

Sea level variations and topography of the Arcachon Bay using satellite altimetry



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Abstract

Satellite radar altimetry was developed to accurately measure ocean surface topography. Important effort in the development of new applications of altimetry is oriented towards extending the capabilities of current and future altimeters as close as possible to the coast.

The Arcachon Bay, on the southwest coast of France, was flown over by the RA-2 radar altimetry mission onboard ENVISAT over 2003-2012, and has been under a Saral radar altimetry mission onboard AltiKa track since February 2013. First comparisons between Saral altimetry measurements with Arcachon tide gauge records, located at a few hundred meters from the altimeter track, show that radar altimetry is able to retrieve the sea surface height within a few centimeters. These comparisons will be extended to the whole Envisat RA-2 period. They will permit to assess the accuracy and the biases of the two altimetry missions in coastal zone.

Besides, along-track profiles present variations consistent with the bathymetry of the Bay at low tide.

Altimetry data from ENVISAT/RA-2 & SARAL/AltiKa

Orbit characteristics of ENVISAT (ESA) and SARAL (CNES/ISRO)

- * orbit : 790 kilometres
- * inclination : 98.54 degrees

- * sun-synchronous
- * cycle duration : 35 days

RA-2 instrument:

- * bi-frequency Ku (03/2002-06/2012) and S-bands (08/2002-01/2008) radar altimeter and a bi-frequency radiometer

AltiKa instrument:

- * mono-frequency Ka-band radar altimeter and a bi-frequency radiometer (since 02/2013)

- * frequencies = 13.575 GHz (Ku) = 3.2 GHz (S)

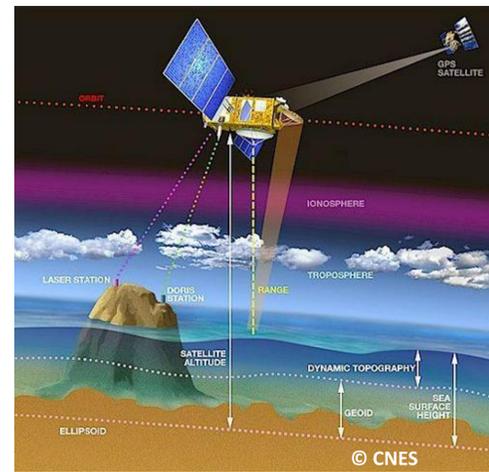
- * frequency = 35.75 GHz (Ka)

Principle of radar altimetry

The principle behind radar altimetry is as follows: the altimeter emits a radar pulse and measures the two-way travel-time from the satellite to the surface. The distance between the satellite and the Earth surface – the altimeter range (R) – is thus derived with a precision of a few centimetres. The satellite altitude (H) with reference to an ellipsoid is also accurately known from orbitography modelling. Taking into account propagation delays from the interactions of electromagnetic waves in the atmosphere and geophysical corrections, the height of the reflecting surface (h) with reference to an ellipsoid or a geoid can be estimated as follows:

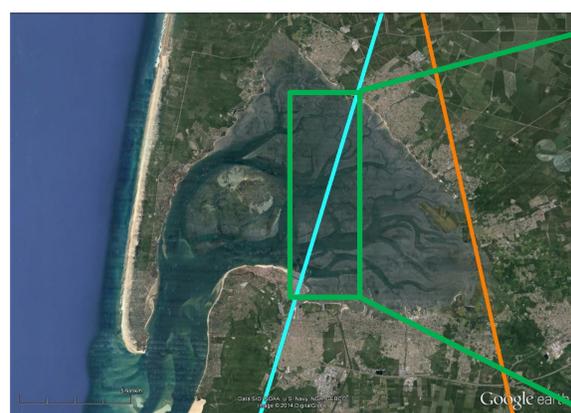
$$h = H - R - C_{\text{iono}} - C_{\text{dry tropo}} - C_{\text{wet tropo}} - C_{\text{solid Earth}} - C_{\text{pole}}$$

where C_{iono} is the correction for delayed propagation through the ionosphere, $C_{\text{dry tropo}}$ and $C_{\text{wet tropo}}$ are corrections for delayed propagation in the troposphere from pressure and humidity variations, respectively, and $C_{\text{solid Earth}}$ and C_{polar} are corrections that account for crustal vertical motions from the solid and polar tides, respectively.



The study zone

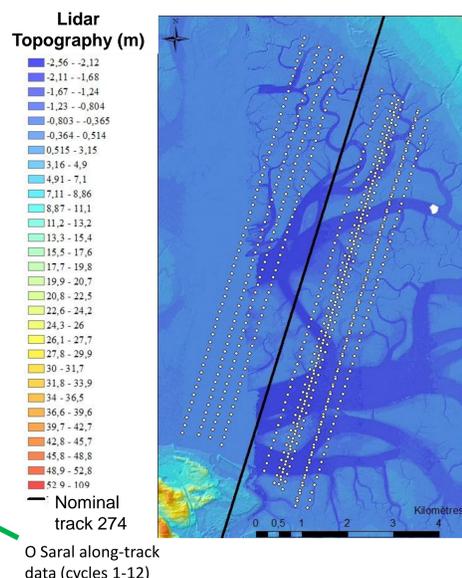
The Arcachon Bay is meso-tidal laguna located in the Bay of Biscaye, 100 km south of the Gironde estuary. Its area is around 100 km².



ENVISAT (06/2002-09/2010) track 274 on nominal orbit
 SARAL (since 02/2013) track 274 on nominal orbit
 ENVISAT (11/2010-06/2012) track 345 on interleaved orbit

Altimetry data editing

ENVISAT and SARAL data were selected and edited using MAPS over the Arcachon bay over 03/2002-06/2012 and since 02/2013-05/2014.



These periods correspond to :

- * Orbit cycles 7–93 on ENVISAT nominal orbit (track 274)
- * Orbit cycles 96–100 on ENVISAT interleaved orbit (track 345)
- * Orbit cycles 1–13 on SARAL nominal orbit (track 274)

Depending on the tide level, altimetry heights represent:

- * either the water level in the Arcachon bay when the sea level is higher than the topography (high tide),
- * or the topography of the Arcachon bay when the sea level is lower than the topography (low tide).

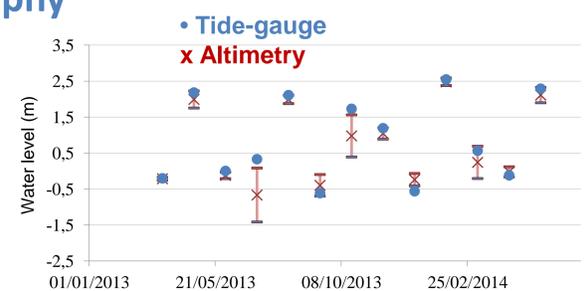
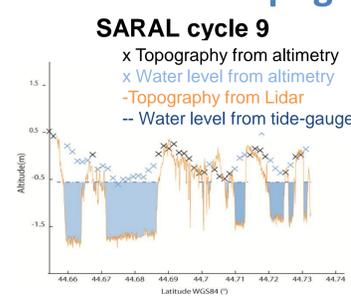
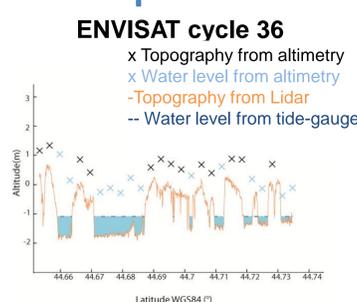
Datasets

* GDRs altimetry data are provided by CTOH (LEGOS-OMP)

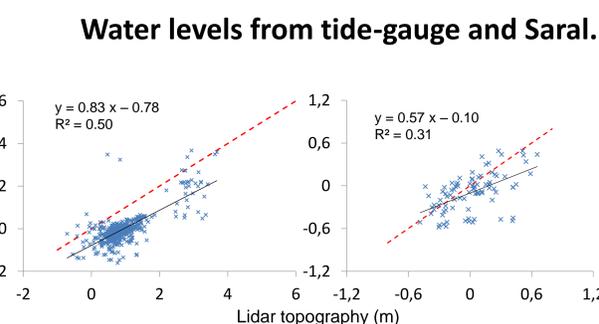
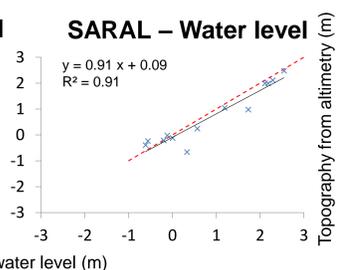
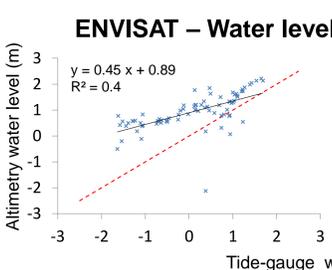
* Data from the Arcachon-Eyrac (-1.16355°, 44.66355°) tide-gauge are provided by REFMAR (SHOM)

* Lidar topography data of the Arcachon bay come from SIBA

Comparisons to tide levels and topography



Along-track altimeter profiles of the Arcachon bay.



Processing of altimetry data

Altimetry data were processed using the Multi-mission Altimetry Processing Software (MAPS) jointly developed by GET-OMP, LEGOS-OMP and EPOC-OASU to obtain altimeter heights, to select the right altimetry data and estimate altimetry-based water levels.

