



Combining altimetry, numerical modeling and in-situ data for the observation and the understanding of fine scale coastal processes

F. Toubanc^{1*}, N. Ayoub¹, F. Birol², P. Marsaleix³, N. Fuller²



*florence.toubanc@legos.obs-mip.fr

¹ CNRS/LEGOS, ² CTOH/LEGOS, ³ CNRS/LA – Toulouse, France

The circulation in the Bay of Biscay is greatly determined by its bathymetric features, resulting in complex interactions between currents over the shelf and the slope. X-Track along-track altimetric data provide a 20 years dataset with a spatio-temporal configuration suitable for the study of slope currents and shelf circulation in the Bay of Biscay. Previous studies have shown the potential benefit of nadir altimetry for the studies of eddies in the deep plain (Dussurget et al., 2011) and of the slope current (Herbert et al., 2011 from along-track SLA, and Xu et al., 2015 from gridded SLA). They have also highlighted the difficulties of analyzing the along-track signal near the coast because of the higher level of errors (tides, wet troposphere, sea state bias). Here, we explore the observability of the seasonal circulation over the shelf and slope, taking benefit from recent advances in data corrections and editing (Birol et al., 2014; Fuller et al., this meeting) and the complementary use of in-situ data and/or numerical modeling.

Data & Methods

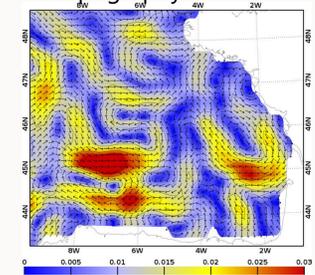
Altimetric data

Topex/Poseidon, Jason 1 and Jason 2 20 years data processed with X-Track (CTOH/LEGOS) (Roblou et al., 2011)

Mapped AVISO dynamic topography



Tracks of Topex/Poseidon, Jason 1 and Jason 2 missions in the Bay of Biscay



Mapped mean geostrophic current velocities (m/s) (AVISO)

In-situ data

- Tidal gauges
- Buoys : surface temperature and current velocities

Model

Primitive equations SYMPHONIE model (Marsaleix et al., 2008): BOBSHELF configuration

- Variable horizontal resolution: 3km in the open sea, < 800 m on the shelf, < 300 m in the Gironde estuary and the Pertuis Charentais
- 43 sigma levels

How to interpret SLA variability ?

Standard deviation of the SLA: dynamic signal or residual errors ?

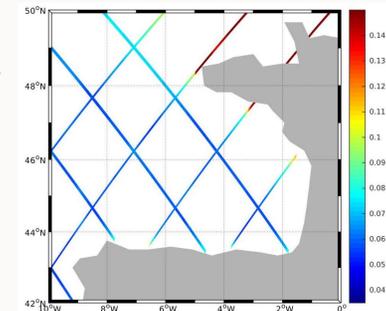
Deep ocean: weak circulation + lower residual errors
Coastal ocean: intense circulation and seasonal variability + stronger residual errors (wet tropo, sea state bias, tides) (see N. Fuller's poster OUT_001 for SSB impact)

Strategy for detiding altimetric data?

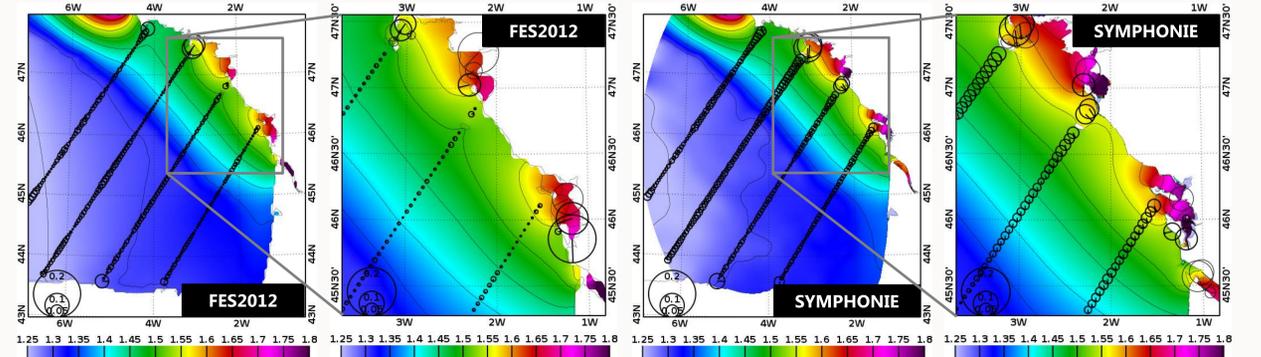
Largest differences between SYMPHONIE and altimetry near the coast
Good comparison between coastal tidal gauges and SYMPHONIE

Hybrid approach with a different detiding for specific areas ?

- Coastal zone: regional model considering specific processes (ex : intertidal areas)
- Open ocean: global tidal model

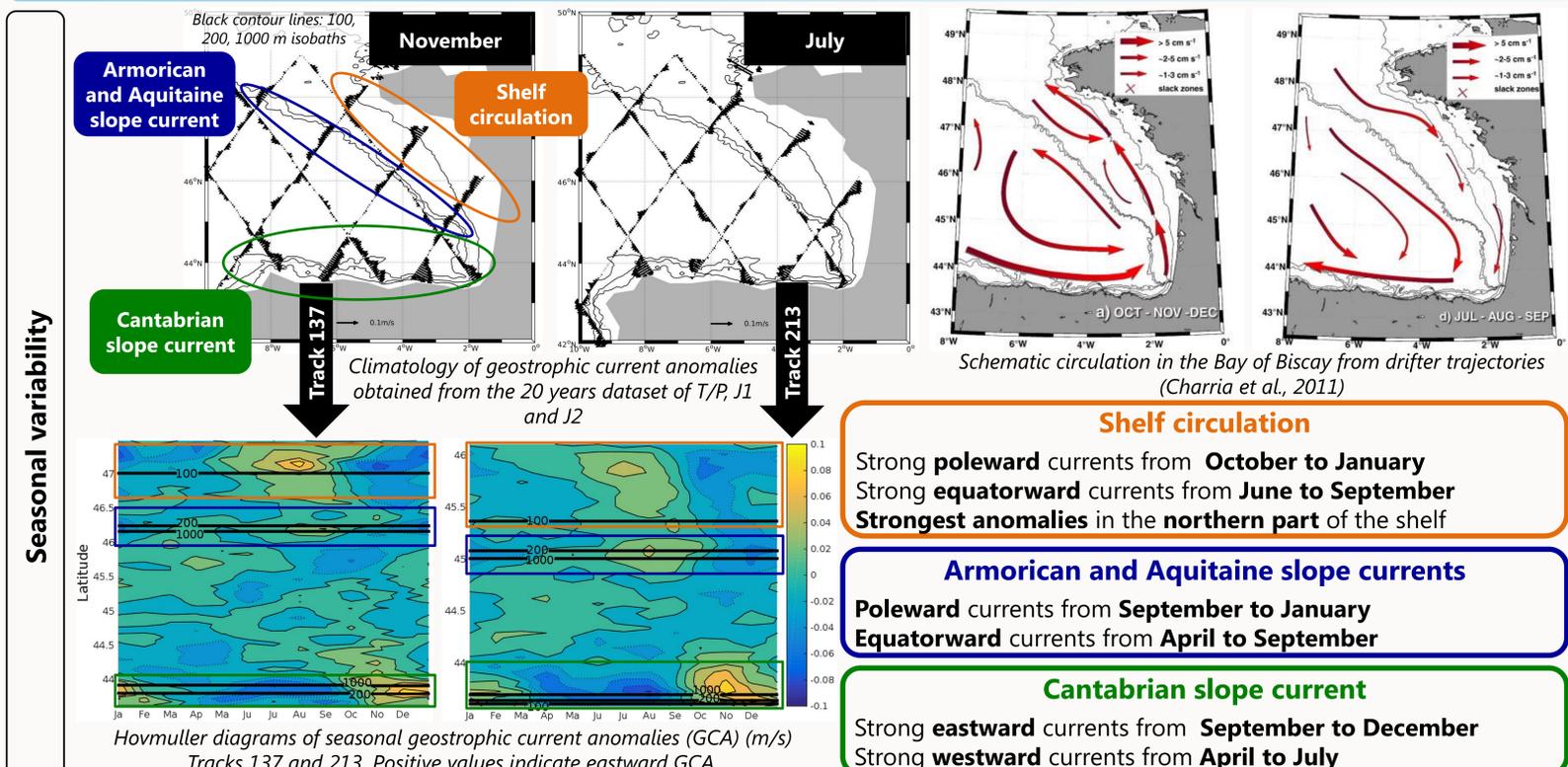


SLA standard deviation (m) over 20 years



Comparisons between the M2 tide harmonic obtained from altimetry, tidal gauges (zooms), FES2012 and SYMPHONIE harmonic analysis
The circle size is proportional to the difference between models and altimetry or tidal gauges

Seasonal and interannual variability of the circulation



Seasonal variability

Interannual variability

- Shelf circulation**
Strong poleward currents from **October to January**
Strong equatorward currents from **June to September**
Strongest anomalies in the northern part of the shelf
- Armorican and Aquitaine slope currents**
Poleward currents from **September to January**
Equatorward currents from **April to September**
- Cantabrian slope current**
Strong eastward currents from **September to December**
Strong westward currents from **April to July**

A marked seasonality and circulation patterns consistent with the literature (Charria et al., 2011)

Over the shelf: combination of flows driven by the wind, tides, and density gradients (river plumes)
Over the slope: signature of the Iberian Poleward Current in early winter

- Signal noisier for the Topex/Poseidon mission (94-02)
- Strong interannual variability on the shelf and over the slope
- Variability between tracks: spatial variability of the dynamics or correction issue?
- Navidad events of 1995, 1997 (Garcia-Soto et al., 2002) and 2006 (Le Cann and Serpette, 2009)

Navidad event of 2006

Spatio-temporal variability

- Track 137 : peak of GCA in november 2006 & january 2007 along the Cantabrian coast
- Track 213 : peak of GCA in november/december 2006
- Results in agreement with in-situ observations of Le Cann and Serpette (2009)
- Signature on the shelf: negative GCA on the shelf for both tracks, but stronger in the southern part of the shelf

References
Birol, F., Delebecque, C., 2014. Using high sampling rate (10/20 Hz) altimetric data for the observation of coastal surface currents: A case study over the northwestern Mediterranean Sea. J. Marine Syst., 129, 318-333
Charria, G., Lazure, P., Le Cann, B., Serpette, A., Reverdin, G., Louazel, S., Batifoulier, F., Dumas, F., Pichon, A., Morel, Y., 2013. Surface layer circulation derived from Lagrangian drifters in the Bay of Biscay. J. Marine Syst., 109-110, 560-576
Garcia-Soto, C., Pingree, R.D., Valdés, L., 2002. Navidad development in the southern Bay of Biscay: climate change and waddy structure from remote sensing and in situ measurements. J. Geophys. Res., 113, C04010
Dussurget, R., Birol, F., Morrow, R., De Mey, P., 2011. Fine resolution altimetry data for a regional application in the Bay of Biscay. Mar. Geod., 34, 3-4
Herbert, G., Ayoub, N., Marsaleix, P., Lyard, F., 2011. Signature of the coastal circulation in altimetric data in the Southern Bay of Biscay during winter and fall 2004. J. Marine Syst., 88, 139-158
Le Cann, B., Serpette, A., 2009. Intense warm and saline upper ocean inflow in the southern Bay of Biscay in autumn-winter 2006-2007. Cont. Shelf Res., 29, 1014-1025
Marsaleix, P., Auclair, F., Floor, J.W., Herrmann, M.J., Estournel, C., Paireaud, I., Ulses, C., 2008. Energy conservation issues in sigma-coordinate free-surface ocean models. Ocean Model., 20, 61-89
Roblou, L., Lamouroux, J., Bouffard, J., Lyard, F., Le Hénaff, M., Lombard, A., Marsaleix, P., De Mey, P., Birol, F., 2011. Post-processing altimetry data toward coastal applications and integration in coastal models. Chapter 9 in Vignudelli, S., Kostianoy, A.G., Cipollini, P., Benveniste, J. (eds), Coastal Altimetry, Springer Berlin Heidelberg
Xu, W., Miller, P.L., Quartly, G.D., Pingree, R.D., 2015. Seasonality and interannual variability of the European Slope Current from 20 years of altimetry data compared with in situ measurements. Remote Sens. Environ., 162, 196-207

Conclusions and perspectives

Along-track altimetry data processed with X-Track can be used to determine the seasonal patterns of the circulation in the Bay of Biscay (shelf and slope). The results obtained are in good agreement with other studies on slope currents and shelf circulation.

Future work will include other comparisons with in-situ data: HF radar data and buoys data along the Cantabrian coast; and tidal gauges time series. SYMPHONIE simulations will be used to evaluate the geostrophic and non-geostrophic parts of the coastal circulation.

Acknowledgements: the authors especially thank the CNES for the funding of this study through the MICSS-II OSTST/TOSCA project. Many thanks also to D. Allain and F. Lyard (LEGOS)