REPROCESSING ALTIMETER DATA RECORDS ALONG EUROPEAN COASTS: LESSONS LEARNED FROM THE ALTICORE PROJECT


(1) Consiglio Nazionale delle Ricerche, Istituto di Biofisica, Area Ricerca CNR San Cataldo, 56127 Pisa, Italy. E-mail: vignudelli@pi.ibf.cnr.it
(2) P.P. Shirshov Institute of Oceanology, Nakhimovsky Pr. 36, 117997 Moscow, Russia
(3) Geophysical Center, Molodezhnaya Str. 3, 119296 Moscow, Russia
(4) National Oceanography Centre, European Way, SO14 3ZH Southampton, United Kingdom
(5) Laboratoire d'Etudes and Géophysique et Ocèanographie Spatiale, 18 Av. E. Belin, 31401 Toulouse Cedex 9, France

ABSTRACT

A coastal-oriented processing strategy has been developed in the Northwestern part of the Mediterranean Sea and has showed that improved altimetry in the costal ocean is feasible and could be extended to other regions. In this work, we will provide an overview of current capabilities and challenges of existing altimetry products in Black, Caspian, White and Barents seas, in the prospect of increasing the quantity and quality of data in these regions. With respect to the work done in the project called ALTICORE (ALTImetry for COastal REgions – www.alticore.eu), the obstacles limiting the use of the data and the possible areas of improvement are highlighted and discussed.

Index Terms— satellite altimetry, coastal zone, Mediterranean Sea, Black Sea, Caspian Sea, White and Barents Seas

1. INTRODUCTION

Satellite observations are a unique source of information in the areas of coastal ocean dynamics and prediction, and of coastal ocean feature and process analysis. Radar altimetry is an important remote technique for directly sensing sea state from space, providing along-track measurements of sea surface height, wave height and wind speed. While the existing satellite altimetry infrastructure provides superior results in open ocean conditions, the data exploitation in regional seas and even along the coasts is still difficult due to a number of reasons [1]. The existing altimeter sensors are not designed to observe these areas, however, the identification of gaps in knowledge remains a necessity. The evolution of satellite altimetry should improve the resolution capabilities, benefiting from advances in technology (e.g., Delay-Doppler, interferometry, reflectometry) in concert with multiple orbital configurations and possible instrument miniaturization.

A 15-yr long data record from a variety of radar altimeters over costal regions is currently available globally. Under the umbrella of European Union within the INTAS cooperation program, the ALTICORE project (ALTImetry for COastal REgions – www.alticore.eu) [2] has been running since December 2006 aiming at determining the extent to which this unprecedented data set can be improved and usefully exploited along European coasts, specifically over selected validation sites in the Mediterranean, Black, Caspian, White and Barents seas.

2. MEDITERRANEAN SEA

The Northwestern part of the Mediterranean Sea represents the laboratory where novel processing strategies are explored, including the maturity of improved techniques and algorithms [3]. Understanding the accuracy and limitations is critical to the accuracy of the coastal altimeter products. The main development has been the definition of a data post-processing strategy tailored for the coastal ocean which is contributing to the development of the X-TRACK data processor [4].

Major details about algorithms, techniques and possible exploitation of altimeter data in the context of coastal studies in the Nortwestern Mediterranean are available in [5]. Briefly, a more sophisticated editing methodology has been proposed, consisting of minimising the quantity of good data inadvertently discarded. The approach was to screen multiple along-track altimeter data jointly, rather than individual ground points. This methodology permits on one hand to better determine abnormalities caused by the altimeter and the radiometer (impacting on wet and dry tropospheric and ionospheric path delays for instance), and
on the other hand to identify invalid corrective terms. Re-interpolating the missing or bad corrections where can therefore be attempted. In some cases (especially the wet tropospheric correction) it may even be necessary to extrapolate.

Additional key elements for the generation of the improved coastal product were: the use of the high rate data stream (10/20 Hz), better tidal modelling, improved modelling of high frequency atmospheric effects and the computation of an optimal, along track mean sea surface consistent with the optimized altimeter data set and on a high resolution, regular grid following the satellite ground track.

3. BLACK, CASPIAN, WHITE AND BARENTS SEAS

The processing requirements of coastal altimetry are complex and necessitate of local knowledge and ancillary information. This means that the specificities of each region need to be accounted for a proper interpretation of the altimetric retrievals before generating an improved product for that region [6, 7]. Compared to the Mediterranean Sea, the study regions may present extreme weather conditions somewhere (e.g., presence of ice-covered waters, strong wind setups in wide shallow areas) or additional difficulties, e.g. in the Caspian Sea the outflow of the Volga River and poorly understood multi-decadal secular changes of up to 2 meters over the past century. To make matters even more challenging, a proper removal of high tides in the White and Barents Seas is necessary [8]. All these problems may limit the accuracy of the satellite-derived altimeter measurements.

4. DATA AND METHODS

Altimeter data from the TOPEX/Poseidon, Jason-1, Geosat Follow-On and Envisat satellites have been retrieved from the RADS database [9] to form regional archives. Default settings in the RADS database as described by [9] are used at first and then changed following quality control tests. Corrections factors have been applied to altimeter data following standard practices. The in situ measurements (wind, waves and sea level) for satellite altimetry validation come essentially from local metocean sources. At time of this work, only one year of wave measurements in the Caspian Sea are available. To allow for comparison with in situ sea level data, the inverse barometer and tidal corrections are not applied.

5. REVIEW OF SOME RESULTS

The altimeter ground tracks from the various satellite missions in proximity of the available in situ stations were
analyzed. Here we present some examples of the comparisons in terms of waves, wind and sea level. In the case of the waves, the comparison to ENVISAT altimeter suffers from the short period of analysis in relation to the 35-day satellite repeat cycle. Therefore, only a qualitative comparison was attempted with this data set (Figure 1). Visual inspection of the plot shows that the altimeter seems to underestimate the observed waves. The comparison to Jason-1 (Figure 2) benefits from a higher number of wave observations than Envisat and the scatter plot seem to confirm the positive bias, although the study period is not sufficiently long to enable a sound statistical conclusion. Some discrepancies between observed and altimeter-derived waves are presumably a consequence of using daily averages instead of usual hourly in situ data.

A case-study of Geosat Follow-On in the Black Sea (Figure 3) is selected for satellite-in situ wind comparison. Examination of the scatter plot of observed against altimeter-derived emphasizes the fact that wind speeds reported at coastal stations might be non representative of conditions only a few kilometers offshore. A noticeable scatter can be seen and for a better evaluation a new approach is proposed based on the decomposition of the winds in four quadrants in relation to the orientation of the coastal line and the angle the satellite track approaches the coast.

The sea level data match-up is presented with an example at Sevastopol in the Black Sea. Analysis for almost thirteen years of coincident tide gauge and altimeter-derived sea level anomalies are showed in Figure 4. The sea seasonal signal is well reproduced in the altimetric record. Assuming the in situ station working properly, the poor correlation (0.41) is probably due not only to altimetric processing by models and of multiple corrections, but rather could reflect, at least in part, the strong mesoscale variability typical of the region offshore Sevastopol.

6. CONCLUDING REMARKS

Preliminary results of the various satellite-field comparisons conducted during the project ALTICORE were illustrated. At this stage, they cannot be intended as a comprehensive assessment of the altimeter-derived estimates of wave, wind and sea level. The interpretation of the results is still limited in the extent of in situ data actually available, especially in the case of waves.
7. ACKNOWLEDGMENTS

This work was partially supported by INTAS Project “ALTImetry for COastal REgions” (ALTICORE), contract n. 05-1000008-7927.

8. REFERENCES


