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Recovering climate-quality coastal Sea Level measurements from satellite altimetry

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The ESA Climate Change Initiative Sea Level Project (SL_cci) aims at providing long-term satellite-based monitoring of the sea level Essential Climate Variable with regular updates, as required for climate studies. The program has completed its first phase at the end of 2013 and has started in February 2014 the second phase of 3 years, where one of the foci is the improvement of sea level measurements close to the coast, a key region due to the direct potential impacts of sea level change on the human activities.

In this contribution we will highlight some of the efforts being carried out by some of the partners in the SL_cci over the coastal zone in Phase 2 of the Project. The main objectives of these efforts are to better characterize the altimetry errors in this zone and to improve some corrections (in particular the wet tropospheric corrections) and the coastal processing (screening, filtering) in order to better extract the climate signals at the coast.

This work started with a quantification of the user requirements in terms of accuracy and long-term stability in the coastal domain, assessed in May 2014 by means of a dedicated survey amongst a number of altimeter specialists. Target accuracies are 0.8–1.8cm (numbers quoted are 1st and 3rd quartile) for a 'local' product (15km x 15km grid cell, monthly) and 0.4–1.0 cm of the 'global coastal' mean sea level, i.e. a global average along the entire world's coast. Long-term stability requirements (local 0.5–1.0 mm/y, global coastal 0.2–0.5 mm/y) are better than the shorter-term ones (local 0.5–2.5 mm/y, global coastal 0.3–1.0 mm/y), albeit by not much, perhaps reflecting the belief that if the instrument is not highly stable also in the short term it is unlikely to enable meaningful climate applications.

As far as the wet tropospheric correction is concerned, the GNSS-derived Path Delay (GPD) correction had already been computed in Phase 1 for the 6 main missions until October 2010, and showed a clear improvement with respect to the AVISO reference in the coastal regions, except for Jason-2, which already possesses an improved coastal correction. In Phase 2 the GPD

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is being extended to the end of 2014 for all missions: this includes its computation for the first time for SARAL/Altika and CryoSat-2.

For the coastal processing, we will describe several improvements being carried out:

- screening and filtering of the high-rate altimetric data and the atmospheric and geophysical corrections, in the attempt to improve data and corrections in the region (normally from the shelf edge down to 10 km from the coast) where most of the waveforms are Brown-like but corrections are sub-optimal;
- assessing the performance of different families of retrackers that have been proposed for the coastal zone to recover climate-quality signals in comparison with a number of well-monitored and quality-controlled tide gauges, and making recommendations for retracking algorithms of choice;
- revisiting of the idea of analysing waveforms in batches first introduced in COASTALT, developing it into a true simultaneous multi-waveform retracker, then evaluating if this approach can yield sea level trends in the coastal zone of better quality than single-waveform retracking techniques, and finally testing those techniques on the same set of well-monitored tide gauges.

Amongst the various CCI activities for validation and sea level trend verification, we will give details on a regional study to assess the quality of the Fundamental Climate Data Record (FCDR) over the German Bight and the Mediterranean Sea. These are ideal test regions, where reliable and long in-situ time-series are available, therefore allowing a good characterization of the error and comparison of signal and error with the Essential Climate Variable (ECV) regional solution.

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