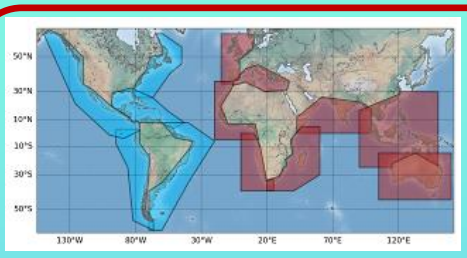
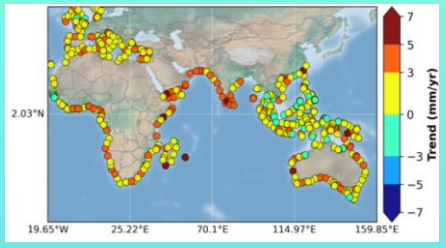
A new network of altimetry-based virtual stations in the world coastal zones

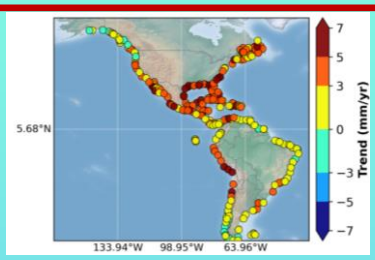
*The Climate Change Initiative Coastal Sea Level Team**

Summary: Until recently, classical radar altimetry could not provide reliable sea level data within 10 km to the coast. However dedicated reprocessing of radar waveforms together with geophysical corrections adapted for the coastal regions now allow to fill this gap at a large number of coastal sites. In the context of the ESA Climate Change Initiative (CCI) Sea Level project, we have recently performed a complete reprocessing of along-track, high resolution (20 Hz, i.e. 350m resolution along-track) altimetry data of the Jason-1, Jason-2 and Jason-3 missions over 2002-2020 along the coastal zones of Northeast Atlantic, Mediterranean Sea, whole African continent, North Indian Ocean, Southeast Asia, Australia, and America. This reprocessing has provided valid sea level data in the 0-15 km band from the coast. A total of 783 altimetry-based virtual coastal stations (distance <6 km from coast) have been selected for all regions. Sea level anomaly time series, together with associated coastal sea level trends, have been computed over the 2002-2020 time span. In the coastal regions devoid from tide gauges (e.g., African coastlines), these virtual stations offer a unique tool for estimating sea level change close to the coast (typically up to 3 km to the coast, but in many instances up to 1 km or less). Results show that at about 20% of the 783 selected sites, coastal sea level trends in the last 4-5 km to the coast are either larger or smaller compared to open ocean sea level trends. Understanding such a behavior will deserve further investigation.

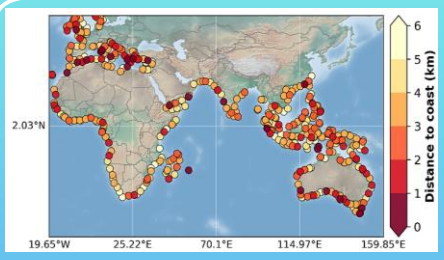


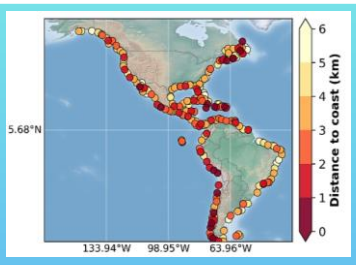
Study regions of the CCI Coastal Sea Level project



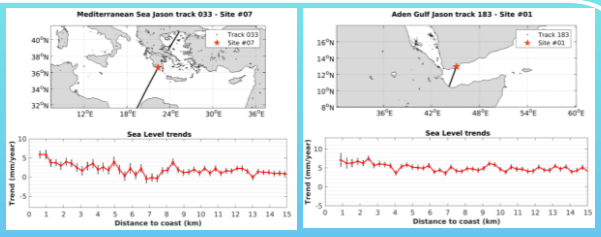


The altimetry-based virtual coastal stations (distance to coast < 6 km) (*Colors represent coastal sea level trends in mm/yr over 2002-2020*)





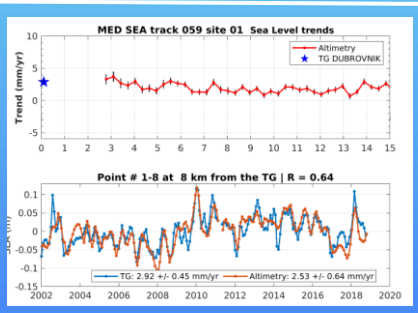
Closest distance (km) to the coast of the first valid point along the Jason track for 783 virtual stations

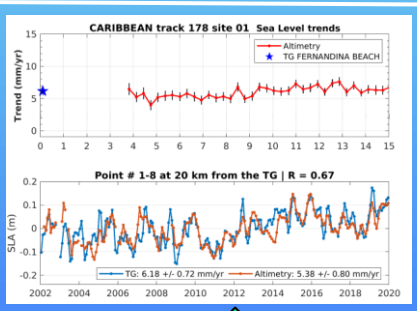


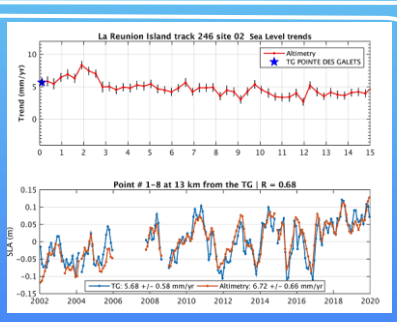
Examples of coastal sea level trends (2002-2020) from retracked Jason-1, 2, 3 altimetry

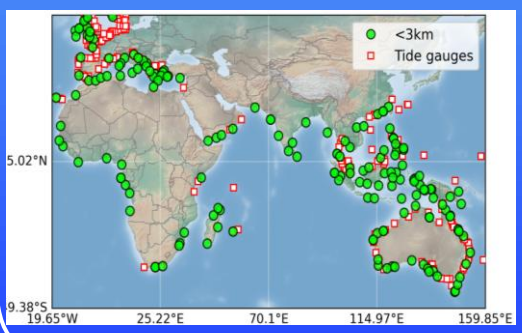
Upper panel: location of the Jason track (black line) and of the virtual station (red star)

Lower panel: sea level trend computed over 2002-2020 against distance to the coast







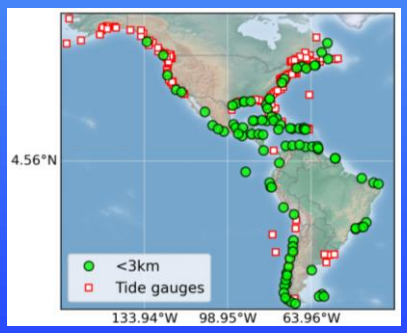


Comparison of altimetry-based coastal sea level with tide gauges records

Upper panel: Sea level trend (2002-2020) against distance to coast (red curve); tide gauge-based sea level trend (blue star)

Lower panel: Sea level time series over 2002-2020 from coastal altimetry (average over 2.5 km; orange curve) and from closest tide gauge (within 20 km from Jason track) (blue curve). R is the correlation between altimetry and tide gauge sea level time series.

Virtual stations at less than 3 km from the coast
(green dots)
with tide gauge sites superimposed (with at most 24 month missing data over 2002-2020)
(white/red squares)



Synthesis: Our results show that at most sites, differences in sea level trends between offshore (~ 15 km away from the coast) and coast (<6 km distance) are within +/-1 mm/yr. Nevertheless, 20% of the studied sites show instead a significant increase or decrease in trend in the vicinity of the coast. Such discrepancies may be caused by small-scale coastal processes such as coastal currents, wind & waves, fresh water input in river estuaries, etc. Small-scale coastal processes possibly causing this nearshore trend behavior need further investigation. This new coastal sea level data set (sea level anomalies and trends) –version v2.1- will be shortly available. It will update the previous version downloadable from the SEANOE repository → https://doi.org/10.17882/74354 (The CCI Coastal Sea Level Team; *Nature Scientific Data*, published online 20 October 2020).

Yvan Gouzenes[1], Anny Cazenave[1], Florence Birol[1], Francisco M Calafat[2], Marcello Passaro[3], Fabien Leger[1], Fernando Nino[1], Andrew Shaw[4], Jean François Legeais[5], Jérôme Benveniste[6] and Julius Oelsmann[3], (1) LEGOS, Toulouse, France, (2) NOCS, Southampton, UK, (3) Technical University of Munich, Munich, Germany, (4) SKYMAT Ltd., Southampton, UK, (5) CLS, Ramonville-Saint-Agne, France, (8) European Space Agency (ESA-ESRIN), Frascati, Italy. Contact: anny.cazenave@legos.obs-mip.fr

Recent publications: Gouzenes et al. Coastal sea level change at Senetosa, Ocean Sciences, 2020; The CCI Coastal Sea Level Team (Benveniste et al.), Coastal sea level anomalies and associated trends from Jason satellite altimetry over 2002-2018, Nature Scientific Data, 2020; Birol et al., The X-TRACK/ALES multi-mission processing system: new advances in altimetry towards the coast. ASR, 2021; Dieng et al., Trends and inter-annual variability of coastal sea level in the Mediterranean Sea, Advances in Space Research, 2021;