SAR altimetry for Coastal Applications – Awaiting Sentinel-3 SAR altimetry in the North Sea

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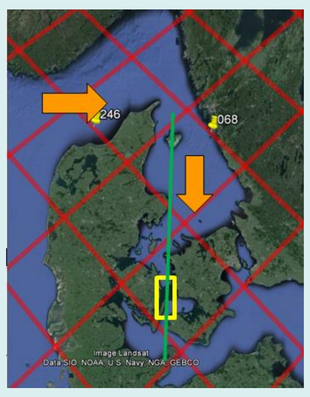
Abstract

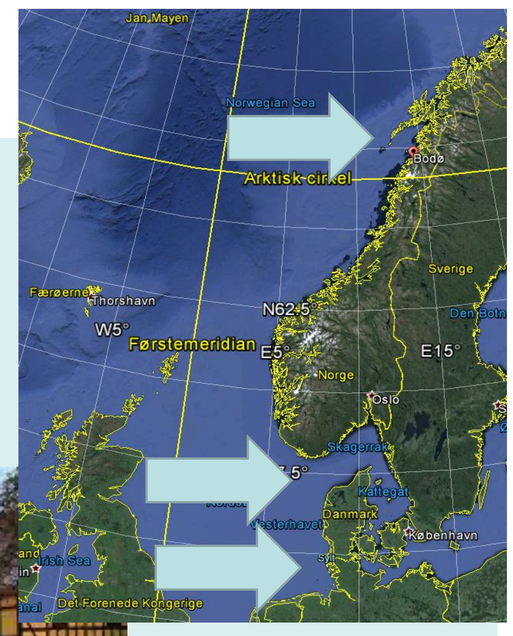
Cryosat-2 offered the first ever possibility to perform coastal altimetric studies using SAR-Interferometry as well as SAR altimetry in preparation for the Sentinel-3 mission. With this technological leap forward it is now able to observe sea level in very small water bodies and also to provide coastal sea level very close to the shore.

The use of the Cryosat-2 and Sentinel-3 is furthermore investigated for possible assimilation into sea level forecasting along the coasts of Denmark. This is a part of the EU sponsored project LOTUS in which. The advantage of the SAR data compared with conventional altimetry is the fact that the increased spatial resolution of Sentinel-3 and Cryosat-2 SAR provide valuable sea level observations within the narrow Straits around Denmark. The results highlights the importance of improving range and geophysical corrections like the IB and Ocean tide correction in order to get the full pontential of Sentinal-3 .

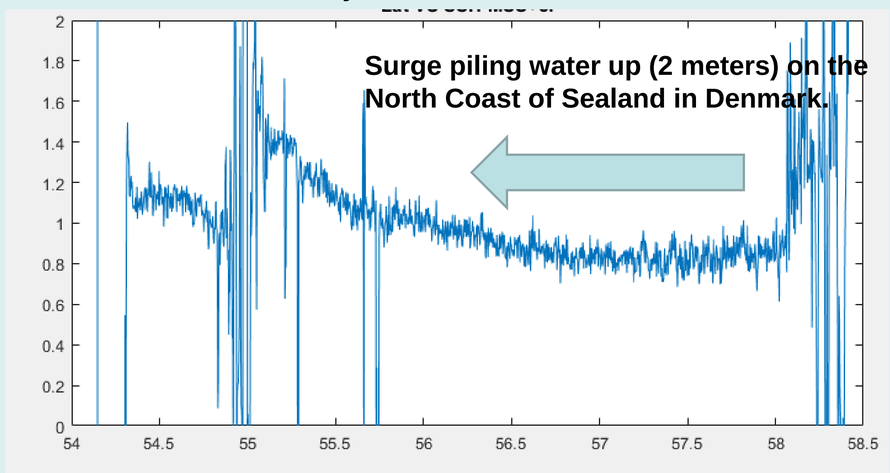
SAR altimetry for Storm Surge warning

Storm surges
The 2013 December Storm Surge Bodil or Xavier was captured by Cryosat-2 in the North Sea. The storm surge caused a 2 meter sea level surge (which was the largest on record) in Kattegat and severe flood damage in Denmark.. Below satellite altimetry processed as 1 Hz RDSAR from RADS is compared with 20 Hz SAR altimetry.

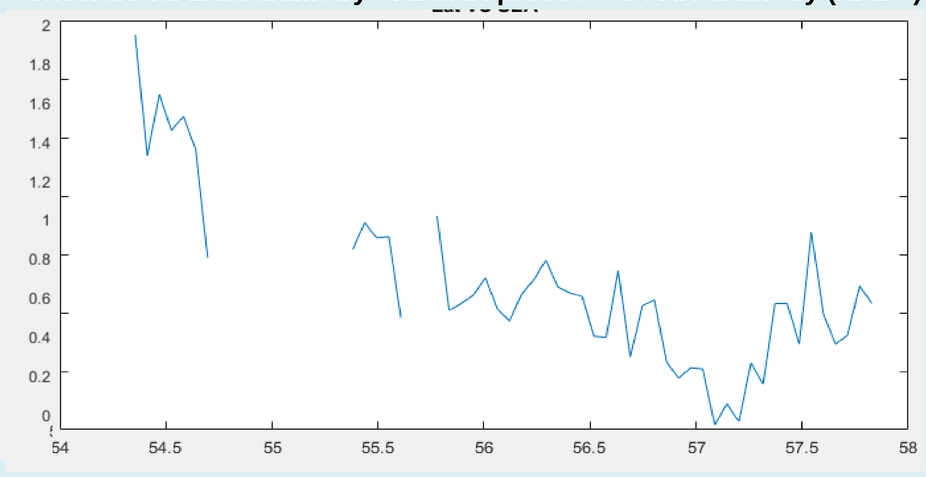




SAR altimetry

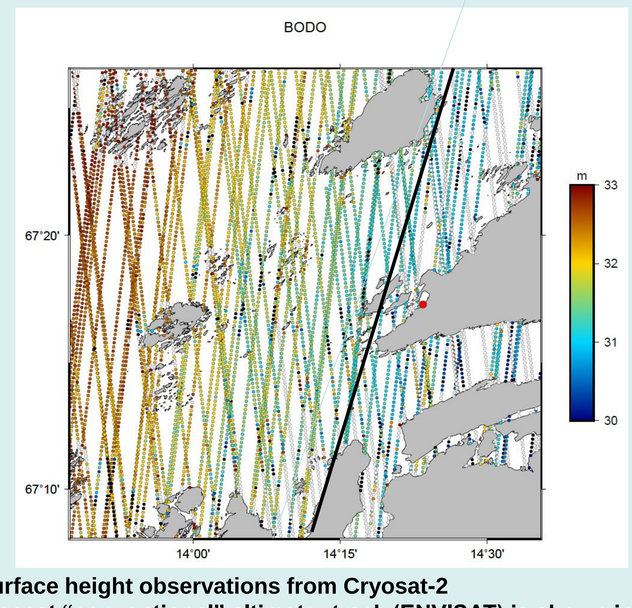


Conventional LRM altimetry - RDSAR processed SAR altimetry (RADS)



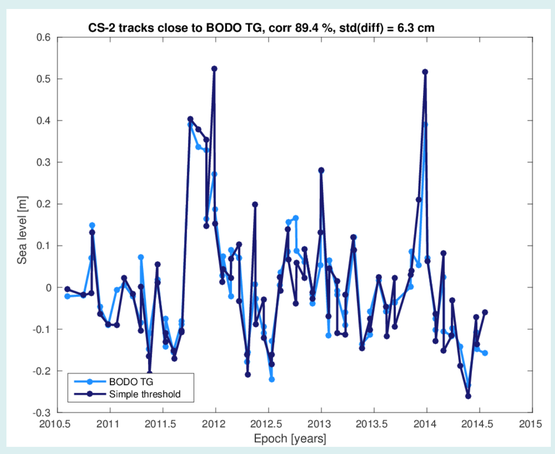
Accuracy evaluation with tide gauge.

Norway is generally operated under the Cryosat-2 SAR-in mask. By only using range observations from one antenna it can be treated as SAR altimetry (with a lower PRF). Hence being slightly less accurate. To evaluate the accuracy of SAR altimetry four years of Cryosat-2 altimetry was evaluated against the Bodø tide gauge in Northern Norway for sea level recovery. A total number of 7468 Cryosat-2 20-Hz observations from 85 tracks were used for the investigation. An initial screening with a 1 m threshold to DTU15 MSS further removed 1201 points. Sea level were determined using the DTU Narrow peak retracking method. The tide gauge operates at 10 minutes interval measuring surface pressure as well. Hence the standard Ocean tide correction (FES2004) and DAC+IB correction on Cryosat-2 can be substituted with local correction for ocean tide and high frequency IB correction (10 min sampling). This hugely improves the accuracy comparison. (Se poster by Idzanovic et al. ID 608). Subsequently the averaged sea surface height from each track crossing was computed by averaging all 20 Hz SSH observations.

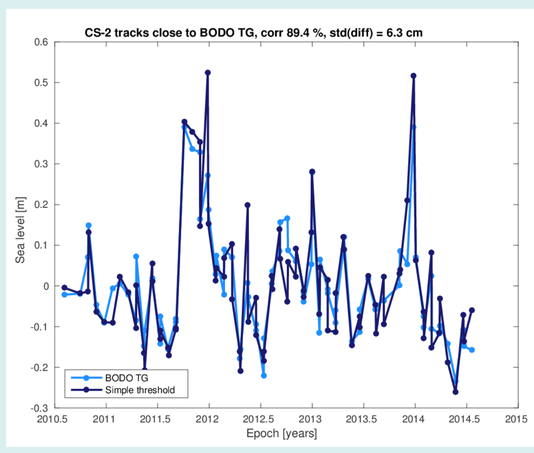


Sea surface height observations from Cryosat-2
The closest "conventional" altimetry track (ENVISAT) is shown in black.

Standard Ocean tide + DAC/IB correction



Tide Gauge derived Ocean tide and high frequency IB correction



Processing level (Cryosat-2 20 Hz data)	Std Difference (cm)	Temporal Correlationn
Standard range correction	13.4	69.6
Improved OT + IB correction (from 10 min TG observations)	6.3	89.4

SAR around Denmark.

The figure to the left shows Cryosat-2 tracks and available data for 2011 around Denmark and the Jason2 tracks at the same time. Notice the huge difference in coverage as well as how close to the coast data are available. Notice that Cryosat-2 indicate that there is a potential problems with the ocean tide model in the German Bight (very high sea level variation).
A close inspection (figure to the right) shows the Cryosat-2 data with an ocean tide correction of zero which indicate that the default ocean tide model (FES2004) on C2 doesn't have coverage.

Below a detailed investigation of a single Cryosat-2 track very close to the Coast of Denmark and below 55N being inside the Wadden Sea (extremely shallow) is shown.

Four different physical retrackers have been Used to analyse the data. The ESA Sarvatore (SAMOSA-2) retracker and the DTU Adapted SAMOSA-3 (Maulik). Also the CLS CPP data And the Starlab CPP data as part of the LOTUS Project is shown. The 7 m offset for the Starlab Retracker is well known and corrected by postprocessing.

A very characteristic parabolic SSH structure Is seen the SAR data close to the coast. It is assumed that the altimeter tracks the nearby Wadden Sea (bright Target) . This could have been corrected if SAR-in had been employed here.