Coastal Sea Level Trends from Retracked Satellite Altimetry over 2002-2016; Differences between coastal and offshore trends: SENETOSA site case of study

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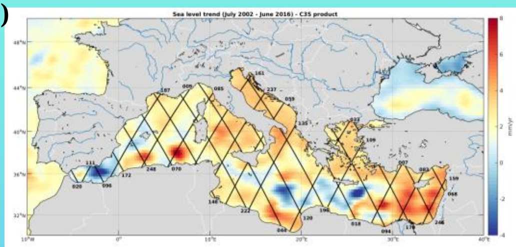
Summary: Here we present novel results of coastal sea level rise over 2002-2016 based on dedicated reprocessing of nadir altimetry data of the Jason-1 and 2 missions performed in the context of the ESA Climate Change Initiative project. We computed high-resolution (20 Hz) along-track sea level time series as close as possible to the coast applying the Adaptative Leading Edge Subwaveform (ALES) retracker to radar echoes and using the Xtrack processing system developped at LEGOS. This new data set was further used to compute valid coastal sea level trends in three regions: western Africa, Mediterranean Sea and western Europe. After thorough examination of the coastal sea level time series and severe editing, we observe in a number of cases an increase of coastal sea level within about 5 km from the coast, compared to offshore. We examined the case of Senetosa in Corsica (calibration site of the Topex & Jason missions) to check the robustness of the results. The analysis of each geophysical corrections shows that the observed continuous increase cannot be explained by spurious trends in these corrections. The comparison of the altimetric trends with the trends of the 3 Tide gauges of Senetosa ensures that our product is robust until 2 km. Below 2 km the observed trends are suggestive of wave forcing.

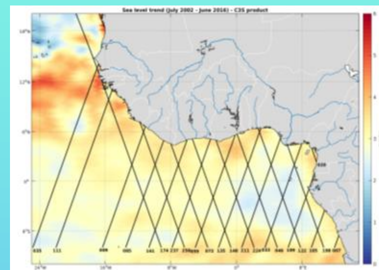
Method

1. Reprocessing of Jason-1 and Jason-2 data by combining the ALES retracking (Adaptative Leading Edge Subwaveform) retracking of radar waveforms (Passaro et al., 2018) with improved XTRACK geophysical corrections (Birol et al., 2017)
2. Use of 20-Hz along-track reprocessed data
3. Computation of sea level trends from open ocean to coast (Marti et al., 2019)

a)



b)



c)

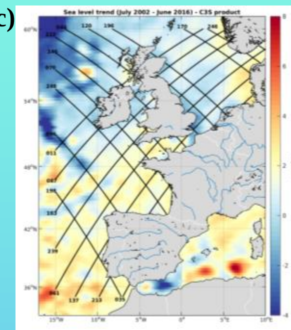


Fig 1. Sea level trends from C3S product (June2002-July2016) with Jason tracks superimposed in **a) Mediterranean sea, b) western Africa, c) north-east Atlantic**

Results

Track 96 Spain

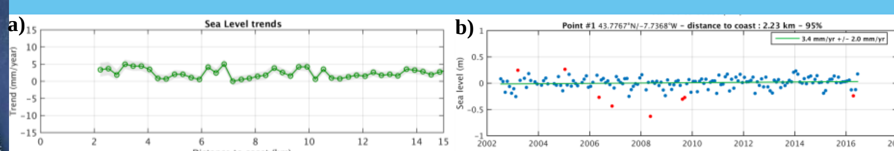


Fig 2. a) Sea level trends (July2002-June2016) b) Sea level time series for the closest valid point to the coast. Track 96 in North East Atlantic

Track 174 Dakar, Senegal

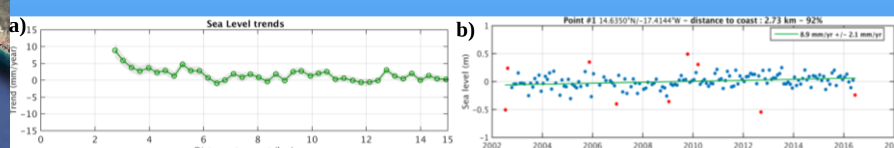


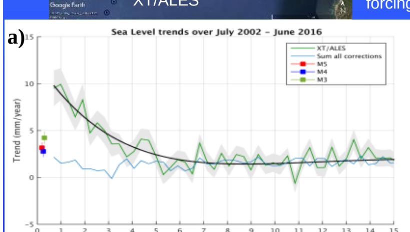
Fig 3. a) Sea level trends (July2002-June2016) b) Sea level time series for the closest valid point to the coast. Track 174 in Western Africa

Results: The case of Senetosa (Corsica)

Track 85 Mediterranean Sea

Specific behavior is observed for the track 85 at Senetosa. Sea level trends are stable up to 5 km from the coast and increase as we approach the coast. The constant geophysical trends along the track show that they are not responsible of the observed sea level trends rise. The Tide gauges trends are in agreement with the XT/ALES trends between 2 and 4 km. Close to the coast (< 2 km), physical processes not seen by tide gauges may increase sea level trends. More researches about wave forcing as the main process responsible of this rise are underway

a)



b)

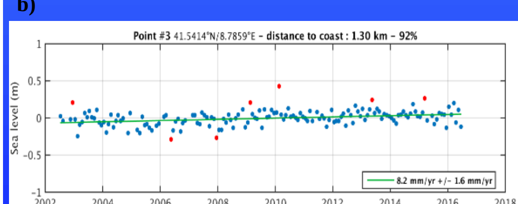


Fig 4. a) XT/ALES trends (green curve) fitted with a polynomial function (black curve), tide gauge trends of Senetosa (squares) and sum of geophysical correction trends (blue line) as a function of distance to coast. b) Sea level time series at 1.3 km to the coast.

Conclusions:

-Combining ALES and XTRACK 20-Hz sea level products allows retrieving valid data very close to the coast.
-In some instances, sea level trends significantly increase towards the coast.
-The case of Senetosa shows that the geophysical corrections applied are not responsible of this behavior.
-Observed differences with the tide gauges trends suggest that physical processes, not seen by the tide gauges may be involved between the coast and 2-3 km offshore.
-This specific behavior may be suggestive of wave driving.

References: Passaro et al., Validation of a global dataset based on subwaveform retracking: improving the precision of pulse-limited satellite altimetry; 11th Coastal Altimetry Workshop, Frascati (ESA-ESRIN), Italy, 2018-06-15, 2018; Birol et al., Coastal applications from nadir altimetry: example of the X-TRACK regional products. Advances in Space Research, 10.1016/j.asr.2016.11.005, 2017; Marti et al., Sea level change from satellite altimetry over 2002-2016 along the coasts of Western Africa, ,Advances Space Research, published online 24 May2019, https://doi.org/10.1016/j.asr.2019.05.033, 2019.