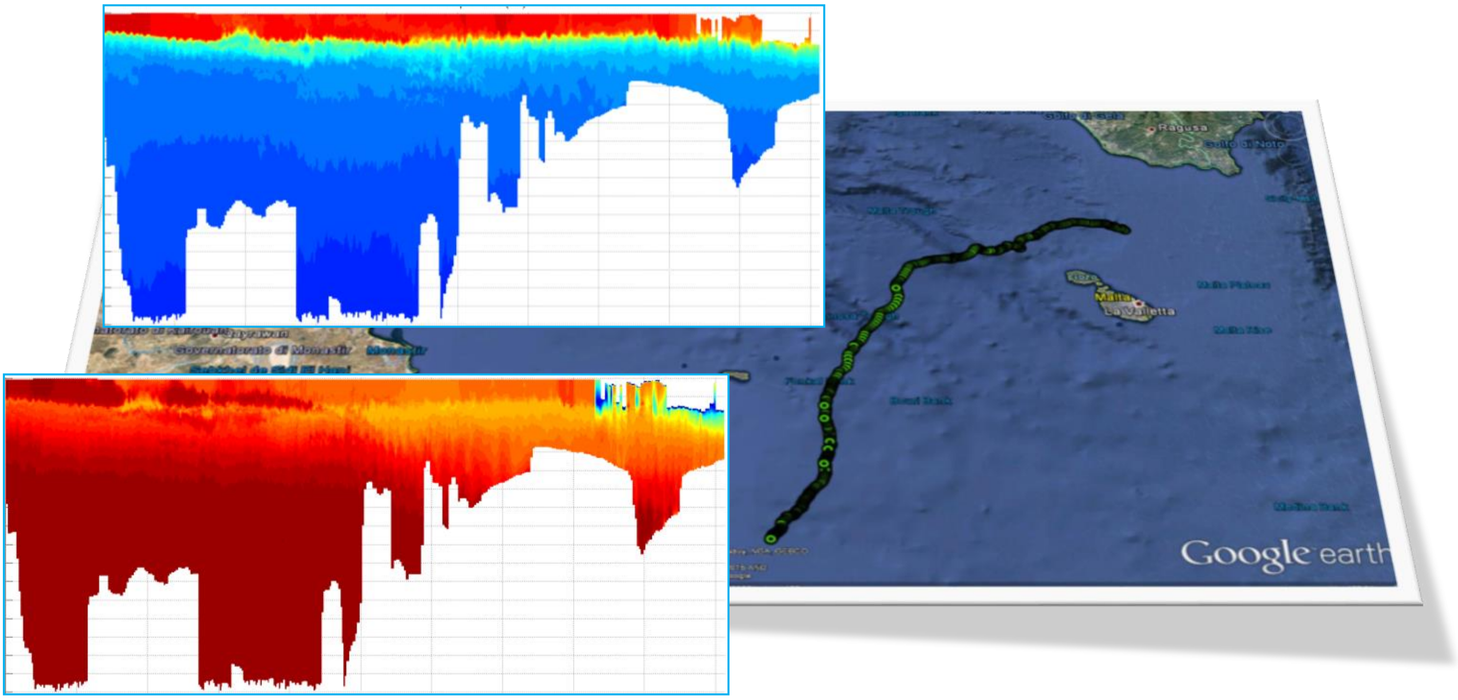
ISTITUTO NAZIONALE
DI OCEANOGRAFIA E DI GEOFISICA SPERIMENTALE

Arvor-C data report: Malta Channel mission, October 2016

M. Pacciaroni*, P.-M. Poulain*, G. Notarstefano*, A. Bussani*

*Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS), Trieste, Italy



Approved for release by ....
Dr. Paola Del Negro
Director, Oceanography Section

Table of Contents

1. Introduction.

The thermohaline properties that characterize the Malta Channel in the end of summer have been investigated by employing an NKE Arvor-C float, whose peculiarity is the high vertical resolution in combination with frequent transmission period. The float performed about 400 cycles in an area with irregular bathymetry. Data transmission is based on Iridium telemetry and all the *.SBD messages are stored and managed by automatic procedures implemented at OGS.

2. Setting up the instrument for deployment.

The Arvor-C mission parameters are summarized in Table 1.

Mission Parameters	Description	Value	Units
PM0	Number of programmed cycles	397	integer number
PM1	Mission delay to start after magnet removal	10	minutes
PM2	Transmission period after mission terminates	30	minutes

Table 1. List of mission parameters.

With the help of our colleague in Malta University the float was repeatedly programmed because of multiple delays in time due to bad weather conditions and finally the mission began on the 25th of September 2016. The cycling period was set to 3 hours starting from 25/09/2016 00:00:00, sampling vertical resolution was set to 1 m (Arvor-C user manual, 2014). The Arvor-C was equipped with an SBE 41CP CTD probe whose temperature and salinity measurement accuracies were respectively 0.002 °C and 0.005 psu (as declared by SBE Sea-Bird Electronics).

The deployment was made with a boat of the local Department of Defense in Malta. The deploying point is shown in Figure 1.

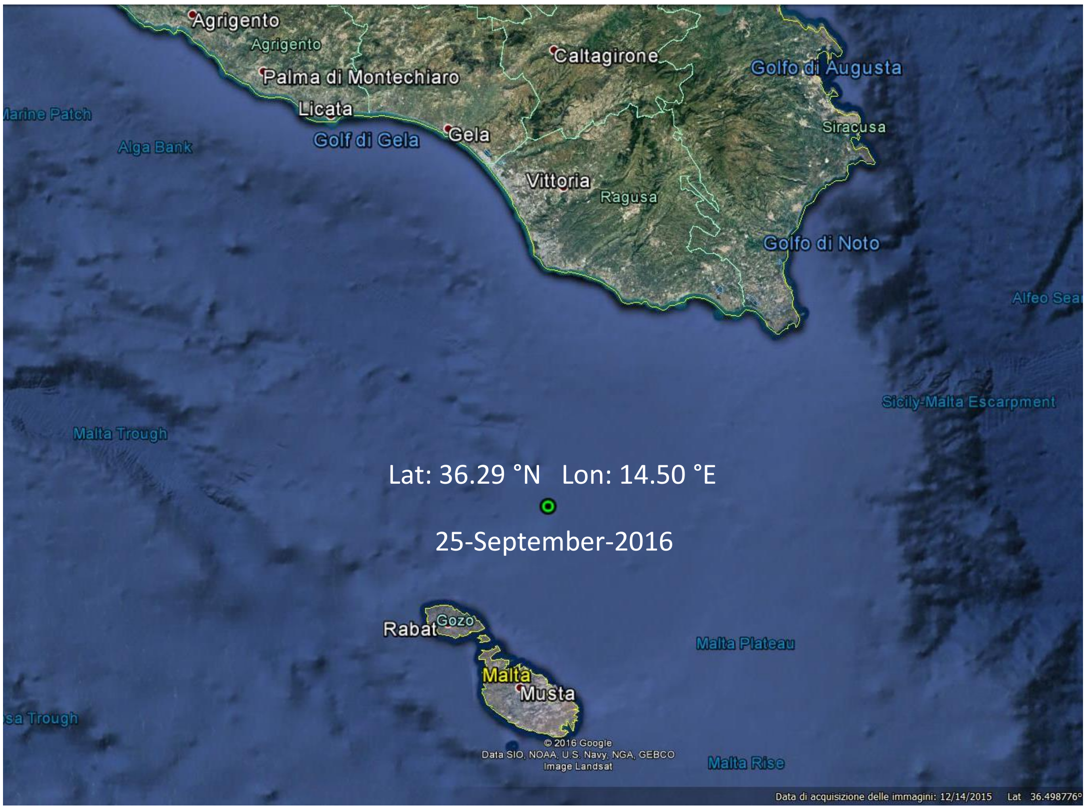


Figure 1. Arvor-C deployment location and date.

The full trajectory (by connecting the surfacing points) is depicted in Figure 2; the float went through an irregular bathymetry touching the bottom several times (every time the bathymetry was lower than 425 dbar, see also the scatter plots below); its internal battery voltage stayed around 10.0 Volts, while its internal vacuum ranged between 610-645 mbar.

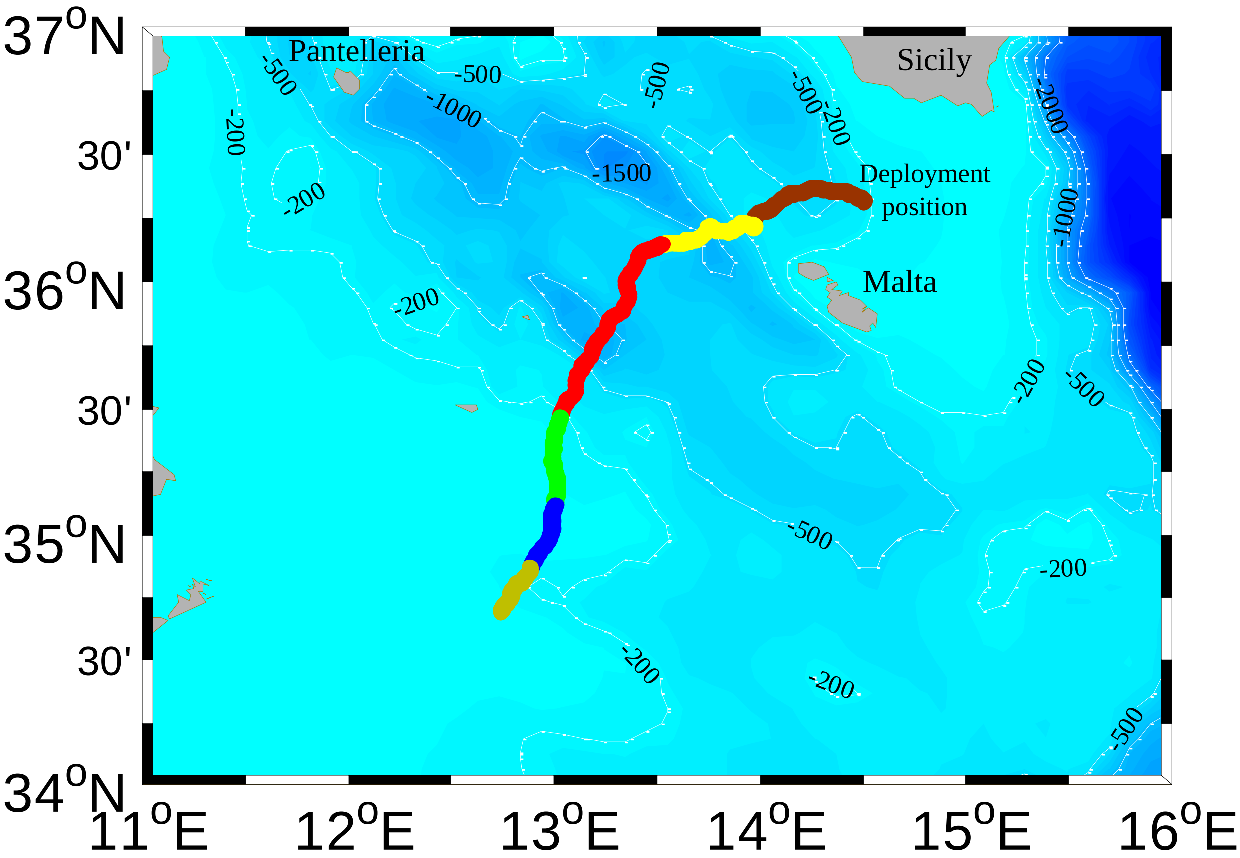


Figure 2. Arvor-C trajectory, from 25/09/2016 (deployment) till 06/11/2016 (last fix). Colors along trajectory indicate one week of mission.

3. The measured dataset.

The measured temperature (*in situ*) and the salinity profiles versus time (hours and dates) and cycle number are shown in Figures 3 and 4; no flagging is applied to the dataset. The estimated local bathymetry was interpolated starting from ETOPO1 dataset, at 1 arc-minute resolution (Amante, C. and B.W. Eakins, 2009) and it is depicted with a black continuous line and red/black symbols.

The float started to manifest troubles with the conductivity sensor and consequently with salinity determination after the 30th of October (profile number 335, see Figure 4). This was particularly evident in the thermocline zone and up to the surface, except for the intermediate to deep zones.

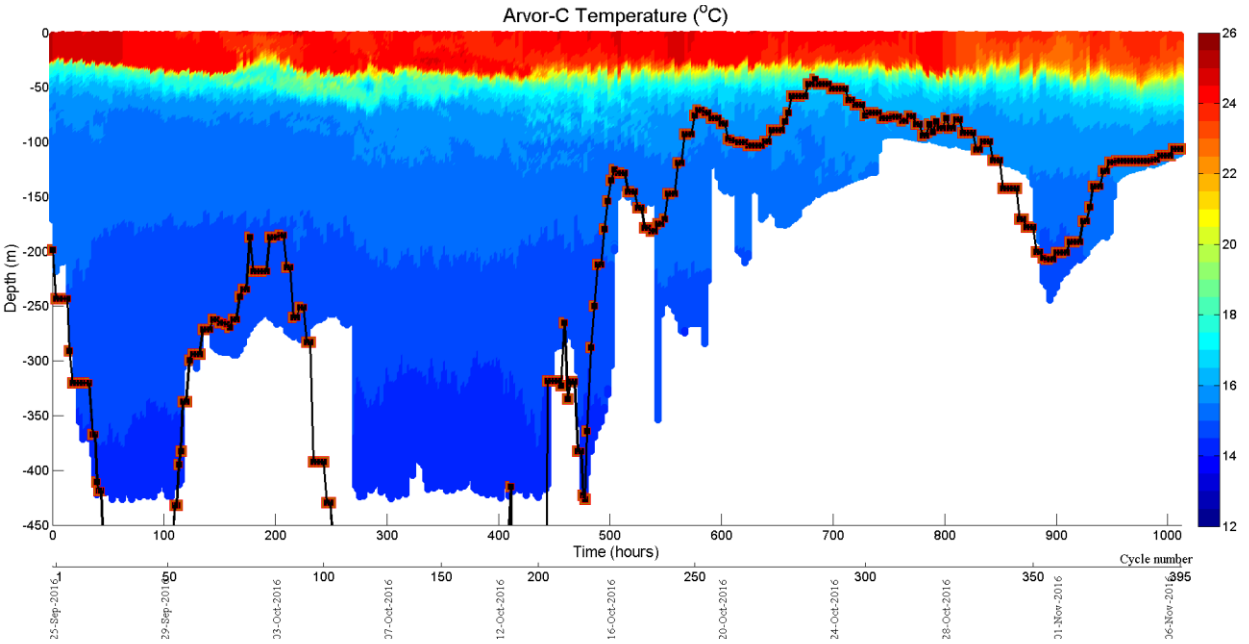


Figure 3. Measured temperature (°C).

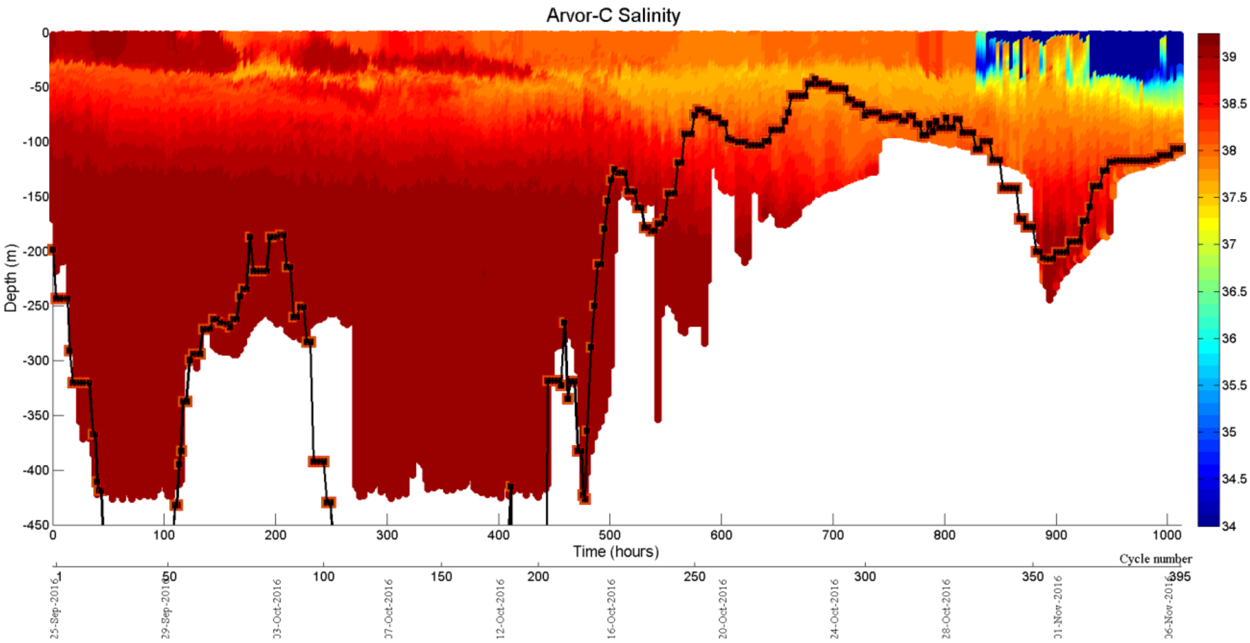


Figure 4. Measured salinity (p.s.u).

To overcome the issue related to the bad conductivity measurements a flagging system based on a comparison to another Arvor float (WMO 1900629) engaged in the same area and period was operated. In addition the Arvor-C's measured values above 1.5 dbar were discarded in order to eliminate unreliable data. The edited database is shown in Figures 5, 6, 7 and 8. In detail, all salinity values below 37.5 were cut after profile 334, then 3 depths were considered: 50, 130 and 180 dbar and the erroneous salinity values were cut according to the following rules:

$$0 \leq \text{depth} \leq 50, \quad \text{salinity} <= 38.6$$

$$130 \leq \text{depth} < 180, \quad \text{salinity} <= 38.1$$

$$\text{depth} \geq 180, \quad \text{salinity} <= 38.8$$

3.1 The processed parameters.

The Gibbs-Seawater oceanographic toolbox (TEOS-10 functions for evaluating the thermodynamic properties of seawater, McDougall, T.J. and P.M. Barker, 2011) was used to determine the conservative temperature (Figure 5), the absolute salinity (Figure 6), the potential density anomaly (Figure 7) and to calculate the squared Brunt-Väisälä frequency (Figure 8).

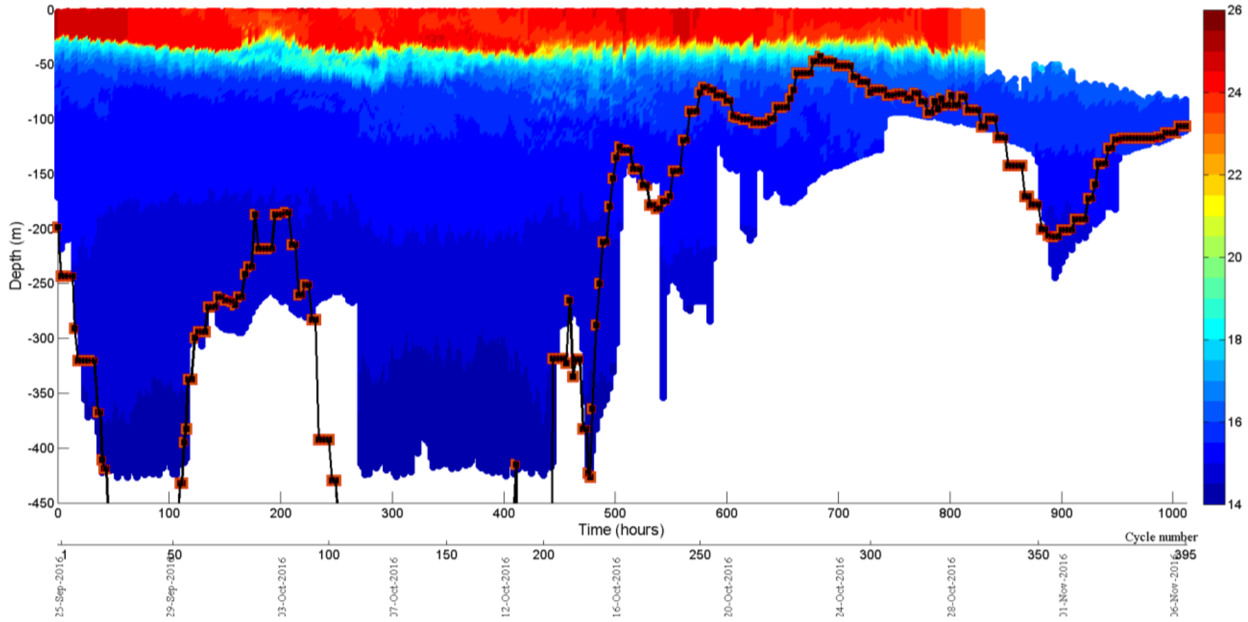


Figure 5. Computed conservative temperature (°C).

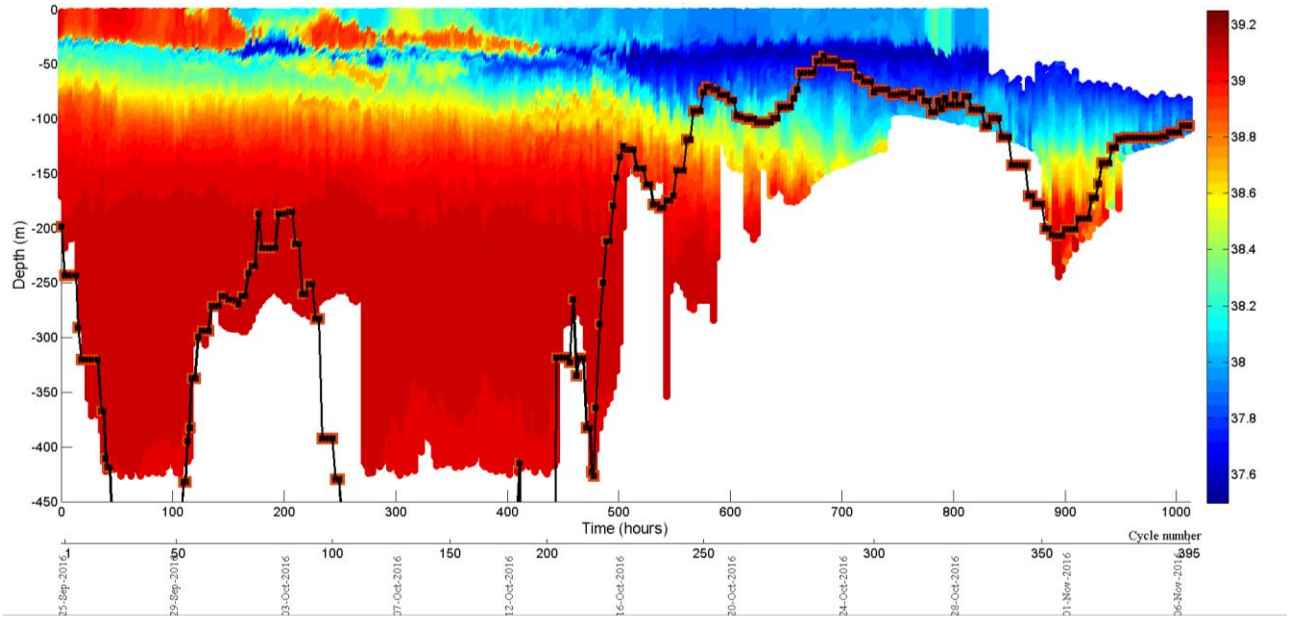


Figure 6. Computed absolute salinity (g/kg).

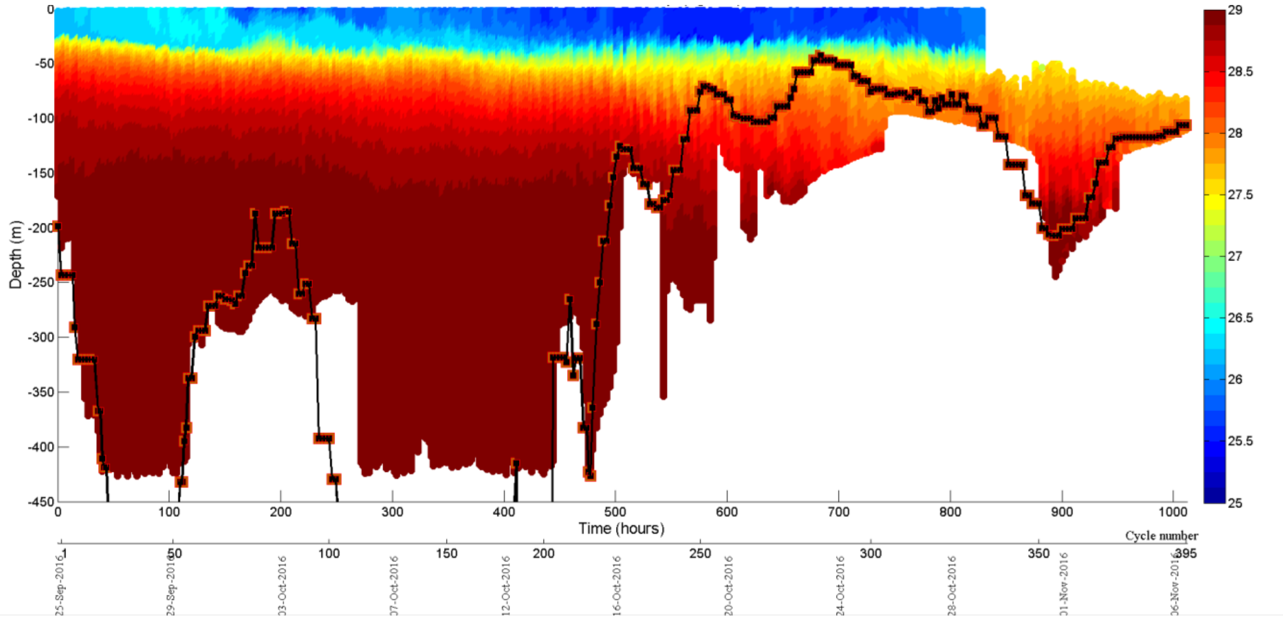


Figure 7. Computed potential density anomaly (kg/m^3).

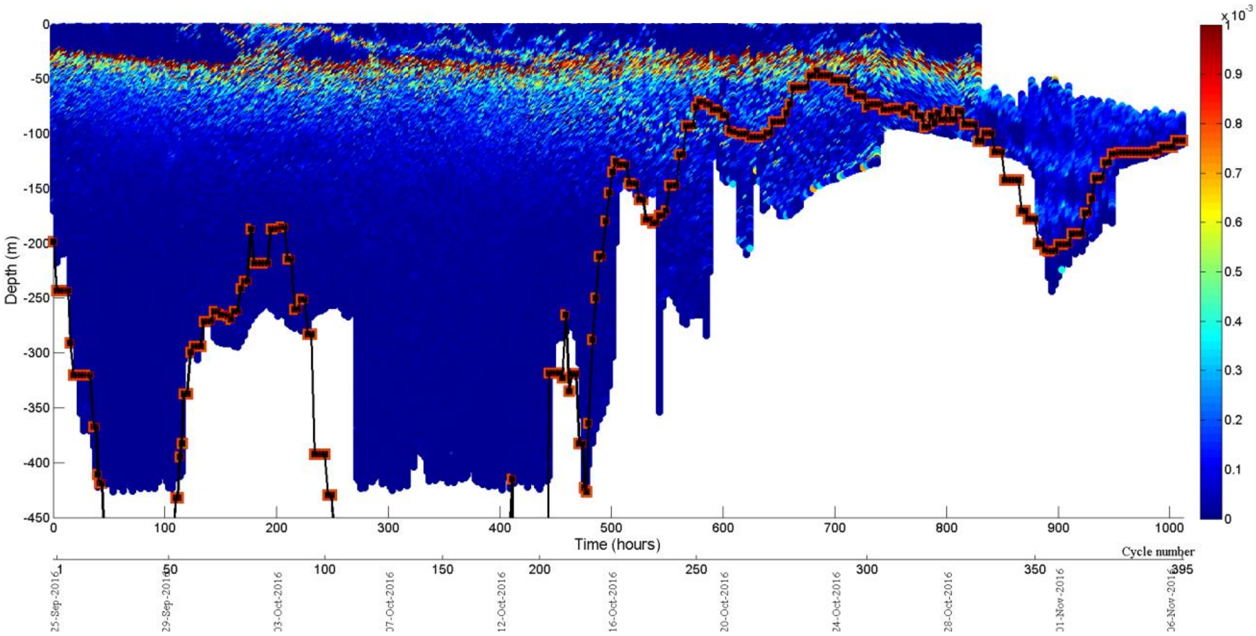


Figure 8. Computed squared Brunt-Väisälä frequency (1/s^2).

3.2 Dataset vertical profiles.

The processed and edited dataset (395 profiles) were divided into 6 weeks and then plotted by means of vertical superimposed profiles (see Figures from 9 to 14).

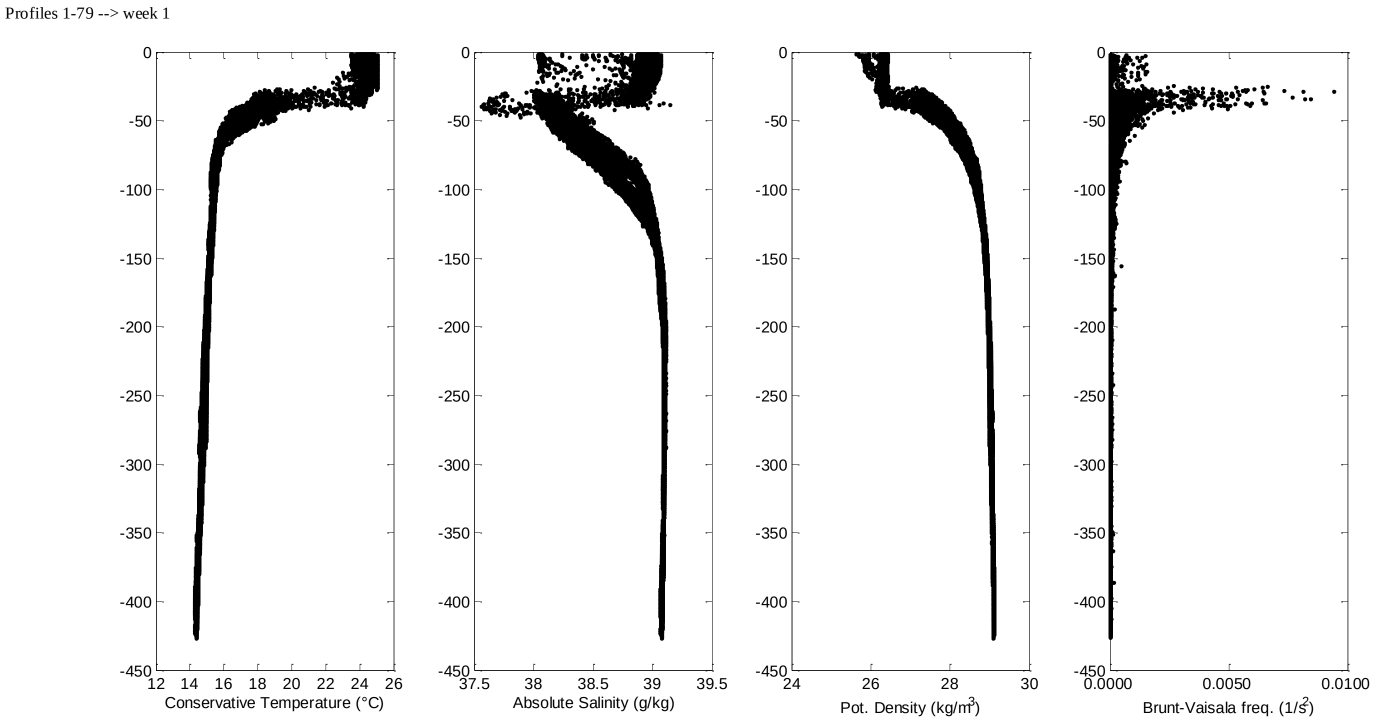


Figure 9. Temperature, salinity, potential density and squared Brunt-Väisälä frequency vertical profiles during the first week of measurements.

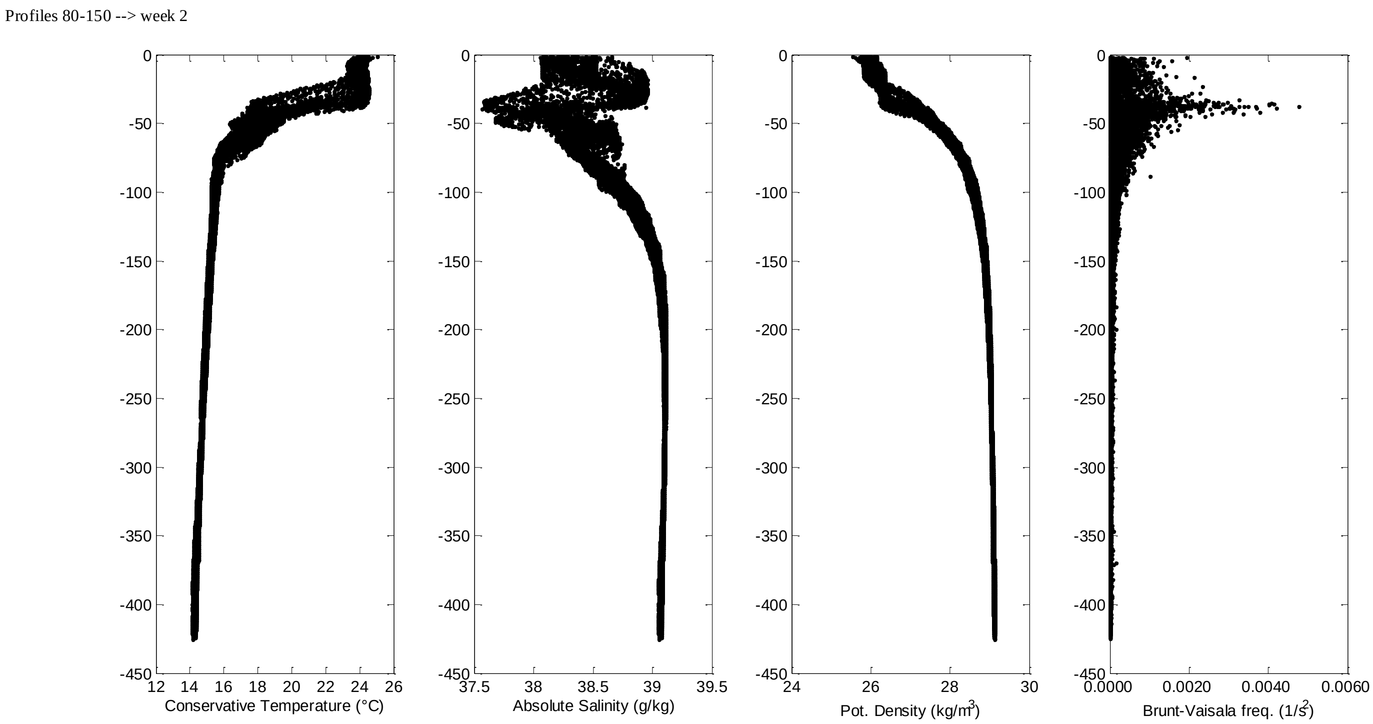


Figure 10. Same as Figure 9 but for the second week of measurements.

Profiles 151-230 --> week 3

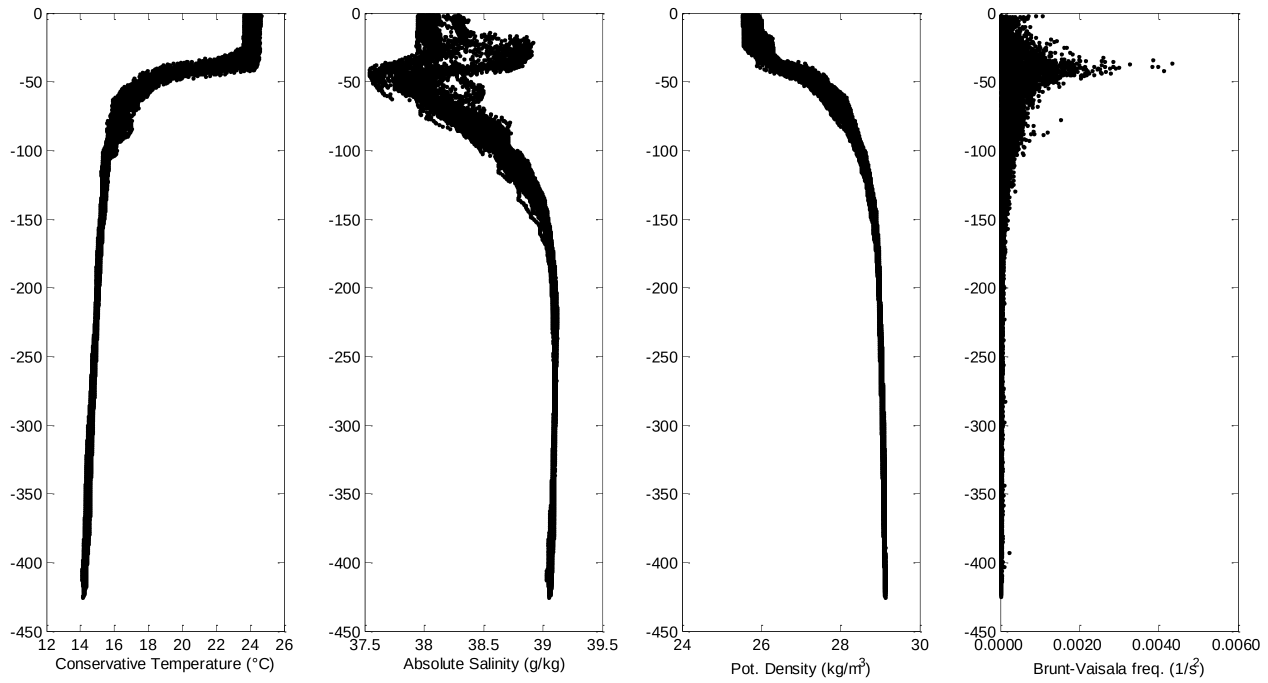


Figure 11. Same as Figure 9 but for the third week of measurements.

Profiles 231-285 --> week 4

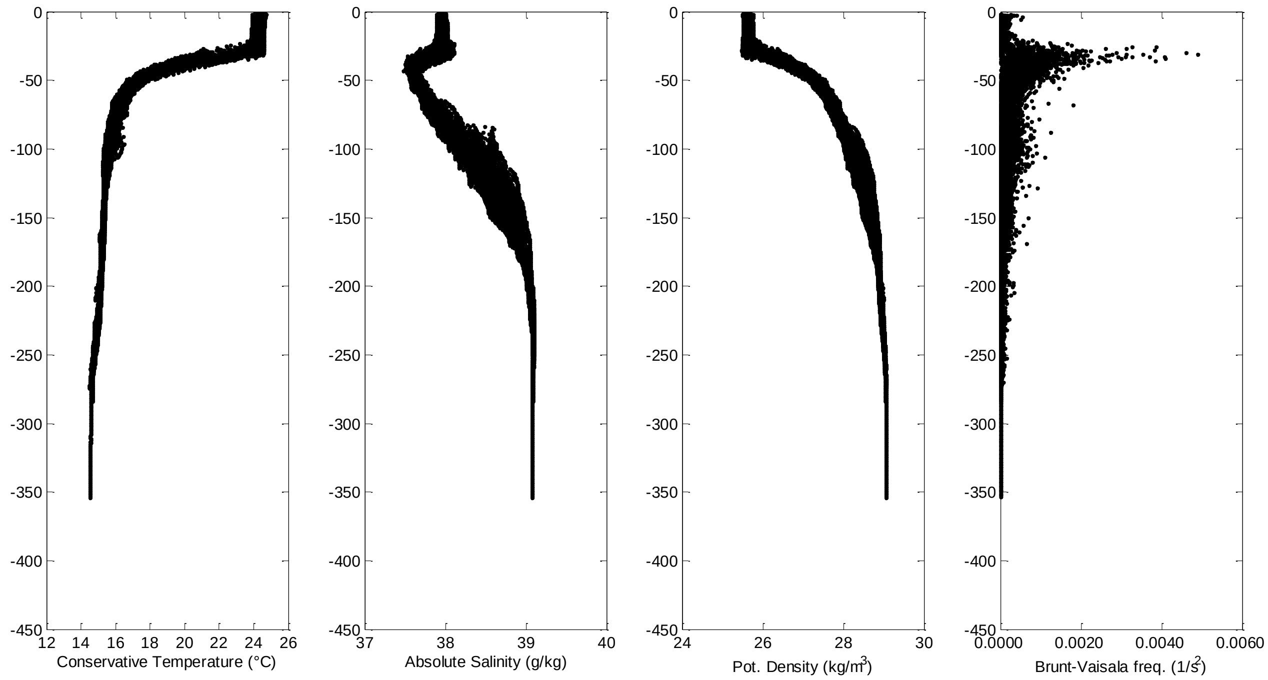


Figure 12. Same as Figure 9 but for the fourth week of measurements.

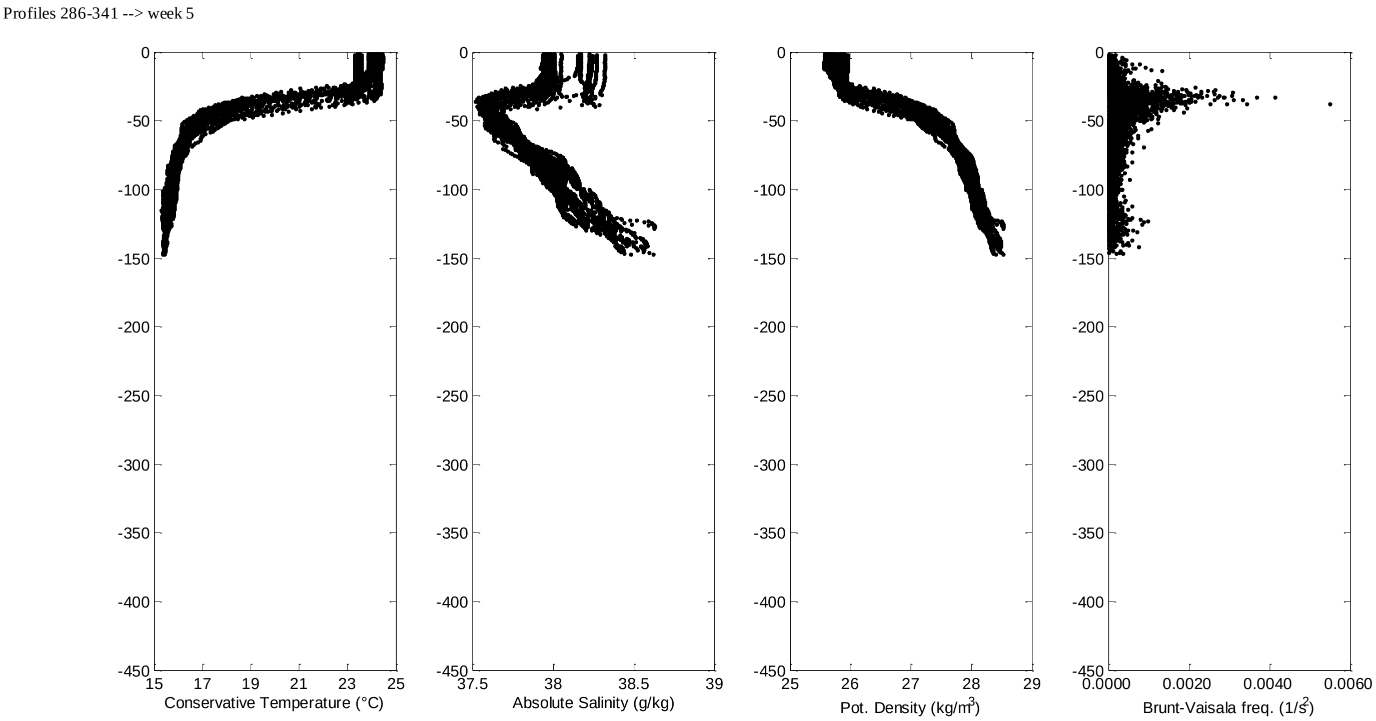


Figure 13. Same as Figure 9 but for the fifth week of measurements.

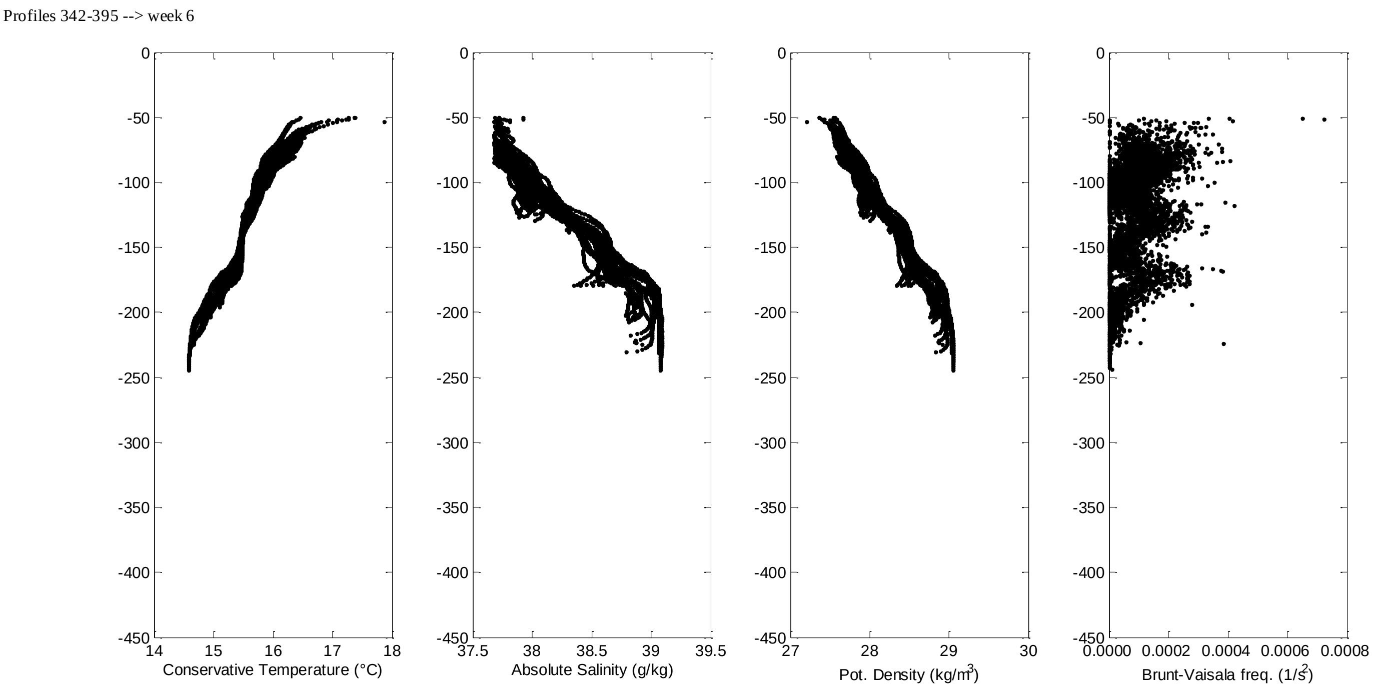


Figure 14. Same as Figure 9 but for the sixth week of measurements.

The float's cycling period is reported in Figure 15: its value basically swings between 2-3 hours (subplot (a)) depending on the instrument contact or not with the bottom (subplot (b)). The bathymetry has been interpolated starting from the ETOPO1 dataset.

The float is designed not to go deeper than about 425 dbar (red dashed line in panel (b)); it is observed that the Arvor-C's cycling time is 3 hours only in case of grounding, otherwise it is about 2 hours, with a few little exceptions.

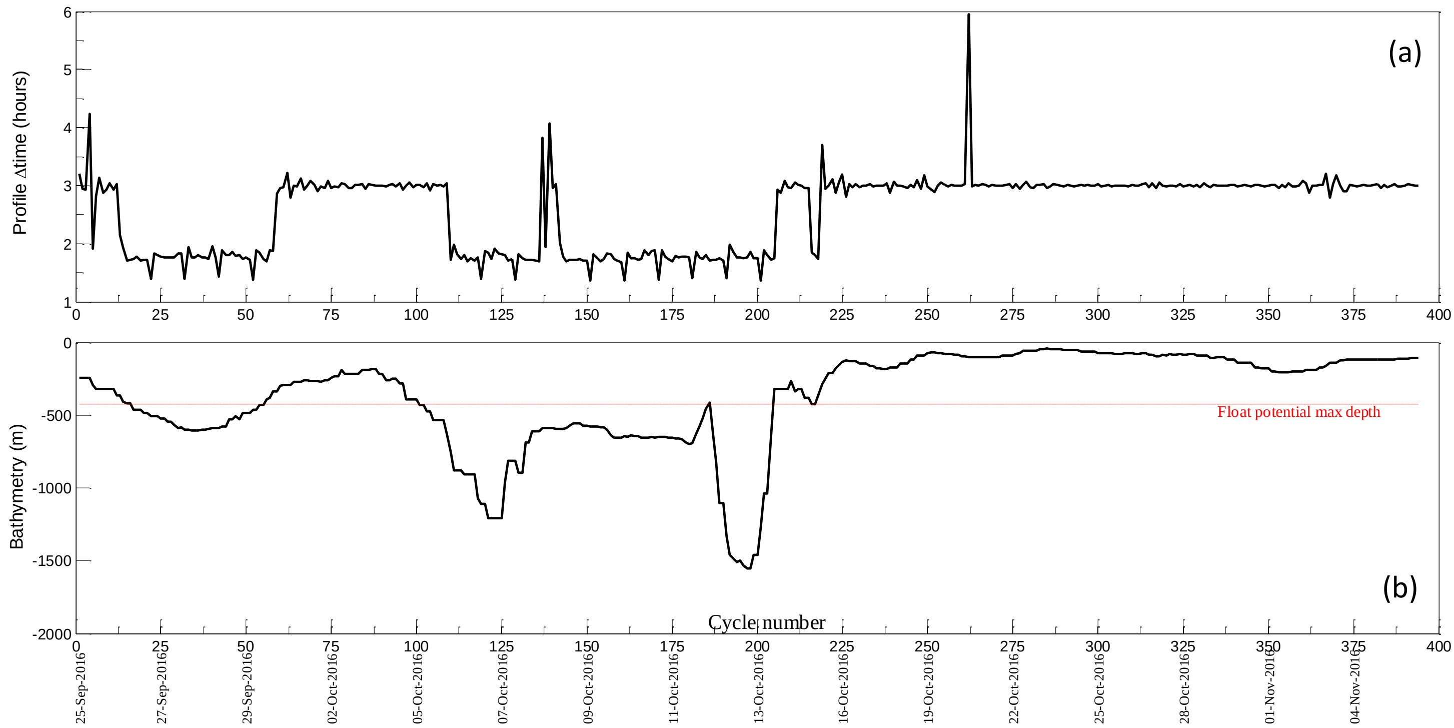


Figure 15. Arvor-C cycling period (a) and estimated bathymetry (b) versus time.

4. Conclusions.

An NKE Arvor-C was deployed on the 25th of September 2016 North of Malta and successfully performed more than 300 profiles with 1 m vertical resolution and cycling period between 2-3 hours (see text for details). The collected dataset consisted of *in situ* temperature and salinity profiles, which were used to compute the TEOS-10 conservative temperature, the absolute salinity, the potential density and the squared Brunt-Väisälä frequency.

Unfortunately the floats started to face problems with the conductivity sensor during its last profiles (about one week before the end of the mission), especially in the upper (less than 75 dbar) zone.

5. Acknowledgments.

The authors would like to thank Adam Gauci from Malta University for his fruitful collaboration.

6. References.

Arvor-C user manual, 33-16-010_ARVOR-C_UTI_GB_2014, pgg. 32.

Amante, C. and B.W. Eakins, 2009. ETOPO1 1 Arc-Minute Global Relief Model: Procedures, Data Sources and Analysis. NOAA Technical Memorandum NESDIS NGDC-24. National Geophysical Data Center, NOAA. doi:10.7289/V5C8276M.

McDougall, T.J. and P.M. Barker, 2011. Getting started with TEOS-10 and the Gibbs Seawater (GSW) Oceanographic Toolbox, 28pp., SCOR/IAPSO WG127, ISBN 978-0-646-55621-5.