Validation of the Jason-1 altimetric data based on kinematic GPS sea level measurements during the DRAKE passage, Part 1 :

Calibration of the Floating Line of the research vessel POLARSTERN and GPS-buoy water level measurements inside the port of Puntas Arenas, Chile

Melachroinos, S. A. (1), Sundaramoorthy P. P. (2), Faillot M. (2), Menard Y. (2,3), Biancale R. (1,3), Provost C. (4)

(1) GRGS/DTP UMR5562, 14 Avenue Edouard Belin, 31400 Toulouse, France (stavros.melachroinos@dtp.obs-mip.fr), (2) GRGS/LEGOS UMR5566, 14 Avenue Edouard Belin, 31400 Toulouse, France,

(3) CNES, 18 Av. Edouard Belin, 31400 Toulouse, (4) LOCEAN/MNHN UMR 7159, 4 place Jussieu, P.O. box 100-4, Paris cedex 05

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Introduction

Several satellite altimeter missions are currently operating (ENVISAT, JASON-1) and others are planified for the future such as JASON-2 . With the current evolutions of global warming and mean sea level changes, these instruments are anticipated to contribute to the monitoring of global oceans. Therefore the monitoring and precise calibrations of biases and drifts of these altimeter systems are required.

The Drake campaign, which took place in January and February 2006, has been a very successful mission in collecting a wide range of oceanographic data along the JASON-1 altimetry ground track n°104. In order to provide a good validated altimetry data-slot for oceanographers during this mission, a sea-level GPS campaign took place all along JASON's ground track on the Drake passage during the same period of one month. These GPS sessions where performed in the harbor of Puntas Arenas during departure of the research vessel Polarstern, in the open sea, at O'Higgins in the Antarctic peninsula during arrival and back. A set of GPS receivers installed onboard the research vessel Polarstern, and a wave-rider GPS buoy for the calibration of the ship's floating position, were used.

This sea level data combined with altimetric data, allow us to cross-compare the sea surface height (SSH) estimates and measure the significant wave height (SWH) during the cruise across the Drake passage. These independent SWH measurements allow us to validate and correct the altimetric data as sea-state bias is one of the major sources of altimetry errors.

1. Data description of the Drake GPS campaign

The total GPS campaign along the Drake passage consists of :

- 2 GPS buoy – ship sessions inside the Port of Punta Arenas
- a total of 50 GPS buoy sessions in the open sea all along the Drake passage
- continuous GPS sessions from 3 receiver antennas onboard the Polarstern research vessel
- CGPS sessions from a total of 6 IGS and non IGS stations at 1s level.
- INS measurements for the Polarstern's attitude and accelerations determination

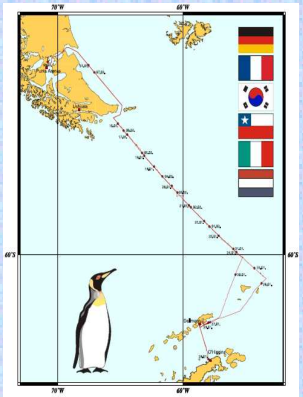


Fig. 2 : The Drake passage and the ship-buoy GPS sessions along Jason-1 104 ground track

In this project we calibrate the floating line wrt. Ashtech antenna onboard the Polarstern at the two terminals (Asmar terminal and Gas terminal) in the Punta Arenas harbor and in the mean time we perform GPS-buoy water level measurements. These periods of treatment are henceforth referred to as the first and second calibration periods. In the Asmar terminal, equipment was being unloaded off the vessel and the main activity in Gas terminal was fuelling. Independent positions are determined for the buoy and ship receiver during the two calibration periods. These solutions are subsequently used to derive the floating line. During the second calibration period we also evaluate the position time series for the Ashtech and the Trimble receivers onboard the Polarstern to analyze the correlation in motion between the two ship receivers.

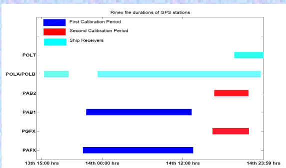
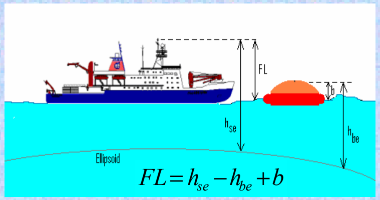


Fig. 3 : Data disponibility for the 1st and 2nd calibration periods



$$FL = h_{se} - h_{be} + b$$

Fig. 1 : The geometry of the ship's floating line determination

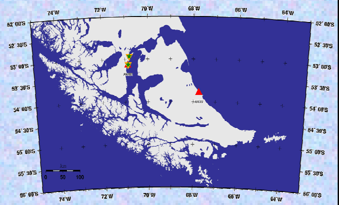


Fig. 4 : The GPS network used in the 1st and 2nd calibration period

2. 1st calibration period :
GPS buoy-ship campaigns in the Asmar terminal

Basically 1s Rinex observations from three different kinds of GPS stations are used :

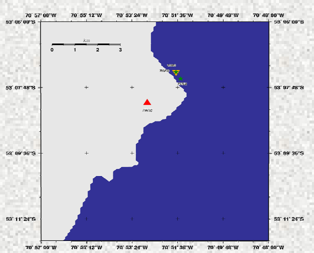
- Fixed stations (Dock Stations and CGPS stations)
- Buoy sessions (Wave rider GPS buoy)
- GPS Antenna sessions on the Polarstern

We are using the CNES/GRGS GPS software GINS to form normal equations with 10s and 3s interval. The time series were obtained for two cases, with ambiguities fixed for baselines with stable stations, and with ambiguities not fixed for baselines with moving stations (buoy-ship).

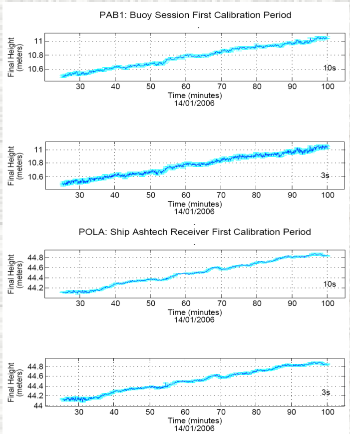
Fig. 5 : Figures from the GPS campaign inside Puntas Arenas port

(GPS data collected by M. Faillot and Y. Menard)

GPS stations of the 1st calibration period



2.1 GPS water level measurements



	RMS Errors (mm)					
	10 s			3s		
	phi	lambda	height	phi	lambda	height
PAB1	9.0	12.5	10.6	9.4	9.3	10.6
POLA	6.0	6.1	6.6	9.6	7.7	10.1

Fig 6: Determination of the buoy's and ship's vertical positions and RMS errors statistiques

2.2 1st Floating line

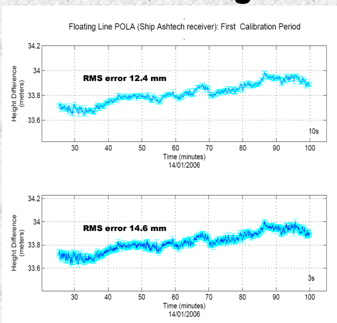
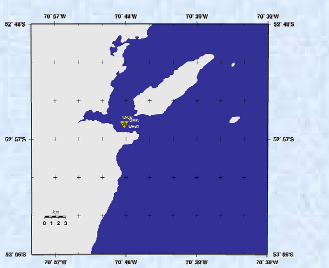


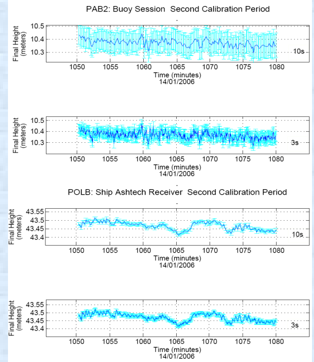
Fig 7: Determination of the ship's floating line in the 1st calibration period and RMS errors statistiques

3. 2nd calibration period :
GPS buoy-ship campaigns in the Gas terminal

GPS stations of the 2nd calibration period



3.1 GPS water level measurements



	RMS Errors (mm)					
	10 s			3s		
	phi	lambda	height	phi	lambda	height
PAB2	48.5	180.5	83.6	24.0	85.2	41.3
POLB	5.4	17.4	8.6	5.4	11.7	8.5

Fig 8: Determination of the buoy's and ship's vertical positions and RMS errors statistiques

3.2 2nd Floating line

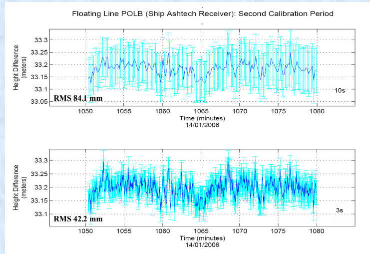


Fig 9: Determination of the ship's floating line in the 2nd calibration period and RMS errors statistiques

3.3 Ship's attitude

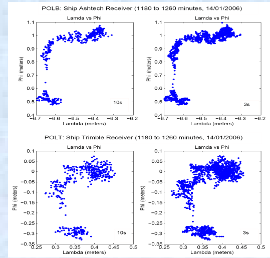


Fig 10: Correlation in horizontal motion between the two ship receivers

4. Conclusions - Perspectives

- We conclude that the difference in the Floating line between the 1st (before fuelling) and the 2nd calibration period (after fuelling) is of the order of 60cm !!!
- We have implemented the 1s GPS data mode processing inside GINS and in pre-processing stage!
- We developed a calibration procedure for the determination of the ship's floating line!!
- We have accomplished water level measurements in a calm environment (inside port) with cm and sub-cm precision!!!!

- We continue with the determination of the buoy's position in the open sea sessions were we derive all the necessary sea state parameters (SSH, SWH etc.) and we compare with Jason's altimetry measurements for bias extractions!
- Then by integrating the attitude variations from the ship's INS measurement unit we are going to determine sea state parameters all along the Drake passage and then again compare to the Jason's altimetry measurements for bias extraction on the ground track 104.