Preliminary result of sea surface height calibration/validation for multiple satellite altimeters in Taiwan

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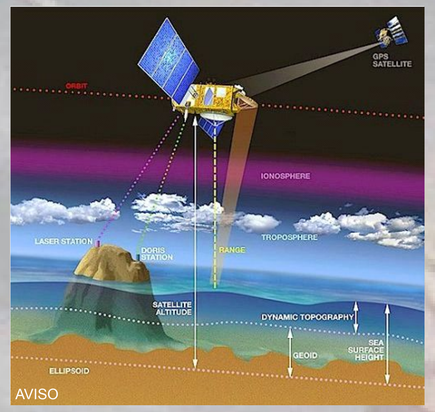
This study presents the calibration/validation (Cal/Val) activities in Taiwan for multiple satellite altimeters, including Jason-1, and the future work for Jason-2, Envisat/SARAL AltiKa. The objective is to support the global effort in the multiple altimeter calibration by providing information of sea surface height bias in the coastal area of Taiwan. The calibration mechanism used in this study is established with a GPS-buoy, which is a simple and compact lifesaver or waverider buoy equipped with a geodetic-grade GPS antenna. In addition, other techniques involved are Continuous GPS (CGPS) stations and coastal tide gauges. The locations for the absolute calibration in this study have been carefully selected based on the groundtracks of altimeters, the availability of tide gauges and CGPS stations in the area, and other factors such as instrumental and geophysical path corrections and sea state bias. Preliminary results of sea surface height bias of Jason-1 in the southwest coasts of Taiwan, and the plan for establishing the calibration for Jason-2, Envisat/SARAL AltiKa missions are reported.

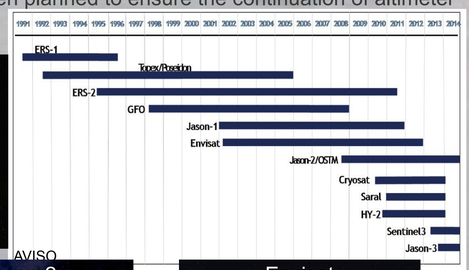
Satellite Altimetry

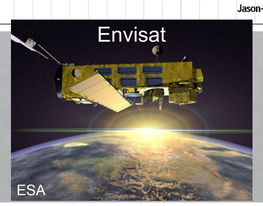


The altimeter satellite sends a radar pulse and counts the travel time of the pulse, as it is bounced back by the sea surface, which is used to inferred the range between the satellite and the sea surface. With a known satellite altitude above the reference ellipsoid, the sea surface height can be determined by subtracting the range from the satellite altitude.

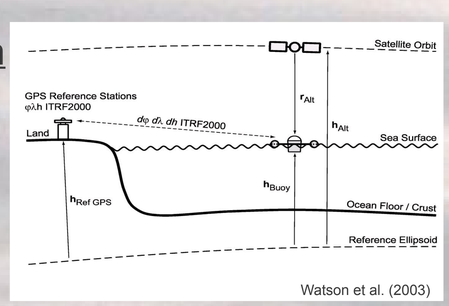
Essentially, satellite altimetry is an active remote sensing technique for the global observations of: Sea surface height, wind speed, and significant wave height. Satellite altimetry has been successfully used to observe oceanic phenomena such as El Nino, mesoscale circulations, tides, bathymetry and others. It is also used, along with coastal tide gauges, to study the issue of global sea level rise, whose trend is regarded to be a few mm/year depending on the location.

Several altimetry missions has been planned to ensure the continuation of altimeter measurements.





Absolute Calibration of Altimeters



Watson et al. (2003)

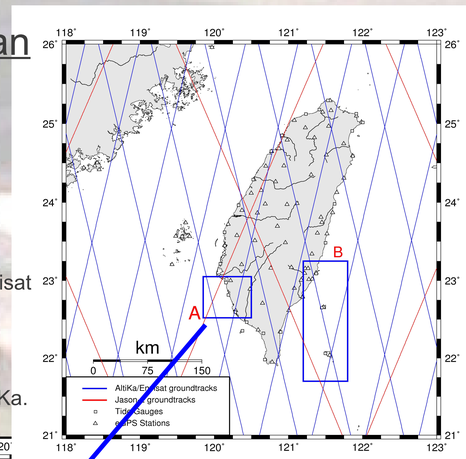
The calibration of satellite altimeters helps to assure the performance requirements of the altimetric height, especially for studies of global sea level rise, by carefully analyzing the sea surface bias and its drift with accurate *in situ* observations. In this study, we used a GPS buoy and CGPS stations and coastal tide gauges to setup the absolute calibration mechanism. The method is similar to Cheng et al. (2010) and Watson et al. (2009; 2004).

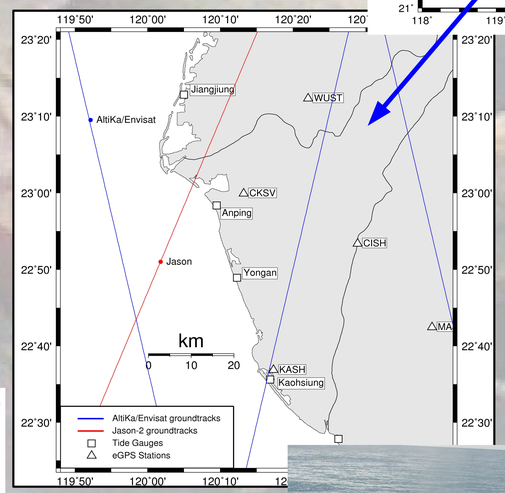
Calibration in Taiwan

After carefully examining the groundtrack locations and the availability tide gauges and CGPS stations. The suitable sites are:

Box A has been established for the calibration of Jason-1 and Jason-2 since 2008 and with a tide gauge added, it will have the work for Envisat and SARAL AltiKa involved in the future.

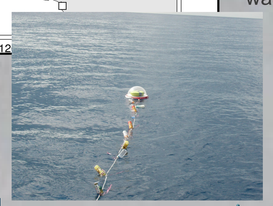
Box B is primarily planned at a crossover point for Envisat and AltiKa.

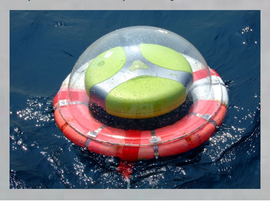




The crew members and the boat, ~12 m, to which the buoy was tethered.

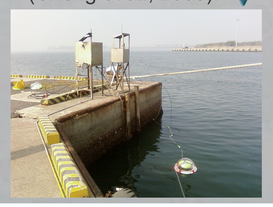
The GPS buoy in this study is based on a simple and compact lifesaver (waverider) buoy.

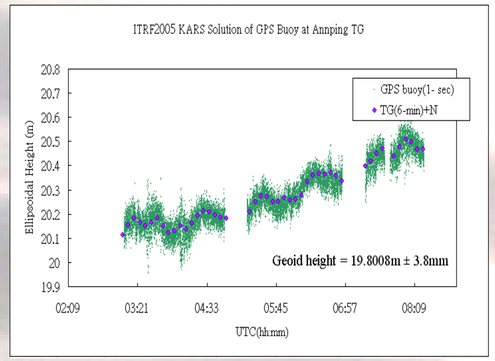




The buoy was also deployed at footprints of altimeters for calibration and validation.

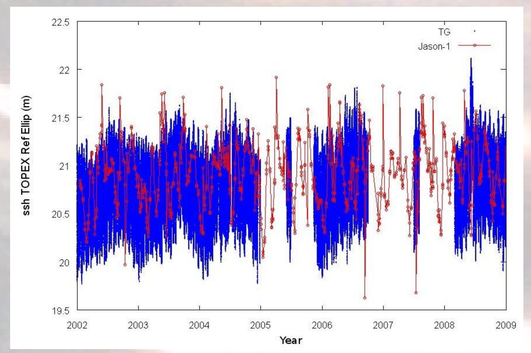
The buoy was deployed near the tide gauge to link gauge level to the altimeter's datum (Cheng et al., 2008).

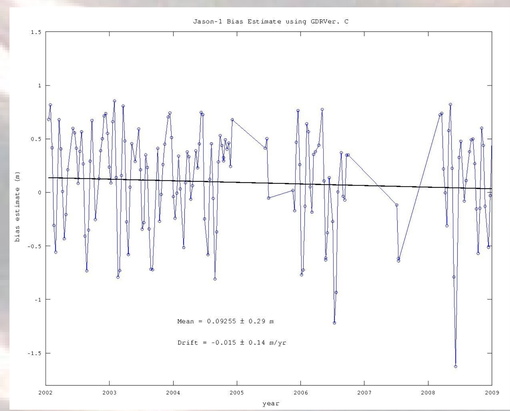




Based on Cheng et al. (2008), the geoid height (N) at Anping tide gauge is 19.801 m, which was determined with a 6-hour GPS 1 Hz kinematic solution and the tide gauge data (6-min interval). The GPS data was collected on April 2, 2008. Several repeated campaigns in the following years yield similar result. As can be seen in the figure, both data sets exhibits good correlation.

The time series of Jason-1 sea surface height with the tide gauge level superimposed. The gauge level has been corrected with geoid height, and the surface gradient from the gauge location to the Jason-1 footprint.





The bias estimate using GDR Version C with the data from Cycles 1–259 (Jan 2002 – Jan 2009) before Jason-1 orbit maneuver is 93 ± 294 mm. The drift of bias estimates is -15 ± 140 mm/year. The formal error of the drift is due to large variation in the time series. Gaps in the figure are due to the loss of either Jason-1 or tide gauge data.

Summary

The preliminary result of the sea surface height bias for Jason-1 determined at Taiwan's calibration site is 93 ± 294 mm, which is comparable to the main calibration sites. For example, the bias with GDR Version C is 70 mm Harvest and 63 mm at Corsica, respectively. The results at Taiwan's sites for different altimetry missions, such as Jason-2, Envisat and SARAL AltiKa, will be reported. Further investigation for path delay and sea state will also be included.

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