Comparison and validation of multi-mission coastal altimetry around Venice

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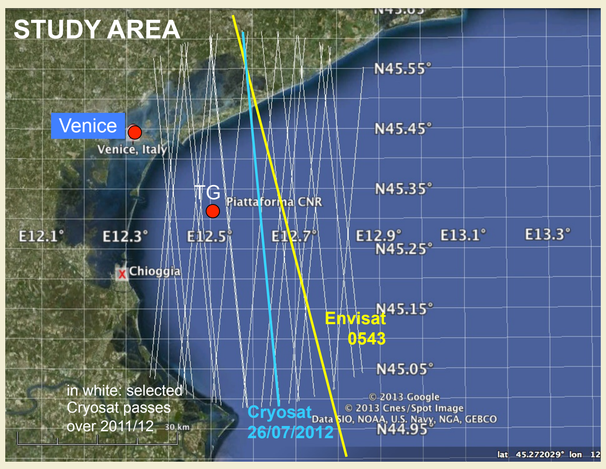
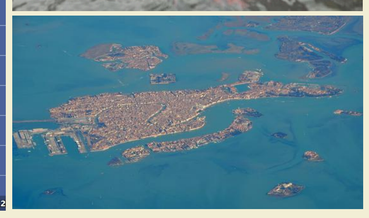
Rationale and Study area

Following on the coastal altimetry work for Envisat started in the COASTALT project (2008-2012), the NOC coastal altimetry processor is being extended to process data from multiple altimetric missions within the ESA DUE eSurge and eSurge-Venice projects for the provision of Earth Observation data in support of storm surge monitoring, modelling and forecasting.

An important calibration and validation site is the area in the Northern Adriatic Sea, where storm surges (locally called 'acqua alta') are particularly frequent – this is the site of the eSurge-Venice project.

For this validation activity we have processed Envisat and Cryosat data in the area, and compared them with data from the CNR tide gauge (TG) at the "Acqua Alta" platform ~14 km from the coast of Venice Lido. We also looked at Jason-1 and -2 over an adjacent area in the Northern Adriatic – see talk and OSTST poster by Passaro et al.





Key quantity from Altimetry:

Total Water Level Envelope (TWLE)

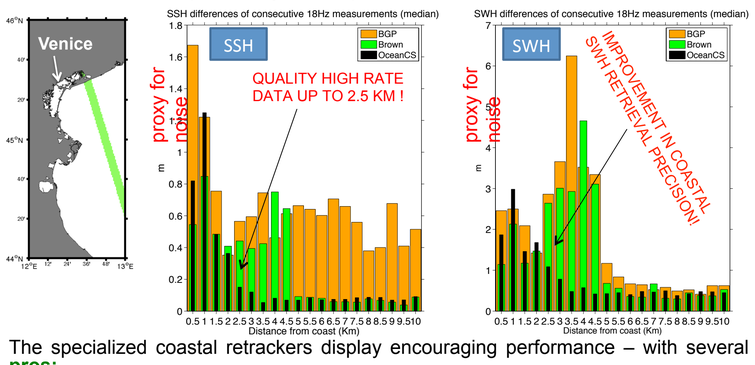
That's the level you get – inclusive of tide, pressure, HF atmospheric effects, wave setup, etc…

Altimetry inherently measures TWLE: **coastal altimetry extends TWLE measurements to the coastal strip**, i.e. where they are most relevant to storm surge research, applications and services (see poster by Harwood et al)

The wave field in the coastal strip is also relevant, as it helps development of more realistic wave models that can be used to estimate wave setup and overtopping

With specialized retrackers we get much closer to the coast!

Envisat example, 20 cycles of pass 0543 over Northern Adriatic



The specialized coastal retrackers display encouraging performance – with several pros:

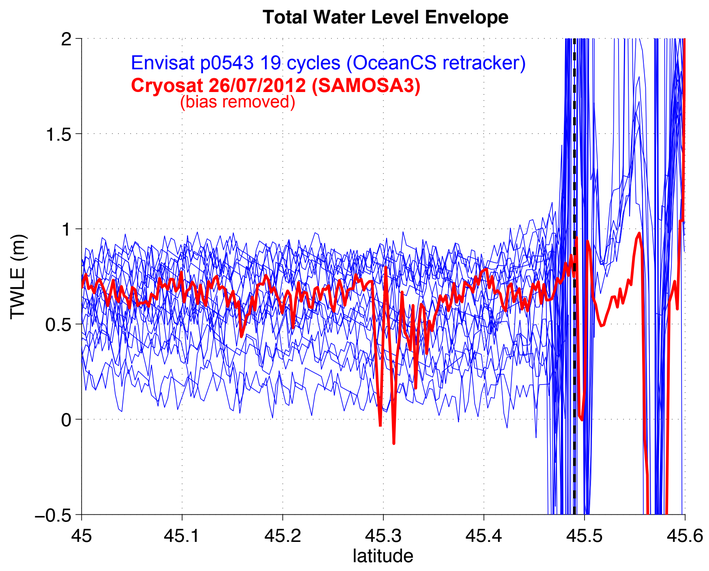
BGP (Halimi et al, 2013): Better trailing edge fitting (useful to retrieve sigma0 or mispointing with greater precision)

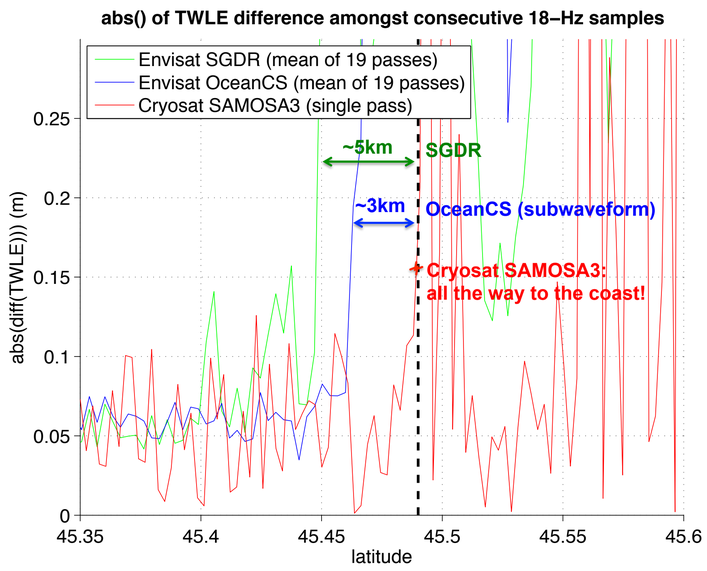
OceanCS (Yang et al, 2012): "Open ocean" precision in SSH and SWH UP TO 2.5 KM FROM THE COAST; Precise leading edge fitting, better than classic schemes also far from the coast

→ now NOC have developed ALES, a sub-waveform retracker based on OceanCS but where the fitting window width is adapted according to the significant wave height,. ALES is only marginally suboptimal than standard retrackers over the open ocean and outperforms them in the coastal zone (see talk and OSTST poster by Passaro et al.)

Envisat data have been processed with Yang's **OceanCS** and now with the new **ALES** retracker, which is included in the eSurge processor. Cryosat-2 data have been retracked with the **SAMOSA3** model also included in the eSurge processor. All the comparisons are done at high-rate (20Hz).

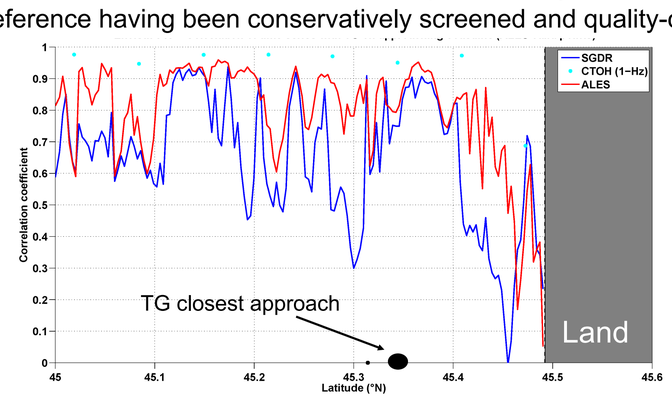
Comparison Envisat SGDR *vs* Envisat reprocessed *vs* Cryosat-2





Correlation between Envisat and TG

We compared, in terms of correlation of the TWLE series, ALES-reprocessed Envisat data against the SGDR and the coastal 1-Hz data produced by CTOH in Toulouse which are a good reference having been conservatively screened and quality-controlled:



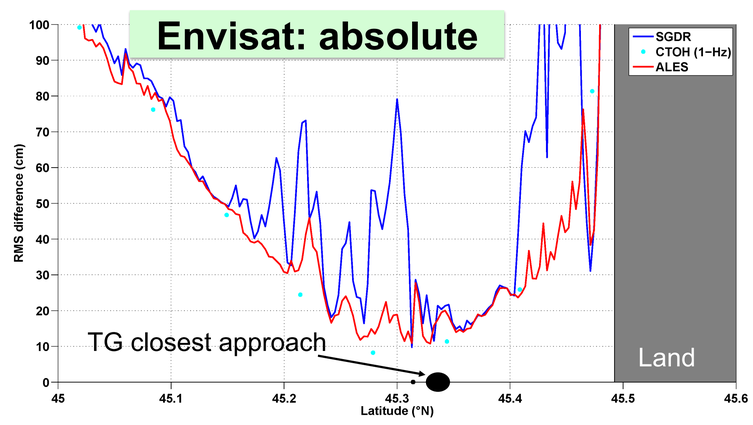
- ALES improves correlation everywhere compared to SGDR.
- ALES maintains correlation above 0.8 over most of the 18-Hz locations, except for a few locations.
- The correlation for the CTOH 1-Hz series is only marginally higher. This is expected being ALES a high-rate non-filtered product.

Envisat: up to 3 Km from coast; absolute RMS with TG at <10cm!
Cryosat SAR: only relative calibration (8 cm RMS) but goes all way to the coast!

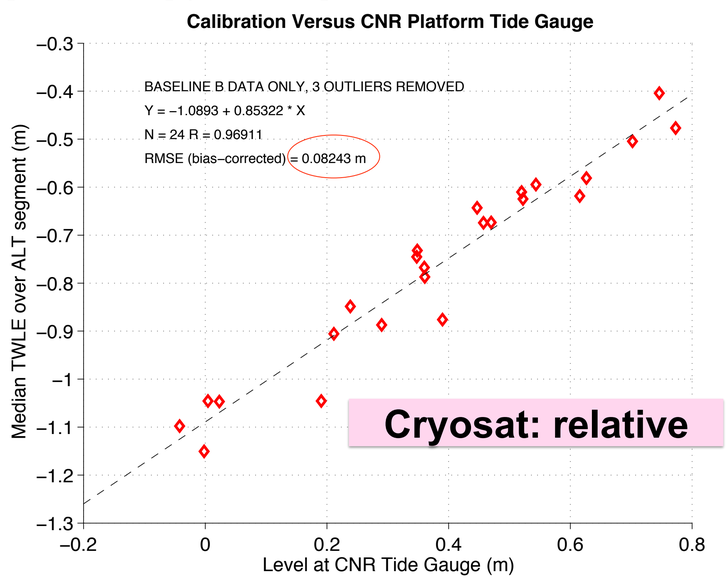
Absolute vs Relative Calibration

Often altimeter/tide gauge intercomparison is **RELATIVE**, that is the common bias is removed and anomalies are computed and compared.

WE aim at performing an **ABSOLUTE** calibration, i.e. closing the altimetric height budget using absolute references (WGS84 ellipsoid), without removing any biases by hand, and **working with absolute levels**. This is possible for Envisat (see below), but not yet for Cryosat-2 as there are large remaining processing biases.



- RMS error decreases in points in close proximity to the TG
- RMS error below acceptable threshold (< 15 cm near TG, with average this can get below 10 cm)



What we have learnt so far from these results

The comparison of our retracked data against the standard data in the Envisat (and Jason, see other poster) SGDRs shows that:

1. with dedicated sub-waveform retrackers (and in particular with the ALES retracker) we can retrieve more and better data closer to the coast. Correlations with the tide gauge data improve especially in the coastal strip (~10-20 km from the coast) but also, slightly, in the open ocean region, as many waveforms in this area suffer from the presence of bright-target-like artefact and therefore do not conform well with the Brown model.
2. 20-Hz noise levels for the ALES-retracked Envisat are flat until about 3 Km from the coastline, as opposed to ~5 Km for the SGDR data.
3. RMS values between ALES and tide gauge are at ~10 cm order of magnitude on the **absolute** water level (i.e. NOT using anomalies) which is a good result indicating a substantial closure of the SSH equation.
4. Cryosat-2 data show an even better performance very close to the coast, with noise levels compared to the offshore ones up to less than 1 km from the coast, even if unresolved bias problems prevent an absolute RMS calculation so far.
5. For Cryosat-2, the RMS difference with the tide gauge, computed with anomalies, is of the order of 8 cm.

For more information, to access data and to contact us, visit the project website at

www.storm-surge.info

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