CTOH REGIONAL ALTIMETRY PRODUCTS: EXAMPLES OF APPLICATIONS

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ABSTRACT:

The Centre for Topographic studies of the Oceans and Hydrosphere (CTOH) is a French Observation Service dedicated to satellite altimetry studies, which are an important component of the ocean observing system. However, the use of this type of data for observing the coastal ocean is challenging because of instrumental limitations and some of the standard corrections are not adapted to marginal seas.

In this context, a processing software (X-TRACK) dedicated to recovering altimetry data over marginal seas has been developed at LEGOS for some years. After a validation stage in several geographical areas, the X-TRACK software is now routinely operated at CTOH, providing data for coastal and regional applications.

The question of how to interpret sea level anomalies observations in terms of coastal processes is still open. This study presents several examples of applications which start to address this issue and show that coastal altimetry data are able to capture characteristics of the coastal dynamics.

1. CONTEXT

The objectives of the Centre for Topographic studies of the Oceans and Hydrosphere (CTOH) are to 1) maintain and distribute homogeneous altimetry databases for applications over the oceans, the hydrosphere and cryosphere, 2) help scientific users develop new altimetry derived products and 3) contribute to the development and validation of new processing approaches of altimetry data in emerging research domains.

Altimetry data are an important component of the ocean observing system. They have been intensively used over the last decade for observing and analyzing the large scale circulation variability in many areas of the world ocean. However, the use of this type of data for observing the coastal ocean is challenging because of three types of problems. First, and certainly the strongest limitation, the radar echo itself interferes with the surrounding land, which results in unreliable data within ~5-10 km off the coastlines [1]. Second, the standard corrections (e.g. wet troposphere correction, wave height, high frequency and tide corrections from global models, etc…) applied to the altimeter data are not adapted to the intrinsic characteristics of the coastal dynamics (shorter spatial and temporal wavelengths) and add to the problem of poor quality altimeter data over shallow waters. As a consequence the precision decreases dramatically when approaching the coast and the data are usually flagged within 50 km of the land in products distributed by operational centres. Finally, the space-time sampling of the altimeter satellites is generally too low to capture a wide range of coastal ocean processes. In the near future, the new generation of altimeter missions will better fulfil the requirements for coastal observations (AltiKa, SWOT, etc…). But in parallel, we need to develop new approaches to address the problems mentioned above, i.e. data processing strategies dedicated to coastal purposes, to interpret the coastal SSH data in term of underlying ocean dynamics, to define their usefulness and limitations, and to analyse how they could be complementary with other types of coastal observing systems. Experience gained from existing altimetry data is crucial to optimize both quality and quantity of altimetry data records in the coastal zones.

In this context, for some years, a dedicated data processing system has been developed at LEGOS to recover information from altimetry over marginal seas: the X-TRACK software [2]. Starting from classical Geophysical Data Record (GDR) products, it incorporates the latest corrections available in the CTOH database. A variable sampling rate processing has been included (1Hz to 20 Hz) and the editing strategy has been re-defined to recover a maximum of useful information. Inversion algorithms have also then been added to estimate a high resolution mean sea surface directly from the improved altimeter data. The post processing step is based on user's defined criteria. When available, improved geophysical corrections from regional high-frequency models of tides and atmospheric loadings are also applied. The result is a processing tool which can be easily tuned to respond to particular applications.

After a validation stage on dedicated oceanic regions ([3], [4], [5], [6]), where the improvement resulting from this processing tool was shown (in terms of error reduction and data availability near the shelf), the X-TRACK software is now routinely operated by the CTOH for regional or coastal applications. On request, 1Hz or higher frequency along-track data from different altimeter missions are reprocessed on a regional basis. Once they are validated [7], these data are made freely available through the CTOH website: http://ctoh.legos.obs-mip.fr.

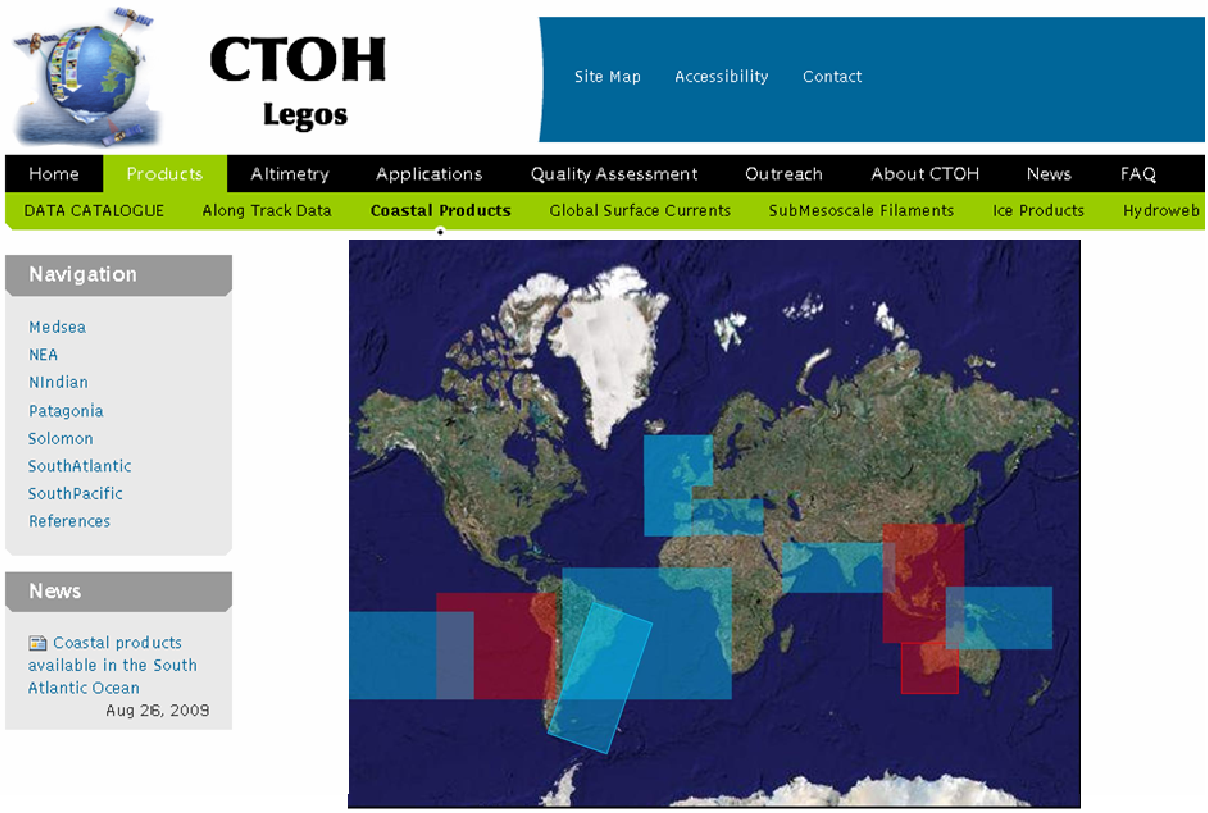
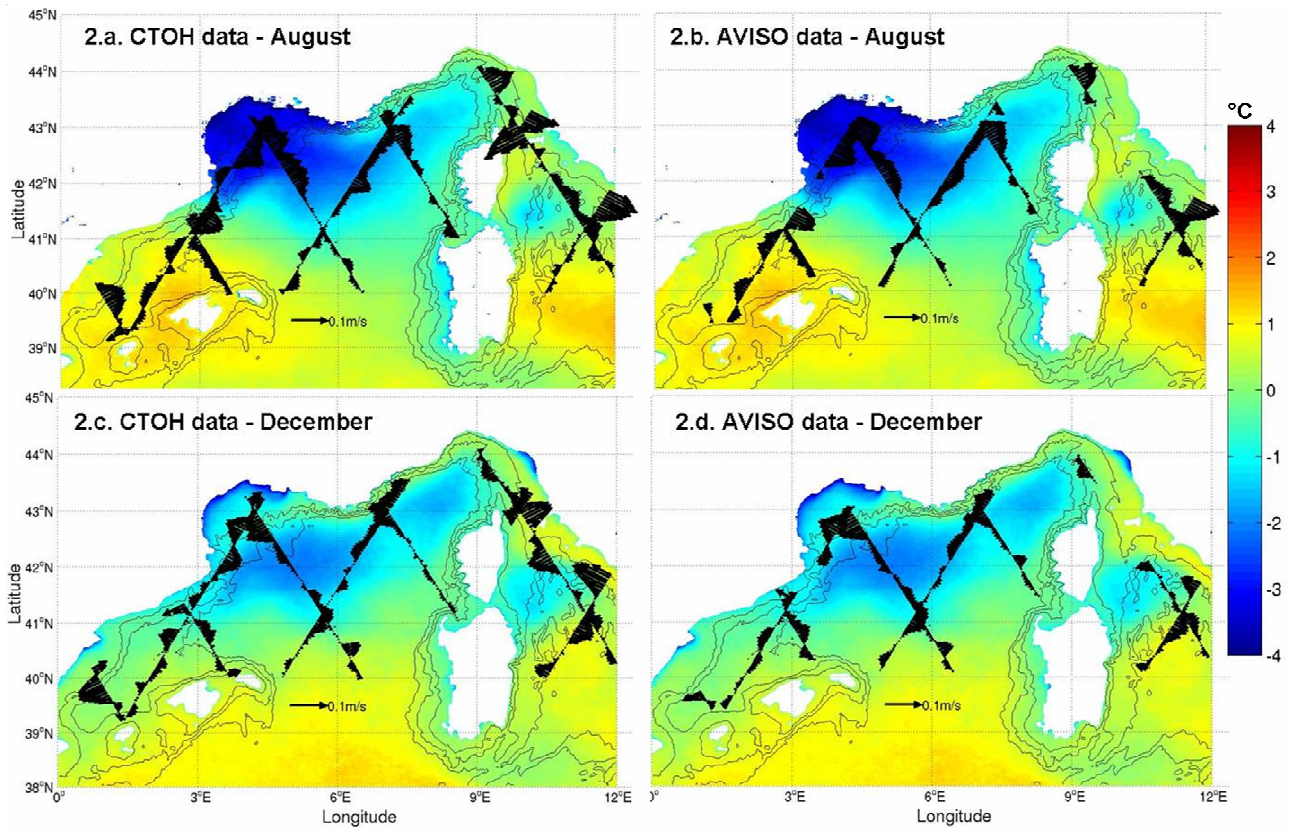


Figure 1: Coastal products distribution via the CTOH website: blue rectangles show areas where data are available and validated, red ones indicate regions where the data are still under validation.

2. APPLICATIONS

CTOH regional altimetry products have already been used for various scientific applications (eg coastal and shelf ocean dynamics, regional model validation, data assimilation, …) in different areas: in the Mediterranean Sea, the southwest and southeast Pacific Ocean, the northern Indian Ocean, the Gulf of Biscay, and the Great Australian Bight. The question of how to interpret sea level anomalies observations in terms of coastal processes is addressed here using different examples of applications. It is shown that altimetry data offer the opportunity to document coastal trapped wave activity, processes associated with mesoscale variability near the coasts as well as shelf circulation in different areas of the world ocean.

As an example, in the case of the North-western Mediterranean Sea boundary circulation, the seasonal picture of the coastal circulation system emerging from altimetry agrees fairly well with in-situ current data and with the Sea Surface Temperature (SST) pattern [8]. Fig. 2.a. and 2.c. show that the structure of the Liguro-Provençal-Catalan (LPC) Current is clearly visible on the shelf break. The winter SST pattern shows a steep thermal front over the shelf break that separates the relatively warm waters of the LPC current from the colder upwelled waters spreading from the Gulf of Lion. Despite the large inter-track spacing of the Topex/Poseidon and Jason-1 missions which limits the spatial resolution of the whole shelf edge current system, a consistent regional picture of the seasonal evolution of the boundary flow appears: intensification (decrease) of the boundary flow in winter (summer). This regional picture can not be so clearly identified when using AVISO data (Fig. 2.b. and 2.d.) because of more missing data. The seasonal cycle dominates the spectrum of the coastal circulation variability in the area of interest, although a wide range of time scales is also revealed (not shown here).



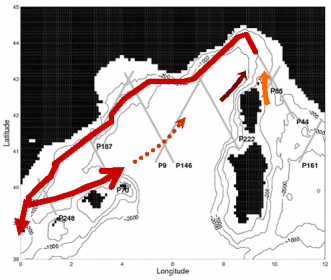


Figure 2: Variability of the Liguro-Provençal-Catalan current, in the Northwestern Mediterranean Sea. Monthly climatology maps of cross-track geostrophic current anomalies (derived from T/P and Jason-1 data; black arrows) and of SST anomalies (AVHRR data) for August (2.a.: CTOH data and 2.b.: AVISO data) and December (2.c.: CTOH data and 2.d.: AVISO data). Monthly SST anomalies have been constructed by removing the average monthly mean over the domain. The SST dataset covers the period Jan. 1998 – Dec. 2008. The altimetry dataset covers the period 1993-2007. The coastal circulation scheme is shown for information.

3. CONCLUSION

Even if a lot remains to do, different studies have already shown that altimetry data reprocessed with coastally-oriented algorithms are able to capture characteristics of the coastal dynamics, offering the opportunity to document the variability of various dynamical processes at different time scales. Therefore, we believe that satellite altimetry, even with its intrinsic limitations, is an important component of coastal observing systems. The nearly global availability of altimetry data holds considerable promise for advancing our knowledge of the near shore ocean variability, especially in numerous regions where the surface boundary circulation is of great interest but is difficult to observe with direct in situ measurements.

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