R/V YUNUS-S (Istanbul University) cruise report
Nov 12-13, 2018
Istanbul – Esenköy – Istanbul

Science party

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Summary

The primary objectives of this cruise were to recover an instrumented frame deployed in Kumburgaz basin during a previous R/V *Yunus-S* cruise January 29-30, 2018, recover the data recorded by the instruments, do maintenance and redeploy the frame at another site, in Çınarcık Basin. This cruise was also an opportunity to perform coring in Kumburgaz basin with a light gravity corer provided by İTÜ.

The frame was successfully recovered. The bottom pressure recorder functioned until battery failure August 14, 2018. The other instrument (a Seaguard doppler recording current meter equipped with additional sensors) had failed during descent because of an insulation fault on a sensor and did not provide any useful data. The instrumented frame was redeployed at the planned location without incident.

1-Cruise context and objectives

Deployment of Bottom Pressure Recorders on the seafloor of the Sea of Marmara deep basins is required by MAREGAMI project in order to detect and measure resonant frequency oscillations in the Sea of Marmara. These resonant oscillations (also known as seiches) are thought to play an important role in tsunami generation and influence the characteristics of turbidite-homogenite deposition after earthquakes and landslides. In addition, monitoring of bottom water variations in pressure, temperature, salinity, and of bottom currents will help understand the causes of perturbations affecting acoustic ranging measurements performed in Kumburgaz Basin as part of a geodetic experiment (Nov 2014 – Jan 2018) and shall be taken into account for the planning of future geodetic monitoring on the North Anatolian Fault in the Sea of Marmara.
The cruise operations were jointly funded by MAREGAMI and bilateral collaboration project between ANR and TÜBITAK and by EMSO-France Research Infrastructure. Instruments and technical support were provided by CNRS/DT-INSU.

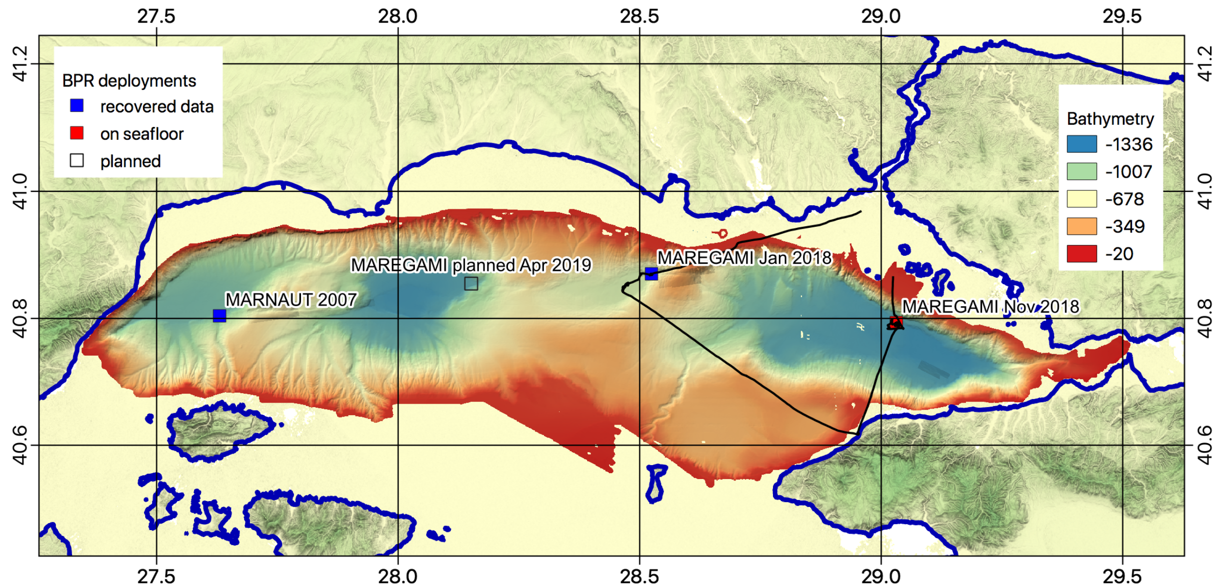

***Figure 1**: Ship track of YUNUS-S during November 12-13, 2018 cruise and location of BPR deployments. Pressure records were previously obtained in Tekirdağ basin in 2007-2008 (Marnaut cruise of R/V L'Atalante). This cruise recovered instruments deployed in Jan 2018 in Kumburgas Basin and redeployed them in Çınarcık Basin. Next cruise is planned in April 2019 to recover the instruments and deploy them again in the Central Basin*

2-Instrumented frame recovery and redeployment

Instrumentation on the frame (Figure 2 and 5) comprises (1) an RBR bottom pressure recorder (BPR) 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.

The frame was equipped with 2 acoustic releases (DT-INSU n° 976 and 1380) attached to each end of the anchoring chain for redundancy. The frame was released at the first attempt (9:27 UTC), the frame surfaced 10 minutes later 400 m from starboard side, upside down as implied by the design and was then lifted on board with the side crane.

***Figure 2**: Recovery of instrumented frame. (left) Frame floating upside down in water while the blue nylon recovery leash is being hooked; (center) frame is lifted on board, back in upright position; (left) frame was immediately positioned on the new concrete ballast before instruments (RBR Bottom Pressure Recorder and Seaguard Recording Current Meter) were removed for data download and maintenance*

Bottom Pressure Recorder data

The pressure inlet of the RBR BPR, presumably a copper alloy piece, was corroded beyond recognition (Figure 3), but this did not affect the integrity of the pressure vessel. More problematic, the autonomy of the batteries has been less than half as expected. The instrument started experiencing problems (anomalous pressure drops and resets) after 2018-08-12 19:55:15, and failed recording pressure data after 2018-08-14 01:24:10, little more than 7 months after recording started. When plugged to the computer onboard, the data logger started recording again, but with a clock reset at 2018-11-14 00:00:00.

After data download, a resynchronization was attempted, but the clock remained one hour ahead of UTC (local French time). It was eventually set to UTC during conditioning for redeployment. Data exports are available in Ruskin (RBR software) format and in txt format (Table 1).

Table 1 - Time series acquired by RBR BPR

Data export	First record	Last record	Comments
052665_20181112_1311.rsk	2018-01-10 08:00:00	(2018-11-14 00:30:25)	From before deployment to after recovery. Clock first reset at 2018-08-14 01:38:17
052665_20181112_1733.rsk	2018-01-10 08:00:00	(2018-11-14 04:51:25)	Data download after thermal equilibration. Clock first reset at 2018-08-14 01:38:17
052665_20181113_0455.rsk	2018-11-12 17:25:19	2018-11-13 05:54:14	On board, Clock UTC+1
052665_20181113_0501.rsk	2018-11-13 04:59:40	2018-11-13 05:01:05	On board (synchro check), Clock UTC

To test the possibility of calibrating the 0 of a Digiquartz sensor during a cruise, an atmospheric barometer (VAISALA PTB330TS) was brought on board the ship and set to record pressure every minute from 12/11/2018 09:59:50 to 13/11/2018 14:25:50 local time (UTC+3). The accuracy of the barometer is 0.1 hPa at lab temperature. Pressure records are available as ASCII csv and column tabulated files (2018-11-12 9_59.csv, 2018-11-12 9_59.m70, 2018-11-12

9_59.txt). The RBR was set horizontally in the same position as on the frame (lettering up, horizontal flat spot) (Figure 2).

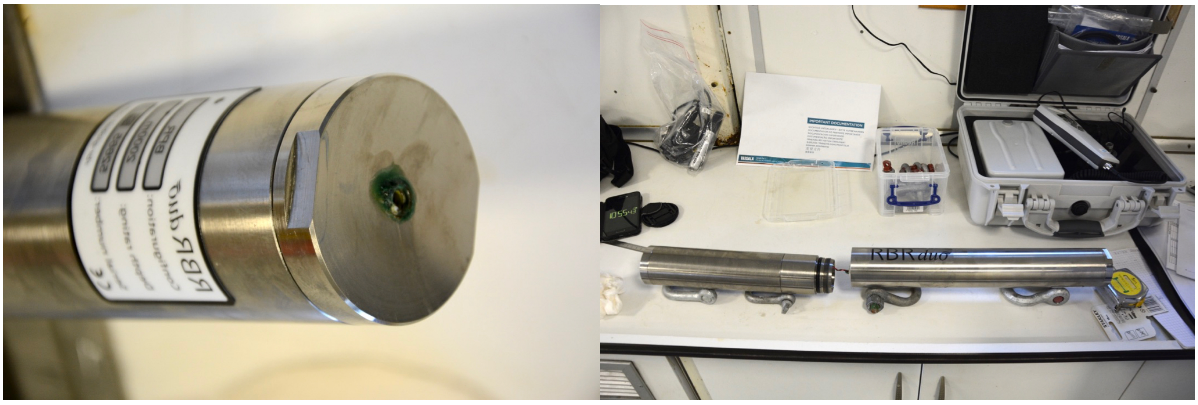

Figure 3*: RBR bottom pressure recorder: (left) corroded residues of pressure inlet; (right) RBR instrument in shipboard laboratory with extra battery case open. Vaisala PTB330TS barometer used for intercalibration is in the suitcase.*

Seaguard RCM

The Seaguard RCM was found stopped with a black screen, while the power switch was on. The battery voltage had dropped to 3.6 V while nominal full voltage is 7.2 V. Only 3 data points were recorded in the water (Table 2). Record 31 was acquired on deck, record 32 and 33 were acquired in surface water, record 34 at the beginning of descent at about 63 m depth. Measurements are consistent with knowledge of Sea of Marmara oceanography, with a low salinity well oxygenated surface layer down to about 40 m depth overlying high salinity and low oxygen deep water.

Table 2 – RCM data

Record N°	Time tag (GMT)	Battery Voltage (V)	Temp. (°C)	Salinity (PSU)	Pressure (kPa)	[O_2] (µM)	Current Speed (cm/s)	Current Direction (Deg.)
31	30.01.18 11:08:41	7.357	12.754	0.011	102.28	333.028	12.738	32.912
32	30.01.18 11:13:41	7.345	9.178	27.129	112.784	363.833	29.575	33.861
33	30.01.18 11:18:41	7.35	9.214	27.555	102.879	361.952	68.097	298.421
34	30.01.18 11:23:41	7.297	15.75	40.701	735.395	76.946	29.778	169.126

The cause of failure is evident as water entered through a mechanical adapter set on the plug of the oxygen optode sensor (Figure 4). Two O-rings that normally seal the adapter on the sensor side had been replaced by a black plastic spacer that had not sealing capability. Water thus entered the plug at the beginning of the descent resulting in an insulation fault and, eventually, power failure. This situation also explains the low battery voltage at recovery. The data logger and the other sensors begun working correctly again once the battery packs were replaced but it is not known whether the oxygen sensor is still functional or can be repaired. The electrical cable connecting the optode to the RCM was not apparently damaged but male and female plugs on the sensor side were both corroded. The connector could not be removed for redeployment because there was no cap available to seal the plug on the RCM barrel. The connecting cable was thus left in place, cut and its end sealed with several layers of heat-shrink tubes.

Figure 4: *Damaged optode plug. The black plastic ring in the middle is a spacer that had been set in place of the sealing O-rings, allowing water to enter through the annulus between the sensor plug (left)and the mechanical adapter (right). The connector was screwed on the adaptor thread.*

Frame repair and redeployment

The frame was brought back on board in good overall condition in spite of the incident that occurred during deployment in January 2018. However, the fall of the frame and ballast assembly on the deck had damaged the threads that allowed to vary the height of the three feet of the frame, and thus adjust the tension on the chain tying the metal frame to the concrete ballast. These could not be repaired on board but sufficient stability of the system for redeployment was achieved with plastic blocks (Figure 5). Deployment was done without difficulty. A Seacatch releasable hook (Figure 6) fit to a lifting tackle and the warping head of a winch were used to lift the frame/ballast assembly overboard and two ropes passing through slots in the concrete slab allowed lateral stabilization. The assembly weight was then transferred to the acoustic release device attached to the main winch cable (Figure 6). Water depth at deployment site is 1240±4 m according to multibeam maps while the shipboard sounder indicated 1225 m. The wire out indicator on the ship winch has only 3 digits and thus needed to be reset at 1000 m, probably causing a small underestimation of total wire out length (about 10 m). The device was first lowered at about 1 m/s down to about 1000+150 m and stopped. At this point, acoustic range was measured at 1204 m (assuming 1500 m/s sound speed) interrogating the acoustic device on the cable (n° 1973). In order to monitor touch-down, the device was lowered at about 0.5 m/s and acoustic range determined every 10 s. Range stopped increasing after 1250 m for a wire out length of 1000+210 m. Beyond 1000+220 m a decrease of cable tension was apparent from visual observation and manual testing and an acoustic release order was sent. The device acknowledged execution after first try. Effective release was verified by slowly wiring in and alternately checking acoustic range to acoustic device n° 976 on the frame and n° 1973 on the wire. Ranges did diverge as the boat drifted away and the cable was lifted. The location of the frame on the bottom was then determined by triangulation (Figure and Table) interrogating device n°976. Two acoustic range measurements (assuming velocity 1500 m/s) were performed at each of three points 1500 m WSW, ESE and N from the releasing point. The frame location thus determined was 92 m NNE of release point, with an immersion of 1225 m and a theoretical wire out of 1230 m. It can be concluded that the wire out indicator on RV Yunus has good accuracy and is consistent within 10 m with the shipboard sounder even for depths > 1000 m

***Figure 5**: Instrumented frame before redeployment. (top) RBR bottom pressure recorder; (left) Seaguard Recording Current Meter; (right) Assembly ready for launch*

Figure 6: *Deployment setup. (Left) Seacatch quick-release hook, used to hoist the device overboard. (Right) Acoustic release system attached to the main cable*

3-Coring

Studies of Calypso cores (long piston cores) taken with Ifremer R/V *Pourquoi pas ?* during Marsitecruise in 2014 yielded a seismoturbidite record spanning the last 6100 years, but from which the last 800 years or so are missing (Yakupoğlu et al., in press). The sediment-water interface and first 1-2 m of sediment are often missing or heavily disturbed in long piston cores. During Marsite, 2 short cores (1.14 m and 0.89 m) were taken with the İTÜ light corer, but a sampling gap is probably present between the top of the Calypso core and the seafloor as no event was sampled between 989 AD and present.

During this cruise, we attempted to recover longer cores using longer tubes (1.80 and 1.70 m) but the same weight (about 30 kg). The corer (Figure 7) was lowered down on the wire to 5-7 m above the seafloor, stopped to allow correction of ship position, then released in free fall. The first attempt (with 1.80 m PVC tube), near MRS-CS01 site was successful but the core was shorter than the one previously sampled (84 cm vs. 114 cm).

The two other attempts (with 1.70 m PVC tube) failed. Mud stuck on one side of the weight and on one side of the tube indicates that the corer did not penetrate but fell on its side. Increasing free fall from 5 m to 7 m did not help. This may be explained by the increase of wind speed (up to 10 knts) and ship drift in the afternoon. The corer is very sensitive to drift not only because of its light weight, but also because the PVC tube is neutrally buoyant and thus subject to a very large drag compared to its weight in water. In addition, this "heavy head and light tail" configuration makes the upward orientation of the corer during fall in water unstable, causing it to rotate before hitting the seafloor. The weight is likely to hit the seafloor first if the free fall is too long and the corer not initially aligned with the vertical.

***Figure** 7: ITU interface corer*

4-Navigation

Detailed navigation maps for Day 1 (Nov 12, 2018) (Figure 8) and Day 2 (Nov 13, 2018) (Figure 9) and location of remarkable points (Table 3) are given here after.

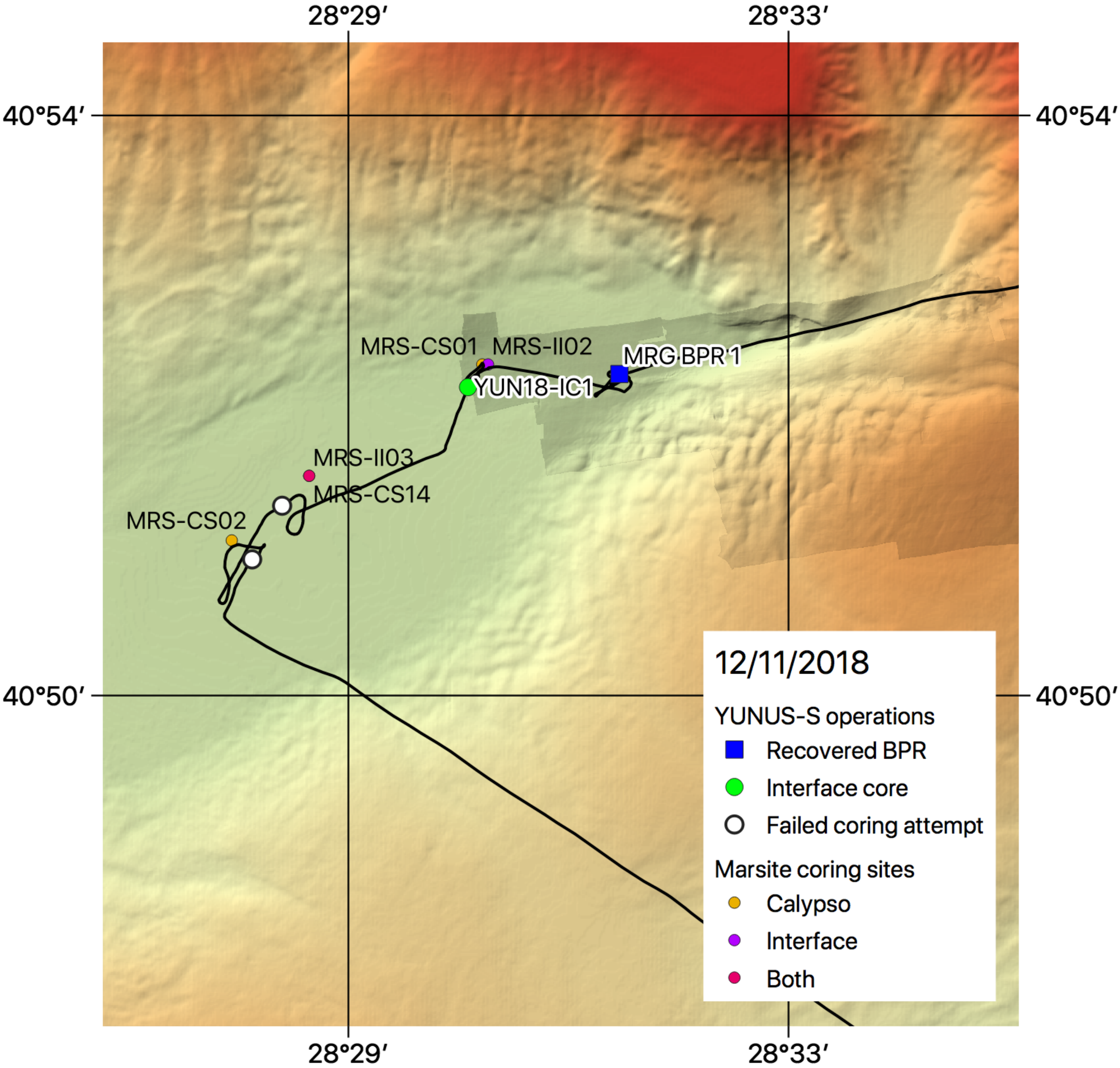

***Figure 8**: YUNUS-S Navigation map and operations on Day 1 and location of cores sampled during Marsitecruise (RV Pourquoi Pas ?, 2014) in Kumburgas Basin.*

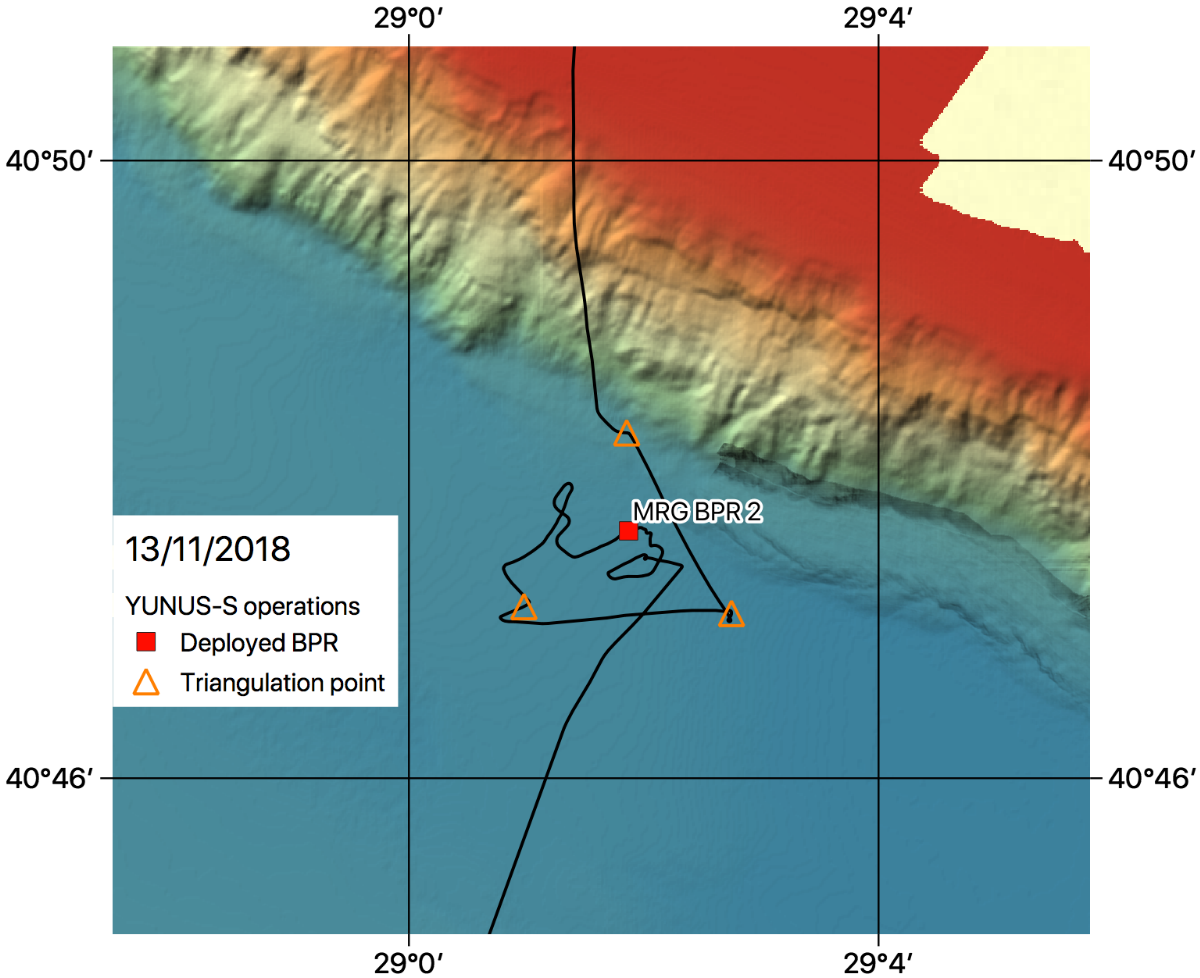

***Figure 9**: YUNUS-S Navigation map and operations on Day 2 in Çınarcık Basin.*

Table 3 – Remarkable points

Point	Lat	Lon	Lat	Lon	Depth	Comment
MRG BPR1	40.8703	28.5244	N 40° 52.218'	E 028° 31.464'	805 m	recovered BPR
MRG BPR2	40.7934	29.0312	N 40° 47.604'	E 029° 01.872'	1225 m	BPR redeployment
1	40.7852	29.0163	N 40° 47.113'	E 029° 00.980'		triangulation point
2	40.7845	29.0458	N 40° 47.068'	E 029° 02.748'		triangulation point
3	40.8040	29.0309	N 40° 48.239'	E 029° 01.855'		triangulation point
YUN18-IC1	40.8688	28.5015	N 40° 52.127'	E 028° 30.088'	822 m	0.84 m core
coring site	40.8552	28.4733	N 40° 51.310'	E 028° 28.398'	815 m	failed attempt
coring site	40.8490	28.4688	N 40° 50.939'	E 028° 28.126'	813 m	failed attempt

5- Operation timeline

Wind conditions were 2 to 3 on Beaufort scale

Local time is UTC+3

Time (UTC)	
12/11/18	**Monday**
6:30	Start tracking position with OpenCPN and BU353-S4 GPS receiver set port side above central lab porthole, thus offset about 20 aft from bridge antenna
6:59	Start recording atmospheric pressure with Vaisala barometer, 1 record per minute. Barometer is in local time (UTC+3)
8:37	8.7 kts, course 247°, 3.32 M from bottom pressure recorder deployment site
9:20	On site, transponder in water, acoustic range check : 847 m for release n°1380, 852 m for release n°976
9:27	Release order sent to n°976 and executed
9:31	Acoustic range 617 m, apparent ascent rate approx. 1m/s
9:35	Acoustic range 505 m, ship is 400 m from deployment point
9:38	Frame seen on surface, starboard side
9:45	Frame on board
10:00	On coring site (MRS-CS01), ITU interface corer ready with 1.8 m PVC tube, free PVC length is 1.45 m
10:29	Sounder depth 832 m, wire out 804 m
10:40	Core YUN18-CI1 taken, sounder depth 822 m, multibeam map depth 832 m
10:44	Corer on board, core length is 0.84 m
11:22	1.95 kts, course 233°, approaching 2nd coring point (CS-02) wind has increased to about 10 kts.
11:32	Lowering corer with 1.70 m PVC pipe (1.35 m free length), multibeam map depth 822 m
11:48	Corer was released 5 m above bottom, pulling back up
12:13	Corer on board. Empty tube
12:43	Preparing 2nd coring attempt at same site, with same PVC pipe
13:02	Corer in water, winch stopped, wire out 808 m, sounder depth 813 m, map depth 819 m
13:03:20	Corer released
13:30	Corer on board. Empty tube
13:32	Going to Esenköy Port
15:10	OpenCPN track file end

Time (UTC)	
13/11/18	**Tuesday**
4:45	In Esenköy port, preparing frame deployment
4:52	RBR recording while plugged to computer, internal power 12.07 V
4:54	Download RBR data recorded on board (12/11/18 17:25:19 to 13/11/18 05:54:14) logger clock is improperly set to UTC+1
4:59	Resynchronize RBR clock (UTC) and restart recording
5:01	Stop recording and check file content
5:03	Start recording, 1 record every 5s
5:04	Disconnect from computer
5:05	Reconnect, check status and clock synchro
5:08	Check power: 12.08 V internal
5:09	Disconnect from computer, connect to extra battery pack
5:11	Reinstallation of RBR on frame
6:00	Seaguard RCM on, clock time check, record set on
6:11	2nd record written, screen automatically turns off
6:15	RCM pressure vessel closed
6:17	RCM on frame- adjusting orientation of Doppler Current Sensors Leaving port - restart OpenCPN tracking
6:52	En route, 6 M from deployment point, ETA 7:40, checking acoustic release (n°1973)
6:59	Flasher and Argos beacon on
7:39	On site BPR2, preparing for deployment
8:18	Back on site, ready to launch
8:28	Device in water, sounder depth 1225 m, multibeam map depth 1237 m (EM300, 2000) and 1244 m (EM302, 2009). Descent velocity about 1 m/s, but fluctuating.
8:47	Winch stopped with 1000 m + 150 m wire out, acoustic range to beacon n°1937: 1204 m
8:51	Lowering device <0.5 m/s monitoring acoustic range and wire out until touch-down (1250 m range, 1000 m + 210 m wire out)
8:53	Acoustic release executed (n°1937). Ship location N40° 47.5800', E029° 01.8134'
8:55	Wiring in. Check range and beacon status: Device (n°976) 1255 m, Cable (n°1973) 1224 m
9:19	Acoustic release n°1973 on board – Lunch time
10:18	On triangulation point 1 range to n°976 : 1971 m and 1976 m (2 measurements)
10:40	On triangulation point 2 range to n°976 : 1997 m and 2003 m
10:55	On triangulation point 3 range to n°976 : 1698 m and 1699 m
11:00	En route to Istanbul – Data archival on external HD
13:00	On dock at Haydarpasa port

6- Preliminary data assessment

Data from RBR BPR and Vaisala PTB where converted to matlab binary format. Explanation of variables in matlab files is given in Table 4a and 4b

Table 4a – Variables in BPR Matlab file

Name	Type	Comment
Time	datetime array	Time in datetime format Time.TimeZone='UTC' Time.Format='yyyy-MM-dd HH:mm:ss.S'
Timestring	cell array	Time as character string
elapsed_days *or* elapsed_hours	double array	time elapsed since first record in file days(Time-Time(1)) *or* hours(Time-Time(1))
Period	double array	Pressure sensor measured period in ps
Period1	double array	Temperature sensor measured period in ps
BPRpressure	double array	Pressure in dBar (10 kPa)
BPRtemperature	double array	Temperature in °C

Table 4b – Variables in PTB Matlab file

Name	Type	Comment
Time_PTB	datetime array	Time in datetime format Time.TimeZone='UTC' Time.Format='yyyy-MM-dd HH:mm:ss.S'
Timestring_PTB	cell array	Time as character string
P_hPa	double array	Atmospheric Pressure in hPa (mBar)

The RBR Bottom Pressure Recorder provided more than 7 months of useable data (Figure 10). In winter, pressure variations are largest (50 hPa equivalent to 50 cmof water) and probably dominated by meteorological perturbations. Transient temperature drops of 0.01-0.02 °C similar to those reported during the geodetic experiment (Sakic et al., 2016; Timmerman, 2016) are observed and several of them follow rapid pressure variations. Tidal oscillations with ≈12 hours and ≈24 hours dominant periods are observed with maximum amplitudes of 10 cm (crest to crest) of as well as 1-to-5-days intervals of higher frequency noise of centimeter amplitude. The spectral analysis of this higher frequency noise may inform us on water column resonant oscillation frequencies (seiches and internal waves).

Cross calibration at sea of the BPR Digiquartz pressure gauge with the Vaisala PTB atmospheric barometer seems difficult (Figure 11). The Digiquartz sensor appears to respond to acceleration. Noise level while the ship is at sea at the beginning of the record is much higher than in port or on the PTB record during the same time interval. The Digiquartz pressure record was also strongly affected by manipulations c.a. 18h and displayed a random static shift c.a. 20h. It also displays non-linear drift, a non-linear response to temperature variations, and a larger high-frequency content than the PTB. However, variations recorded in the minutes-to-hour range match very well the PTB record.

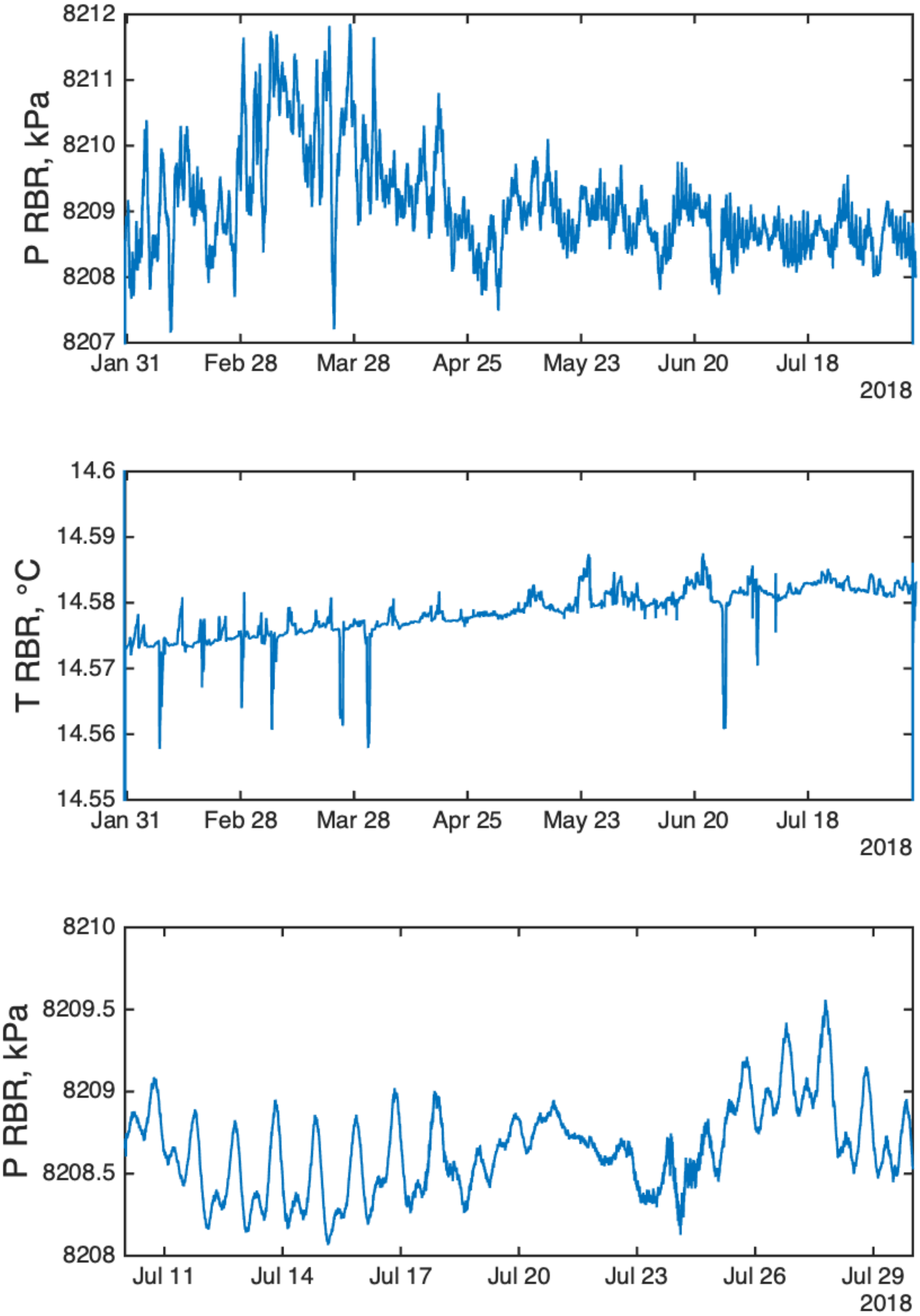

***Figure 10**: Bottom pressure and temperature records from RBR BPR. Anomalous single values were removed with a 3 point median filter (medfilt1): (top) complete usable pressure record (middle) complete usable temperature record (bottom) zoom showing tidal variations.*

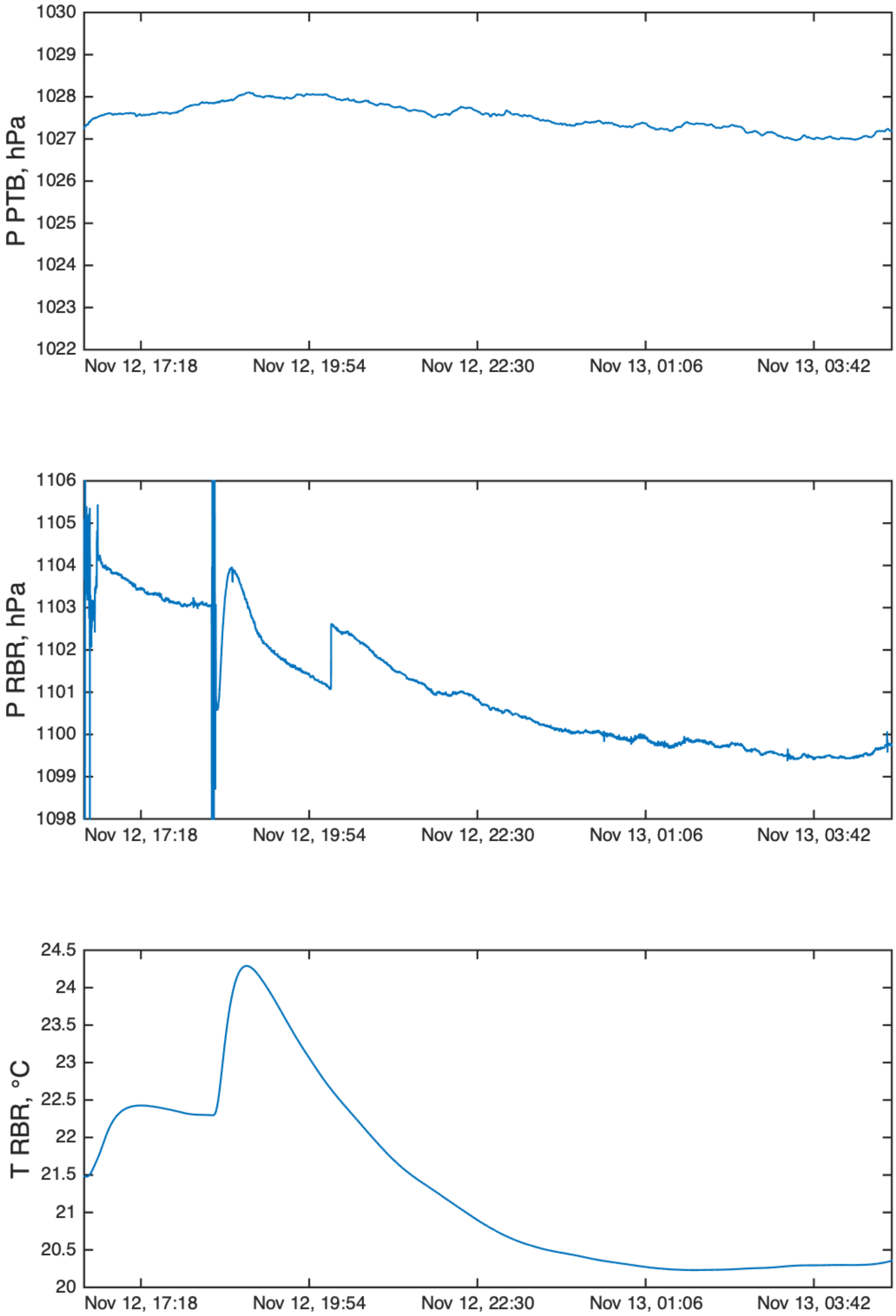

Figure 11*:Records acquired on the ship. (top) Vaisala PTB record (middle) RBR Digiquartz pressure record (bottom) RBR temperature record..*