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A 20-year coastal dataset in the North Sea and Mediterranean Sea

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Introduction

The COastal Sea level Tailored ALES (COSTA) dataset contains dedicated coastal altimetry sea level measurements based on the Adaptive Leading Edge Subwaveform (ALES) reprocessing. In this version, the missions involved are ERS-2 (1996-2002) and Envisat (2002-2010), and the data are available in the Mediterranean Sea and in the North Sea.

The dataset is generated by the application of the ALES fitting algorithm to the radar signal provided by the official products of the missions. The ALES algorithm selects only a portion of the altimetric signal (waveform), in order to estimate the distance between the satellite and the sea surface (range) while avoiding the noise in the tail of the signal. The algorithm is based on the relation between estimated sea state, achievable precision and width of the subwaveform. The sea state bias correction, which accounts for the effects of waves and the tracking errors, is recomputed for the ALES output.

Following this pre-processing, the data are post-processed with updated geophysical corrections, tidal and mean sea surface models. Finally, the sea level measurements are averaged at 1 Hz (one measurement every ~7 km along each track) after removing the outliers. To facilitate the temporal analysis, the sea level anomalies for each track are stored in matrices in which each row corresponds to the time series at one latitude-longitude location (Figure 1).

The COSTA dataset is made available to the scientific community in order to foster the application of coastal altimetry data by users, who are not necessarily trained in radar altimetry processing. Its objective is the provision of easy-to-use along-track sea level data that can be directly used for sea level and circulation studies not only in the open ocean, but also in the coastal regions.

Compared to other available ALES-based products [1], COSTA is a post-processed version in which raw data are already corrected, given as „ready-to-use" sea level data and assembled on nominal tracks in the form of time series. COSTA is a regional product, but the data availability is not limited by the distance from the coast.

References

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[3] Simon J. Holgate, Andrew Matthews, Philip L. Woodworth, Lesley J. Rickards, Mark E. Tamisiea, Elizabeth Bradshaw, Peter R. Foden, Kathleen M. Gordon, Svetlana Jevrejeva, and Jeff Pugh (2013) New Data Systems and Products at the Permanent Service for Mean Sea Level. Journal of Coastal Research: Volume 29, Issue 3: pp. 493 – 504. doi:10.2112/JCOASTRES-D-12-00175.1.

Description of the fields

Data are provided at high-frequency (hf), i.e. one sea level measurement roughly every 350 m along the track, and low frequency (lf), i.e. post-processed measurements derived from the hf, providing one sea level measurement roughly every 7 Km. Hf data are raw measurements that are not flagged, i.e. outliers are not removed. We suggest not to use hf data closer than 3 km from the coastline.

Lf data are commonly used in sea level analysis. They are post-processed measurements, i.e. they are derived from hf data after an outlier detection procedure (see [2] for details). We suggest not to use lf data closer than 5 km from the coastline.

The scope of the data structure is to provide time series at each measurement point. Therefore, sea level data are provided as matrices in which the coloumns correspond to the along-track locations and the rows to the satellite cycles. Each row of the matrices represent a time series at the corresponding location.

To create a time series, data points along the satellite tracks have to be collinear: it is necessary to have measurements at the same geographical location for each cycle. Nominal tracks were therefore created for this study by taking as a reference the CTOH (Centre for Topographic studies of the Ocean and Hydrosphere, http://ctoh.legos.obs-mip.fr/altimetry) 1-Hz tracks, neglecting the across-track displacement of different passes along the same track, which is normally less than 1 km.

Link to COSTA dataset
https://doi.pangaea.de/10.1594/PANGAEA.871920

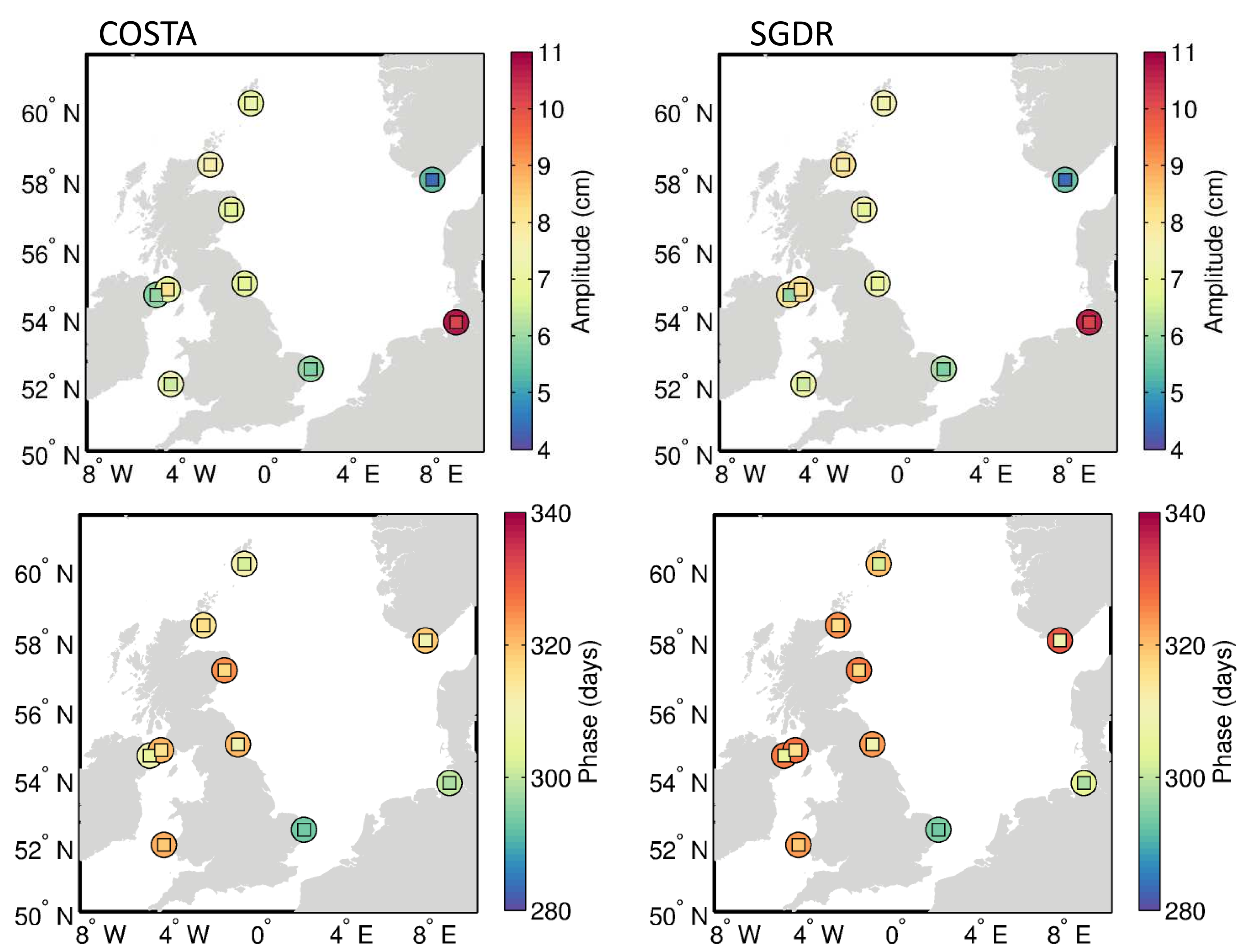

Figure 4: Comparison of estimates of seasonal cycle using COSTA and SGDR data (circles) against in-situ tide gauges (squares)

Validation 1

We take as measurement of noise, the standard deviation (STD) of the 20 hf measurements that are averaged into a lf value. The histogram in Figure 2 is the difference between the noise of the original ocean product (SGDR) and the noise of ALES, considering also the open ocean. The addition of the recomputed sea state bias correction improves the performances of ALES. ALES is more precise in 75% of the domain, and the median noise decreases by 1 cm both in ERS-2 and in Envisat

Figure 1: schematic of a COSTA sea level matrix given n lat lon along-track points and m cycles

lat,lon position →; Cycle number ↓

S(i,j)	S(i,j+1)	…	S(i,j+n)
S(i+1,j)			
…			
…			S(i+m,j+n)

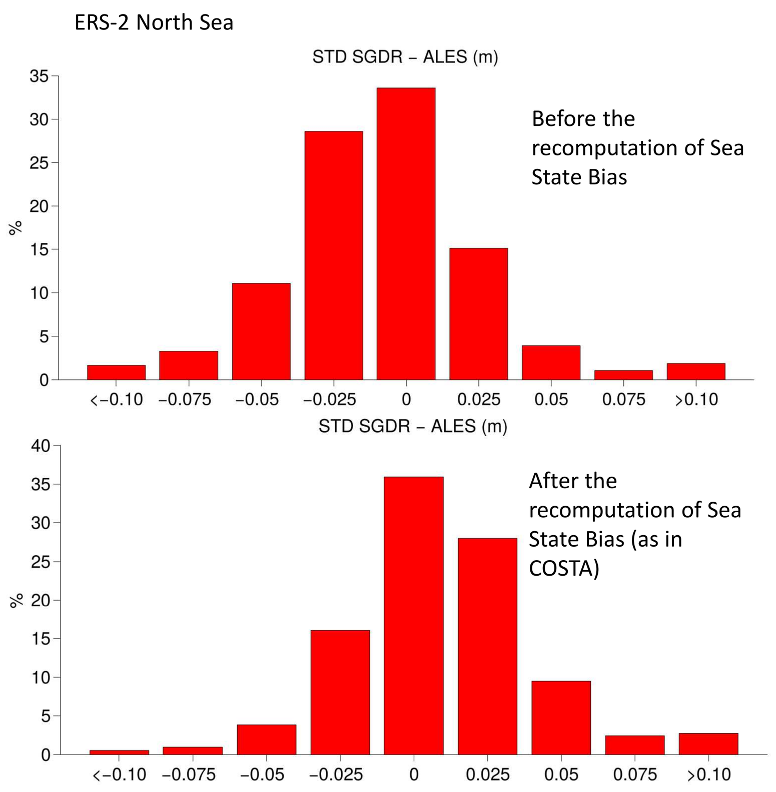

Figure 2: Difference of noise between COSTA and SGDR

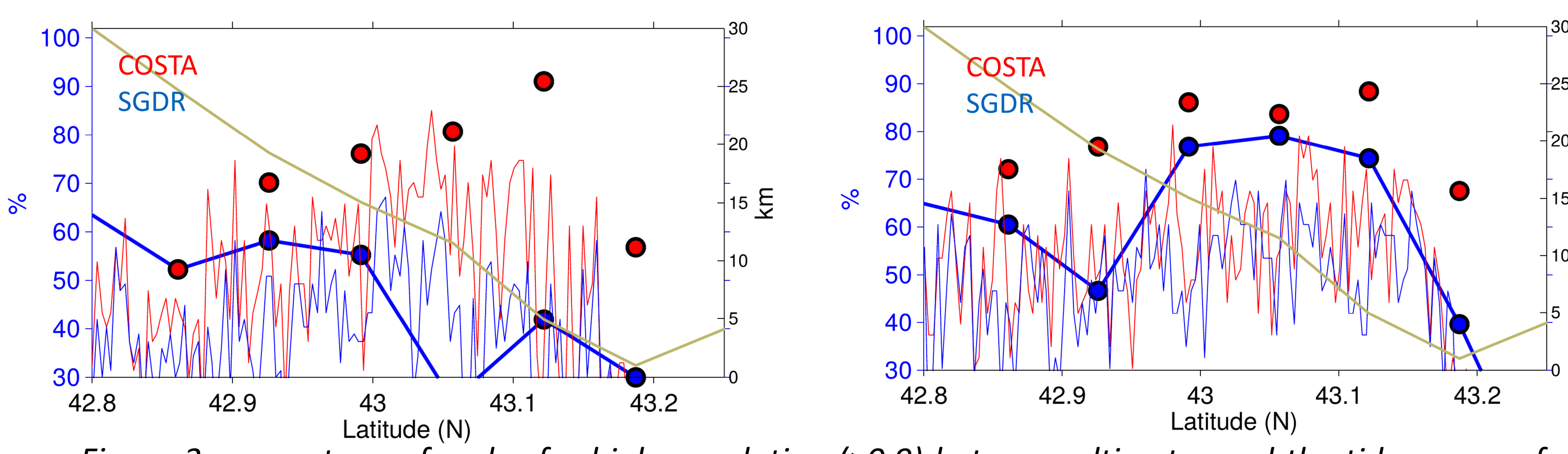

Figure 3: percentage of cycles for high correlation (>0.9) between altimetry and the tide gauge of Marseille. The second y-axis shows the distance to the coast.

Validation 2

Figure 3 shows for Envisat (a) and ERS-2 (b) the percentage of cycles that is possible to use to build a time series that scores over 0.9 in correlation against the tide gauge of Marseille, in the Mediterranean Sea. Results are displayed for lf (circles) and hf (thin continuous line).

Validation 3

The seasonal cycle in amplitude and phase is estimated by harmonic analysis on a set of tide gauges in the North Sea [3]. The estimates are shown in squares in figure 4 The altimetry data from SGDR and COSTA, from 1995 to 2010, are divided by bands of distances from the tide gauge.

The data from the most correlated band are used to estimate the seasonal cycle from altimetry, which is shown in circles in figure 4. The estimates for COSTA are up to 2 cm in amplitude and up more than a month in phase more accurate than in SGDR.

Conclusion

The COSTA dataset provides a post-processed along-track sea level product. The validation work has shown a 15% decrease in the high-rate noise of the measurements if compared to the standard product, with larger improvements in the last 20 km from the coastline and a better precision also in the open ocean.

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