Potential of Aix Island as a CAL/VAL site

B. Martín Míguez[1] C. Letetrel[2] L. Testut[3], V. Ballu[2]

INTRODUCTION

Calibration and validation are essential components of the altimeter measurement system technique. Calibration enables the characterization of the performance of the components of the measurement systems and has proven useful to provide early warnings about changing instrumental behaviors and sources of possible spurious changes in derived sea-surface heights over time (Bonnefond et al., 2011). In the past years, encouraging progress has been made in coastal altimetry. However, one of the remaining issues is the effect of land contamination both on the altimeter and on the radiometer (see for instance Bonnefond et al. 2013). To investigate this problem, different coastal configuration must be studied and Aix island site could be a candidate to look at this effect caused by low lying islands.

THE SITE

Aix island is located on the Atlantic coast of France (Fig. 1 and 2) and is overflight by two TOPEX/Poseidon and Jason nominal tracks, two Envisat and SARAL/AltiKa tracks and a Sentinel-3 track. In this work we will focus on the Jason 2 and SARAL/AltiKa data, shown in Figure 2.

Aix island has a high quality sea level observatory equipped with a radar tide gauge, a pressure tide gauge, a meteorological station and a permanent GPS station (Figure 3). It also benefits from circulation models currently developed at University of La Rochelle (Bertin et al 2014).

The site is part of SONEL system (www.sonel.org), aiming at providing sub-millimeter monitoring of vertical motion at tide gauges. Frequent campaigns are undertaken to maintain the site and calibrate the instruments. Other ancillary variables such as gravimetry, ocean currents or leveling are also measured.

In addition to these advantages, local authorities are particularly supportive to sea-level-related scientific activities, especially after the Xynthia storm surge that severely hit this part of the coast on the 27–28 February 2010.

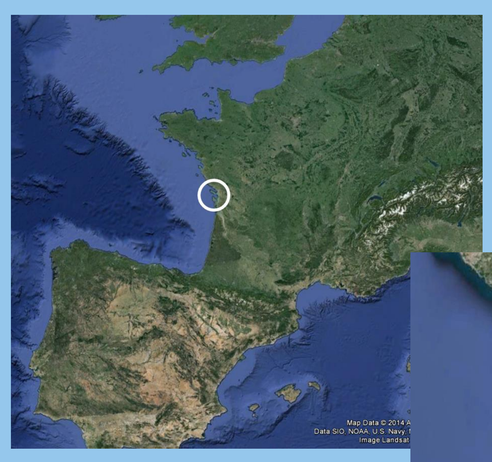


Figure 1 : Location of the study site

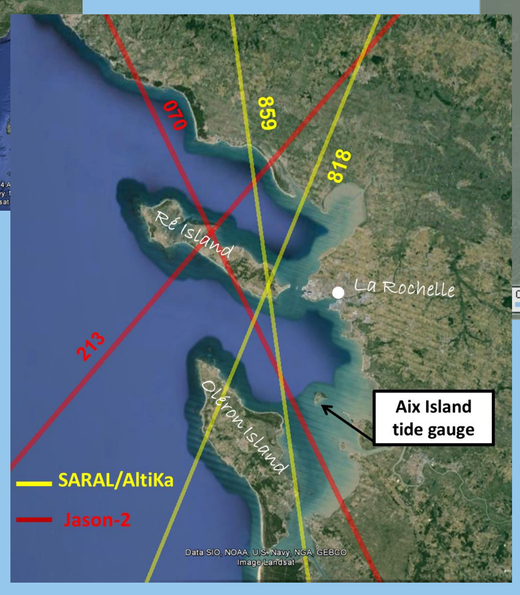


Figure 2 SARAL/Altika (yellow) and Jason-2(red) tracks configuration over the site

Figure 3 : Aix Island sea level observatory

FIRST RESULTS: PRELIMINARY DATA EVALUATION

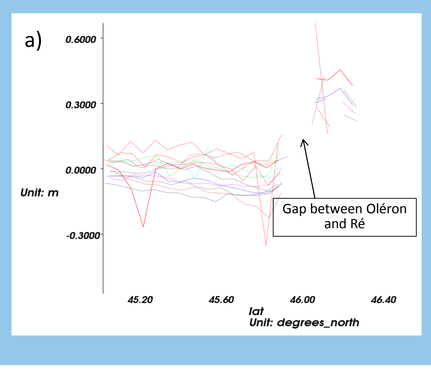
We processed the altimetry data taking advantage of the Basic Radar Altimetry Tool (BRAT, http://earth.eo.esa.int/brat/html/data/toolbox_en.html) and made a first evaluation of the availability, suitability and quality of data, in order to assess the potential of the test site as a CAL/VAL site. We did this for both Jason 2 altimeter and the SARAL/AltiKa one. Results are presented in Figure 4 for the 1 Hz and for the 40 Hz data for the two closest tracks to the test site.

First step: First evaluation of the 1 Hz and 40 Hz data

Figure 4a shows the values of sea surface height above sea level (ssha) along the descendent Saral/AltiKa 818 track. We see the lack of data corresponding to the flight over the two bigger islands (Oléron and Ré). Ssha can be directly downloaded from the AVISO server and takes into account all relevant corrections.

Range variable along with the sea state is the variable that has fewer number of valid values, while the series are almost complete for the rest of variables.

Using the 40Hz data enables to have access to more complete series of data, as we can see in Figure 4b. The data within the circle are close to Aix island and can be used to make an estimation of ssha using alt-range as a proxy, since ssha data at 40Hz is not accessible yet as an AVISO product.



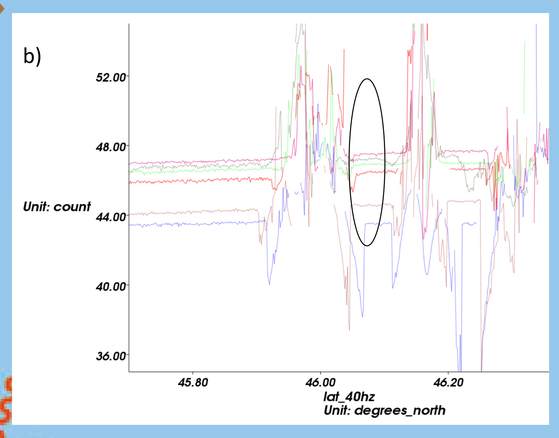


Figure 4 a) ssha and b) alt-range values for the 14 cycles considered (April 2013-July 2014)

Second step: Preliminary comparison with tide gauge data at Aix island

We focused on 40Hz data and calculated the sea level height with respect to the ellipsoid using the following formula.

Sea Level (comparable to tide gauge) =alt - range - iono_corr_gim - model_dry_tropo_corr - rad_wet_tropo_corr - solid_earth_tide -- pole_tide - hf_fluctuations_corr --sea_state_bias

We compared this with the tide gauge data at Aix island evaluating the effect of including or not including the different corrections. Applying the corrections enable to reduce the dispersion (estimated through the STD) of the differences between the tide gauge data and altimeter data by a 80%. The correction with the greatest effect is rad_wet_tropo_corr

Selecting the closest point to Aix island does not necessarily imply that differences are smaller, as data taken over closer points to the coast can also be less reliable. After several trials, the best results (smaller STD) are obtained for points selected around latitude 46.07 (the tide gauge is located at 46.02). Tide gauge time series also has several gaps. As a consequence, the comparison is done only with 10 points (out of 14). The comparison is better for the ascending track (859) which is also the closest to Aix island (6 cm of STD, compared to 10 cm for track 818). Mean values can be related to differences in the geoid or to differences in the ellipsoid used for referencing the sea level heights.

track SARAL/AltiKa	818	859
MEAN value (m)	0.83	0.90
STD (m)	0.10	0.06

Obviously, these are just the first results and we are very far from the values presented for other CAL/VAL sites. Choosing the right point to compare with the tide gauge can be done in a progressively more sophisticate manner, assessing the relative importance of each correction and selecting the right position for each cycle and track. This could help improving the STD values. Results for Jason 2 are worse and still under investigation.

FUTURE WORK

GNSS kinematic surveys: If Aix observatory is selected as a potential CAL/VAL site, our objective is to conduct regular GNSS kinematic surveys beneath the satellite tracks at the time of fly-by for absolute calibration purpose. Aix island is located close to the LIENSs (CNRS/La Rochelle University laboratory), with access to a vessel and 3 GNSS-equipped buoys (Figure 5) that could be used. An intercomparison experiment was undertaken in 2013 to evaluate the performance of those buoys (Andre et al, 2013) and a recent test has been done with a new "sheet buoy" (June 2014, results not published yet) (Figure 6). Under suitable conditions, these buoys together with the permanent GPS receiver could be used to assess the effect of coastal contamination on the range retracking and on the wet troposphere correction

Figure5 : GNSS equipped buoy

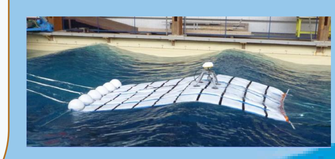


Figure 6: : Sheet buoy

REFERENCES

André, G., Martin Miguez, B., Ballu, V., Testut, L., Wöppelmann, G. Measuring sea-level with GPS-equipped buoys : a multi-instruments experiment at Aix Island (2013). *International Hydrographic Review*, November 2013, 27-38.

Bertin, X., K. Li, A. Roland, Y.J. Zhang, J.F. Breilh, E. Chaumillon (2014). A modeling-based analysis of the flooding associated with Xynthia, central Bay of Biscay, *Coastal Engineering*, 94: 80-89.

Bonnefond, P., Haines, B. J., & Watson, C. (2011). In situ absolute calibration and validation: a link from coastal to open-ocean altimetry. In *Coastal altimetry* (pp. 259-296). Springer Berlin Heidelber.

Bonnefond P., Exertier, P., Laurain, O., Thibout, P., Mercier F (2013). GPS-based sea level measurements to help the characterization of land contamination in coastal areas. *Advances in Space Research* 51, 1383-1399.

ACKNOWLEDGEMENTS

The authors wish to express their gratitude to local authorities at the Aix Island for their interest and support in the carrying out of the experiment, as well as to REFMAR for providing tide gauge data (**www.refmar.shom.fr**)

PARTICIPANTS AFFILIATIONS

[1] Centro Tecnológico del Mar (CETMAR), Vigo, Spain
[2] LIENSs (Université de la Rochelle – CNRS), La Rochelle, France
[3] LEGOS (CNES-IRD-CNRS-Univ. Paul Sabatier), Toulouse, France

OSTST meeting, Lake Constanza (Germany), 27-31 October 2014

We would like to dedicate this work to Pascal Tiphaneau who put a lot of energy in the setup and development of the Aix Island Observatory and passed away this month. We have lost a dear friend and colleague