X-TRACK regional altimeter products for coastal applications

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Climate change is likely to worsen many problems that coastal environments already face: shoreline erosion, coastal flooding, stress and damage of the coastal biodiversity. Sea level variation is one of the major threat for coastal zones. Improving its observation is essential to better understand and predict the behavior of the coastal ocean. Altimetry provides unique long term observational dataset to characterize how sea level variability evolves from the open ocean to the coastal ocean. In order to optimize the completeness and the accuracy of the sea surface height information derived from satellite altimetry in coastal ocean areas, X-TRACK has been developed by CTOH and LEGOS. X-TRACK is tailored for extending the use of altimetry data to coastal ocean applications and provides freely available along-track Sea Level Anomaly time series as well as along-track empirical tidal constants that cover today all the coastal oceans.

NEW

- **→ Jason-1 version E GDR**
- **→ J2 until October 2016 + J3**
- **→ New mission: Saral/Altika**
- **→ doi:10.6096/CTOH_X-TRACK_2017_02**
- **→ MDT_CNES_CLS_09 added**

X-TRACK Products

1hz alongtrack SLA are available all along the coast for different altimetric missions (Topex, Jason-1&2, Geosat, Ers2, Envisat and Saral). **SLA is computed on a reference track using up to 23 years of data to build a precise Mean Sea Surface Height**. SLA files hold alongtrack SLA data together with MSSH, MDT, FES2012 tide, Dynamic Atmospheric Corrections and distance to coast parameters. Users can both retrieve filtered and non-filtered data.

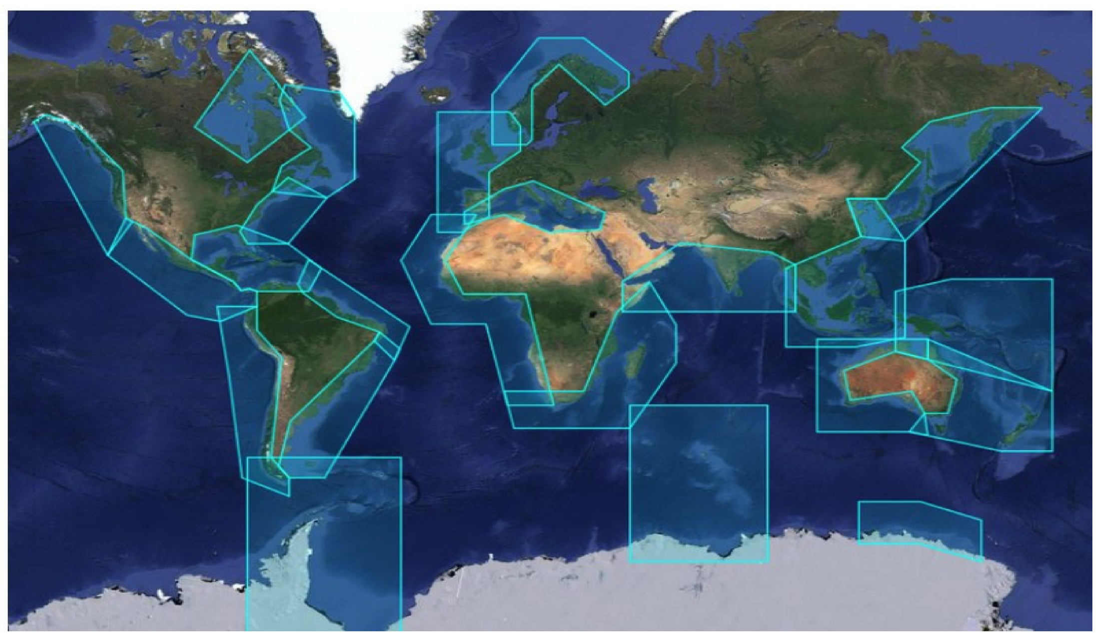

Figure 1: Definition of the regional polygons in release 2016, covering now all the coastal areas.

Period of available data

	Start	End
TP+J1+J2+J3	1993/02/28	2017/08/15
TPinterleaved + J1interleaved	2002/09/21	2012/03/03
GFO	2002/10/01	2010/09/14
Envisat	2000/01/08	2008/09/08
SARAL	2013/03/03	2016/04/07

Along-track tidal constants (amplitude, phase lags and associated estimation errors for 73 constituents) derived from the X-TRACK T/P and Jason are also available every 6-7 km along the satellite ground tracks. They have been computed with the X-TRACK 1hz SLA for the whole TP, Jason1&2 period, and for the TP/J1 interleaved combined mission. An update will be done in 2018, using longer X-TRACK data with an entirely rewritten code.

More details of the products and the different corrections could be find in [1].

The case of SARAL/Altika mission

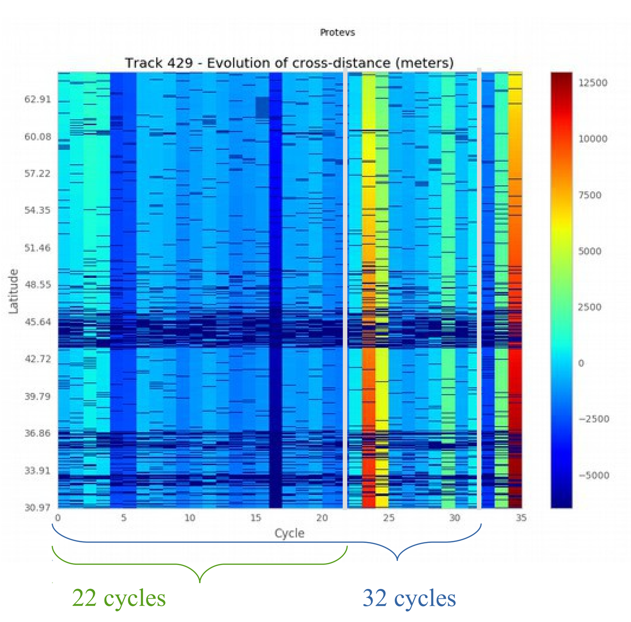

Figure 2: Evolution of the cross distance to the nominal track for the SARAL track 0429

AVISO treated SARAL as a repetitive mission until the end of March 2015, because of a significant ground track drift encountered in cycles 23-24 (see Figure 2) which poses a problem for the mean sea surface height computation. After this event the orbit was corrected and we conducted a study to quantify the impact of SARAL orbit drift on the accuracy of the SLA and MSSH computation.
The mean sea surface height computed with 32 cycles presents the best agreement with the MSSH CNES_CLS_2015 and the corresponding SLA are closer to the tide gauge sea level observations.

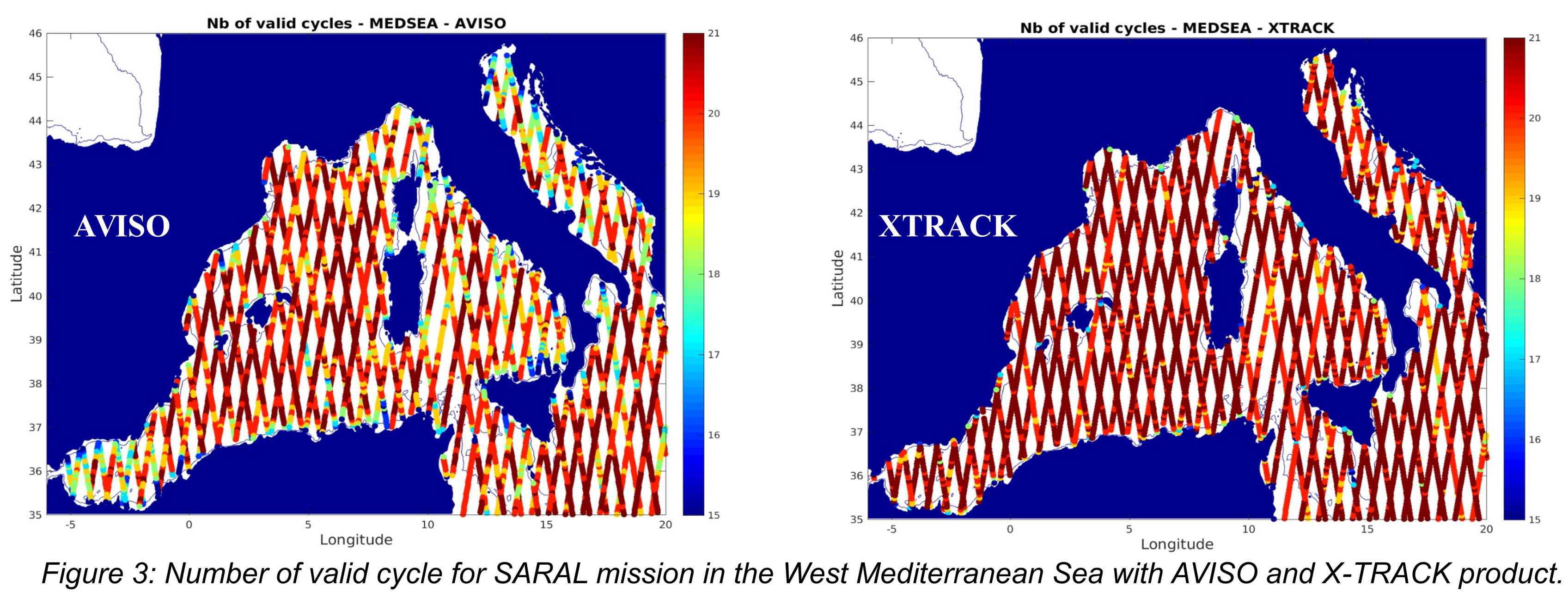

Figure 3: Number of valid cycle for SARAL mission in the West Mediterranean Sea with AVISO and X-TRACK product.

Comparison between X-TRACK and CMEMS L3 SARAL product: more coastal data and availability much more geographically stable in X-TRACK. Better agreement with independent tide gauge observations.

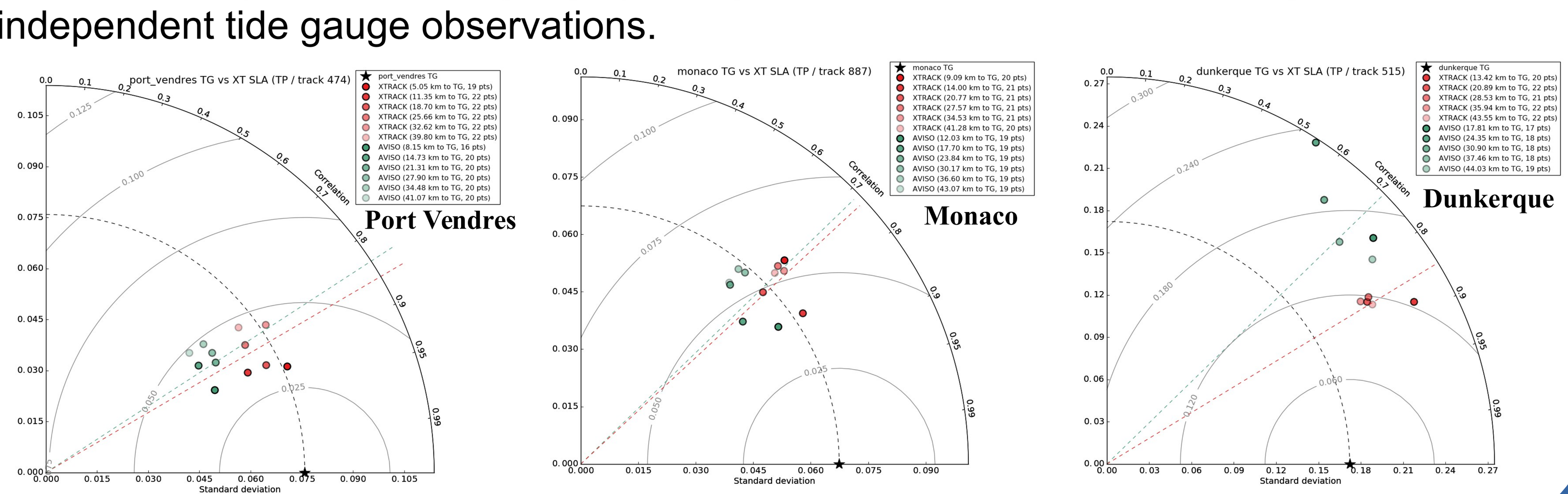

Figure 4: Normalized Taylor diagrams, SARAL X-TRACK in red, SARAL AVISO in green

Toward a new version of X-TRACK SLA multi-mission product at high rate, based on ALES retracker and advanced geophysical corrections

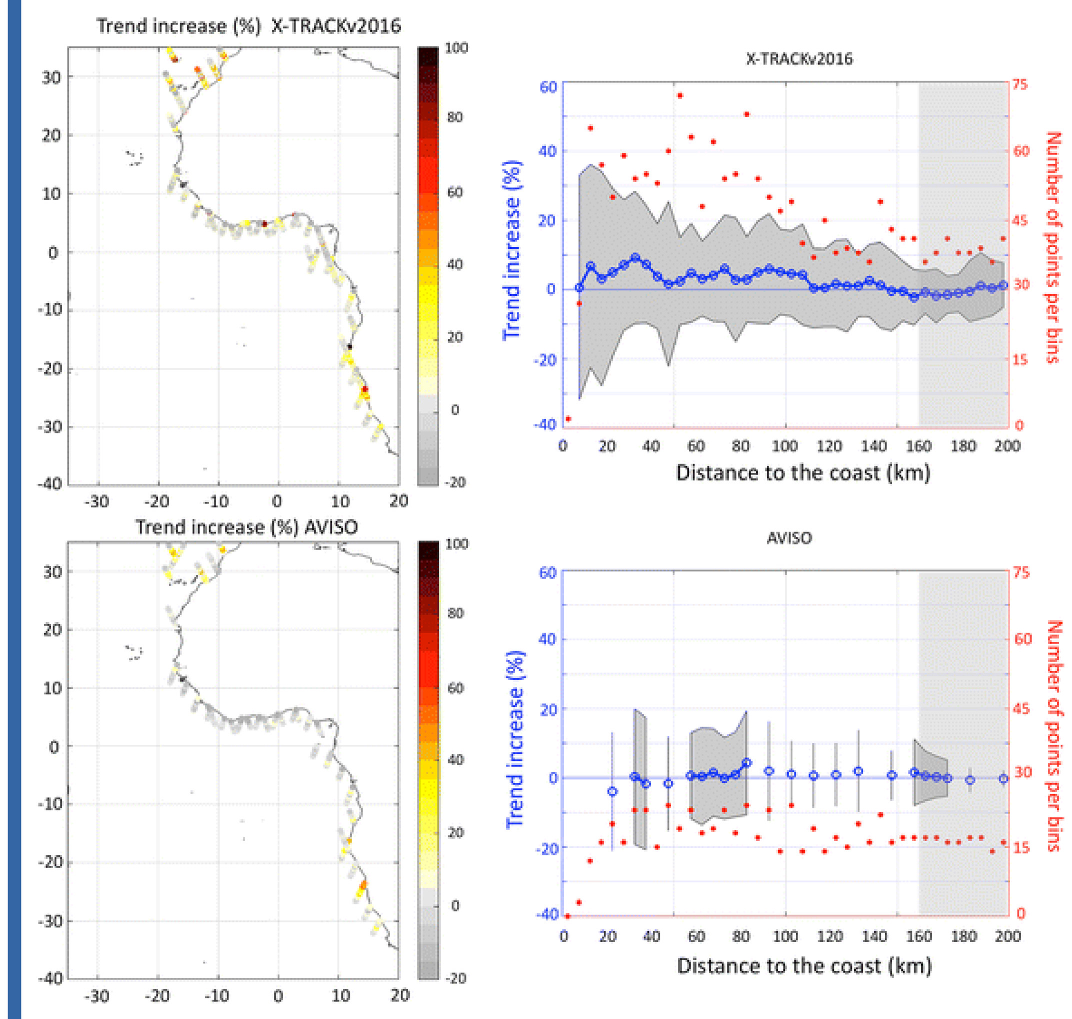

Figure 5: Relative changes in SLA trend (mm/year) over 1993–2012 in percentages along coastal sections of altimetry tracks offshore Western Africa (From [2])

WHY?

Coastal sea level change, including long term variations as well as extreme events, has a large range of socio-economic consequences and altimetry appears as a key tool to characterize and study the spatio-temporal structure of the sea level variability across the coastal zone.

Sea level change are far from being geographically uniform and we need accurate estimations of sea level change. In [2], several altimetry products are used to compute the linear trend of sea level change along the western coast of Africa, leading to significant differences (Figure 5). The recommendation was that "**additional efforts are needed to study sea level trends in the coastal zone from past and present satellite altimeters**».

HOW?

We aim to take advantage of the large progress that have been made in coastal altimetry during the past decade. X-TRACK is now a mature L3 1-Hz multi-mission product and its editing ant post-processing strategy allows to obtain more accurate data closer to the coast. The ALES retracker is able to retrieve more coastal altimeter waveforms than the standard processing, and then significantly more reliable 20-Hz SLA data [3]. And in parallel the geophysical corrections, in particular the wet tropospheric and tidal corrections have been largely improved in the coastal domain.

In this project we aim to compute an X-TRACK L3 multi-mission product combining the better spatial resolution provided by high-rate data, the post-processing strategy of X-TRACK (adapted to 20Hz data), the advantage of the ALES retracker (as well as other retrackers such as those of the PEACHI project), refined geophysical corrections as the GPD+ and a new DAC correction and dedicated studies on the impact of correction and processing on resulting sea level trends.

20-Hz data vs 1-Hz data

Despite they have a much higher noise level than the classical 1-Hz data, once filtered, they allow to recover more information on coastal sea level variations (Figure 6).

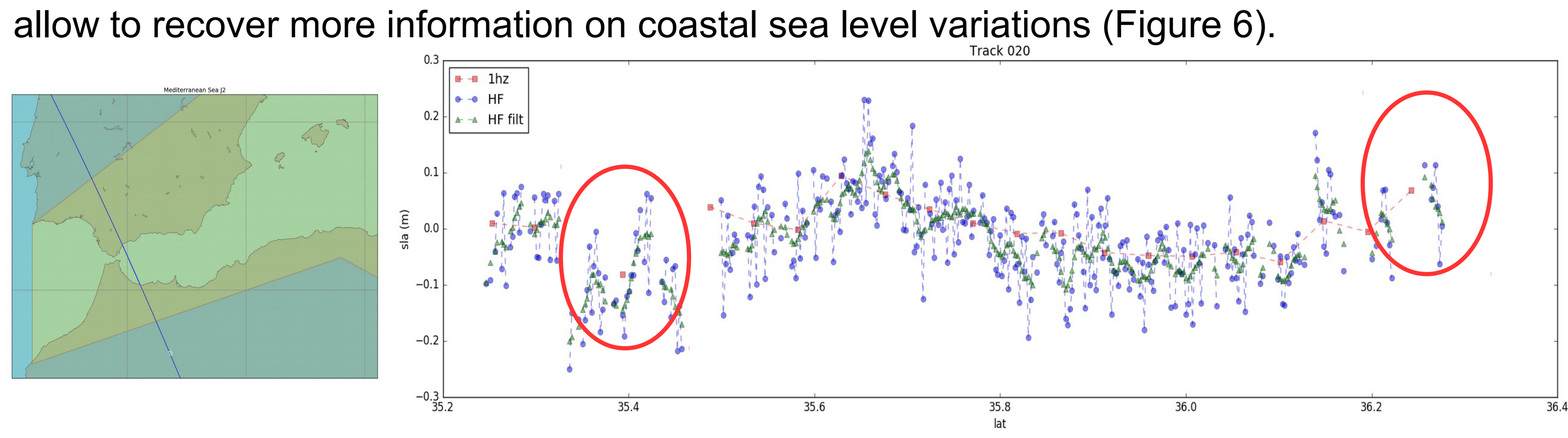

Figure 6: 1-Hz (red), unfiltered 20-Hz (blue) and filtered 20-Hz (green) sea level anomaly along Jason2 track 020 in the Western Mediterranean Sea

Geophysical correction

The wet tropospheric correction is a significant error source in most altimetry products. The GPD+ [4] should significantly improve the accuracy of coastal sea level data (Figure 7).

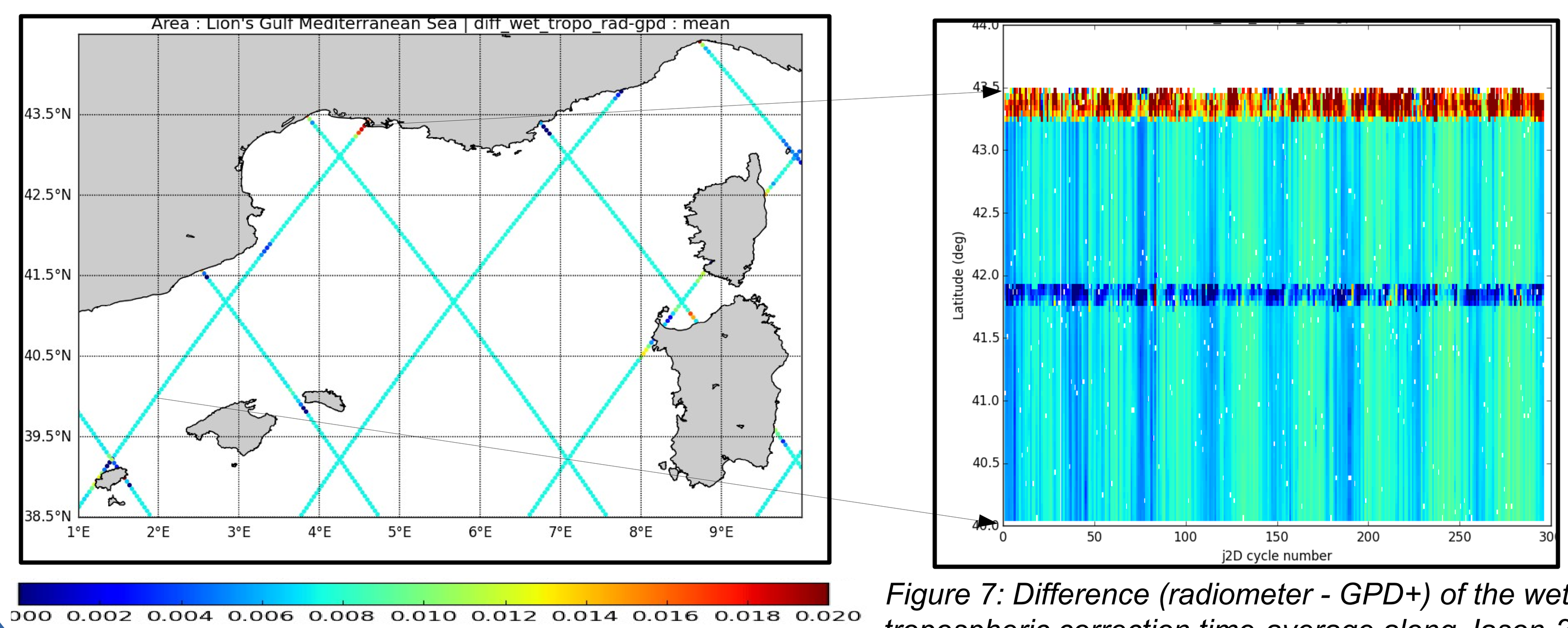

Figure 7: Difference (radiometer - GPD+) of the wet tropospheric correction time-average along Jason-2 track 187 (in meter)

Data access
AVISO+ portail or CTOH website
https://www.aviso.altimetry.fr
http://ctoh.legos.obs-mip.fr/products/

Acknowledgments
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References
[1] Birol et al (2017). Coastal application from nadir altimetry: example of the Xtrack regional product. *Advances in Space Research.*
[2] Cipollini et al (2016). Monitoring Sea Level in the Coastal Zone with Satellite Altimetry and Tide *Gauges, Surveys in Geophysics.*
[3] Passaro et al (2014). ALES: A multi-mission adaptive subwaveform retracker for coastal and open ocean altimetry, *Remote Sensing of Environment.*
[4] Fernandes et al (2016). GPD+ Wet Tropospheric Corrections for CryoSat-2 and GFO Altimetry Missions. *Remote Sensing.*