Operations on board Istanbul University RV YUNUS – 29-30/01/18

Science party

Nurettin Yakupoğlu, İTÜ
Dietrich Lange, Geomar
Pierre Henry, CEREGE

Summary

The objectives were (1) to recover acoustic ranging data logged by the Geomar and LGO acoustic transponder networks since the previous data recovery cruise (on R/V Yunus, May 4 and 5, 2017) (2) to recover as many of the 4 LGO "Fetch" acoustic transceivers as possible (4) to deploy at the seafloor the BPR mooring frame prepared by DT-INSU for bottom pressure and current recording.

All the equipment shipped by GEOMAR (from Kiel), LGO and DT-INSU (both from Brest) were on board as well as 4 wooden boxes prepared for the return shipment of the LGO geodetic beacons. The Geomar beacons remained silent, but data could be downloaded from 3 or the 4 LGO beacon, thus providing measurements of all baselines of the French network; 2 of the 4 LGO acoustic beacons (Figure 1) were recovered. The BPR was successfully delivered to the seafloor.

The complete set of data available from both geodetic networks, including the data back to the installation with RV Pourquoi Pas? end of 2014, was exchanged in-between the science party.

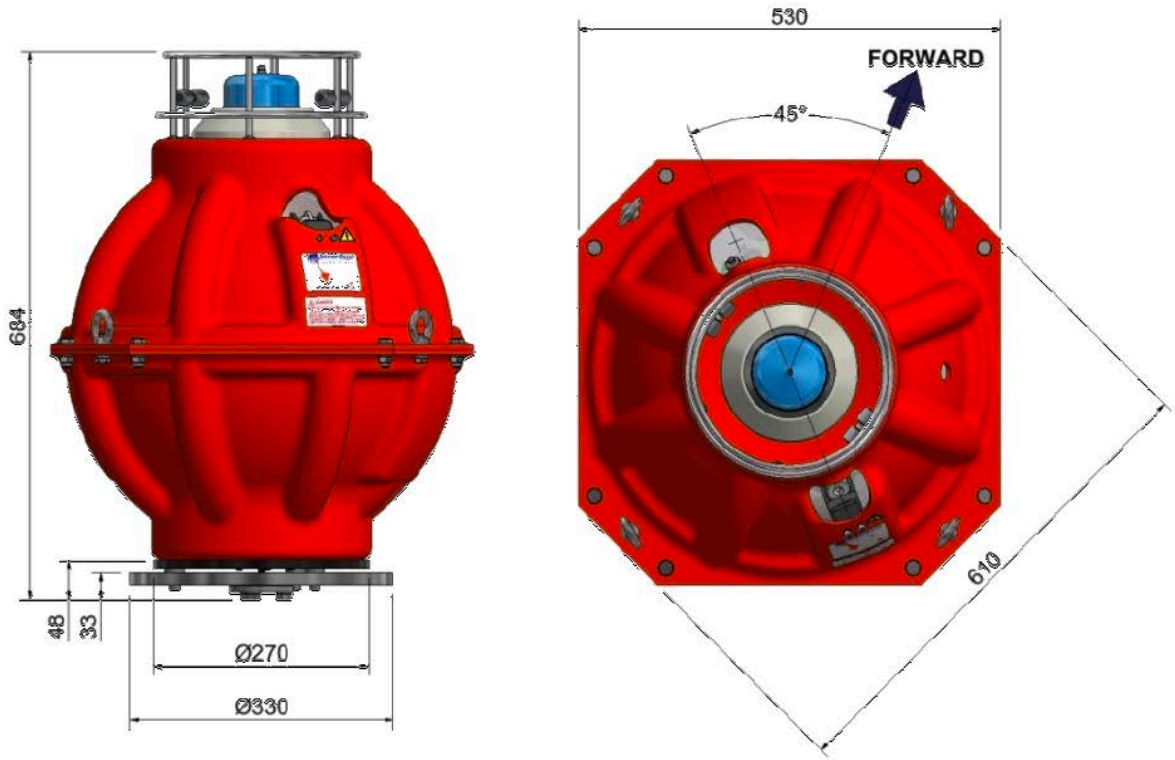


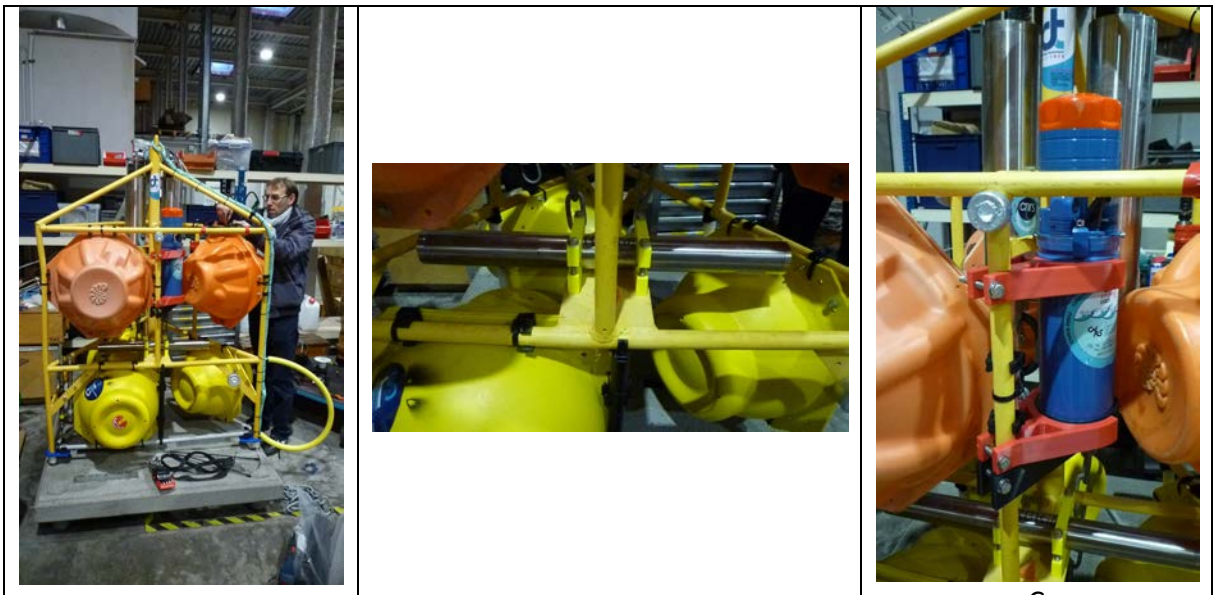
Figure 1: Sonardyne "Fetch" acoustic transponder releasable unit.

Description of BPR mooring frame and objectives of deployment

The primary objective of the mooring frame deployment is to provide high accuracy bottom pressure records for MAREGAMI Task 2 (ANR/TUBITAK collaborative project). The aim is to detect water column oscillations (seiche) caused by meteorological events and/or Bosphorus and Dardanelle hydrodynamics. This will allow to verify the accuracy of water column oscillations calculated by hydrodynamic models of the Sea of Marmara and used for tsunami modeling. A bottom pressure record acquired in 2007-2008 in Tekirdağ basin with a Digiquartz type with a sampling interval of approx. 5 minutes recorded small pressure oscillations of maximum amplitude of a few hPa (cm of water height) in the 10 minutes to 200 minutes range and several resonant oscillation periods could be detected.

The MAREGAMI objectives thus imply deployments at several other locations in the Sea of Marmara in order to determine whether the observed oscillation modes are local (and hence having a different oscillation period spectrum in each basin) or global (affecting the whole Sea of Marmara). Consequently, the mooring must be recovered later in 2018 and redeployed at another location with fresh batteries.

The mooring instrumentation (Figure 2) comprises (1) a RBR bottom pressure recorder with a Paroscientific 0-2000 m Digiquartz sensor, (2) a Seaguard recording current meter (RCM) equipped with additional sensors: temperature, pressure (tide sensor aandera 5217), conductivity, oxygen (aandera optode). The tide sensor is a piezoresistive sensor of accuracy comparable to that of the Digiquartz sensors (0.02% vs 0.01% for Digiquartz), and 0.2 hPa (2 mm) resolution. The sampling interval was set to be compatible with a required minimum battery autonomy of at least a year. The RBR pressure sampling interval was thus set to 5s and the Seaguard RCM to 5 minutes (for all sensors). The RBR system was acquired with MAREGAMI funding, the Seaguard RCM was loaned by DT-INSU, as well as the acoustic release systems, a flasher and an Argos beacon. The tide sensor fit on the Seaguard RCM was acquired with EMSO funding.



A B C

Figure2: mooring frame instrument set up. (A) general view. (B) RBR Bottom Pressure Recorder. (C) Seaguard Recording Current Meter

The mooring frame is relatively lightweight and fitted with 6 flotation spheres. The ballast is a concrete sole fitted to the base of the mooring frame. The total weight in air is about 850 kg. The ballast is held with a steel chain attached at each end to an Oceano acoustic release system (Figure 3). The two acoustic release systems are thus holding the full weight of the ballast, which the frame is mechanically unable to support. The mooring frame can thus only be lifted with a rope or strap attached to the top of both acoustic release systems (Figure 2). For deployment on the seafloor a third acoustic releaser is fitted to the strap at its lower end and to the ship cable at its upper end. The frame is 2.3 m high and the strap 0.5 m long. The total air draught with the acoustic release system (829 mm) is thus 3.7 m. In the eventuality that the RV Yunus would have insufficient headroom between the stern roller and the A-frame pulley, a short aramide ring was attached to the top of the mooring frame and a SeaCatch quick release hook provided. Additional lift could thus be given with an additional cable and pulley fitted on the A-frame.

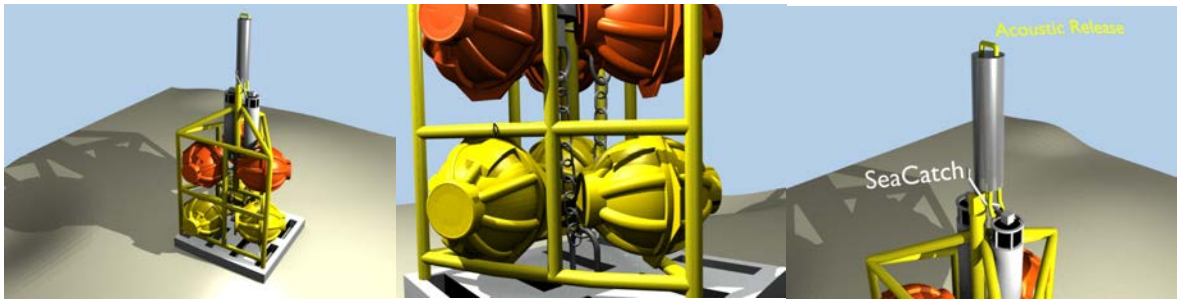


figure 3: Frame 3D sketches. Left: general view. Center: ballast, chain and release system. Right: frame hoisting points

During recovery, which should be performed within 6 to 12 months, after release, the frame will rotate 180° within 10 m of the seafloor and then stably ascend and surface upside down. For this reason, flasher and Argos beacon were attached upside down near the base of the frame, and a leach strapped to the edge of the frame for recovery. Release and recovery tests were performed in a 20 m deep basin at Ifremer.

Operation timeline

Wind conditions were 2 to 3 on Beaufort scale
Local time is UTC+3

Time (UTC)	
29/01/18	Monday
6:30	Leave Haydarpaşa port
7:15	Refueling (Yenikapi)
10:58	On site, Geomar Modem transceiver (HPT) in water at 50 m depth
11:27	attempting to wake up beacons with SC:AAAA;W1,UHHHH,OV1 command no beacon responds (AAAA= address; HHHH= Unit ID)
12:29	Geomar HPT back on deck, LGO HPT in water at 50 m depth
12:31	Link to beacon 2002. Check configuration: battery low (8%)
12:33	Link to beacon 2004. Check configuration: 36% battery Link to beacon 2003. Check configuration: 37% battery 13.9 V Link to beacon 2001. Low strength (probably near range limit)
12:35	Link to beacon 2002. Retrieve data. Bookmarks: 5274 - 6545
13:02	Beacon 2002 data retrieved, export
13:17	Ship drifted SE. Bringing ship back closer to 2002 position
13:24	Attempt to release using Sonardyne Monitor GUI. Unlike in the manual, there is no "Release" item on the menu but "screw" and "unscrew". No error message and no confirmation of release.
13:35	Red object at sea surface. Ship closes in to find an bunch of balloons
13:40	Beacon 2001. Check sensors PR 8255.1, INC +0.17, T 14.44 Range 1011.28 m
13:54	Beacon 2001. Bookmarks: 4725 - 5807
13:57	Beacon 2002. Check sensors PR 8140.3, INC +1.37, SV 1521, T 14.5.
14:12	Start 2001 data download (4725-5807)
14:32	2001 data retrieved, export
14:36	2004 test link VS2004;W1,NO_DATA,R1342653[X253,SNR9,DBV-49,TEL,NONE] cannot check config nor get bookmarks (no response)
14:43	2003 test link : too far
14:53	2003 test link: range 1244.60 m, test config OK
14:54	2003 check sensors: PR 8365.5, INC +2.63 -1.66, SV 9998, T -327°C bookmarks: 3724-4637
15:00	Start retrieving data from 2003 Received information from Sonardyne that the version of Sonardyne Monitor used is not sending the proper command to release beacons. Procedure should be (1) arm the release mechanism through GUI (2) open command window and send command manually: REL:AAAA;W1,U00HHHH,FOPEN (or UNWIND if unsuccessful)
15:19	2003 data retrieved, export data from 2001, 2002 and 2003 saved to USB key, Mac and external XFAT HDD Night at port

30/01/18	Tuesday
5:00	Leave port
5:36	Testing Geomar HPT on deck: acoustic emissions heard. Increase power level to max, lower in water to 50 m. Attempt to communicate with beacons. Still no response
6:03	LGO HPT in water at 50 m Device check OK send release command REL:2002;W1,U003FC4,FOPEN
6:21	2002 check acoustic link. Range 666 m -> coming up
6:24	Range 559 m
6:26	2002 Check sensors PR 5404 kPa
6:28	start tracking depth = 395 m
6:31	depth = 277 m
6:35	depth = 120 m (ascending ≈ 1 m/s)
6:38	at surface
6:43	2002 recovered
6:44	2001 release command sent REL:2001;W1,U003FF9,FOPEN -> RELEASING start tracking depth
6:45	depth = 806 m
6:47	depth = 806 m
6:48	retry FOPEN, failed without error message
6:55	REL:2001;W1,U003FF9,UNWIND
6:57	REL:2001;W1,U003FF9,FOPEN -> RELEASING test acoustic link, range = 899.75 m Depth tracking: 806 m (no change)
7:00	2004 test acoustic link - no distance obtained armed - OK (apparently) then does not answer FOPEN and UNWIND commands MR : no answer
07:04	2003 test acoustic link, range: 1317 m REL:2003;W1,U004011,FOPEN -> RELEASING
07:06	Range: 1216 m
07:08	Depth tracking: 706 m coming up ≈1m/s
07:12	interrogating 2001: range 867.3 m 2001 Depth tracking: 806 m (still on bottom)
07:16	2003 Depth tracking: 320 m
07:17	2003 Depth tracking: 272 m
07:19	check acoustic link, range: 163 m
07:33	Beacon 2003 on board. Mud on top of beacon
07:40	beacons 2003 and 2002 rinsed on deck

07:55	LGO HPT recovered. All Colson collars tying HPT electric cable to hoisting cable broke when ship was moving, but with no apparent damage to cable. The friction knot at the HPT end (called a Valdotain tresse in the Alps, I do not know how it is called at sea) prevented pull on the plug and the slack loop was still in place. 3rd attempt to communicate with Geomar beacon with Geomar HPT HPT lowered to 60 m. Still no responses
08:57	Exchange SIU (modem lab unit): using LGO SIU instead of Geomar SIU Preparing mooring frame for deployment: -Seaguard is on, recording -Flasher and Argos ready and checked -Optode cap removed -Flash and Argos started with magnet.
09:49:41	lat="40.869022" lon="28.525865" (Phone position)
10:08	Recovering Geomar HPT
10:14:34	lat="40.868961" lon="28.525922" (Phone position)
10:15	water depth according to map: 801 m, ship sounder 791 m -> 10 m offset
10:51	Height of A-frame pulley above stern roller is obviously insufficient to lift the mooring frame overboard. Preparing to use SeaCatch. Fitting 2nd pulley on A-frame. During a first attempt, the aramide rope ring was held in the SeaCatch hook without using a shackle. The ring got cut and the frame fell back on deck. The shock was in part taken by the main cable (with the acoustic releaser) but 2 of the 4 short legs extending below the concrete ballast (those located on the aft side, which was also the side where the sensors are attached) were pushed up through the ballast when they hit the deck. The Colson collar restraining the top of the flotation sphere located below the oxygen sensor and its connector broke, and the sphere dropped by 10 cm. It could be clamped back in place and re-attached to the metal bar with a Colson collar. A nylon strap and a shackle provided by the crew were used during a second, successful, attempt.
11:12:38	lat="40.870281" lon="28.523702" (Phone position)
11:13	BPR Mooring frame in water
11:22	Lowering device ≈ 1 m/s (≈ 50 m depth)
11:37	Interrogating acoustic releaser 1973 winch stopped, cable length in water 738 m acoustic range 780 m, DIAGNOSTIC value 5249
11:41	acoustic range 780 m
11:42:32	lat="40.872379" lon="28.526683" (Phone position) bringing ship back to position
11:52	On position waiting. Cable swinging back to vertical sounder seafloor depth 796 m (map 805 m) acoustic range 782 m, cable length in water 739 m
11:56	Start lowering device slowly
11:56:28	lat="40.870326" lon="28.524433" (Phone position)
11:57	acoustic range 793 m

	acoustic range 816 m
12:07	acoustic range 821 m, constant, device on bottom
12:09	acoustic range 792 m, bringing in cable and acoustic release 1973 to 740 m (cable length in water) and stop. Check status of acoustic release systems on seafloor device. Releaser 1380 : acoustic range 836 m, DIAGNOSTIC value 5272 Releaser 976 : acoustic range 847 m Device release is thus confirmed, although the "executed" light never lit during the process. Device is upright.
12:16	Releaser 1973 : acoustic range 684 m. Bringing cable in.
12:35	Cable and acoustic release on board. Going back to port.

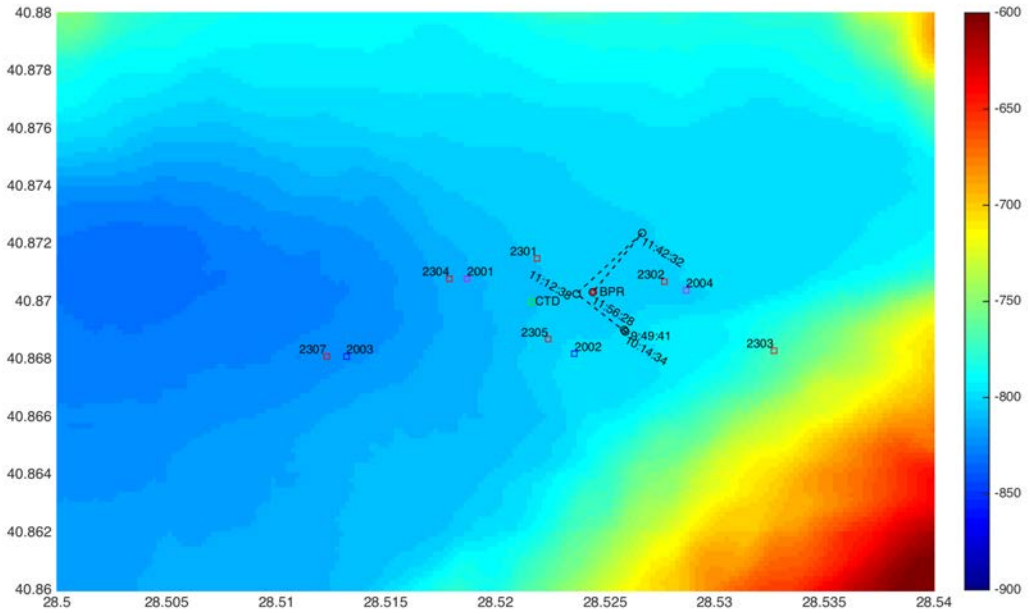


Figure 4: Bathymetric map of area (grid from Suroît 2000 EM300) with location of acoustic beacons, deployment point of CTD (with Poseidon in 2016) and of bottom pressure recorder (BPR, with R/V Yunus in January 2018). Ship positions logged during BPR deployment are indicated. Acoustic beacons still on the sea floor are indicated in red (Geomar beacons) and magenta (LGO beacons). Retrieved beacons (LGO beacons 2002/003FC4 and 2003/004011) are indicated in blue

Operation summary.

Acoustic Beacons

Geomar beacons never answered the commands that were supposed to wake them up from the low power protection mode (SC:AAAA;W1,UHHHH,OV1 i.e. SC:2401;W1,U1234,OV1 or SC:AAAA;W1,U00HHHH,OV1 i.e. SC:2401;W1,U1234,OV1).

One attempt at communication (lasting one hour) was made on 29/01/18 and two (30 minutes and 2 hours) on 30/01/18. Following a suggestion of Sonardyne, the emission power was increased to the maximum. The HPT was most likely functional as emissions could be heard when the HPT was on deck. During the final tests the HPT dunker was lowered to a depth of 60 m and the LGO SIU was used instead of the Geomar SIU.

Complete battery failure, although initially considered unlikely, appears as the main possible explanation.

LGO beacons 2001, 2002 and 2003 answered requests and new data were downloaded and exported to ASCII files. Data plots show no obvious anomaly in the baseline and pressure and tilt data, but for Beacon 2003 the sound velocity and temperature sensor seems to have failed recently. Beacon 2004 remained silent when interrogated through the acoustic modem, but still communicates with the other beacons. The status of the beacons was thus fairly similar to that during the previous Yunus cruise May 4-5, 2017.

Beacons 2002 and 2003, located south of the fault were recovered (Figure 5). Beacon 2004 could not be released because of failed communication. More surprisingly, Beacon 2001 did not release although the FOPEN command was apparently received and executed (Figure 6a and 6b). For comparison, Beacon 2003 released successfully (Figure 6c). There is a possibility that Beacon 2001 acoustic release was actuated but that the sphere stuck to its base for mechanical (or biomechanical...) reasons. It thus remains possible that a delayed release occurs spontaneously, in which case there is a risk that the beacon will be lost.

The beacons remaining on the seafloor still have about 35% battery autonomy, but the only remaining active baseline (2001 to 2004) does not cross the fault.

Figure 5: Beacons 2002 and 2003 on deck. Attached organisms include bivalvs and cnidaria

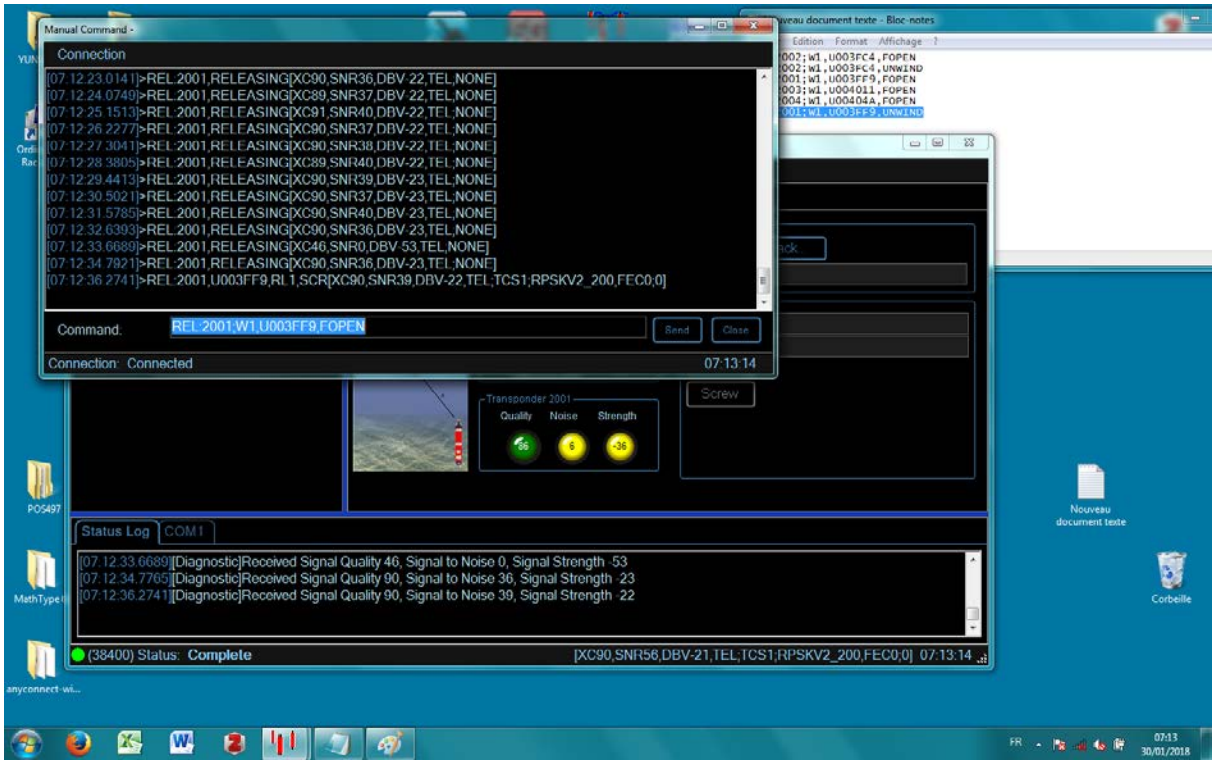


Figure 6a: screenshot of first attempt to release beacon 2001, failed

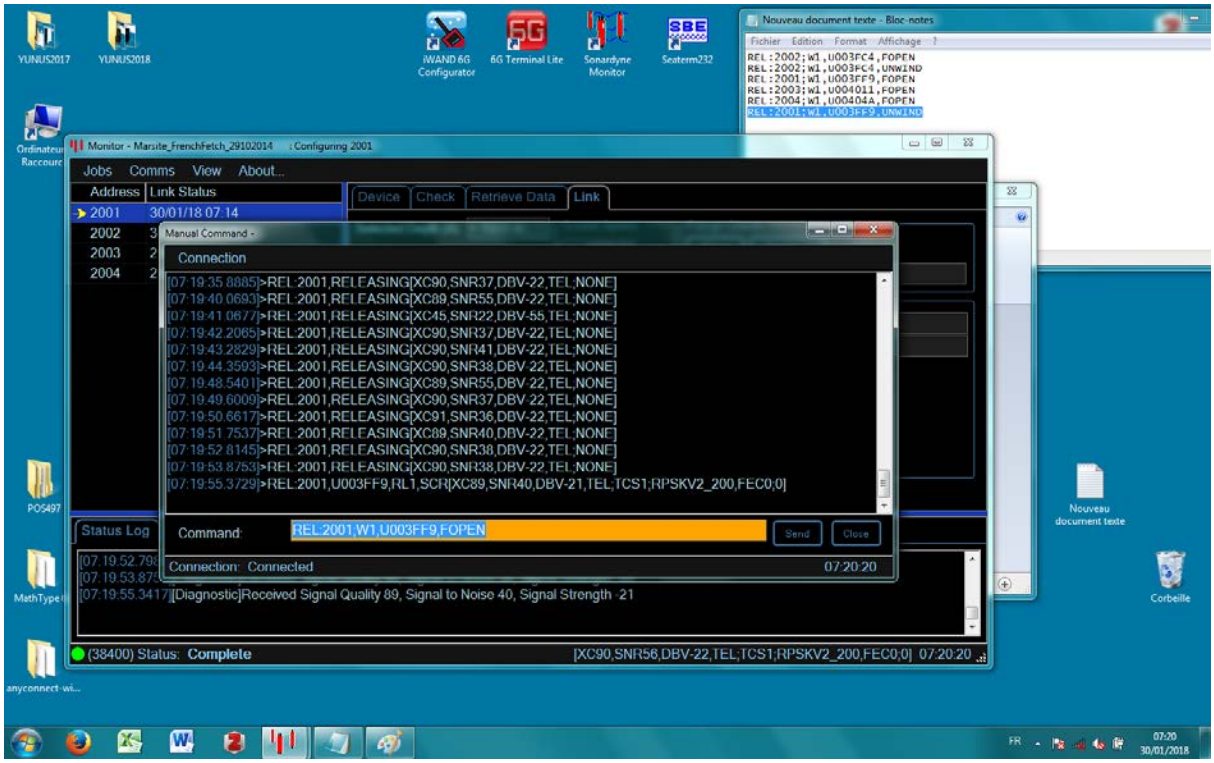


Figure 6b: screenshot of 2nd attempt to release beacon 2001, failed.

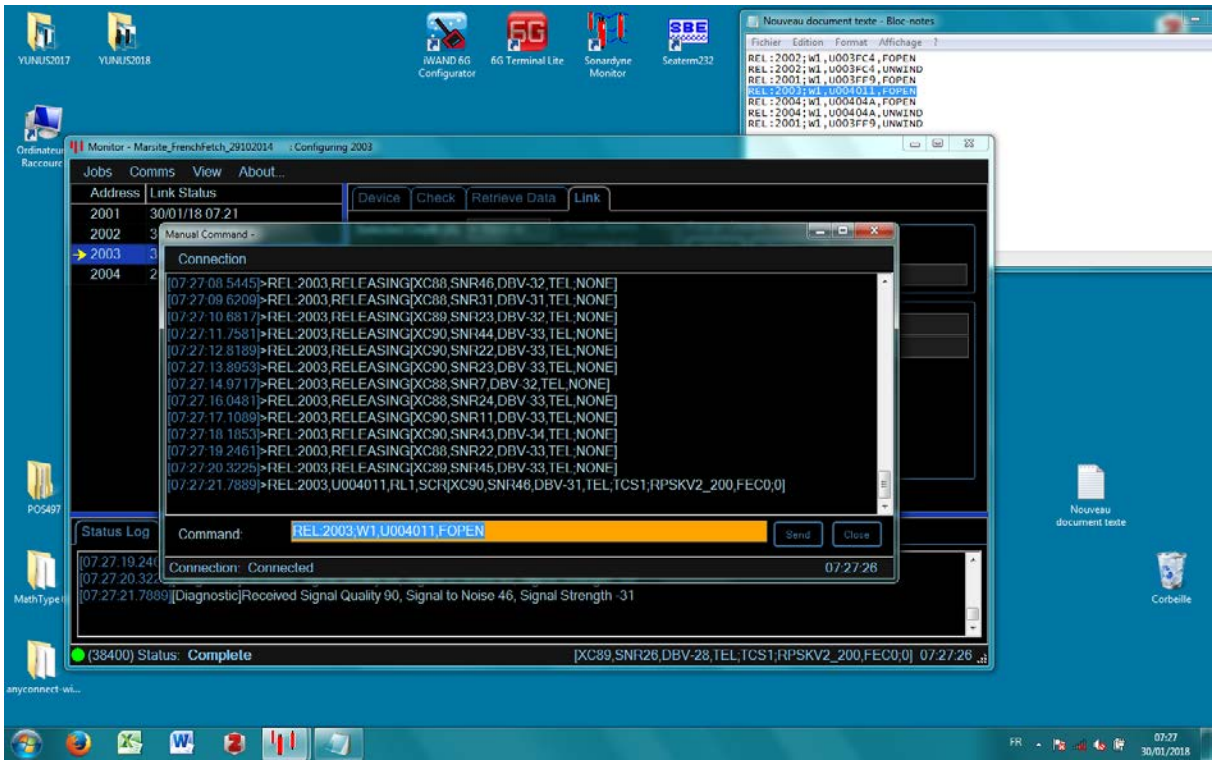


Figure 6c: screenshot of 1rst attempt to release beacon 2003, successful.

BPR mooring frame deployment

The Seaguard pressure vessel was opened to set the power on and start recording, with a preset sampling interval of 5 minutes between measurements. The O-rings were verified and greased before closing the vessel. No verification was performed on the RBR bottom pressure recorder, which was set to start automatically before the initially planned deployment date (January 10).

It appeared necessary to use the additional hoist rope and the SeaCatch quick release hook to lift the frame above the stern roller, and an additional pulley and cable was fit to the A-frame for this purpose (Figure 7a). And incident occurred as the SeaCatch cut the aramide rope that was holding the device. This could have been avoided by fitting a shackle between the SeaCatch and the aramide rope. No injury occurred when the frame fell back on deck. The shock was in part taken by the main cable (with the acoustic releaser) but 2 of the 4 short legs extending below the concrete ballast (those located on the aft side, which was also the side where the sensors are attached) were pushed up through the ballast when they hit the deck. The Colson collar restraining the top of the flotation sphere located below the oxygen sensor and its connector broke, and the sphere dropped by 10 cm. It could be clamped back in place and re-attached to the metal bar with a Colson collar. A nylon strap and a shackle provided by the crew were then used and the frame successfully lifted overboard and lowered in water.

Figure 7: Deployment of BPR mooring frame. Left: fitting additional pulley on A-Frame. Center: mooring in water. Right: View of acoustic releaser system used for deployment at the seafloor.

The device was then lowered on the main winch cable to 740 m water depth at 1 m/s and stopped. Acoustic ranging distance was then 780 m. Seafloor depth at deployment point was 796 m according to ship sounder, 805 m according to map. The device was then slowly lowered until cable tension visibly dropped. Acoustic ranging distance remained constant at about 820 m while RELEASE commands were send repeatedly over several minutes. The

acoustic releaser (n°1973) acknowledged command reception, but never acknowledged command execution. However, the release was successful. DIAGNOSTIC value 5272 from acoustic releaser n°1380 on the mooring frame indicates that the mooring did not capsize and releaser battery voltage is 9.3 V. It was not possible to do a triangulation for lack of time. The position given below is that of the ship when the device was lowered from 740 m water depth to the seafloor.

	Lat N	Lon E	Lat	Lon	depth (map)
BPR frame	40.870326	28.524433	N40°52.220'	E028°31.466'	805 m