uptake of the data by 'expert users', coastal altimetry processors must be open, flexible, expandable, easily upgradable and fully documented.

Data filtering and corrections

- the whole issue of filtering for the various corrections needs to be revisited, with correlation scales clearly identified and data screening and filtering schemes clearly recommended. These depend on the application to some extent and location.
- the Sea State Bias (SSB) correction needs a reassessment in the coastal zone, with the investigation of specific models.

Validation and data use

- Validation is crucial and should be supported further, establishing clear validation protocols.
- Coastal altimetry applications should be supported and encouraged, with easy data access, outreach and training activities, and demonstration studies.

National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

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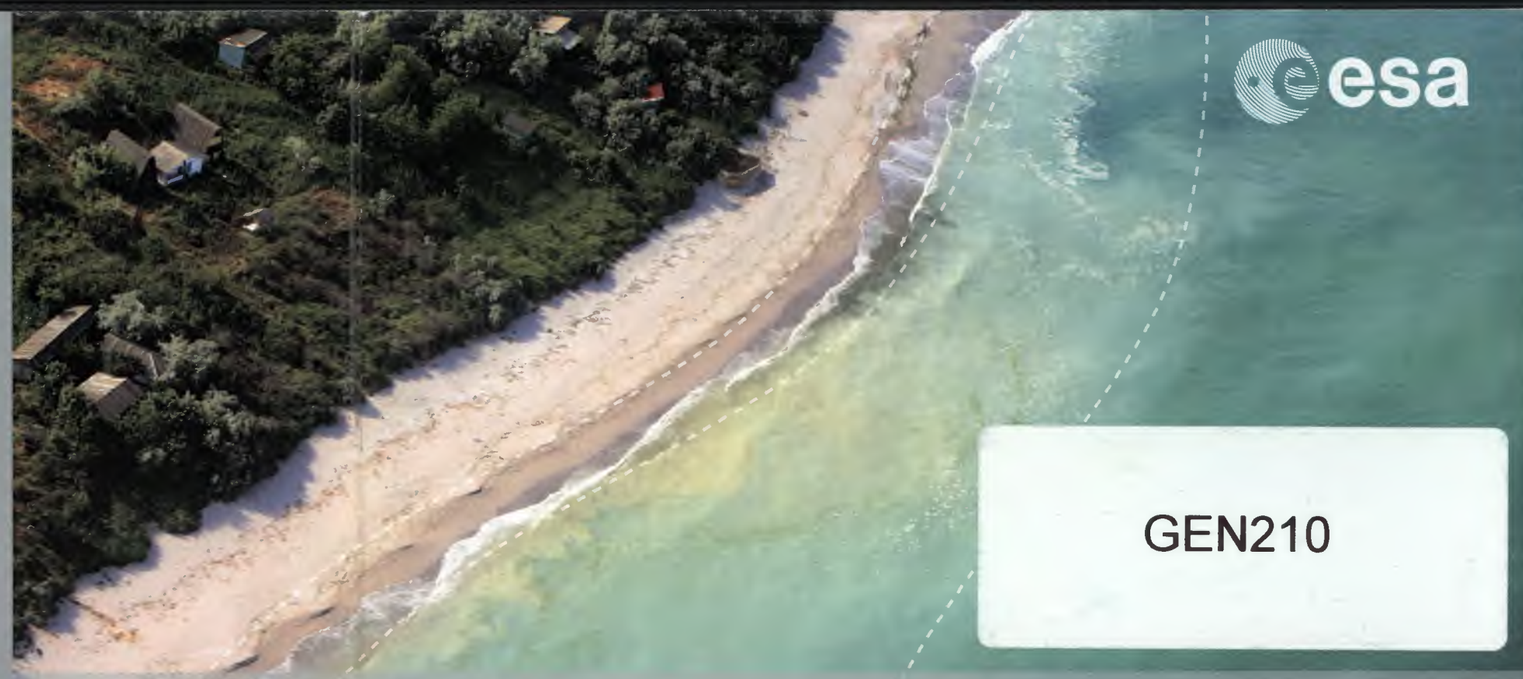

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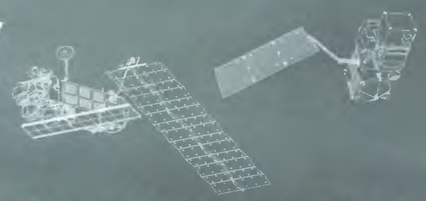
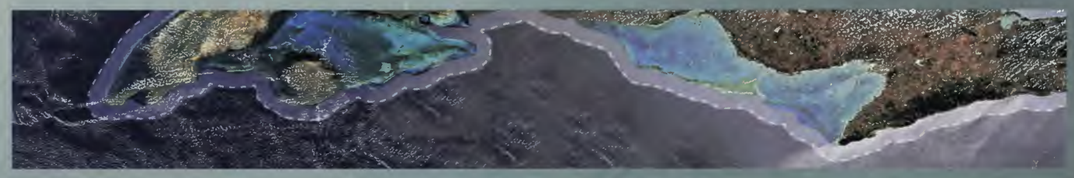
→ COASTAL ALTIMETRY AND COASTALT





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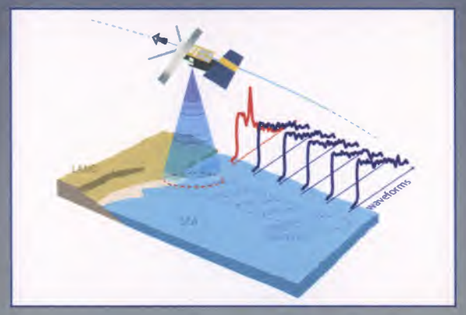
European Space Agency

COASTAL ALTIMETRY AND COASTALT

Altimetry is ready to sail closer to the coast
Altimetry over the open ocean is a mature discipline, incredibly useful both for process studies and operational forecasting. **The objective is now to replicate this success in the coastal zone**, where data are often discarded (i.e. flagged as bad) simply because it is difficult to interpret/model land effects on the altimetric waveforms, and/or for lack of adequate corrections for various effects such as path delays, coastal tides, high frequency atmospheric signals.
There is a good possibility that the information (sea surface height and wave height) hidden in those 'bad data' can be recovered.

Information from coastal altimetry will be invaluable to study the very region where the impact of the changing ocean on society is strongest - the coastal strip.

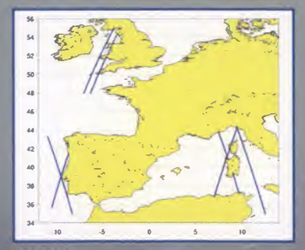


When a satellite altimeter approaches the coast, land entering the radar footprint modifies the shape of the waveforms (as shown by the waveform in red), making the estimate of range and other derived quantities more difficult.

Recovering information from coastal altimetry requires the development of specialized techniques for processing the raw altimetric data in proximity to the coast, but once those techniques are up and running, **more than 20 years of data from several missions are ready to be reprocessed in the archives**... a tantalizing prospect!

THE PROJECT

COASTALT was a Project on "Development of Radar Altimetry Data Processing in the Coastal Zone" funded by the European Space Agency (ESA/ESRIN contract 21201/08/I-LG) whose main objective was **to contribute to the transition of pulse-limited coastal altimetry towards a mature, pre-operational phase**, by defining and testing new coastal radar altimeter products. This is ultimately to prepare the way for a routine generation and distribution of these products by ESA, including a coastal reprocessing of the ERS-1, ERS-2 and Envisat Radar Altimeter data, but exploiting the improved capabilities of the novel SAR altimeters on Cryosat-2 and Sentinel-3.


COASTALT test areas, Envisat tracks.

COASTALT was led by the National Oceanography Centre, Southampton (UK); other partners consist of the Consiglio Nazionale delle Ricerche, Pisa (Italy); the University of Cadiz (Spain); the University of Porto (Portugal), the University of Lisbon (Portugal), Starlab Barcelona SL (Spain), Hidromod, Lisbon (Portugal), and the National Oceanography Centre, Liverpool (UK). Project Manager: Dr. Paolo Cipollini (NOC, UK); Project Scientific Officer: Dr. Jérôme Benveniste (ESA/ESRIN, Italy).

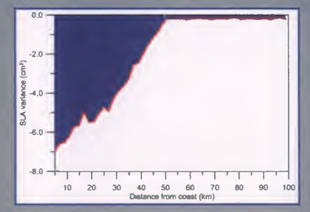
COASTALT has explored the improvements that are needed in the processing and correction of altimetric data to make reliable estimates of sea surface height and significant wave height.

Re-processing of the raw waveforms (known as retracking) is often necessary when their shape changes in the coastal environment (for instance due to land or bright targets, like a patch of calm water, entering the altimeter footprint).

Dedicated corrections are needed to compensate for instrumental and surface effects and also for the delay introduced by the ionosphere, by the tropospheric gases ("dry tropospheric" correction) and by water vapour ("wet tropospheric" correction).

RESULT HIGHLIGHTS FROM COASTALT

COASTALT has developed a novel wet tropospheric algorithm (GNSS-derived Path Delay or GPD) based on measurements by GPS stations (and applicable to Galileo in the future). This correction is now the recommended choice by the ESA Sea Level CCI project for the retrieval of climate-quality measurements of sea level.



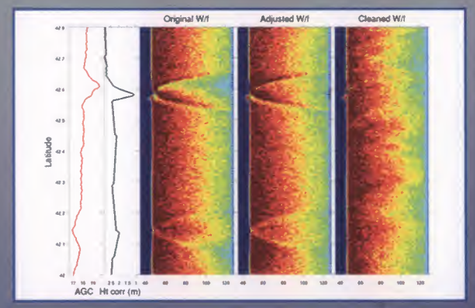
Sea Level Anomaly variance difference (cm²) between the GPD wet tropospheric correction and the Composite Correction (the reference used in AVISO products).

COASTALT has explored innovative methods for waveform retracking in the coastal zone. The waveforms often show artefacts due to quasi-specular reflection from 'bright' targets (such a target could be a patch of very calm water in a sheltered bay, as the Project has found out in several instances).

The spiky signals from these targets migrate along the waveform in a predictable (hyperbolic) manner, and this has allowed the development of a technique that 'cleans' a batch of waveforms from such artefacts to improve the precision of the sea surface height and wave height retrieval.

Product specifications for coastal altimetry and an all-inclusive Envisat Coastal Altimetry User Handbook are downloadable from the COASTALT web site, **www.coastalt.eu**.

COASTALT has been an incubator of ideas for coastal altimetry and a catalyst for the international community of coastal altimetry specialists. The series of Coastal Altimetry workshops, in particular, remain as a lasting legacy of the project and of companion projects like CNES' PISTACH and some OSTST ones.



An example of removal of hyperbolic artefacts in sequences of waveforms. Each row in the colour maps is a single 20-Hz waveform for Envisat, near Pianosa island (Italy). From left: Automatic Gain Control (AGC); Tracker Window position (Ht_corr); original (uncorrected) waveforms, clearly showing hyperbolic features; waveforms after adjustment of AGC and Ht_corr; 'cleaned' waveforms after application of the COASTALT technique to fit and remove the hyperbolic features.