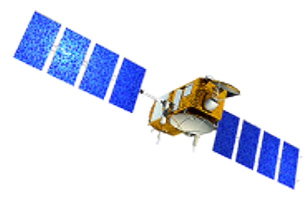
Comparison of sea-surface heights from altimetry and GNSS kinematic data offshore Vanuatu



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Summary: Two seamounts equipped with seafloor pressure gauges are located at the cross-over points of altimetry satellite ground-tracks. One is located at the cross-over point of tracks 303 and 374 of ERS/Envisat/Altika altimetry missions and the second one is located at the cross-over point of Topex-Poseidon/Jason1/Jason2 track 238 nominal mission and track 199 interlaced mission. During four field campaigns, we have collected GNSS data on buoys anchored above the pressure gauges, as well as on the R/V Alis while in motion or anchored.

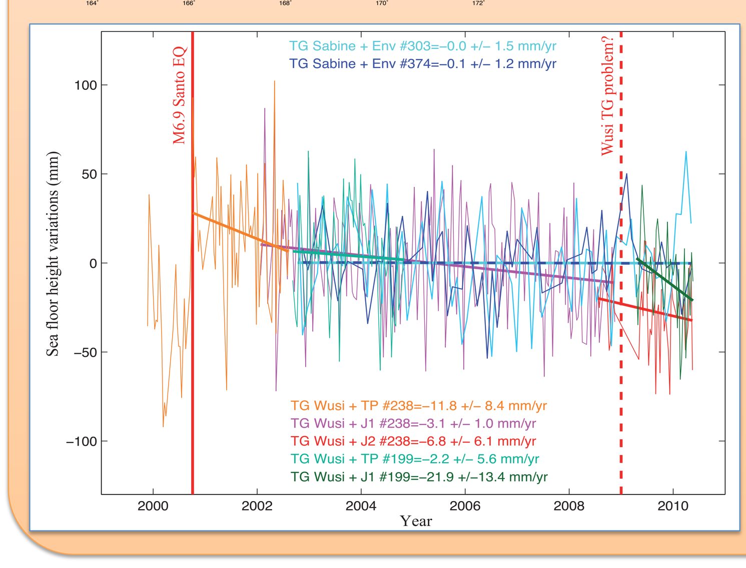
We have processed the GNSS data in kinematic mode using a variety of technics, including double difference mode using RTKLIB software and PPP mode using CNES GINS program (with and without Integer ambiguity fixing).

Our objective is to compare sea-surface heights derived from altimetry data with sea-surface heights computed from GNSS data for calval activities.

Study area and previous results

The New Hebrides Subduction zone is part of Pacific Ring of Fire, one of the most active seismic zone. The Australian plate is diving under the North Fiji Basin, on the western border of the Pacific plate at a mean convergence rate of 12 cm/yr.

This area has been selected both for its specification (optimal location of 2 seamounts beneath satellite tracks) and its geodynamical interest.

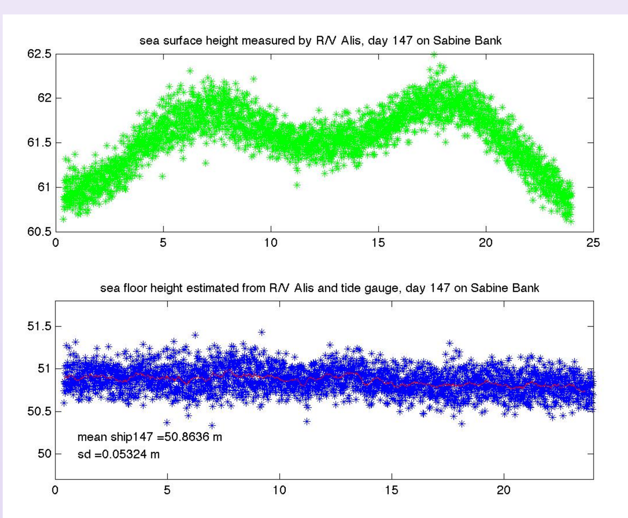


Absolute motion derived from tide gauge and altimetry data. We can see a clear difference in trend between the two gauges (on 2 different tectonic plates). This shows the evidence the subsidence of the over-ridding plate close to the plate limit (Ballu et al. 2013), which is an indication of subduction locking.

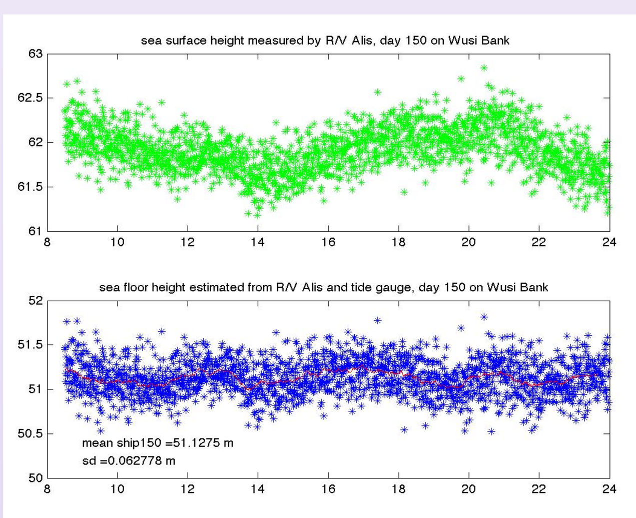
Comparison between altimetric sea surface height (ssh) and GNSS ssh

We compare seafloor heigths computed from altimetry and GNSS measurements using the same tide gauge data for water level corrections.

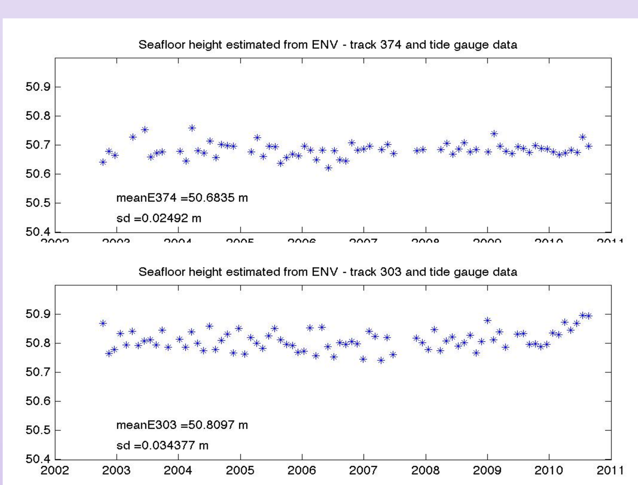
Seafloor height = sea surface height – water depth



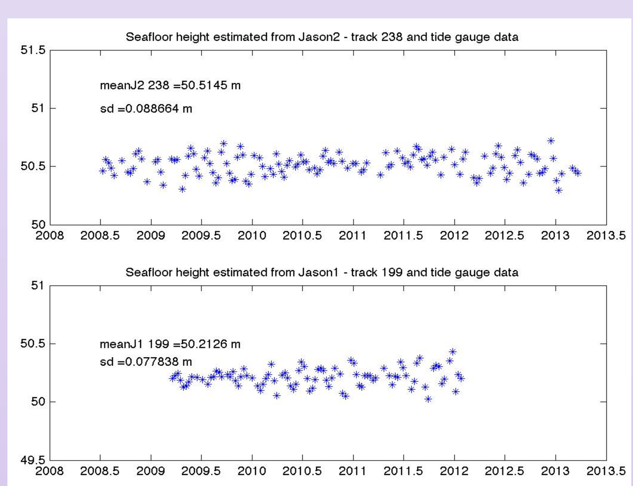
Sea surface and seafloor heights measured at Sabine Bank, using R/V Alis GNSS and Sabine tide gauge (doy 147, 2010). Hfloor=50.86 +/- 0.05m



Sea surface and seafloor heights measured at Wusi Bank, using R/V Alis GNSS and Wusi tide gauge (doy 150, 2010). Hfloor=51.13 +/- 0.06m

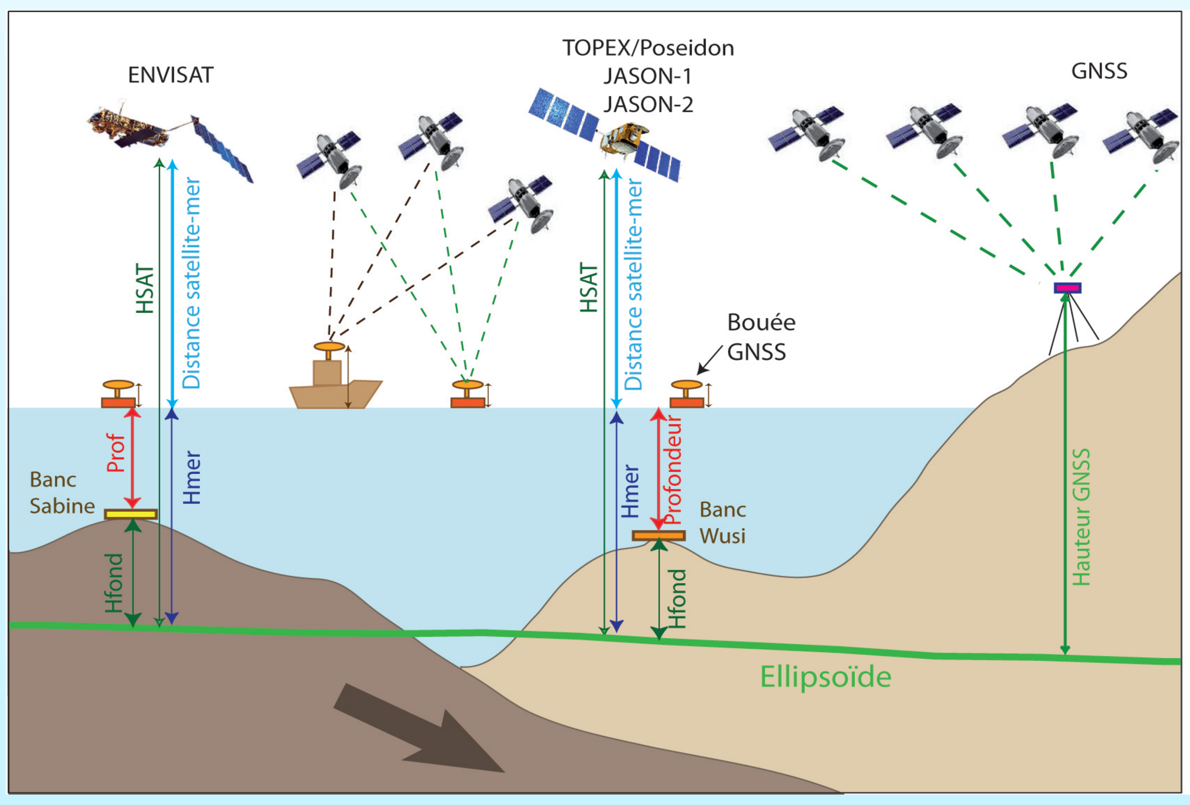


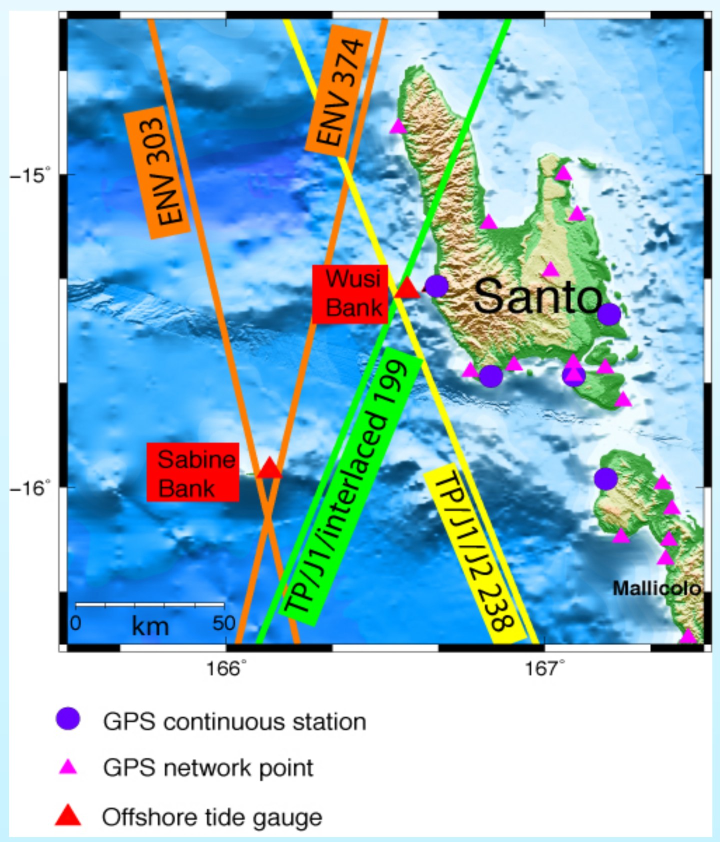
Seafloor height estimated at Sabine Bank tide gauge using Envisat data and Sabine tide gauge data.
Hfloor374=50.68 +/- 0.02m.
Hfloor303=50.81 +/- 0.03m

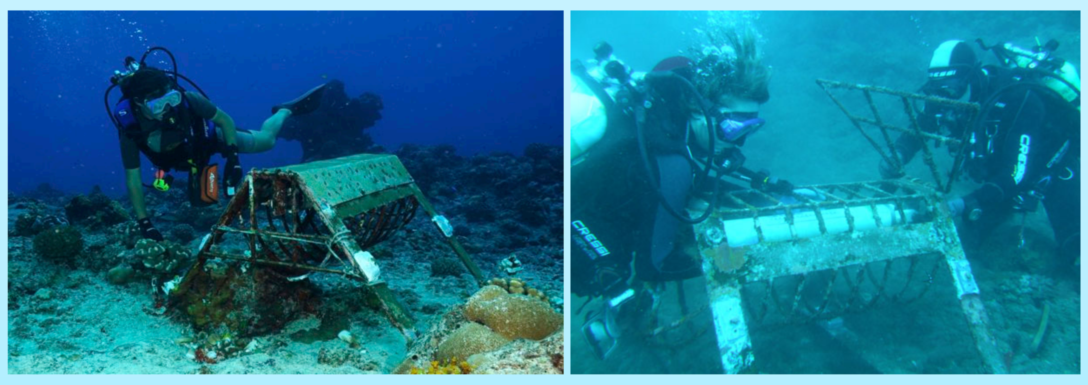


Seafloor height estimated at Wusi Bank tide gauge using Jason1 (track 199) and Jason2 (track 238) data and Wusi tide gauge data.
HfloorJ1=50.21 +/- 0.08m.
HfloorJ2=50.51 +/-0.09m

Experimental configuration







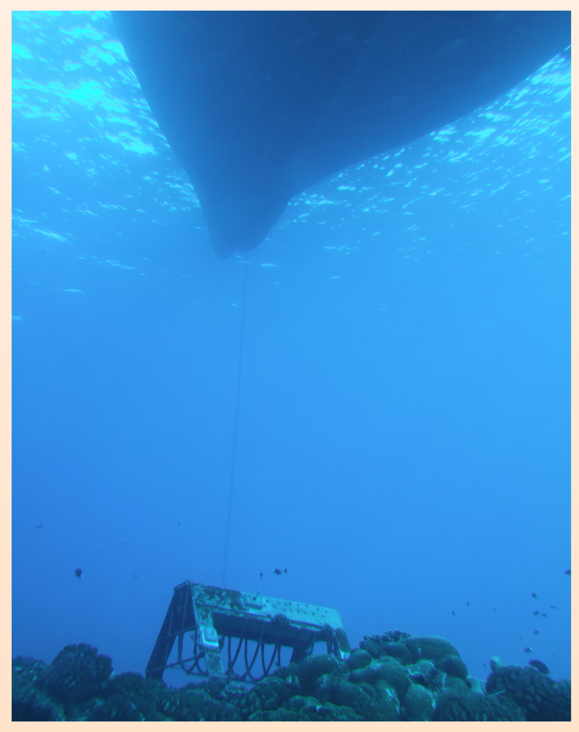
Both seamounts are located on both sides of the plate interface, allowing the direct analysis of vertical motion close to plate limit, where vertical deformation is expected to be the strongest in case of seismic stress accumulation.

SBE26 and SBE26plus tide recorders are deployed for 1 to 2 year periods and calibrated at the manufacture between deployments when possible. They are installed in a fixed frame and replaced exactly in the same position each time.

GNSS kinematic data collection and processing

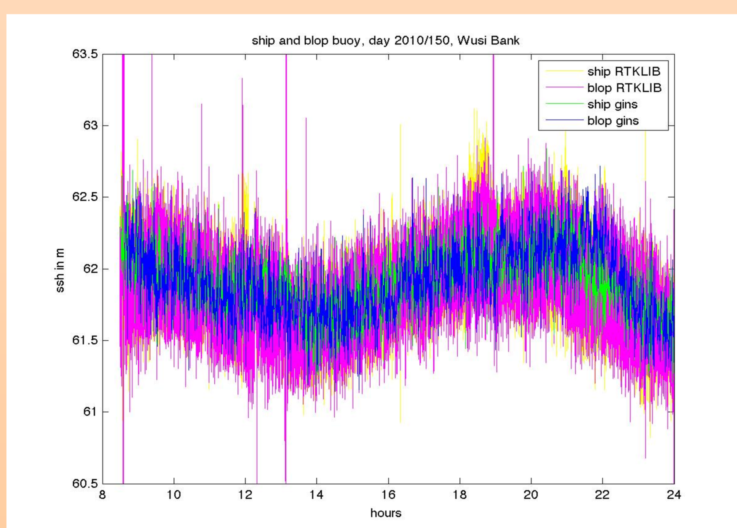
2 GNSS buoys (BIPG and BLOP) are attached to the R/V Alis while in station. This combined measurements help reduce the uncertainty on the antenna heigth above water determination.

R/V Alis

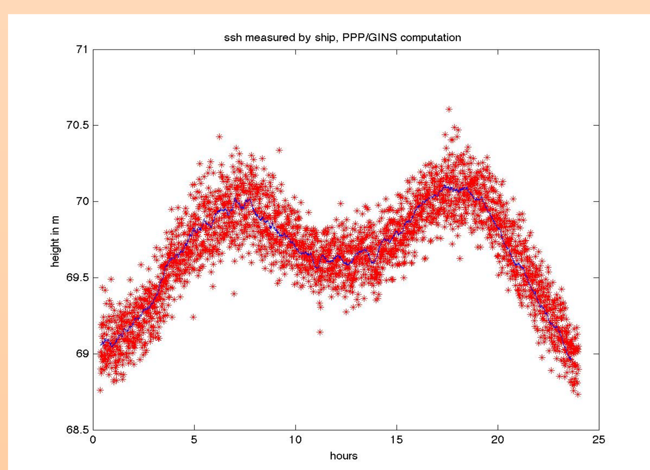


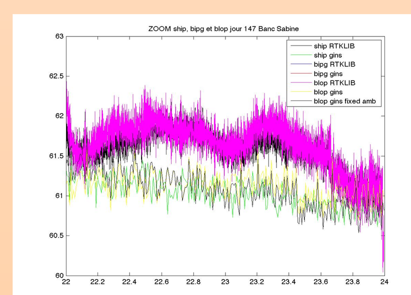
R/V Alis anchored above Sabine Bank tide gauge to determine sea surface height (2010 jour47).

We have collected sea surface height measurements above the 2 tide gauges using a ship (R/V Alis, equiped with a GNSS receiver on the roof) and 2 GNSS buoys. A critical use of the buoys was to help to precisely determine the height of the ship antenna above water.
GNSS data were processed both in double difference (using RTKLIB or GAMIT/Track package) and in PPP (Precise Point Positioning) mode (using GINS CNES software).
For Wusi site (10 km from fixed GPS station), both PPP and DD give similar results.
For Sabine Bank (80 km from on-land station), the PPP method gives better results.



Sea surface height measured above Wusi tide gauge with R/V Alis and Blop buoy. In this case, double differences (DD) are noisier than PPP results, but are still reasonnable.



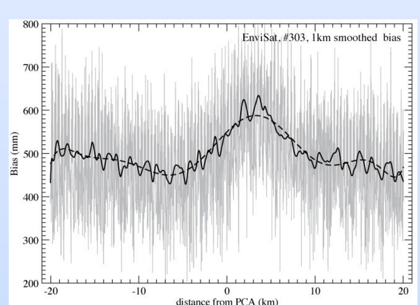


Sea surface height measured above Sabine tide gauge with R/V Alis. The zoom above shows the difference between PPP and DD processing. With a 80 km baseline, PPP processing is more suitable.

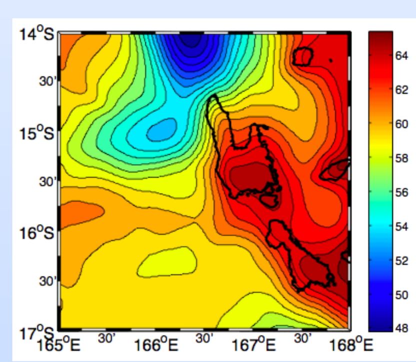
Conclusion and perspectives

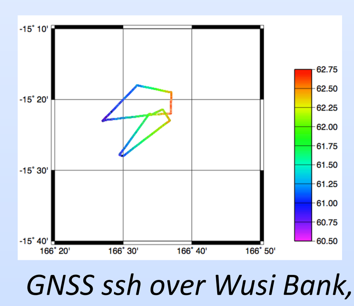
The work presented in this poster is still in progress. Our results show that PPP processing is a suitable method for kinematic computing at long distance from the shore. At Sabine Bank, our estimate of seafloor height using altimetry and GNSS are coherent; however, we observe a significant discrepancy at Wusi bank which still needs to be explored. It may be partly explained by a incorrect geoid difference between the satellite tracks and the tide gauge.

Example of short wavelenght geoid anomaly, not seen in global models, but evidenced by along-track biaises variations (Ballu et al. 2013). Bouin et al. (2009) have shown that EGM08 was the best approximation; however, it doesn't restore accurately the short wavelengths.



EGM08 geoid model over Vanuatu area, showing very high gradients. In the estimate of geoid difference between the satellite tracks and the tide gauge is possible.





GNSS ssh over Wusi Bank, showing the strong geoid gradient.

In order to be able to use our 2 tide gauges and the GNSS measurements above them for absolute altimetry biais estimate, we need to collect data on the geoid difference between the tide gauges location and the different satellite tracks. This could be performed using the Calnageo GNSS floating platform.

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