Continental shelf dynamics from coastal altimetry in the Bay of Biscay

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Objectives

In the Bay of Biscay, located at midlatitudes of the Eastern North Atlantic Ocean, circulation over the continental shelf is mainly driven by tides, winds, and river runoffs. These forcings drive a wide spatio-temporal range of ocean processes. Previous studies from hydrodynamical model or observations highlighted major circulation patterns modulated by a strong interannual variability. For example, Lazure et al. (2008) showed the development of a poleward current in autumn along the French coast. This current does not occur every year for reasons that remain not fully explained.

In this context, coastal altimetry appears as a potential significant contributor to observe and to analyze these intermittent processes over long time periods.

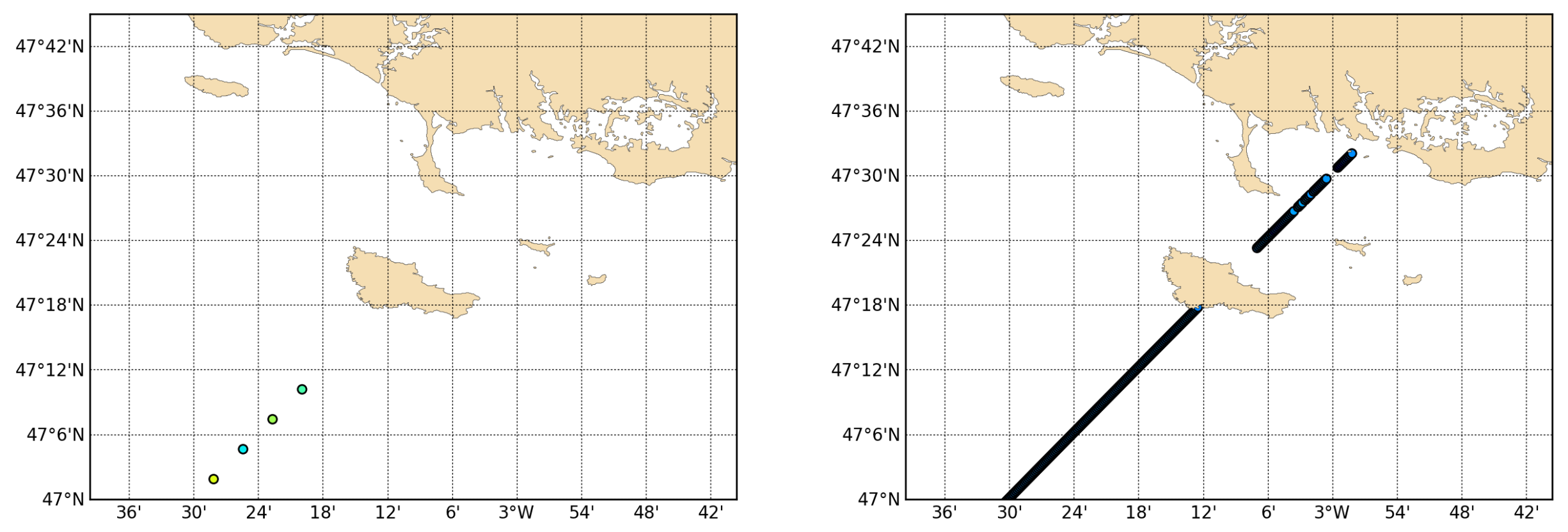
Based on Jason 2 satellite altimetry data (<u>Figure 1</u>), we compare Pistach and SlaExtended standard AVISO products (<u>Figure 3</u>) from 2009 to 2011.

This study aims to determine if some major ocean processes over the continental shelf in the Bay of Biscay can be inferred from coastal altimetry products.

Data

Two coastal altimetry datasets have been used in this study (<u>Figure 4</u>):

- **SlaExtended** (7Km along track resolution, GOT4v7 tide correction)
- **Pistach** (350m along track resolution, GOT4v7 tide correction)



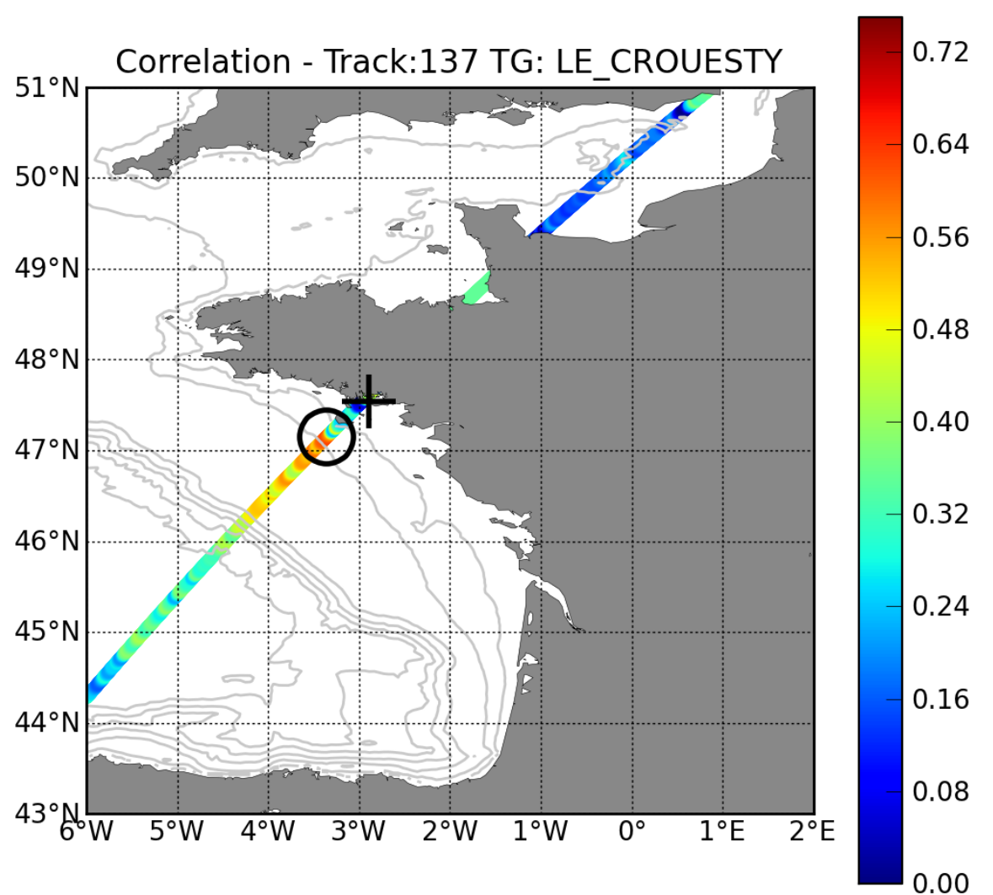
<u>Figure 4:</u> Illustration of available observations close to the coast in Sla Extended (left) and Pistach (right) Sea Level Anomalies.

To identify coastal processes that we can detect and monitor in coastal altimetry, the present study focuses on track n°137 from Jason 2 (<u>Figure 2</u>).

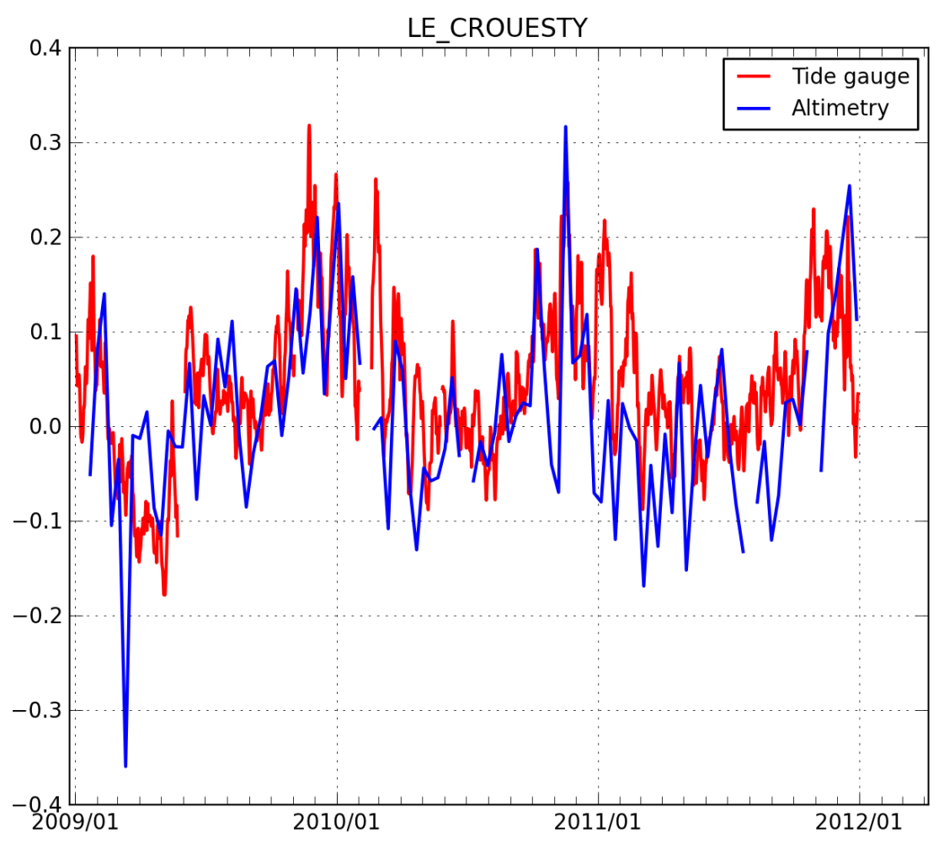
Tide gauges

Observations are validated using tide gauge data from REFMAR French network.

To avoid land contaminated timeseries from altimetry, we perform the comparison with best correlated points. Correlations estimated can be above 0.7 (<u>Figure 5</u>). For the track n°137, we obtain a good agreement between tide gauge and altimetry data (<u>Figure 6</u>).



<u>Figure 5:</u> Correlation of SLA timeseries with tide gauge data.

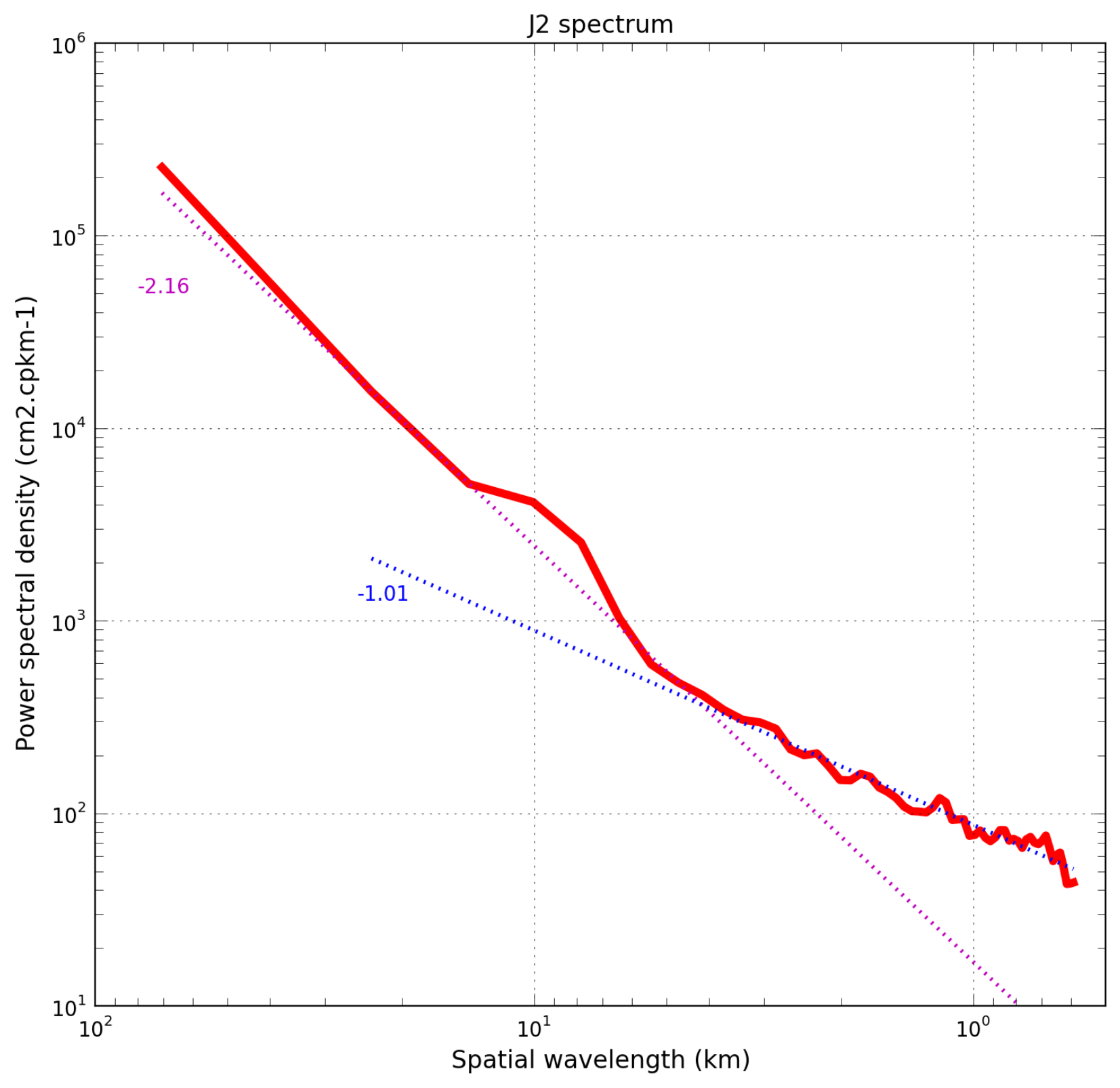


<u>Figure 6:</u> Comparison between tide gauge and Pistach filtered data (m).

Spatial spectral content

Along track spectra allow describing spatial scales observed in the different datasets.

In the Bay of Biscay, from the track n°137 spectrum (<u>Figure 7</u>), we observe the measurement noise for scales smaller than 5-7Km. The k$^{-2.16}$ slope for larger scale is in agreement with previous observations (Dussurget et al., 2011).



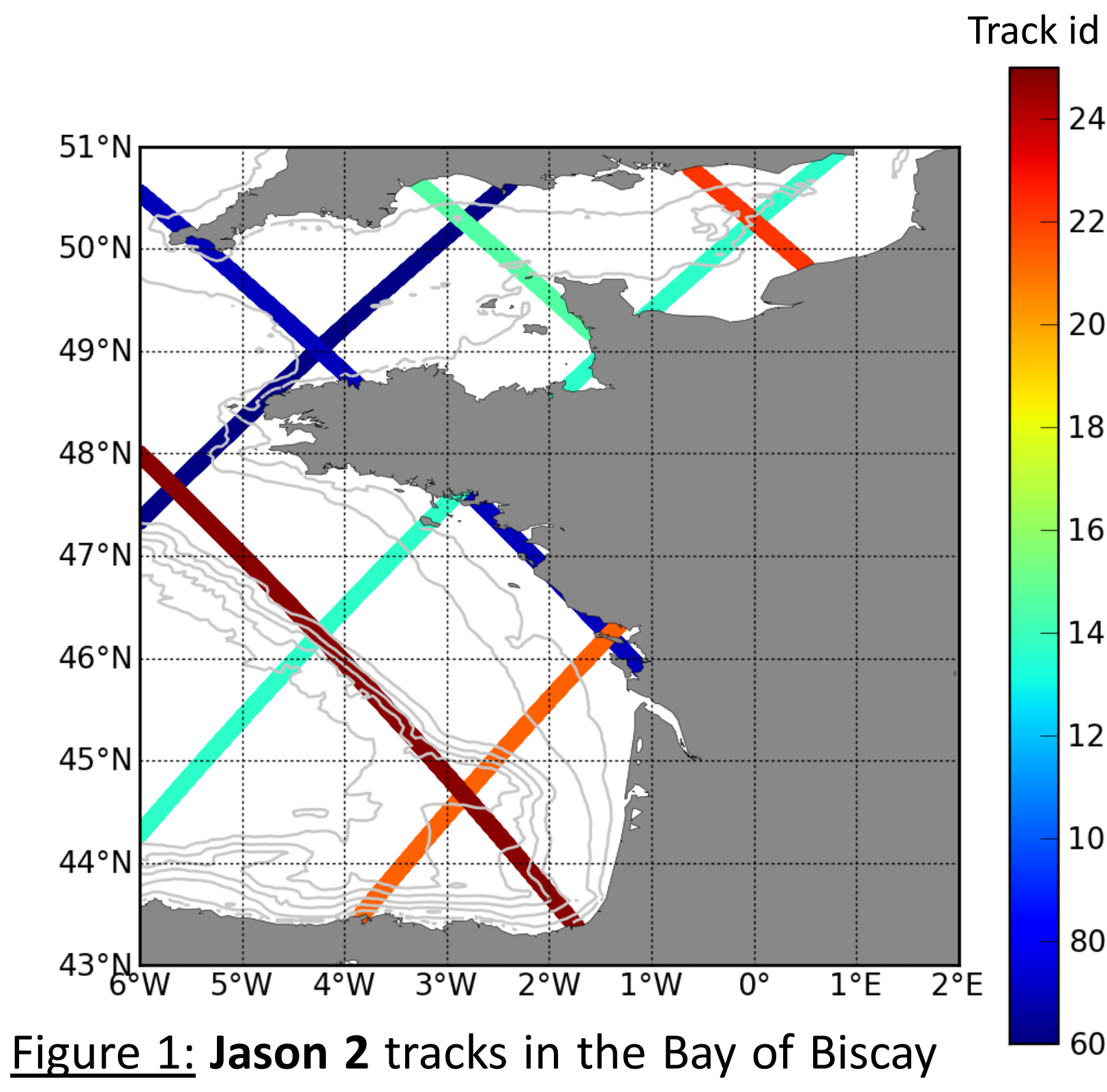
<u>Figure 7:</u> Averaged power density spectrum along track n°137.

<u>References:</u>

Dussurget, R., F. Birol, R. Morrow, and P. De Mey (2011), Fine Resolution Altimetry Data for a Regional Application in the Bay of Biscay, Marine Geodesy, 34:3-4, 447-476.

Lazure, P., F. Dumas, and C. Vrignaud (2008), Circulation on the Armorican shelf (Bay of Biscay) in autumn , Journal of Marine Systems ,72 (1-4), 218-237.

Lazure, P., V. Garnier, F. Dumas, C. Herry, and M. Chifflet (2009), Development of a hydrodynamic model of the Bay of Biscay. Validation of hydrology, Continental Shelf Research, 29(8) , 985-997.



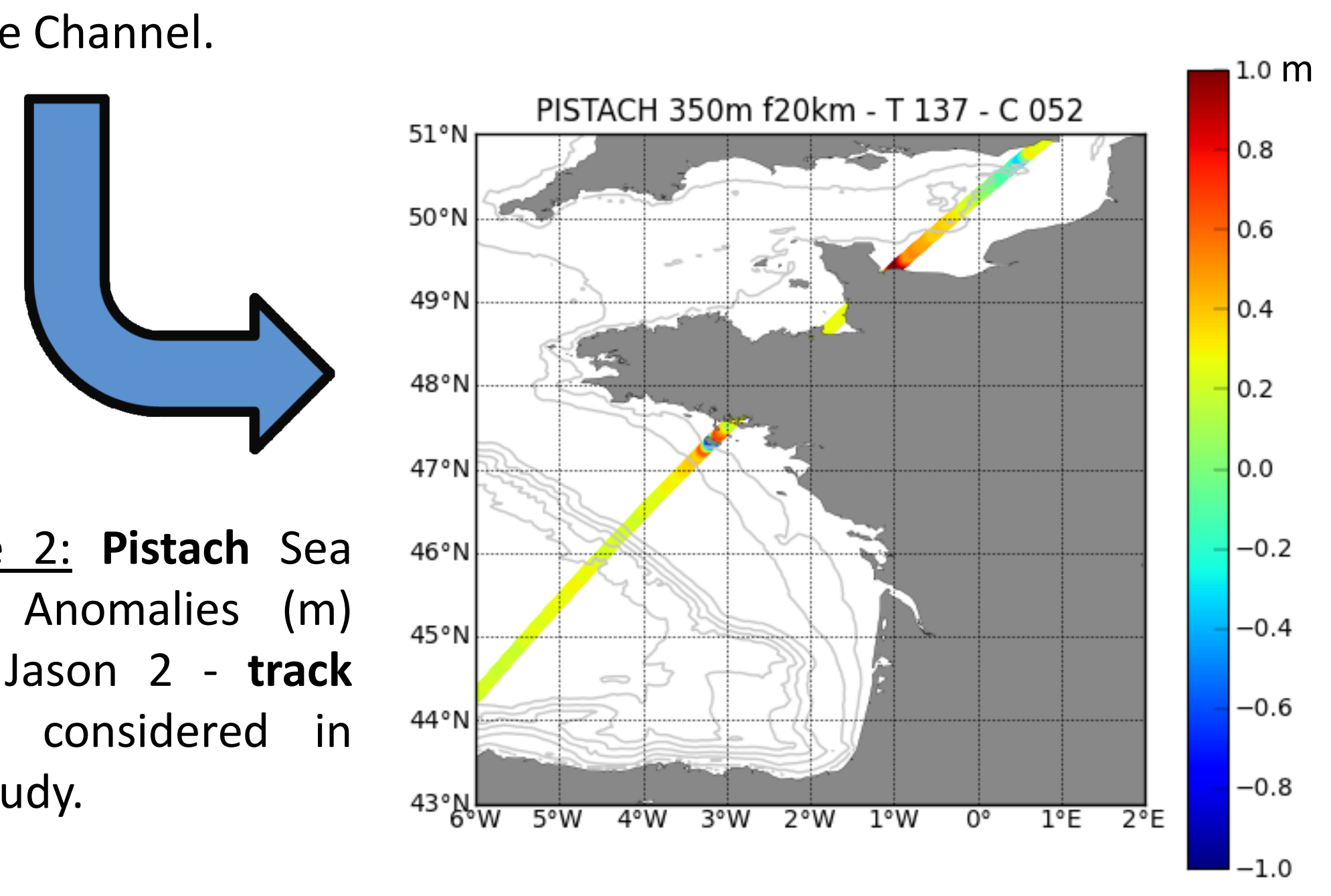
<u>Figure 1:</u> **Jason 2** tracks in the Bay of Biscay and the Channel.

Main findings

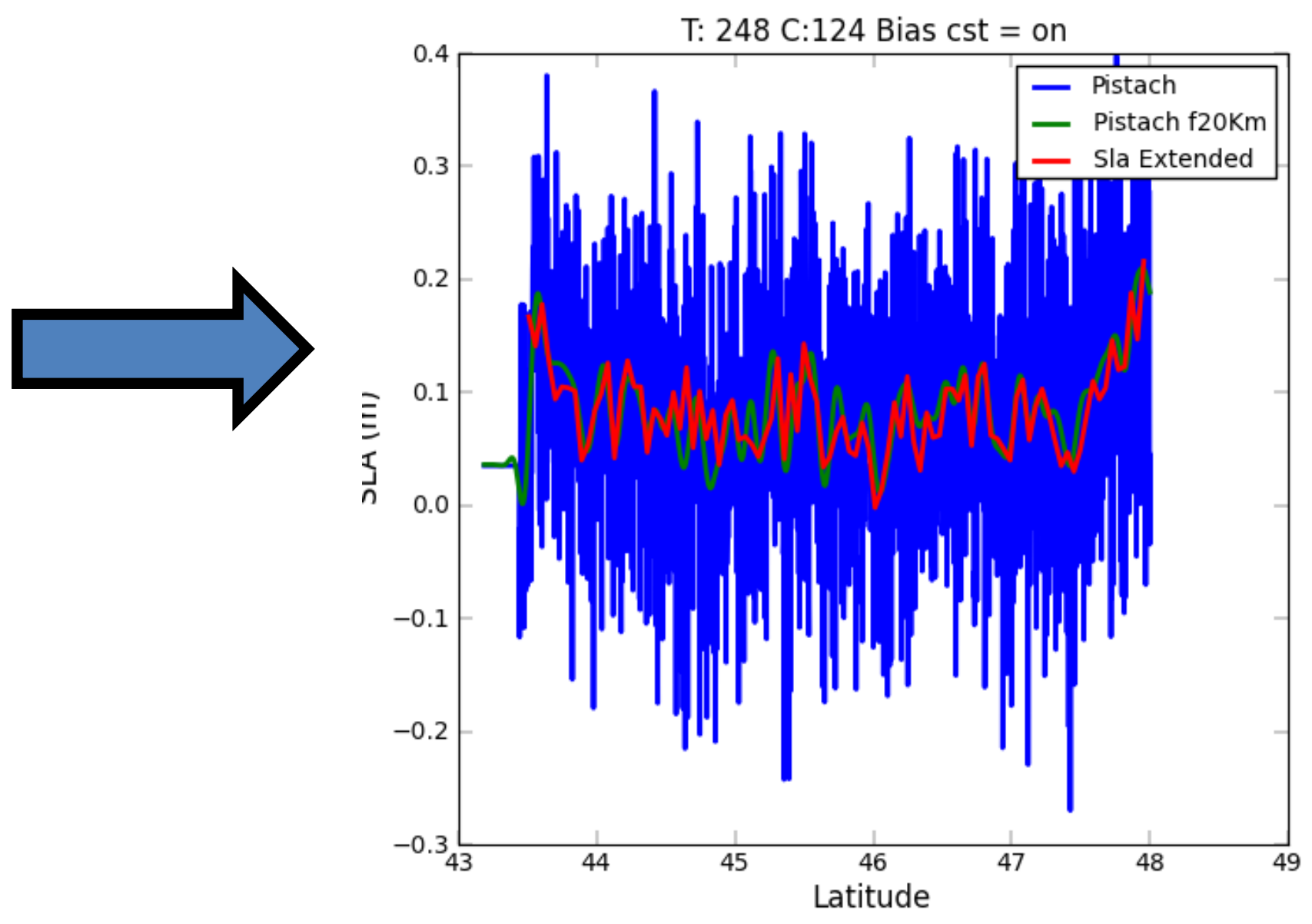
The use of coastal altimetry to monitor dynamics over the continental shelf in the Bay of Biscay appears as a challenging but promising aim. Indeed, our results show that most of processes of interest are corresponding to small scales and then, in the noisier part of the spectrum.

In the meantime, interannual variability observed in the data shows interesting features that will be further investigated.

Based on some improvements in the corrections (e.g. tides), the coastal altimetry would be a valuable proxy to monitor the circulation in the Bay of Biscay.



<u>Figure 2:</u> **Pistach** Sea Level Anomalies (m) from Jason 2 - **track n°137** considered in this study.



<u>Figure 3:</u> Sample of different SLA products:

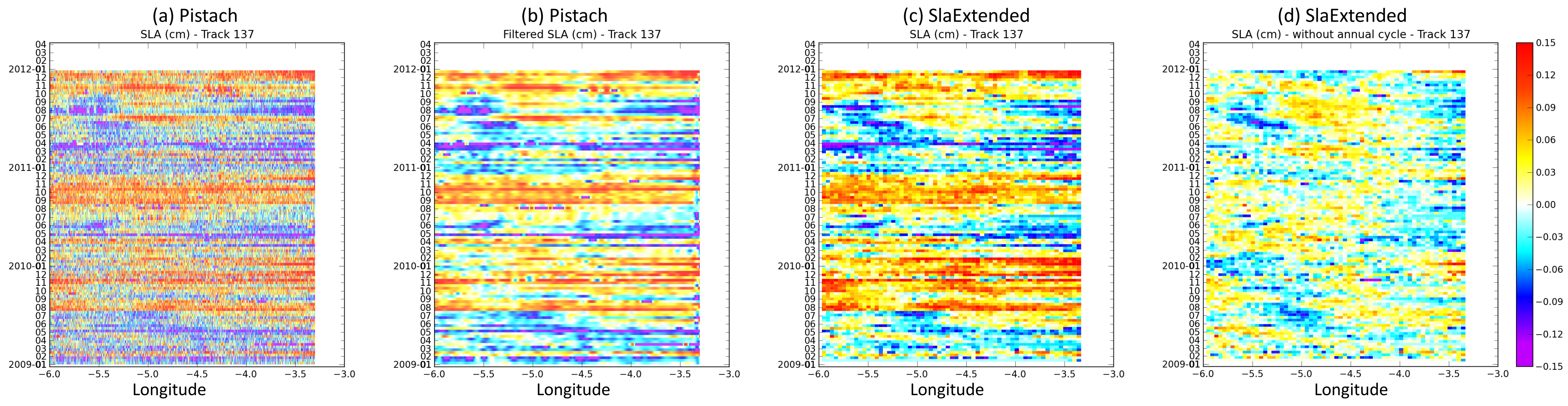
- Pistach,
- filtered Pistach (20Km low-pass filter),
- along track SlaExtended products from Aviso.

Interannual variability

The length of the available dataset (2009-2011) allows a first exploration of the interannual variability.

From the <u>Figure 8 (a, b, c)</u>, we can observe the strong seasonal cycle with fluctuations following the year considered (even in raw full resolution data – <u>Figure 8a</u>). Indeed, in 2011, it appears that the higher SLA values do not persist after December 2010 (<u>Figure 8b, c</u>). At the opposite, in 2010, large values remain until April 2010.

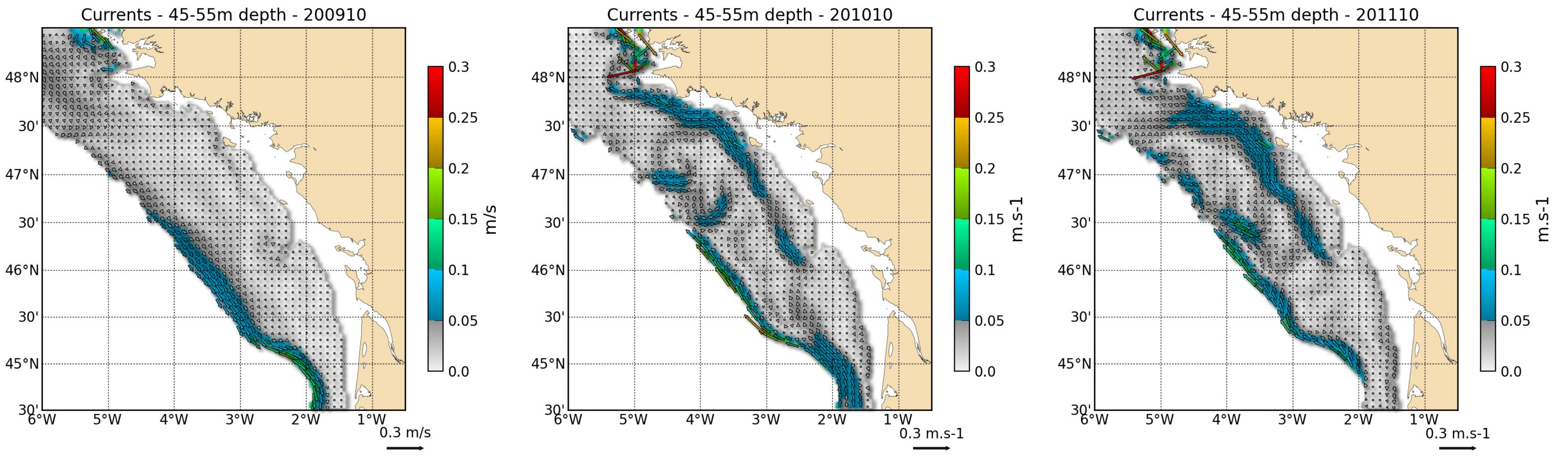
This annual cycle is removed by substracting a zonal average for each cycle (<u>Figure 8d</u>). The main remaining signal is the signature of the dynamic boundary layer induced by the presence of the continental slope around 4.5W. Temporal fluctuations can be interpreted as a signature of water exchanges between the continental shelf and the open ocean.



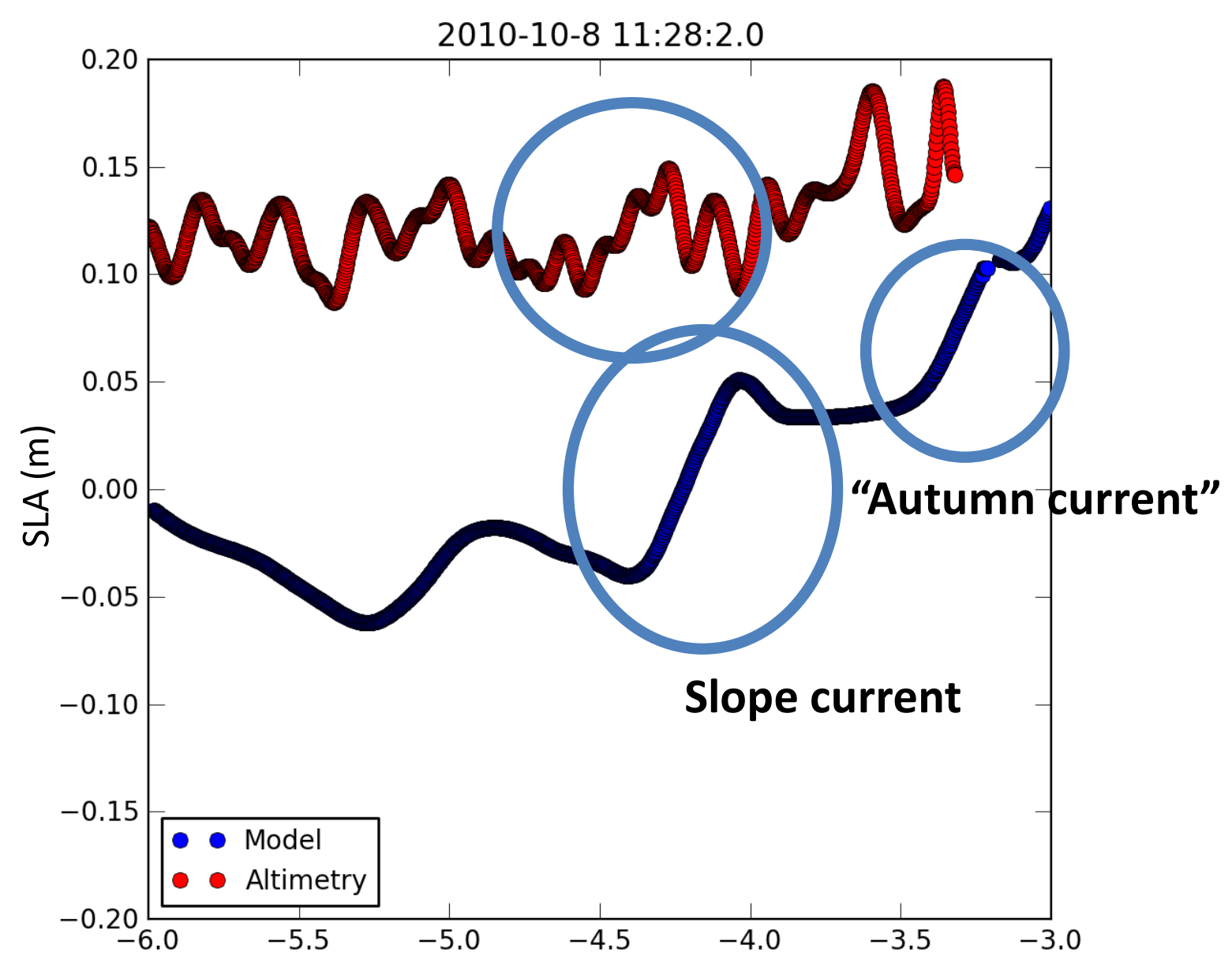
<u>Figure 8:</u> Time/longitude plots of SLA (cm) along the track n°137 from (a) raw Pistach data, (b) filtered Pistach data, (c) SlaExtended data and (d) SlaExtended data after removing the annual cycle.

The “autumn current”

Lazure et al. (2008) underlined the existence of a poleward current occuring in autumn South of Brittany on the continental shelf. This current is not appearing every year as illustrated in <u>Figure 9</u> from 3D operational model results (PREVIMER project, http://www.previmer.org).



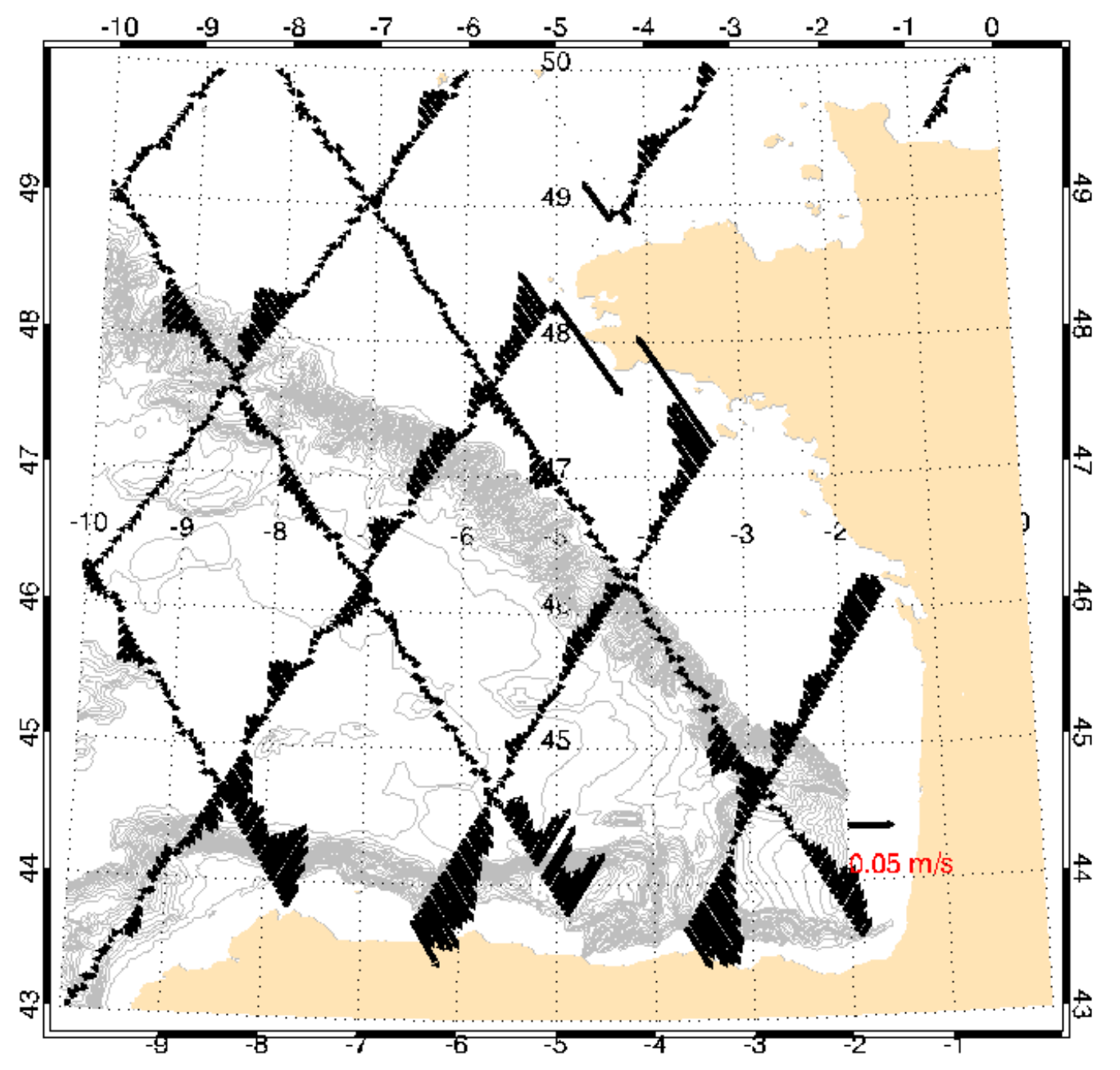
<u>Figure 9:</u> Averaged currents (between 45 and 55 meter-depth) from a 3D ocean model (MARS3D, Lazure et al., 2009) in October 2009, 2010 and 2011. The signature of the “autumn current” is clearly observed in 2010 and 2011.



<u>Figure 10:</u> Sea Surface Height (m) from model simulation and altimetry (filtered Pistach) in October 2010.

Based on coastal altimetry, we manage to identify the “autumn current” in altimetry products (<u>Figure 10</u>). However, the noise level for such scales remains important and then further processing is necessary to improve corrections and to reduce this noise level.

However, coastal altimetry products remain promising to monitor coastal currents above the continental shelf, even in a macrotidal sea. <u>Figure 11</u> illustrates that after a different processing and a temporal average, the signature of the “autumn current” can be detected.



<u>Figure 11:</u> Surface geostrophic current anomalies in Autumn (September-October-December) deduced from altimetry after Xtrack processing.