
SEAFLOOR GEODESY MARMARA

RV YUNUS CRUISE



JEAN-YVES ROYER



4-5 MAY 2017



SUMMARY OF OPERATIONS

The objective of the cruise was to download data from the sea-bottom distancemeter stations in the Kumburgaz Basin, Marmara Sea. The stations were installed by the Marine Geosciences Laboratory in Brest and Geomar Institute in Khil during RV Pourquoi Pas ? Marsite cruise late October 2014. The first data set was downloaded during the 3rd leg of the Marsite cruise, after only 15 days of operations. A 2nd cruise was organized in April 2015 by GEOMAR using RV Poseidon (POS484) to collect the data after 6 months of operation. A 3rd download was performed in April 2016 using again RV Poseidon (POS497). This cruise was the 4th data collection and was organized by the Technical University of Istanbul (ITU) using RV Yunus. The stations have been ranging on the sea-bottom for 2 years and 4 months.

The RV Yunus was on site the 4th of May 2017 from 13h15 to 20h30 (local time). After a night in Mimar Sinan, the ship was back on site the 5th of May from 8h00 à 13h30 (local time) and returned back to Istanbul late afternoon. In total, 12h45 of effective work were spent on site (about 30 nautical miles from Istanbul). The conditions were optimal with a beautiful weather and a calm sea.

Shipboard party: Ziyadin Çakir (ITU), Dietrich Lange (GEOMAR), Pierre Henry (CEREGE), Jean-Yves Royer (LGO), a Turkish master student (biology), the captain, and 4 crew members.

CTD MOORING

In 2016, a CTD mooring was laid on the seafloor, however the acoustic releases got entangled with the expandable weight. We used this opportunity to check whether the acoustic releases were freed or still horizontal (i.e. still entangled with the weight). An acoustic head was deployed from

the ship side, and the two acoustic releases replied to the acoustic deckset. However, with the same diagnostic, that they are still horizontal. An ROV will thus be needed to recover the mooring.

LGO ACOUSTIC BEACONS (2001 À 2004)

The three LGO acoustic beacons 2001, 2002 and 2003 responded immediately to the commands sent through the acoustic modem deployed at the aft of the ship (50m immersion). With few communication losses when the ship drifted too far away from the beacons. The beacon 2002 displayed an abnormal drainage of its battery (27% power left vs 47-49% for the other beacons), despite its reconfiguration in 2016 limiting the power consuming measures of attitude and battery level.

Beacon 2004, after a short successful communication, was unable to communicate with the surface modem, despite many attempts. From the last pages of data downloaded from the other beacons, it is still communicating with beacon 2002, 855 m away from it. Its communication with beacon 2001, 1311 m away, seems however interrupted since 20 April 2017. After a post-cruise examination of the log files by the manufacturer Sonardyne, it may be due to a default in the beacon acoustic head, noticed on other beacons of the same kind, and points to a definitive failure in a near future. Its recovery, at the end of the experiment, may turn out problematic. A closer examination of the data shows that the repeated attempts to communicate with this beacon in April 2016 (cruise POS497) have modified the electronics of the beacon (offset in the flight travel times).

Downloading the data from beacons 2001, 2002 et 2003 respectively required 51, 33, and 52 minutes, including, for 2001 and 2003, a repositioning of the ship when her drift was too important. Attempts to connect with beacon 2004 lasted 1h27 out of a total of 6h30.

GEOMAR ACOUSTIC BEACONS (2301 TO 2305 AND 2307)

Interrogations of the GEOMAR beacons started when all the data were downloaded from the LGO stations. They are all operating normally, except for the failure of some auxiliary sensors on some of them (pressure or temperature sensors). No difficulty occurred in downloading the data, except for the drift of the ship. In total, downloading the data required 6h.

Beacon	Downloaded pages start-end (number)	Duration minutes	Power left In batteries
2001	3298-4725 (1427 p)	51	47%
2002	3474-5274 (1800 p)	33	27%
2003	2453-3724 (1271 p)	52	49%
2004	0	-	48%
2301	completed	?	
2302	1262-2185 (923 p)	52	
2303	1305-2257 (952 p)	19	
2304	1301-2246 (865 p)	23	21%
2305	1200-2238 (1038 p)	50	
2307	1259-2180 (921 p)	28	

Table 1 : Summary of the pages downloaded from the acoustic beacons. the 4 and 5 May 2017.
Note that beacon 2002 uses more memory than the other beacons.

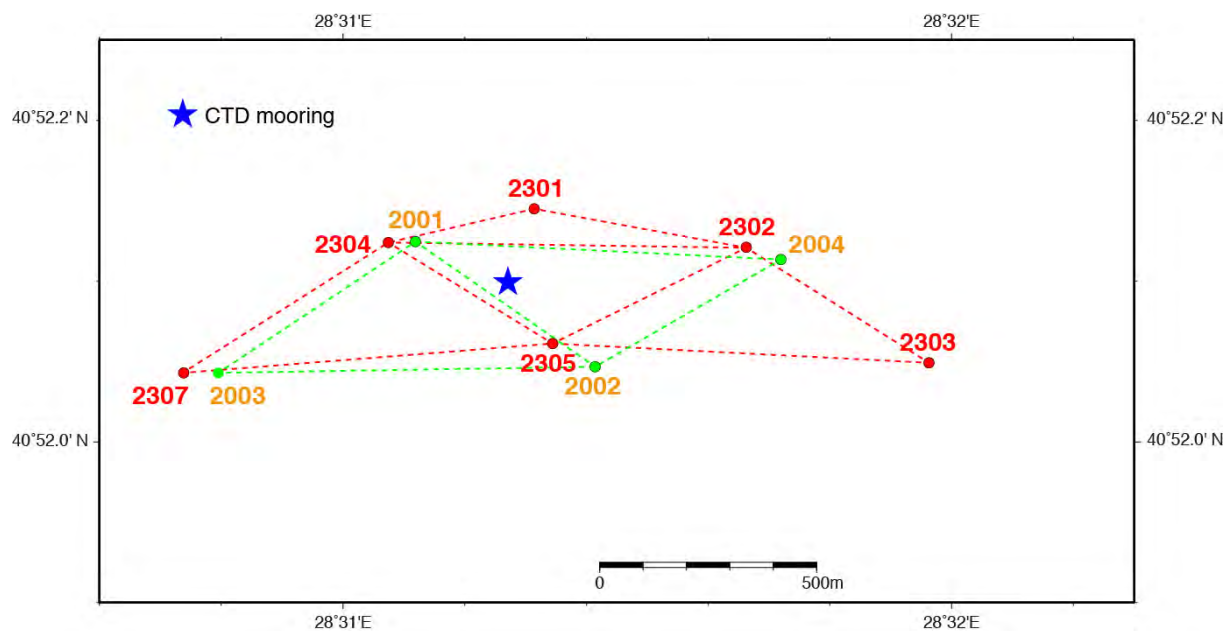


Figure 1: Location of the acoustic beacons stations in the Sea of Marmara : LGO beacons in green (2001-2004), GEOMAR beacons in red (2301-2305 and 2307).

OPERATIONS

On board in the morning of 4th of May 2017 at Hyderpasa harbor, gate D (near the ferry terminal), Asian side of Bosphorus. Some wait at the check-post until the list of shipboard parties was ready. The RV Yunus was only 500m away from the check-post, docked alongside another oceanographic vessel, of which the crane was used to load the equipment on board RV Yunus

4 MAY 2017

Hour UT (Istanbul = UT+3)

- 6h30 Sailing from Hyderpasa harbor (9h30 local time)
- 7h30 End of refueling the ship from a fuel boat, underway towards the CTD mooring site : 40° 52.21N 028° 31.31E ; 8.5 knots
Installation of the acoustic modem on the deck (3 stainless steel shackles were missing for fixing the chain weight onto the protection cage, borrowed from the ship)
- 10h15 In station (after 2h45 of transit) 40° 52.20N 028° 31.33E, deployment of the TT301 acoustic head
- 10h18 **Interrogation of the 1st acoustic release** (ARM 0961, diagnostic 0949)
- 10h21 Range ok 819m, 820m, but still in horizontal position 5.1.3.4 (dots between digits on the display)
- 10h23 Confirmation of its horizontal position: 5.1.3.4 et 5.1.3.4
- 10h24 **Interrogation of the 2nd acoustic release** (ARM 0240, diagnostic 0249)
- 10h25 Range ok 831-832-834m, but also in horizontal position 5.1.5.2
- 10h27 Confirmation of its horizontal position: 5.1.5.4 et 5.1.6.0
The 2 acoustic releases of the CTD mooring are horizontal, as after their deployment in 2016.
- 10h30 **Deployment of the LGO acoustic modem**, 50m depth from the aft A frame
- 10h44 Test ok, the deckset communicates with the modem (unit ID 003CBO)
Load job (i.e. configuration file of the stations)
Connection to 2001
Check config ok 47% battery left
Check time & logging ok
Check sensors ok
- 10h54 Bookmarks : 3298-4722
- 10h55 Downloading pages 3298-3378 (1st & last page, ~80 pages)
- 10h57 3378-3457

11h03 Due the drift of the ship southeastward, the ships comes back to the mooring site, even goes beyond and starts drifting again

11h04 page 3618 ok

11h13 **Connection to 2002**, config ok 27% battery, check sensors ok
Bookmarks : 3474-5233

11h21 3474-3553

11h21 3633 (last page)

11h23 3713, return to the NE waypoint, drift starts

11h25 3793-3873-3953-4033-4113-4193-4273-4433-4513-4593-4673-4753-4833

11h47 4913-4993-5073-5153-5233

11h54 5270, download of beacon 2002 completed in 33 minutes

12h01 Resync time (re-synchronization of the beacon clock with the PC clock, set at the GPS time)

12h02 New connection to 2001
Check config ok 47% battery
Connection to beacon 2004, near the apex of the ship

12h05 Check config : could not find TPL 187 (Telemetry Power Level)
battery 48%

12h09 Time & logging : time offset 18.4s
Bookmarks : 1360-3898 (= 2538 pages)

12h18 Attempt to download pages 1280-1359, with no success

12h19 Check sensors : NO REPLY (ship at 0.26 miles from 2004)

12h20 Checking config 2002 OK although this beacon is at 0.54 miles from Yunus

12h24 Return to point G1
Reconnection to 2001
Downloading pages 3615-3694

12h25 Yunus on the move, downloading interrupted

12h47 Ship in position, download resumed

12h48 3774-3852-3932-4012-4092-4172-4255-4332-4412-4492-4572-4652

13h06 4722, last page. Download completed

13h16 Connection 2003
Check config ok : battery 13.6V 49% 13.8 °C

13h17 Check time & logging : time offset -22.0s

13h18 Check sensors : P=8364.5, inc=+2.17 -1.20 T=14.53 °C

13h20 Bookmarks : 2453-3724 (1271 pages)

13h21 Starting download
2532 failed, ship too far from beacon
Return to G1 (we are 0.3 miles southward)

13h42 **Connection to 2004** (Yunus in drift) : NO REPLY
2002 replies (0.2 miles away)
2003 replies (0.5 miles away)

13h45 2004 does not reply (0.25 miles away)

13h48 Resuming download from beacon 2003: 2532-3724

13h49 2610-2691-2769-2849-2929-3009

13h58 3089, interrogation stopped to let the beacon communicate with the other (ranging)

14h03 Moving 0.3 miles northward 40° 52.10N 028° 31.63E

14h11 **Connection to 2004** (quasi at the apex of Yunus): NO REPLY

14h13 **Connection to 2002**, download of the last page (5271) where we check that the beacon 2004 is still communicating with the others (it does)

14h20 **Connection to 2003**, resuming download 3170-3724

14h21 3249-3327-3407-3487-3568-3647

14h31 3724 (last page)

14h32 Re-download of 3070 to 3170 to make sure to have the whole set of pages

14h33 3070-3150-3170 completed
 Data export indicates that some pages are missing in the beginning

14h38 2450-2550, ship is moving, download failed at page 2529

14h41 New attempt while the ship is drifting

14h43 2530-2550 ok, pages completed

14h45 Back to 2004

15h01 **Connection to 2004, Test acoustic link**
 Transceiver : no lights
 Transponder: Quality=76 (green), Noise=7 (yellow) Strength=-26 (yellow)

15h04 Transponder: Q=80 (green), N=6 (yellow) S=-30 (yellow)
 Check config : NO REPLY

15h05 **Connection to 2001** Time & logging : time offset -6.5s
 Resync time delta = 0.4s

15h07 **Connection to 2002** Resync time delta = 0.4s

15h08 **Connection to 2004** NO REPLY

15h09 Test acoustic link : Q=80 N=6 S=-30
 Telemetry power increased from 174 to 187

15h13 Command line : MR :2004 ;W1 -> no effect !

15h14 FS : 2004 ; W1 -> no effect on 2004 (ok with 2002)
 ALS : 2004 ;W1 -> no effect on 2004 (ok with 2002)

15h43 Ship stopped at the apex of 2004
 NO REPLY
 Test acoustic link
 Link : Q=80 N=6 S=-30
 Tansceiver : nothing !!

16h00 LGO acoustic modem back on deck
Deployment of GEOMAR acoustic modem

16h17 Starting interrogations

16h20 **Connection to 2301:** downloading pages ??- ?? completed

17h16 **Connection to 2307:** downloading pages 1259-2180 completed

17h18 **Connection to 2305:** downloading pages 1276-1350 partially completed

17h30 **Modem on board.** Sailing to Mimar Sinan harbor

19h00 At dock (22h00 local time; 1h30 of transit)

5 MAI 2017

3h50 Sailing from Mimar Sinan (6h50 local time)

5h00 On site (8h00 local time; 2h10 de transit)

5h10 **Geomar acoustic modem deployed**

5h17 **Connection to 2304:** pages 1301-2246 (21% battery left)

5h40 Download completed

5h47 **Connection to 2305:** retrieving the missing 1200-1278 pages
 1350-2120

6h10 Ship moves back to position

6h39 2120-2238

7h25 Download completed (38 minutes + 12 minutes the day before)

7h26 **Connection to 2303:** pages 1305-2257

7h45 Download completed (19 minutes)

7h52 **Connection to 2302:** pages 1262-1472
 Ship moves back to position (7h49-8h10)

8h14 1472-1610

8h31 1610-2185

8h44 Download completed (52 minutes)

9h00 GEOMAR Download completed. Modem on deck. **LGO modem redeployed**, 50m deep

9h15-30 Lunch break

9h31 **Connection to 2002** Check config ok

9h32 Downloading 5271-5274

9h33 **Connection to 2001** Check config ok
 Downloading 4722-4725

9h33 **Connection to 2003** Check config NO REPLY, beacon too far away (0.56 miles)

9h35 **Connection to 2004** Check config NO REPLY
 Test acoustic link : NOTHING !
 Checking the last downloaded pages:
 2001: no data from 2004 (1311m away) since 20 April 2017 - 16h00
 2002: last data from 2004 (855m away) 5 May 2017 - 08h06 (p. 5274); subsea communication between 2002 and 2004 seems to be working.

10h03 **Connection to 2004:** retrieve pages : no reply
 Get some info: SQ=21 SNR=22 SStrength=-54 too weak
 Test acoustic link: SQ=0 SNR=0 SS=0
 Increasing modem power: no effect
 Increasing telemetry power: no effect
 Increasing gain: no effect

10h15 **Connection to 2002** Test acoustic link ok (dist=0.52 miles)
Connection to 2004 Test acoustic link NO REPLY (dist=0.27 miles)
 Beacon 2004 no longer communicates with the modem, but still communicates with the other beacons

10h30 **Modem LGO on deck, leaving for Istanbul** (13h30 local time)

11h04 Equipment partly packed (modem, cage)
 Troubles exporting the data with the LGO software (truncated decimals), using GEOMAR software

13h15 At dock at Hyderpasa harbor (along-side the same oceanographic vessel; 16h15 local time)
 Return transit took 2h45 (24 miles)
 Meeting with Sertan Pehlevan, in charge of sending our shipment back to France and Germany.

18h00 Disembarking RV Yunus, end of cruise.
 Exiting the harbor through gate C (bags checked).

PRELIMINARY RESULTS

BEACON HEALTH STATUS

The battery power is down to 50% for beacons 2001 et 2003, and to 75% for 2002 (Figure 2). The battery voltage is close from its nominal value at 13.7V. Note that we reduced the sampling of some parameters on beacon 2002 in April 2016 to reduce the power consumption. The internal temperature seems relatively constant near 14.5°C, close to the ambient sea temperature. One can notice temperature increases corresponding to the data download in April 2015 (POS484) and 2016 (POS497).

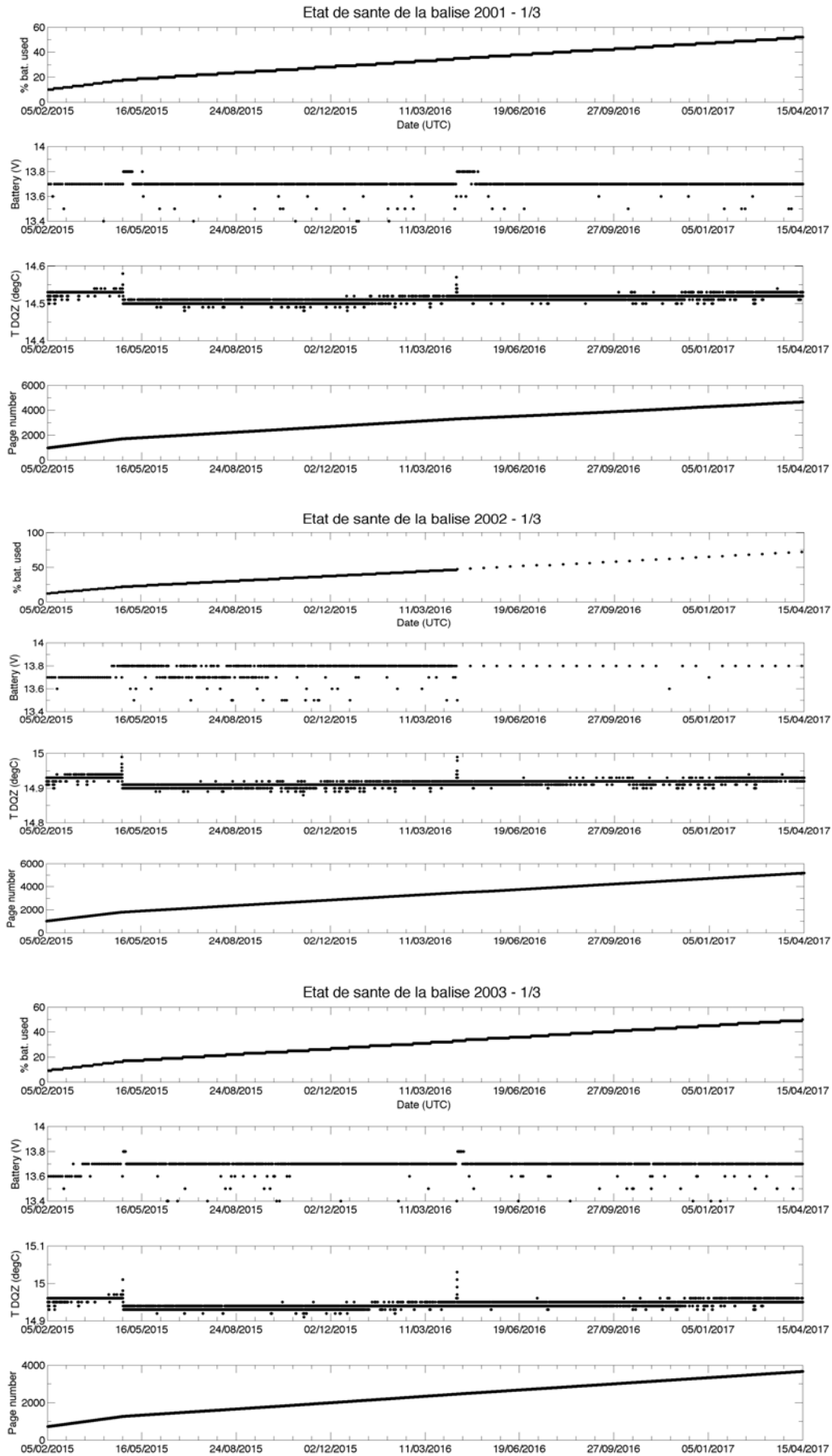


Figure 2: Health status (*état de santé* in French) for beacons 2001, 2002 and 2003. No data could be downloaded from beacon 2004 since April 2015.

BEACON STABILITY

The three beacons prove very stable (Figure 3). Note the down-sampling on beacon 2002 (in blue) to reduce the power consumption (reconfiguration in April 2016).

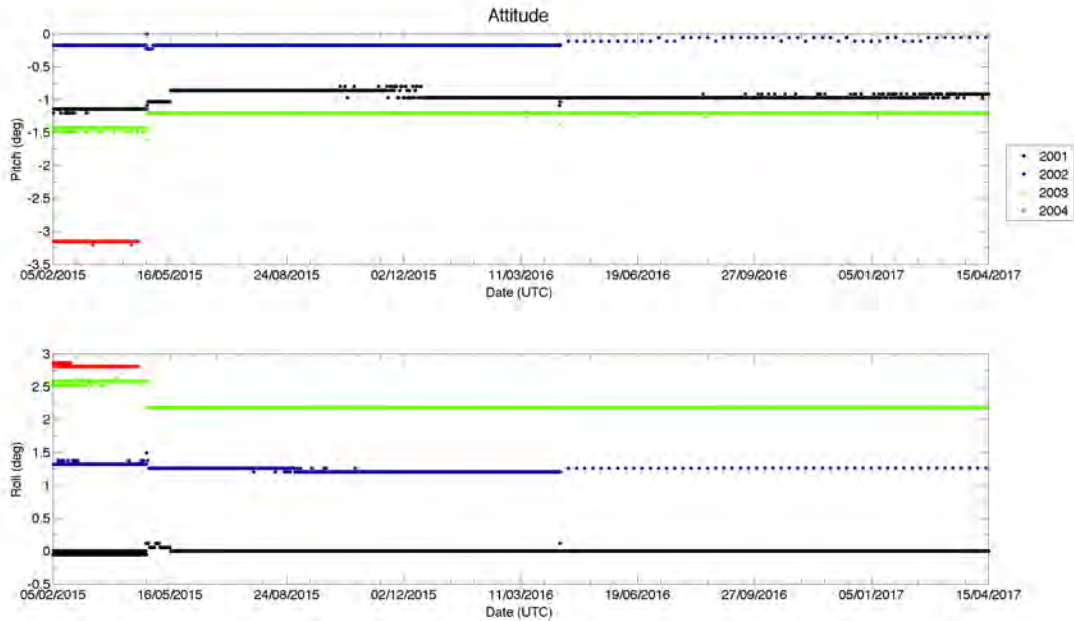


Figure 3: Inclination parameters of the beacons.
No data could be downloaded from beacon 2004 since April 2015.

AUXILIARY SENSORS

All auxiliary sensors show a continuous functioning (Figures 4, 5 et 6). Temperature sensors still record intermittent and transient fall in the order of 0.02°C corresponding to cold fluxes of deep water. The offsets between sensors varies as they drift independently. Pressure sensors show synchronous variations probably linked to the occurrence of low pressure and storms. Sound-speed measurements are still very erratic, with offsets matching cold water pulses and a variable drift.

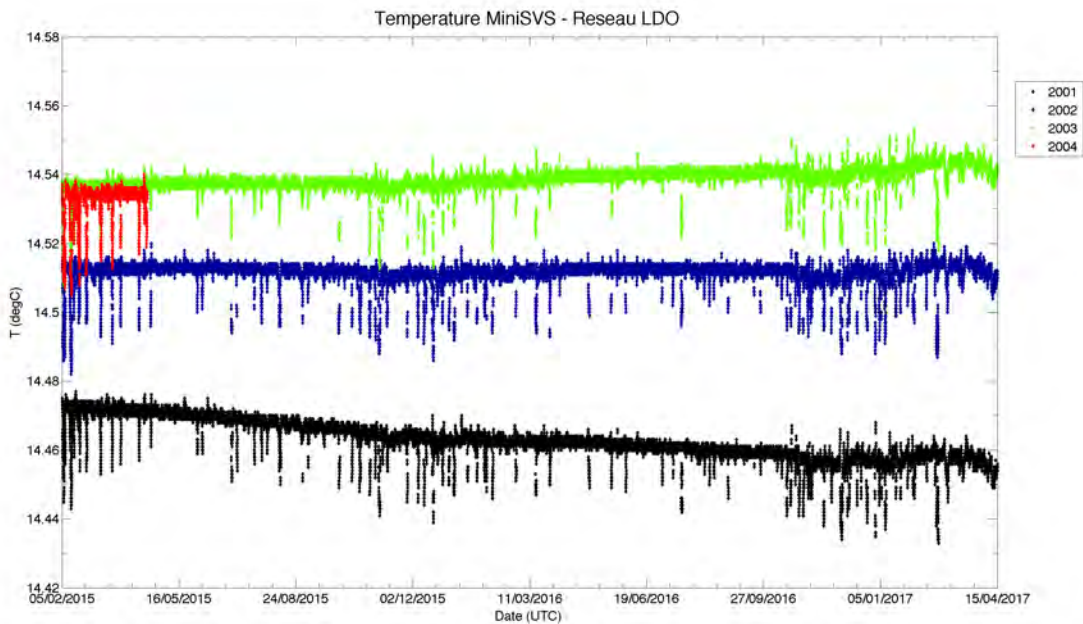


Figure 4: Temperature measurements.
No data could be downloaded from beacon 2004 since April 2015.

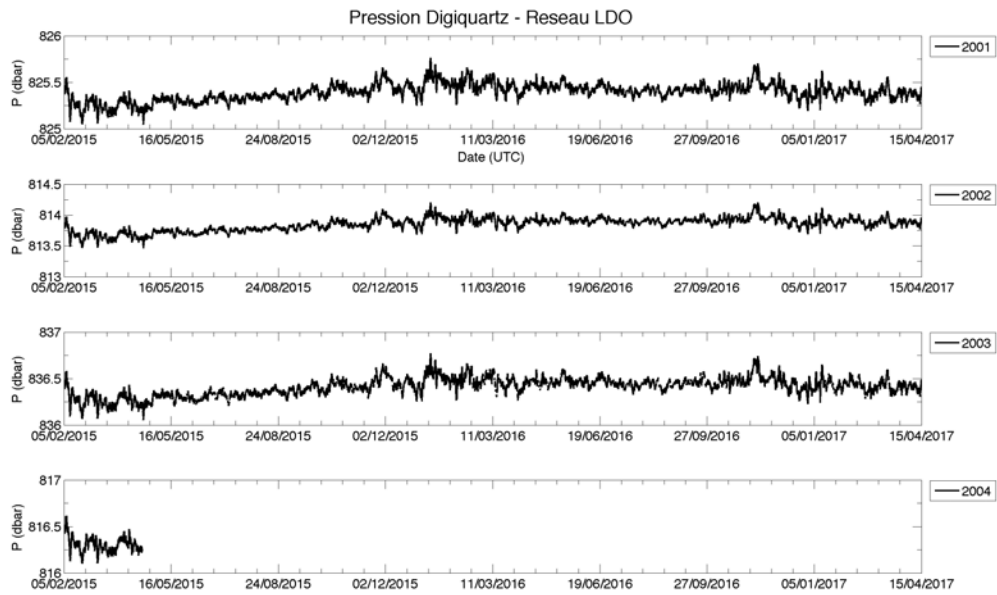


Figure 5: Pressure measurements.
No data could be downloaded from beacon 2004 since April 2015.

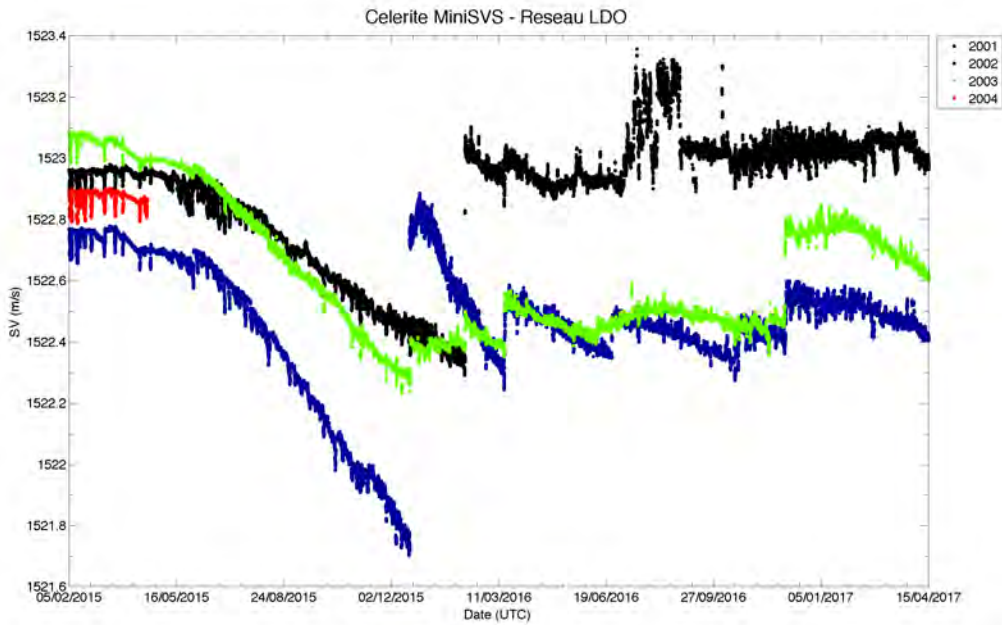


Figure 6: Sound-speed measurements.
No data could be downloaded from beacon 2004 since April 2015.

FLIGHT TIMES

Beacon 2001 communicates with beacon 2002, 2003 and 2004 (Figure 7). One can notice the lack of or discontinuous ranging with beacon 2004, symptomatic of communication problems with its acoustic modem. Flight times are affected by cold water pulses and by long wavelength changes in temperature, for instance early 2017.

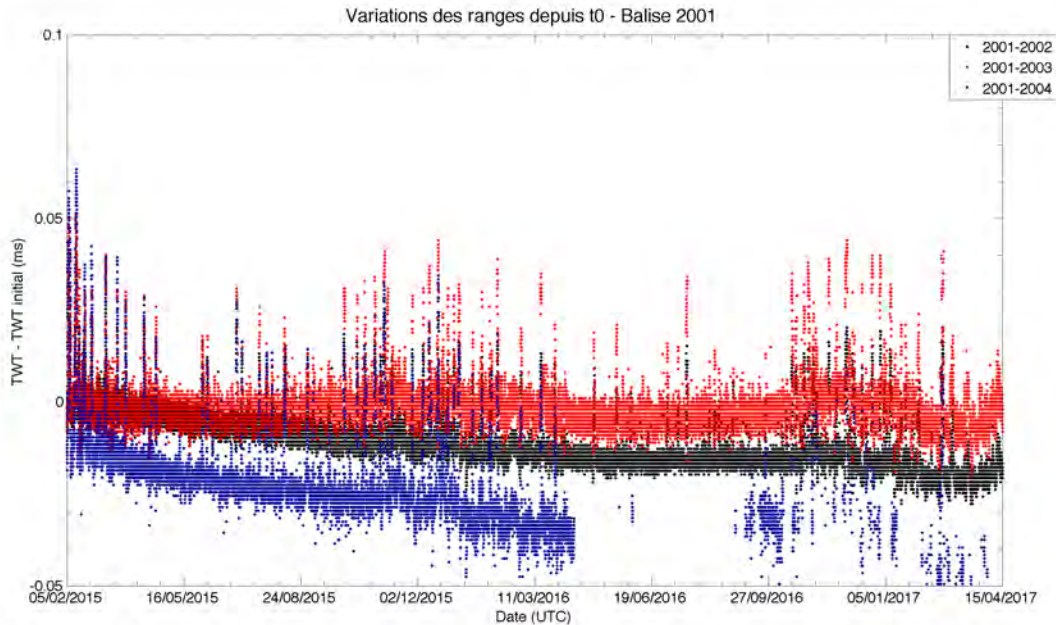


Figure 7: Flight times from beacon 2001.

Beacon 2002 communicates with beacons 2001, 2003 and 2004 (Figure 8). The communication with 2004 is continuous, but the travel times show an important offset in May 2016, corresponding to the data download during cruise POS497.

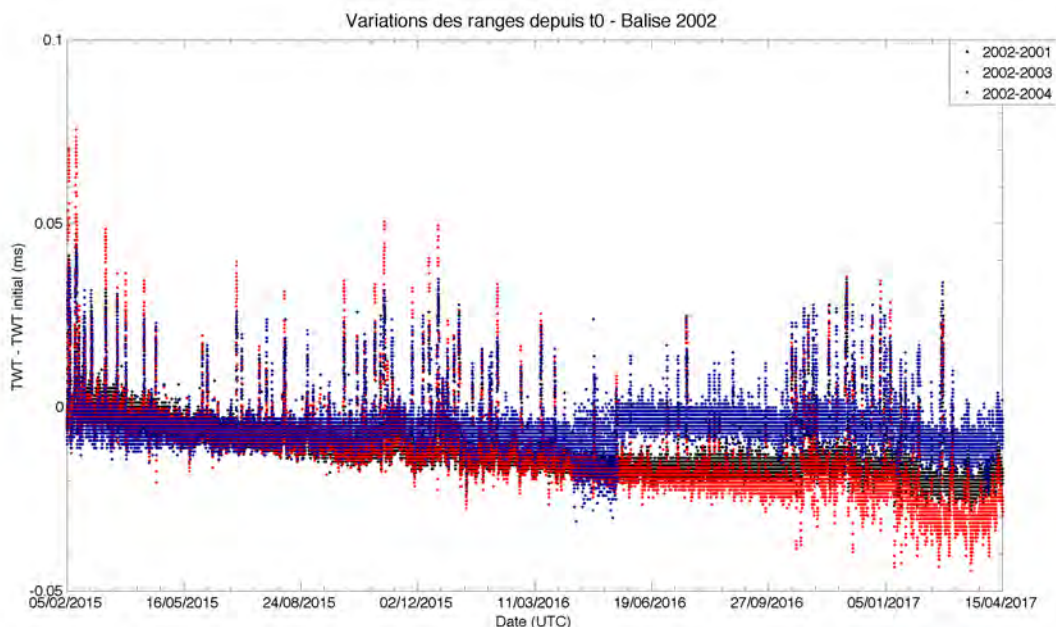


Figure 8: Flight times from beacon 2002.

Beacon 2003 communicates only with beacons 2001 et 2002 (Figure 9). The flight times are consistent with the travel times in the opposite directions, with a lower dispersion, though, compared to the flight times from 2001 (Figure 7).

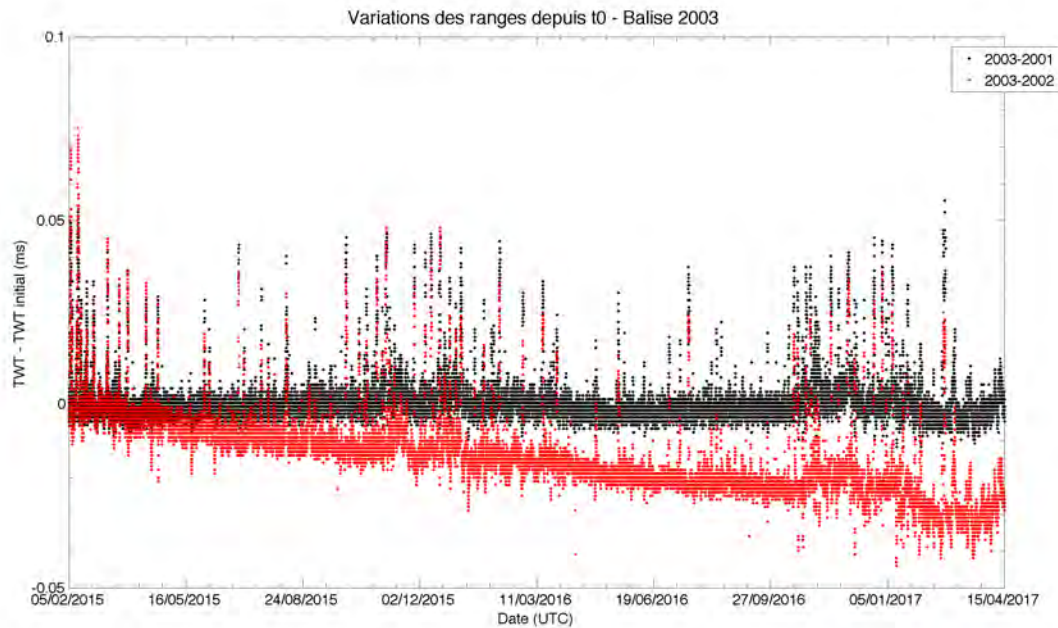


Figure 9: Flight times from beacon 2003.

Finally, beacon 2004 only communicates with beacon 2001 et 2002 (Figure 10). The inability to download any data since April 2005 from beacon 2004 limits the observation.

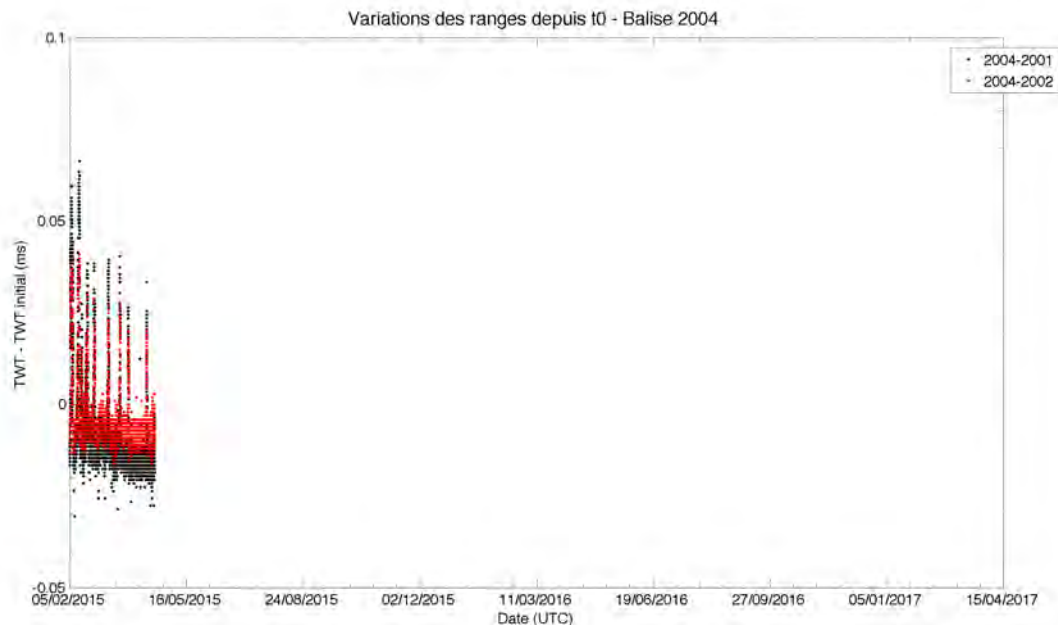


Figure 10: Flight times from beacon 2004. The lack of data only reflect our inability to download any data since April 2015.

PROCESSED DATA

Sound-speeds were recalculated from the temperature and pressure data, using DelGrosso formula. Then, the flight times can be converted into distances between beacons. The comparison of baselines in opposite direction de shows that there is no consistent motion along the North-Anatolian fault. Baselines 2001-2002 and 2001-2003, which would cross an east-west oriented fault, both shrinks of about 20 mm in 2 years (Figure 11). Data from the GEOMAR on the same baselines show the exact opposite ; baselines 2304-2307 and 2304-2305 lengthen by 5 to 10 mm during the same period (Figure 12). The longer baselines 2301-2307 and 2301-2303 confirm the absence of consistent motions (Figure 13). The beacons being stable on the seafloor, these apparent changes in baseline length are likely resulting from the drifts in the temperature and pressure sensors.

In conclusion, these preliminary observations would show that the North Anatolian fault has not been active for the last 2 years or that it is active outside our network of acoustic beacons.

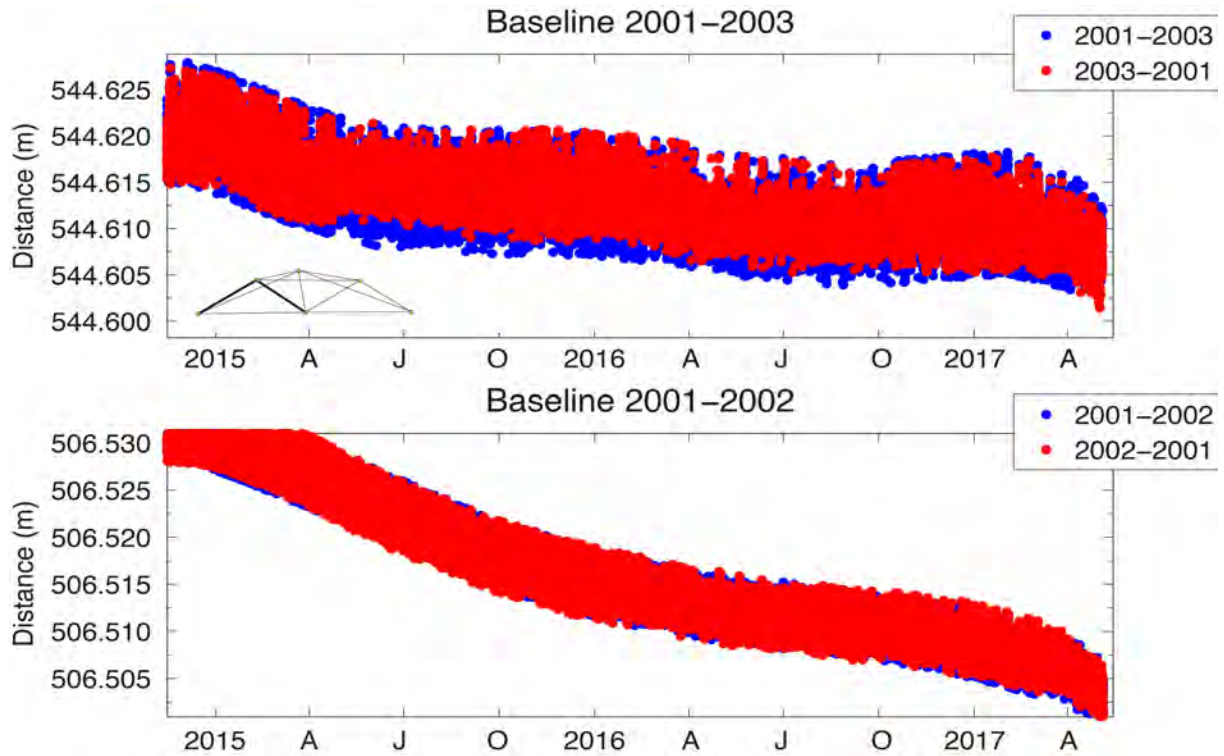


Figure 11: Apparent changes in baseline lengths.
The two baselines of opposite direction shrink (bold lines in inset).

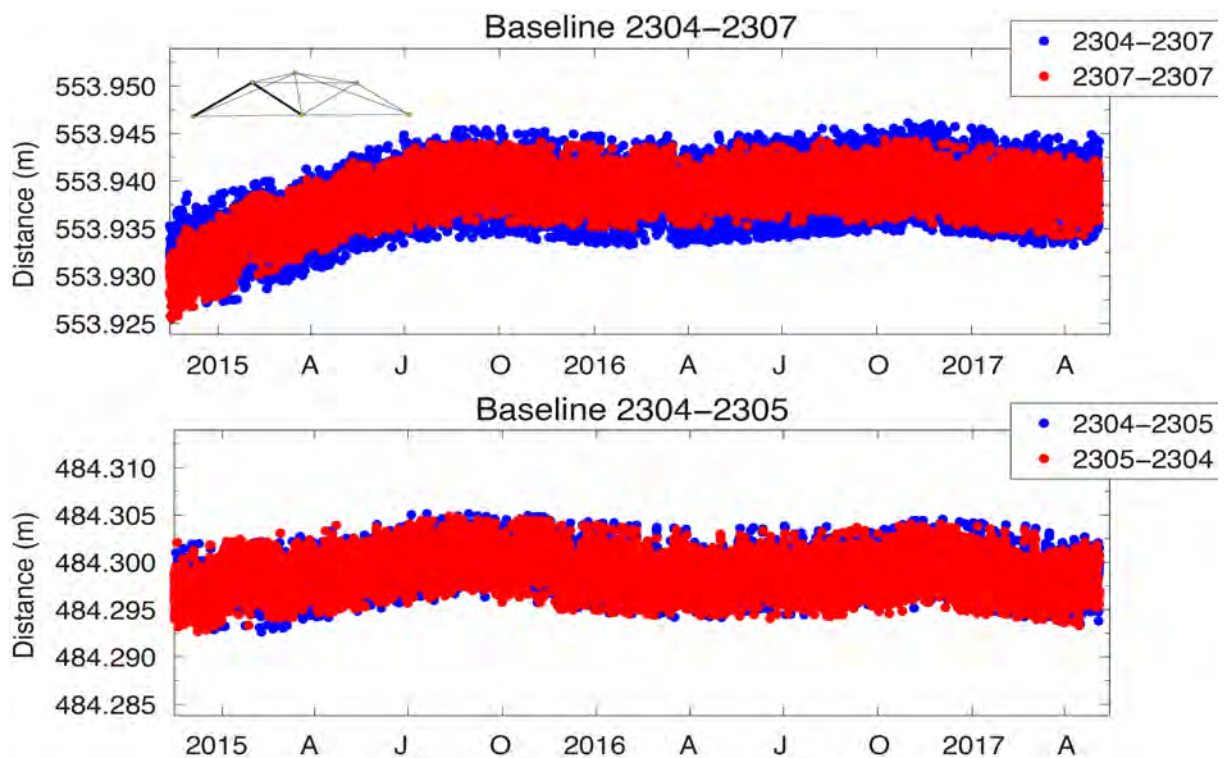


Figure 12: Apparent changes in the same baselines as in Fig. 11 (bold lines in inset) based on the GEOMAR data. The two baselines of opposite direction slightly lengthen.

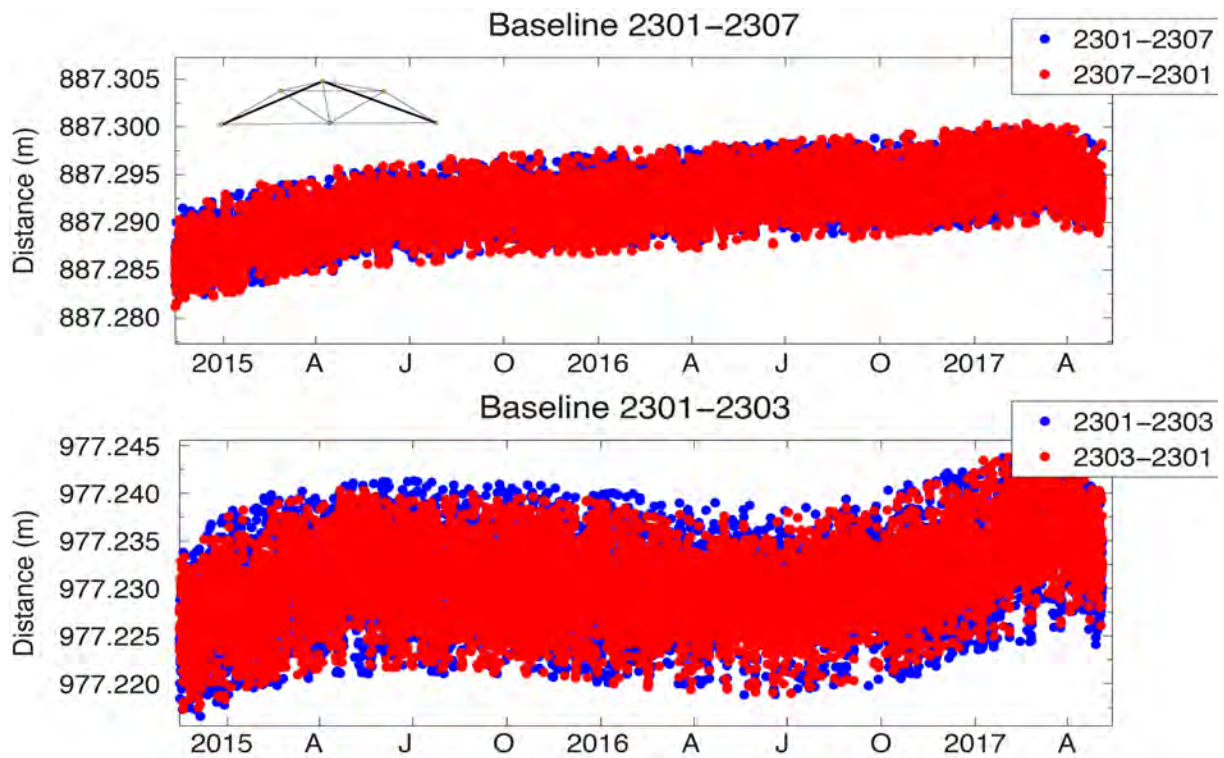
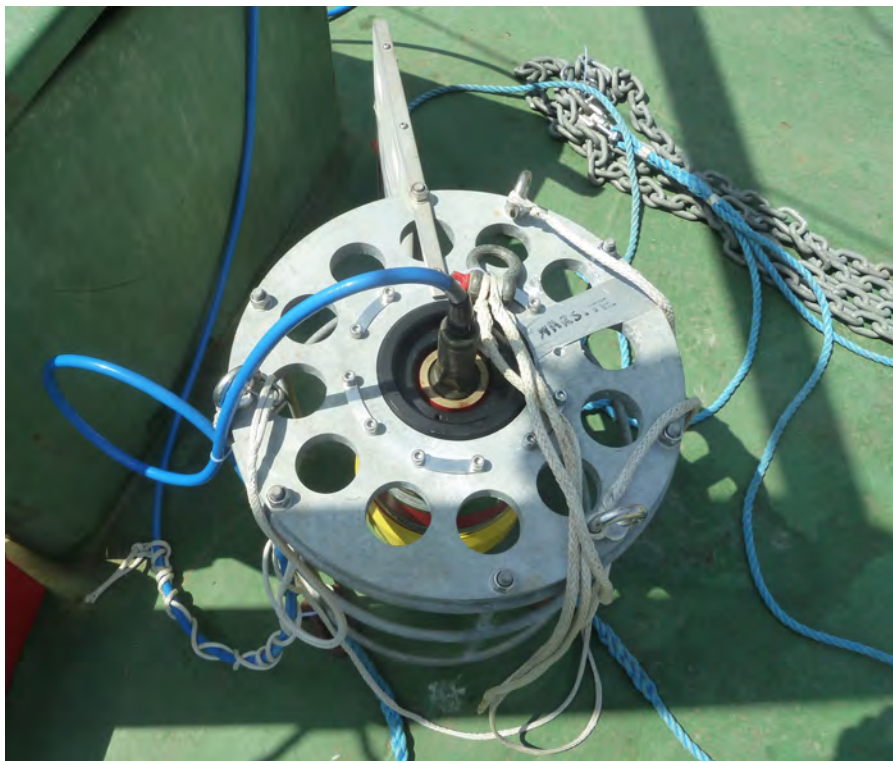


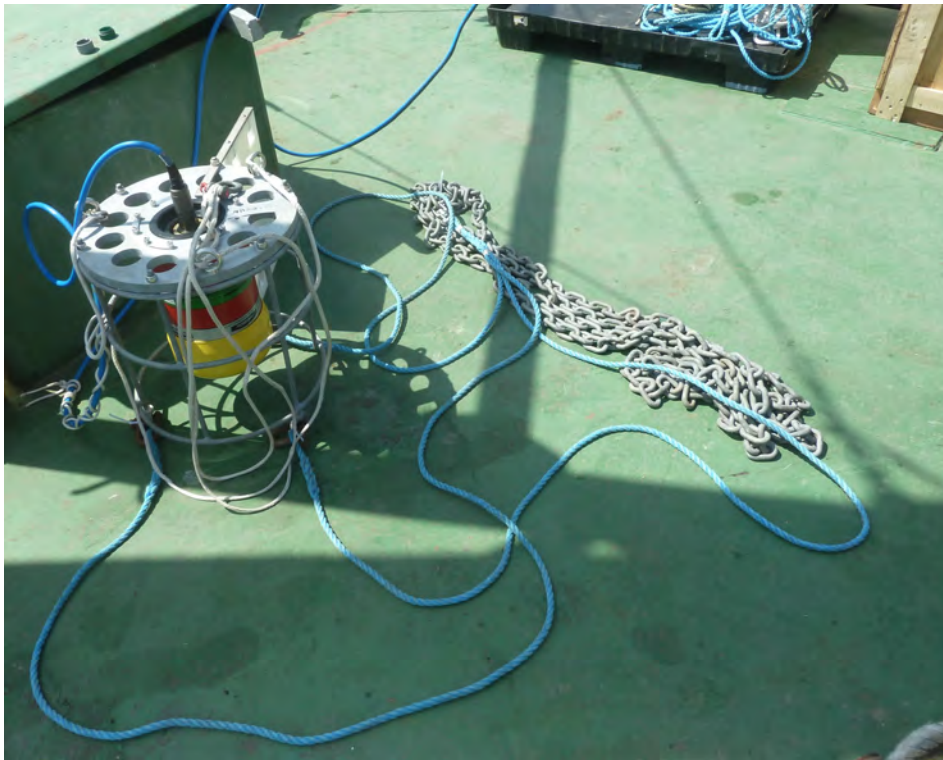
Figure 13: Longer GEOMAR baselines similarly oriented as in Fig 11 and 12 (bold lines in inset). The two baselines of opposite direction also slightly lengthen.

ANNEXES

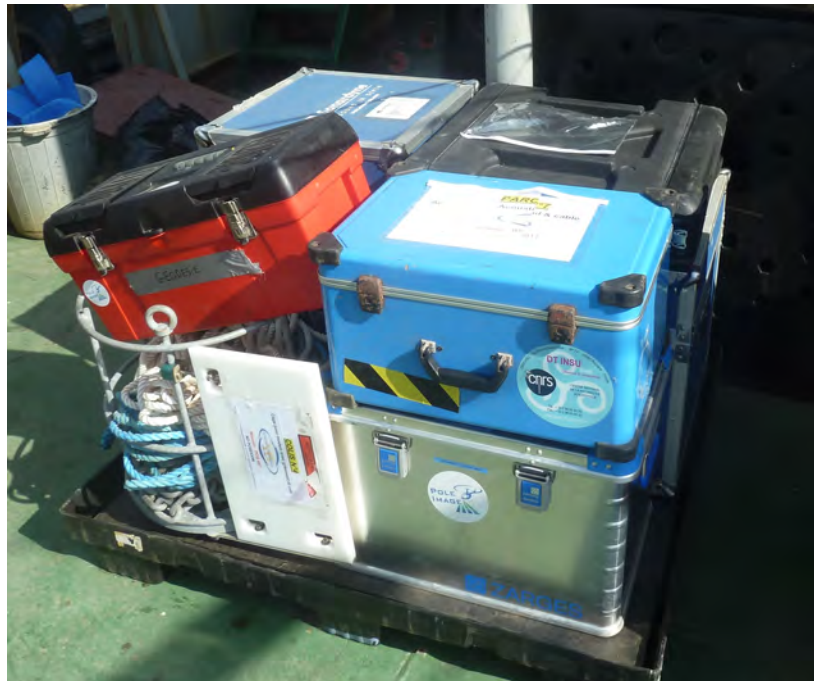
MOUNTING OF THE ACOUSTIC MODEM



Platelet every 2 bolts; use one bolt to fix the centerboard; add a loop on the blue cable and use the suspending ropes to tie and block the blue cable (as shown).



SHIPMENT



Packing of the boxes onto the pallet case (fold sideways the cage centerboard).