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Altimetry in the coastal ocean: regional sea level from CryoSat-2 and ALES-reprocessed Envisat

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Satellite altimetry has revolutionized our understanding of ocean dynamics thanks to finer spatial sampling and global coverage. Nevertheless, coastal data have been flagged as unreliable due to land and calm water interference in the altimeter and radiometer footprints and uncertainty about high frequency tidal and atmospheric forcing. Recent developments in processing and the availability of new instruments are now bringing new possibilities to sea level studies in the coastal zone. This contribution presents some of the improvements achievable with 1) enhanced processing ('retracking') of the waveforms from conventional ('pulse-limited') altimeters, and 2) the exploitation of the new generation of SAR altimeters.

A dedicated retracking algorithm, ALES the Adaptive Leading Edge Subwaveform retracker, has been designed and validated with the aim of reaching the same precision in the estimate of geophysical parameters from pulse-limited altimetry both over open ocean and in the coastal zone. In this study we provide clear evidence that ALES reprocessing improves quality and quantity of Envisat sea level measurements, by comparing the data with the reference time series of Sea Level provided by the Sea Level Climate Change Initiative (SL_cci) and with in-situ data from tide gauges in the North Sea/Baltic Sea transition zone. In the western Arkona Basin (Baltic Sea) correlation between altimetry and tide gauges within 15 km of the coast almost doubles using ALES. In the eastern Arkona Basin, the annual sea level amplitude derived from ALES and tide gauges differ by $\sim$10 mm, while SL_cci overestimates it by 4 cm.

The new generation of altimeters ('SAR', or delay-doppler altimeters) is providing higher precision in the sea level measurements, thanks to their coherent processing of returns with a high Pulse Repetition Frequency (PRF) and the resultant reduced footprint. CryoSat-2 (CS-2) carries the first SAR altimeter in space. An experimental ocean product (SARvatore) is now available from ESA and has ben tested in this study. Preliminary results show a decrease of roughly 1 cm in the noise level of CS-2 20-Hz averages within 50 km of the coast if compared to the ALES-Envisat noise at 18 Hz, even without any coastal-dedicated reprocessing.

Finally we are able to evaluate together for the first time the improvements brought by a coastal dedicated reprocessing of Envisat dataset and the innovative SARvatore product for CS-2. The coastal area around the Indonesian archipelago, a hotspot of sea level rise with few reliable in-situ data, is used as a test-bed with the aim of combining the time series from Envisat and CS-2 for a more accurate assessment of the seasonal and interannual variability of the sea level on a sub-basin scale. This helps coastal planners to increase preparedness to extreme events, such as storm surges, which are monitored in the ESA eSurge project by means of data reprocessed with the ALES retracker.