Long-Term Data Enhancement with the New X-TRACK/L2P Product for Coastal Applications

F. Léger[(1)], F. Birol[(1)], F. Niño[(1)], M. Cancet[(1)], C. Kocha[(2)]

[(1)] LEGOS, Université de Toulouse, CNES, CNRS, IRD, UPS, Toulouse, France
[(2)]CLS, Ramonville St-Agne, France

The X-TRACK processing chain has been developed in the 2000s in the context of research projects in order to retrieve coastal sea level data that were missing from standard altimetry products. It then became a 1Hz multi-mission L3 (i.e. along-track) regional product produced by the CTOH service and progressively covered all the coastal ocean. X-TRACK is now a mature altimetry product distributed on the AVISO+ website and which has been used in many scientific publications. By improving the quantity and quality of near-shore sea level it contributes to a better understanding of the coastal ocean, its variability (past, present, future) and how sea level evolves from the open ocean to the coastal zone.

X-TRACK/L2P

Acknowledgments

X-TRACK/L2P data v2.2
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were developed, validated by the CTOH/LEGOS, France and distributed by Aviso+"

1. X-TRACK/L2P 1 Hz Sea Level product

The most recent version of the 1-Hz L3 X-TRACK product combines the X-TRACK processing and the new L2P DT24 products delivered by CNES/CLS on AVISO+ . It includes the most recent parameters and corrections for all altimetry missions dedicated to the ocean. At the L2P level, all reference missions are mutually aligned and collectively define the GMSL. An intermission bias adjusted on this GMSL is applied for all missions to make them consistent. Those that are on the same orbit are systematically combined in a single sea level time series.

This homogeneous and easy-to-use sea level product covers 14 altimetry missions, based on 8 different orbits and 29 coastal zones, which is unprecedented for a coastal sea level product.

The X-TRACK processing is performed on a regional basis, and for each region there is one file per track, containing for each 1-Hz altimetry point (6-7 km between points), the SLA time series, as well as the time series of auxiliary parameters and corrections associated.

Altimetry missions:

- ➢ Topex/Poseidon, Jason-1, Jason-2, Jason-3 and Sentinel-6A
- ➢ Topex/Poseidon interleaved, Jason-1 interleaved, Jason-2 interleaved, Jason-3 interleaved
- ➢ ERS-1, ERS2, Envisat, SARAL/Altika,
- ➢ Geosat Follow on,
- ➢ HaiYang-2A,
- ➢ HaiYang-2B,
- ➢ Sentinel-3A,
- ➢ Sentinel-3B.

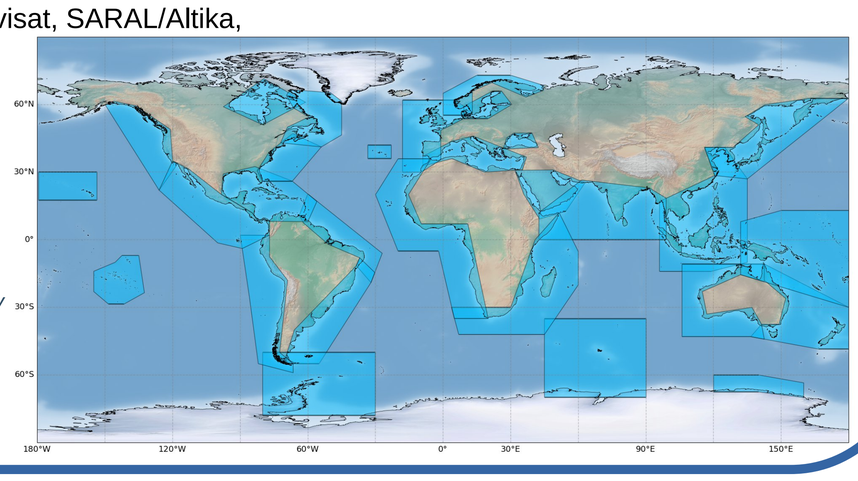


Figure 1 : Map of the 29 coastal zones covered by X-TRACK/L2P

2. What's new?

- **2 new regions** have been integrated to complete the coverage of coastal areas. **Hawaii archipelago** and the **French Polynesian islands**.
- **Three new missions** have been added allowing a better spatial coverage and the continuation of long-time series.
  Sentinel-3B, **HaiYang-2B** and **Sentinel-6A**
- **Temporal extension** of the combined mission
- ➢ Topex/Poseidon, Jason-1, Jason-2, Jason-3 and Sentinel-6A : from 1993/02 to 2024/11
- ➢ Topex/Poseidon interleaved, Jason-1 interleaved, Jason-2 interleaved, Jason-3 interleaved : from 2002/09 to 2024/10

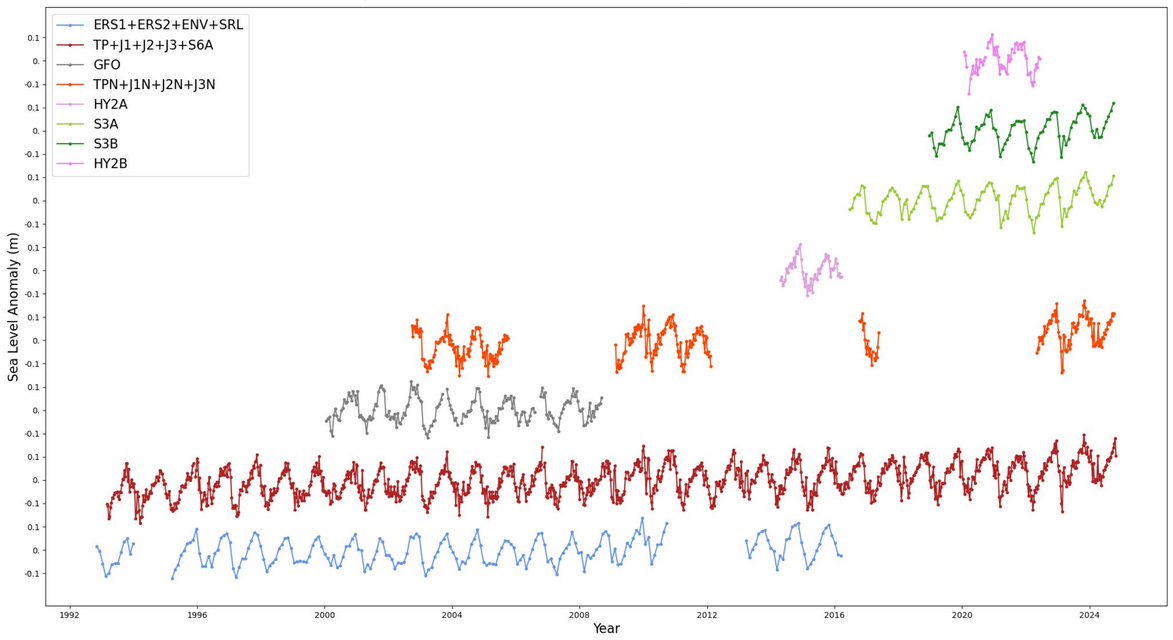
3. List of available variables

Name of variable	Signification	Unit
lon	Longitude	Degrees East
lat	Latitude	Degrees North
mssh	X-TRACK Mean Sea Surface	meters
cycle	Cycle number	-
time	Time of measurement	days since 1950-1-1
sla	**X-TRACK Sea Level anomaly**	**meters**
tide	Global FES22 geocentric tide correction	meters
dac	Global Dynamic Atmospheric Corrections	meters
dist_to_coast_gshhs	Distance to nearest GSHHG 2.3.7 coastline	meters
wet	Wet tropospheric correction	meters
dry	Dry tropospheric correction	meters
iono	Ionospheric correction	meters
ssb	Sea State Bias	meters
pole_tide	Pole tide correction	meters
solid_tide	Solid Earth tide correction	meters
sigma0_ku	Backscatter coefficient	dB
swh	Significant Wave Height	m
bias	Global Mean Sea level Bias	m
mdt_cnes_cls22	Mean Dynamic Topography MDT_hybridCNES-CLS22_cmems2020	m

Table 1 : List of variables in the NetCDF files

The products are stored using the NetCDF format. One netCDF files per track in each region per mission.
In addition to the SLA, the dataset contains many other variables that can be used to complement local studies to better understand sea level variability.

4. A 32 years record of sea level data!



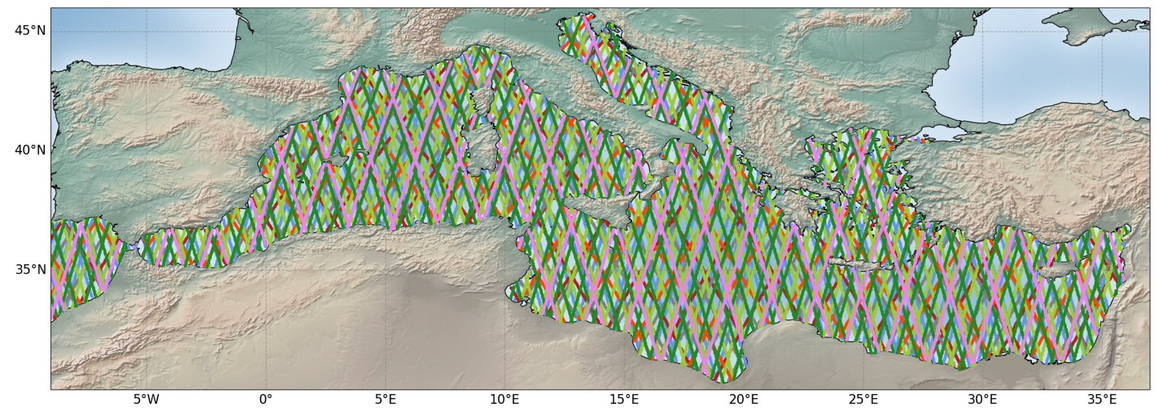


Figure 2 : (top) Mean SLA (m) in Mediterranean Sea using X-TRACK/L2P product. the time series are shifted vertically to make them easier to read. (bottom) Available tracks in the Mediterranean Sea with X-TRACK/L2P product.

For the first time, a dataset has been developed that enables long-term monitoring of sea level using data from multiple satellite missions using a specific treatment for coastal areas. This dataset facilitates higher-resolution monitoring of sea level changes, both spatially and temporally. Since 1993, at least two parallel satellite missions are available, with a maximum of five missions providing data simultaneously. This extended coverage improves our understanding of sea level dynamics and enables more accurate predictions of future changes.

5. What comes next?

Update of the Tidal Constituent Product - end of 2025

Based on this new version of the X-TRACK 1 Hz Sea Level product, the CTOH (Centre for Topographic studies of the Oceans and Hydrosphere) service will soon be updating their tidal constituent product. This updated product will cover the world's coastal ocean regions.

2 tidal constant products will be available using :

- Topex/Poseidon, Jason-1, Jason-2, Jason-3 and Sentinel-6A,
- Topex/Poseidon interleaved, Jason-1 interleaved, Jason-2 interleaved, Jason-3 interleaved

The tidal constituent product derives empirical harmonic constants, including amplitude, phase lag, and error estimates, for a total of 73 tidal constituents. These constants are obtained through harmonic analysis of the X-TRACK sea level time series data.

This altimetry-derived tidal product serves as a complement to tide gauge observations. It provides an independent source of information that can be used for the validation of tidal models and for conducting tidal studies.

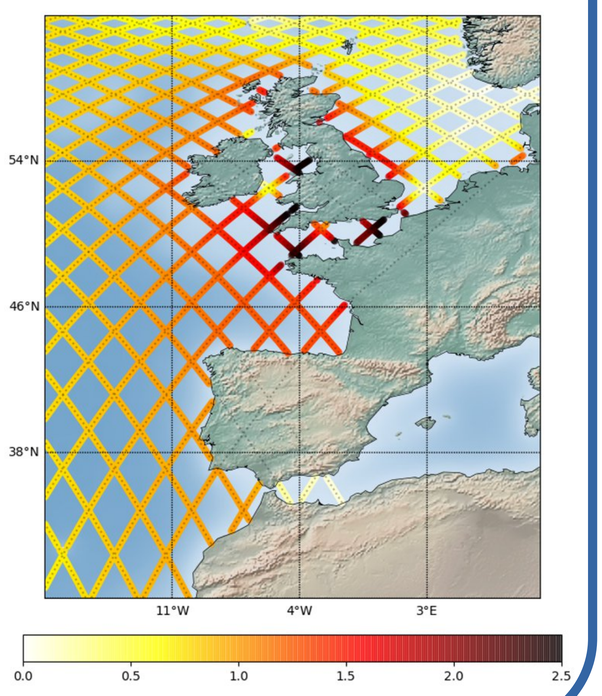


Figure 3 : Amplitude of the M2 tidal constituent (m) over the North East Atlantic region.
Figure done with the previous X-TRACK coastal tide product (doi : 10.6096/CTOH_X-TRACK_Tidal_2018_01)