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Coastal CryoSat-2 SAR and PLRM Altimetry in German Bight and West Baltic Sea

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Unlike previous altimetric missions, the CryoSat-2 altimeter (SIRAL) features a novel Synthetic Aperture Radar (SAR) mode that allows higher resolution and more accurate altimeter-derived parameters in the coastal zone, thanks to the reduced along-track footprint. The scope of this study is a regional analysis and inter-comparison of the CryoSat-2 SAR altimeter products against in-situ data and regional model results at distances to coast smaller than 10 km. The in-situ data are from a network of tide gauges and GNSS stations. The validated geophysical altimeter parameters are the sea surface height above the ellipsoid (SSH), the significant sea wave height (SWH) and wind speed (U10), all estimated at 20 Hz.

We have carried out, from CryoSat-2 FBR (L1a) data, a Delay-Doppler processing and waveform retracking tailored specifically for coastal zone by applying Hamming Window and Zero-Padding, using an extended vertical swath window in order to minimize tracker errors and a dedicated SAMOSA-based coastal retracker (named SAMOSA+). SAMOSA+ accepts mean square slope as free parameter and the epoch's first guess fitting value is decided according to the peak in correlation between 20 consecutive waveforms (in order to reduce land off-ranging effect).

Since the highest remaining uncertainties in the altimeter parameters derived in coastal shallow waters arise from residual errors in the applied corrections we use regional ocean tide and high resolution geoid and mean sea surface models (as TPXO8 for tides, EGM 2008 or EIGEN-6C4 for the geoid and DTU13 for the mean sea surface). We also apply a regional improved wet tropospheric correction computed from the GNSS-derived Path Delay Plus (GPD+) algorithm at the University of Porto. Hence for the in-situ validation, errors in corrections are expected to contribute less then in previous analysis on sea level differences measured by altimeter and in-situ data.

In parallel with SAR measurements, in order to quantify the improvement with respect to pulse-limited altimetry, we build 20 Hz PLRM (pseudo-LRM) data from FBR and retrack them with numerical convolutional Brown-based retracker. Hence, here, PLRM is used as a proxy for real pulse-limited products (LRM), since there is no direct comparison of SAR and LRM possible otherwise. The L2 SAR ocean data products are generated and extracted from ESA-ESRIN GPOD service (named SARvatore) while the PLRM data are built and retracked by Technical University of Darmstadt (TUDa). The region of interest is the German Bight and West Baltic Sea (being a very challenging area for radar altimetry due to its complex coastal morphology and its high tide dynamics) while the time of interest is the complete the mission duration (5 years).

The analysis exploits both geometric parameters, as the distance-to-coast parameter and the sea floor bathymetry with resolution of 300 m (from the MERIS water mask and TPXO8 Atlas) and waveform quality parameters, as the misfit between the SAMOSA model waveform and the received echo, the waveform entropy (an high value of waveform entropy is an index of land contamination) and the equivalent number of Looks (ENL, a very low value of ENL is an index of heavy data dispersion and hence land contamination).

Considering the almost five year long analysis, the final objective is to verify the ability of SAR Altimetry to measure accurately in coastal zone the sea level annual cycle and the sea level trend.