Coastal sea level trends from reprocessed Jason-1, 2, 3 satellite altimetry

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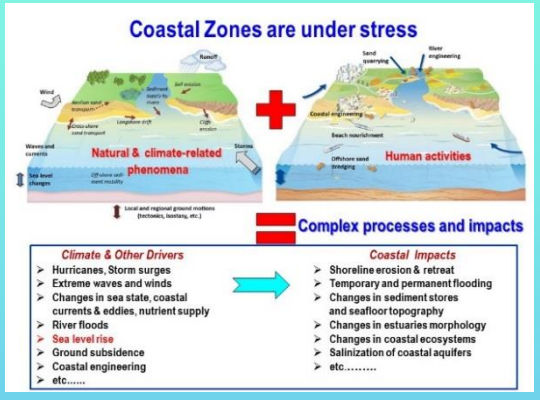
Summary: In the context of the CCI+ coastal sea level project, we provide a new coastal sea level dataset based on complete reprocessing (including retracking) of raw radar altimetry waveforms from the Jason-1, Jason-2 and Jason-3 missions over a 16-year-long (June 2002 to May 2018) time span. This new data set consists of high-resolution (~300 m), along-track sea level anomalies at monthly interval, together with associated sea level trends, at 429 coastal sites in six regions (Northeast Atlantic, Mediterranean Sea, West Africa, North Indian Ocean, Southeast Asia and Australia). Unlike classical altimetry, this coastal data set provides valid sea level data very close to the coast, at distances <3-4 km from the coastline in general, sometimes even closer, within 1-2 km from the coast. The coastal sea level trends, computed over 2002-2018, show no significant difference (within +/-1 mm/yr) with open ocean trends for 80% of the studied sites. Although it had been expected that coastal processes may cause discrepancy in coastal sea level trends compared to the open ocean, these new results seem to contradict this hypothesis. An important consequence of this observation is that it would be possible to extrapolate regional sea level trends computed by classical altimetry missions, up to the coast. However, this is not true everywhere. Indeed, at a few sites, we observe a larger sea level trend close to the coast than offshore, while in some other cases, we note a decrease in trend as the distance to the coast decreases. Small-scale coastal processes able to explain such different trend behaviors close to the coast are investigated.

Coastal Zones are under stress



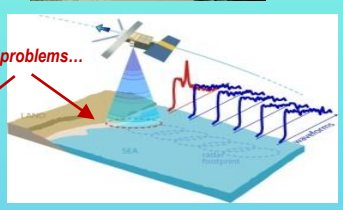
Motivation

- **Questions:**
  1. Does sea level rise at the coast differ from open ocean rise?
  2. What is the contribution of sea level rise to coastal erosion?
- **Answer:**

Need for measurements of coastal sea level changes (from altimetry and tide gauges), on the long term, with global coverage of the world coastlines

Tide gauges coverage (>40 years of data)

But problems…



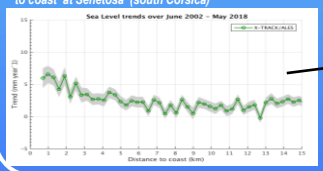
Distorsion of altimetry radar waveforms in coastal zones

Method

Sea level anomalies are computed over 2002-2018 from retracked Jason-1,2,3 altimetry data at successive 20 Hz points along the tracks, using the ALES retracker combined with the XTRACK processing system. Six regions have been studied: Northeast Atlantic, Mediterranean Sea, Western Africa, North Indian Ocean, Southeast Asia, Australia.

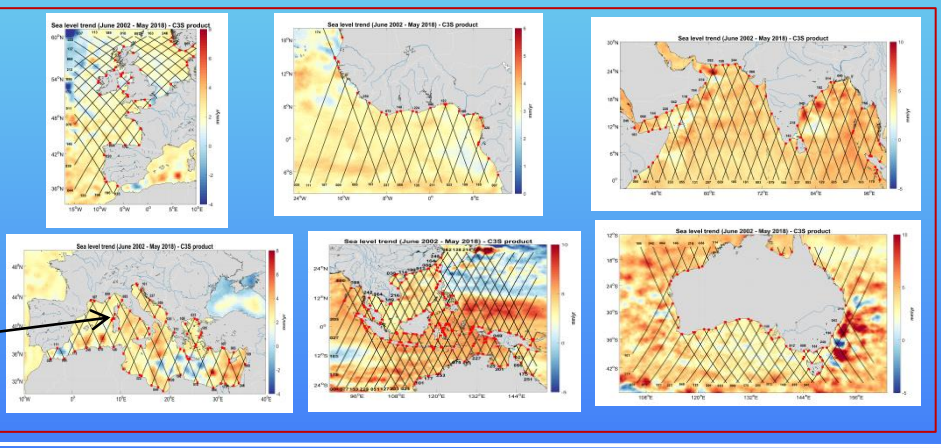
Sea level trends over 2002-2018 are computed at 429 coastal sites and expressed against distance to coast (from 15 km offshore to coast)

Example : Sea level trends (mm/yr) against distance to coast at Senetosa (south Corsica)

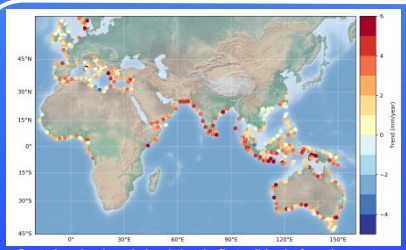


Coastal sea level trends (2002-2018) from retracked Jason-1, 2, 3 altimetry

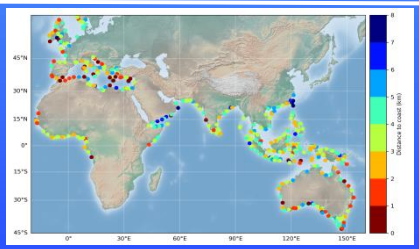
(Black lines: Jason tracks; red squares: selected sites; background map: regional sea level trends from the Copernicus Climate Change Service)



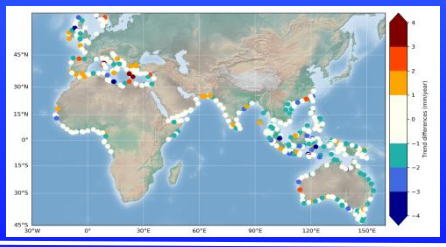
Results



Coastal sea level trends (mm/yr) at the first valid point from the coast at the 429 selected sites.



Closest distance (km) to the coast of the first valid point along-track at the 429 selected sites.



Differences in sea level trends (mm/yr) between an along-track band of 2 km from the closest valid point to the coast and the 14-16 km average, offshore. White points correspond to no significant differences (within +1/-1 mm/yr) between open ocean and coast. Orange-red/blue dots correspond to coastal trend increase/decrease at the coast.

Synthesis: The results show that at most sites, no significant difference (within +/-1 mm/yr) is noticed between the open ocean sea level trends (here assumed ~ 15 km away from the coast) and the coastal zone (the first few km from the coast). However, this is not always true. At a few sites, we observe a larger trend close to the coast than offshore, but with the exception of 3 sites in the Mediterranean Sea and one site in Australia, the increase is modest, of 1-2 mm/yr only, and possibly not significant in view of the trend uncertainties. In a number of cases, we note a decrease in trend as the distance to the coast decreases But here again just a few cases may be significant. Although it had been expected that coastal processes (e.g., coastal currents, wind & waves, fresh water input in river estuaries) may cause some discrepancy in coastal sea level trends compared to the open ocean, the results presented here show no significant difference at the coast compared to offshore in about 80% of our 429 selected sites. However, at the remaining 20% studied sites, coastal trends can significantly differ from offshore. Small-scale processes involved are currently under investigation.

This new coastal sea level data set (sea level anomalies and trends) can be downloaded from the SEANOE repository: https://doi.org/10.17882/74354 (The CCI Coastal Sea Level Team; *Nature Scientific Data*, published online 20 October 2020)

References: Passaro et al., Validation of a global dataset based on subwaveform retracking, 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. ASR, 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, ASR, 2019; Gouzenes et al, Coastal sea level change at Senetosa, Ocean Sciences, 2020; The CCI Coastal Sea Level Team, Coastal sea level anomalies and associated trends from Jason satellite altimetry over 2002-2018, Nature Scientific Data, 2020.