SEAGLIDER TESTS AND MISSIONS DURING 2013

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1. Introduction

During late winter and spring 2013 the SeaGlider "Amerigo" was operated in the Southern Adriatic Sea as part of two missions. Those are the first missions for this glider after the test in the USA. Several problems were faced and solved. In particular, the glider team had to tackle problems with ballasting adjustment, optimization of glider speed, connectors leakage, altimeter malfunctions and data management. The glider team was engaged on 24h 7/7d shifts of about 8 hours in order to trim the instrument and deal with the problems.

Before deploying the glider in the Southern Adriatic Sea, several tests were carried out on land and two tests at sea were executed in the Gulf of Trieste (section 2). The first South Adriatic mission was achieved in March. The glider was recovered after only one day at sea because of several malfunctions (section 3). The second mission was carried out in May and completed after one week (section 5). Sections 4 and 6 report on the maintenance operations which occurred after the missions, while the plots of the collected parameters during the second mission are displayed in section 7.

2. Tests in the Gulf of Trieste

A test sea mission, consisting in a surfacing after 3 yos heading to the south of the Trieste Gulf, was carried out on 19/02/2013. Some problem with web connections (ssh tunnel) occurred immediately and the pre-launch operations took about 3 hours instead of the planned 1 hour. The glider was deployed off Miramare thanks to the collaboration with the staff of the Natural Marine Reserve. The buoyancy of the glider while in surface-mode was optimal (Fig. 1). Unfortunately, during the initial phases of the dive-mode the glider displayed an irregular behaviour (Fig. 2). It took about 15 minutes to go underwater and then it stuck at the bottom for more than 1 hour (even if $T_MISSION was set 15 minutes) probably it was entrapped in the sediments. A scuba diving marker buoy was deployed nearby the glider submerging point (at the last fix) to mark its position, allowing us to notice the glider surfacing around 100 m away from it. A small buoy attached to the glider itself seems to be a better tool to follow the glider during this kind of test.

Fig. 1. The SeaGlider at surface in the Gulf of Trieste with the Miramare castle in the background.

Fig. 2. The SeaGlider during the dive-phases. It lays horizontally at the surface or it is slightly submerged.

The entire set of glider parameters were identical to those using for the test in the USA, idem for the altimeter (set on), nevertheless the glider did not recognize the bottom and touched the sea floor before reaching the $D_TGT (set to 20 m). A second test was carried out on 07/03/2013 and the parameters were changed as reported in the trim sheet supplied after the Seattle Mission and in the calibration documents. The second planned mission was a single yo down to 12 m. The glider buoyancy at surface and its behaviour during the first phase of the dive-mode were good as expected. To better follow at surface the underwater path of the glider, a small fishing bobber with a fishing line was attached to the instrument. Initially it pointed in the right direction but shortly after it stopped, indicating that the glider was stuck again on the bottom. The glider surfaced after less than one hour with the nose dirty of mud.

These two tests clearly demonstrated that a SeaGlider cannot navigate in a very shallow water, a minimum depth of 40 m was suggested by Andrew Woogen. The SeaGlider is not able to perform a yo in that environment and the altimeter, , even if it was correctly set (double checked also by the iRobot personnel), did not have the time to switch on. Maybe a different combination of $ALTIM_PULSE and $ALTIM_SENSITIVITY parameters has to be used in such shallow water; (see iRobot, 2012). On the contrary the test showed a perfect data flow allowing the display of the near real time products on the OGS web pages.

3. First experiment in the South Adriatic Sea

The fist SeaGlider mission in the South Adriatic was carried out on 12/03/2013. The pre-deployment and deployment operations were conducted from the fishing boat “Pasquale e Cristina”. Early in the morning we started to deal with the custom procedure when we left the arbour at about 7:30 GMT. The deployment position was reached at about 11:00 GMT and the pre-launch tests/operations were started maintaining the glider antenna in open space. A long time was spent to set the TAG because of some unsolvable software troubles on the computer dedicated to the TAG programming, then a new software was downloaded thanks to the internet connection onboard and installed on a different computer. The glider was deployed from a rubber boat at about 13:30 GMT with no problems (Figs. 3 to 8). A first yo was commanded down to 30 m (13:49 GMT; 41.276°N – 16.791°E). The glider surfaced regularly and the mission started at about 14:45 GMT with programmed yos down to 40 m.

Fig. 3. The SeaGlider fastened inside the rubber boat before the deployment.

Fig. 4. The SeaGlider immediately before the deployment. The wings have still to be fixed.

Fig. 5. The SeaGlider on the cradle before the deployment.

Fig. 6. The SeaGlider in water with the cradle

Fig. 7. The SeaGlider in the water freed from the cradle.

Fig. 8. The SeaGlider in water in surface-mode.

A minor problem arose immediately after the first dives. The plots on the OGS web pages did not correspond to the last dive, they were delayed by one dive. To solve the problem, the scripts responsible for the data transfer between pcglider-irobot and oceano (Bussani and Gerin, 2013) were modified introducing a delay between the end of the transmission and the data transfer.

Another software problem faced during this mission, was the crash of incrond, a crucial component of exchanging data procedure between pcglider-irobot and oceano and between oceano and nettuno (web server). This service was manually restarted and then an automatic script was created. Further details can be found in the Appendix.

Some major problems occurred when parameters used in the glider trimming were partially displayed or nor displayed at all in the plots generated by the iRobot scripts. At the beginning of the mission the transmission occurred regularly for the first 6 surfacings but then some parameters after the apogee manoeuvre (or even before, Fig. 9) were displayed constant in time. The problem increased after the 6th dive when randomly some plots were not generated at all, making the glider team unable to trim the glider. After some investigation it was found that the missing display of the data was due to the presence of a lot of NaNs in the WetLab sensor outputs. Furthermore, the glider went deeper than the planned 40 m and moved parallel to the coast due to a strong current instead of heading to the waypoint (Fig. 10).

After some e-mails exchanged with the people at iRobot, the $PITCH_GAIN was changed from 45 to 40 (dive 14), with no particular improvement. Due to all those failures and since the depth in the area is about 100 m, not allowing the glider to go deeper in order to increase its speed and to steer the glider far from the coast, during the night we decided to recover the instrument. The recovery occurred on 13/03/2013 at 10:37 GMT at 41.221°N – 16.906°E (glider icon in Fig. 10).

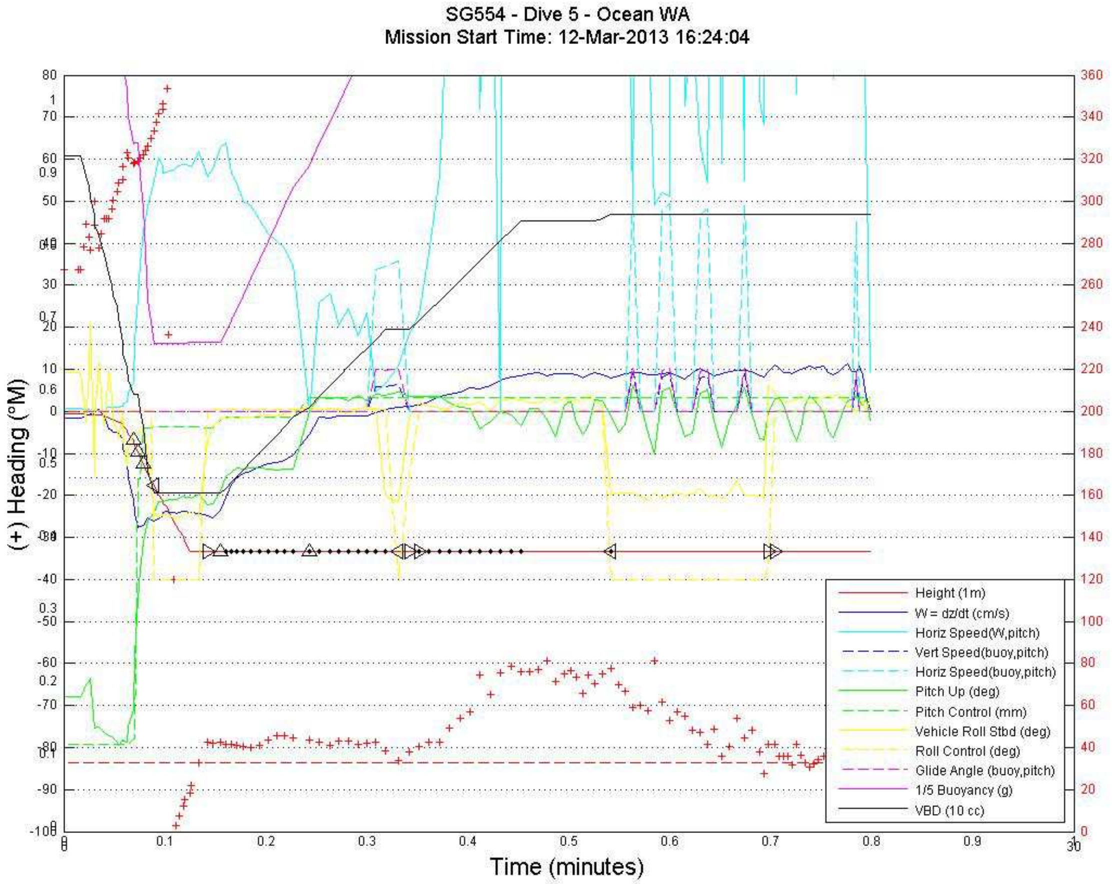

Fig. 9. Plot of the technical parameters. The depth is plotted only down to 33 m, but the glider reached 52 m as shown in the ppc********.eng files. No climbing phase is displayed.

Fig. 10. Glider mission: surfacings (orange points), last position (glider icon) and waypoint (green circle).

4. Glider maintenance after the first experiment

After the recovery, the WetLab sensor was taken apart from the glider and inspected (Fig. 11). A leakage in the connectors was found. The leakage generated a short circuit in the WetLab sensor which produced some NaNs in the parameters and two additional (and unexpected) columns in its file. These malfunctions blocked the correct creation of the plots (confirmed by iRobot staff). The software for the plots was modified by iRobot and then by R. Gerin in order to guarantee the plot of the glider data also in case of NaNs.

Finally, the WetLab connectors were cleaned and mounted again onboard the glider. To assure the correct functioning of the sensor and avoid another leakage, the WetLab connectors were wrapped with self bonding tape.

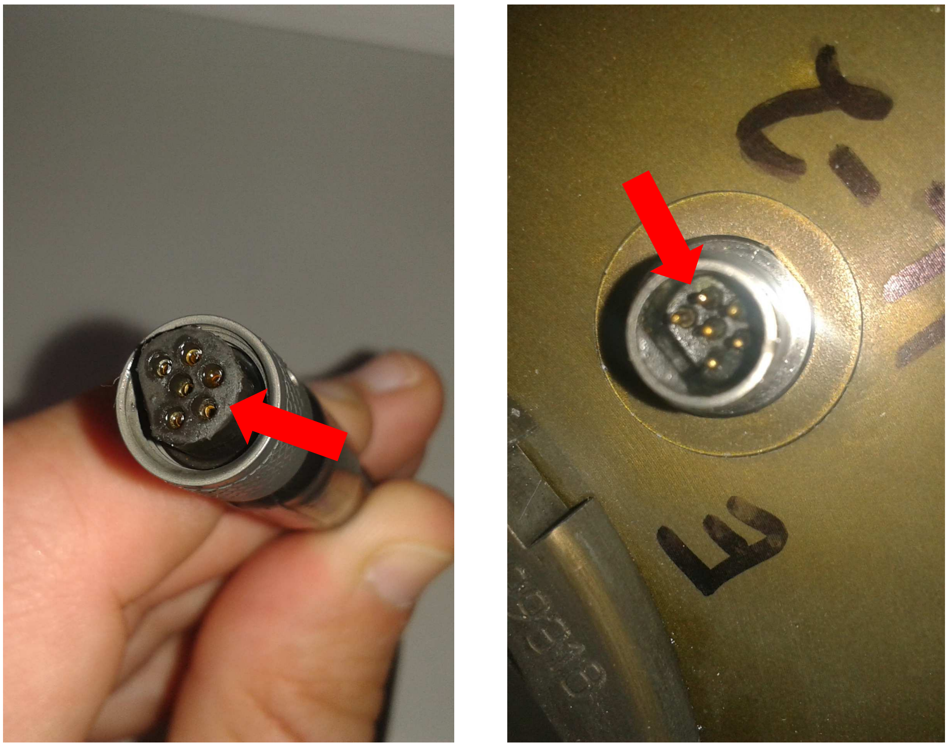

Fig. 11. Signs of corrosion on some pins (indicated by the red arrows) of the WetLab connectors.

Other problems were related to the CTD: the data showed anomalous values. The data were not recorded during ascent (the glider indeed was set to collect CTD data in downcast only), but the acquisition stopped several meters before the apogee manoeuvre and corrupted values were recorded at the end of each ppc*********.eng file. Several tests were conducted in the laboratory with the original CTD and a spare CTD provided by iRobot (Fig. 12). We discovered that the glider interrupts CTD power at the $D_TGT, at deeper depth the values are not collected. Since the CTD acquisition is not stopped properly using the SeaBird command, the data in the buffer before the $D_TGT are not saved in any file and they are lost. The buffer is volatile, and it depends on external power. Any data that is in the buffer, when power is removed, will be corrupted (pags. 22 and 59 of SeaBird, 2013). There was no difference between the two CTD sensors.

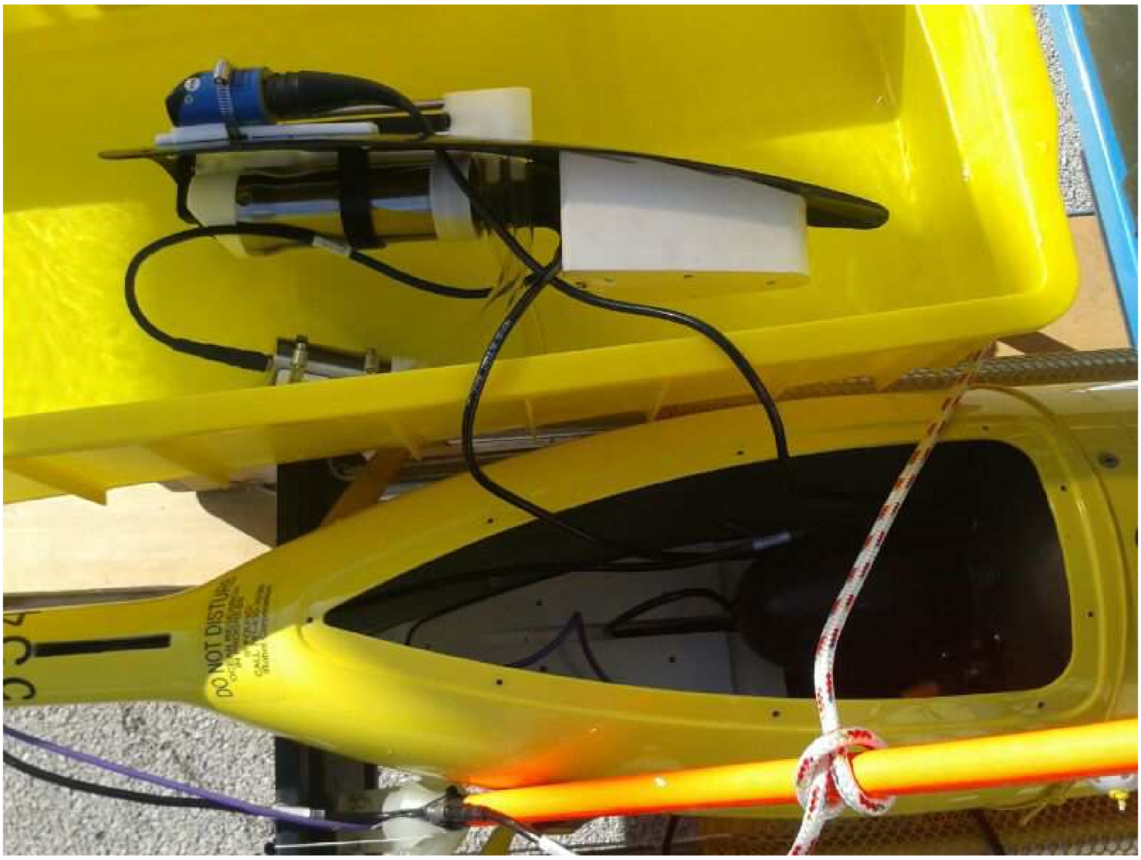

Fig. 12. Test on the CTD with the sensor and the pump inside a bucket of salty water.

5. Second experiment in the South Adriatic Sea

The second experiment was carried out in May 2013. New permission from the Coast Guard was requested (20 days before the experiment) and obtained in due time.

The glider was deployed from the same boat on the 15/05/2013 at 12:10 GMT (41.667°N - 17.068°E). The first part of the experiment (about one day; Fig. 13) the glider was headed toward North-East and was intensely trimmed thanks to the collaboration with Simò Cusì. Then, the glider began its planned mission (transect indicated in Fig. 14). After 2 days, the glider covered about 18 km only toward North-West due to a strong current, therefore, we changed the waypoints and made the glider going South-East for 3.5 days (green circle in Fig. 13). Finally, we recovered the instrument on 22/05/2013 at 08:22 GMT (41.356°N – 17.678°E; glider icon in Fig. 13).

Fig. 13. The SeaGlider path during the second experiment (orange points = surfacings; glider icon = last position; green circle = waypoint).

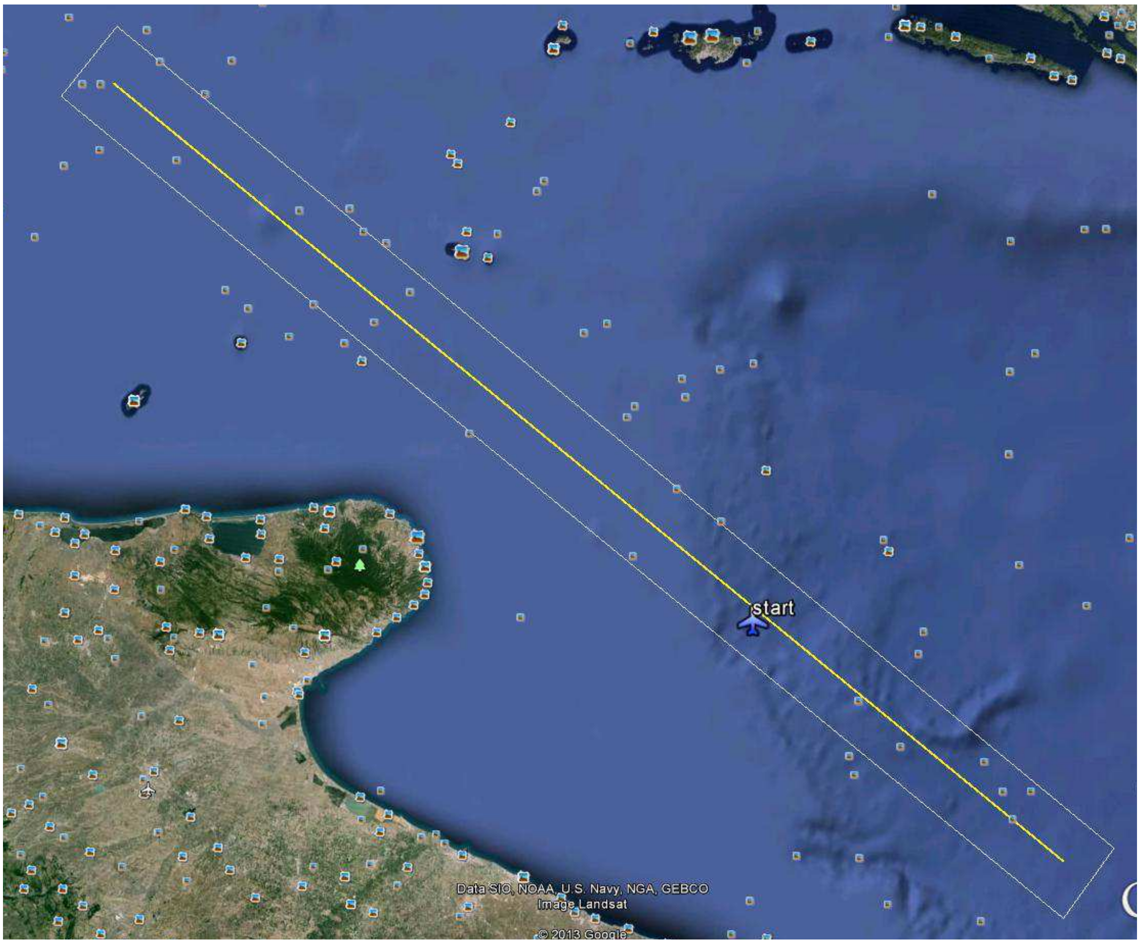

Fig. 14. Planned glider mission in May 2013.

This second experiment gave us the possibility to improve the strategy necessary to trim the glider and to understand how to fine-tune its parameters. The explanation of the parameters and effect of their variations on the glider behaviour can be found in Gerin et all., 2013.

6. Glider maintenance after the second experiment

Since glider data of a few dives were not transmitted via iridium in real-time, all the files acquired during the mission were manually downloaded in the Lab following Zuppelli and Kuchler (2013). Data were analyzed and NaNs were again found in the WetLab data. The sensor connectors were inspected and some water intrusion again was discovered. The connectors were cleaned and both the sensor and the cable were deeply tested in the laboratory. No damage on the cable was found and the sensor passed all the functional tests. The connectors on the glider side demonstrated to be a weak point of the WetLab sensor. It was decided to better protect them for the future missions by using liquid tape.

Fig. 15. WetLab sensor test.

7. Scientific data of the second experiment

Below we reported the time-depth plots of the scientific parameters measured by the SeaGlider during the second mission in the Southern Adriatic (Figs. 16 to 22).

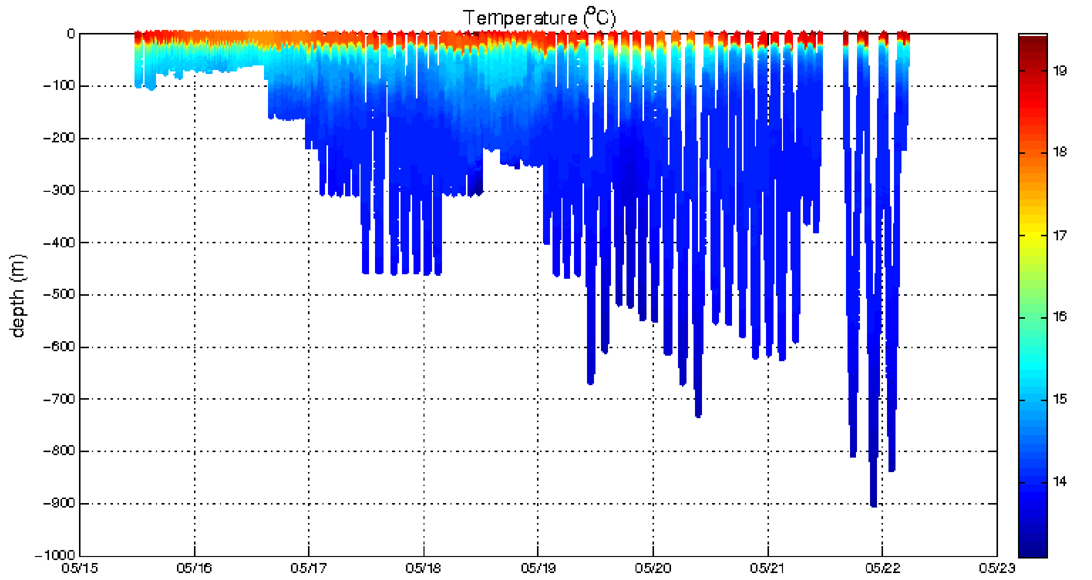

Fig. 16. Temperature.

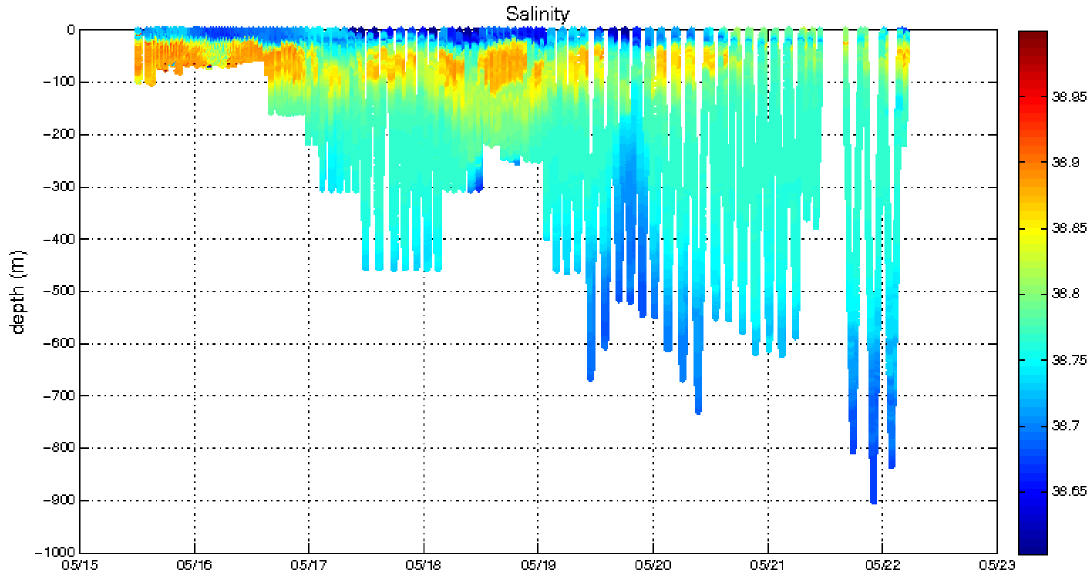

Fig. 17. Salinity.

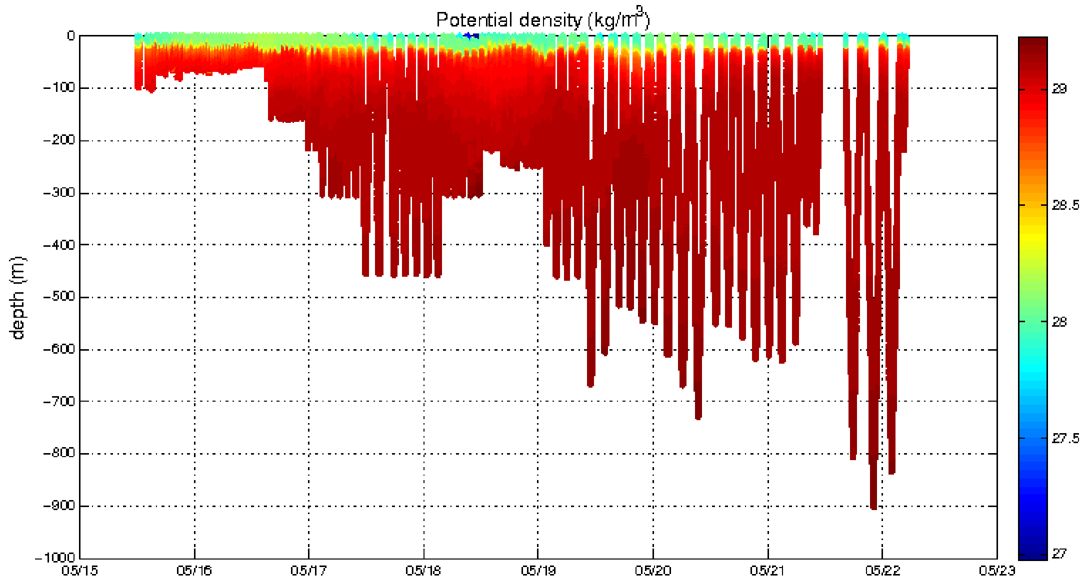

Fig. 18. Potential density.

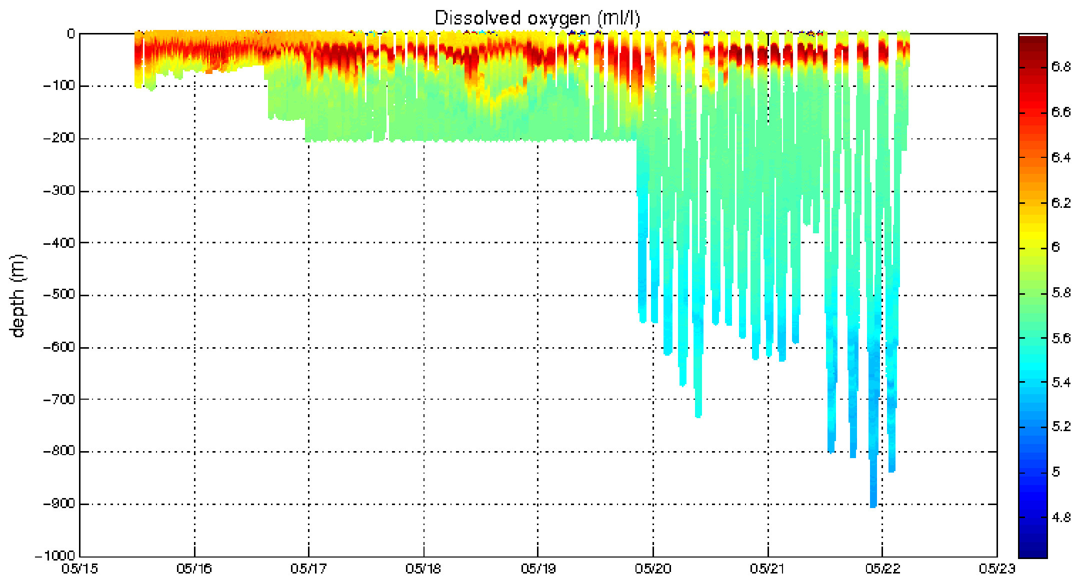

Fig. 19. Dissolved oxygen.

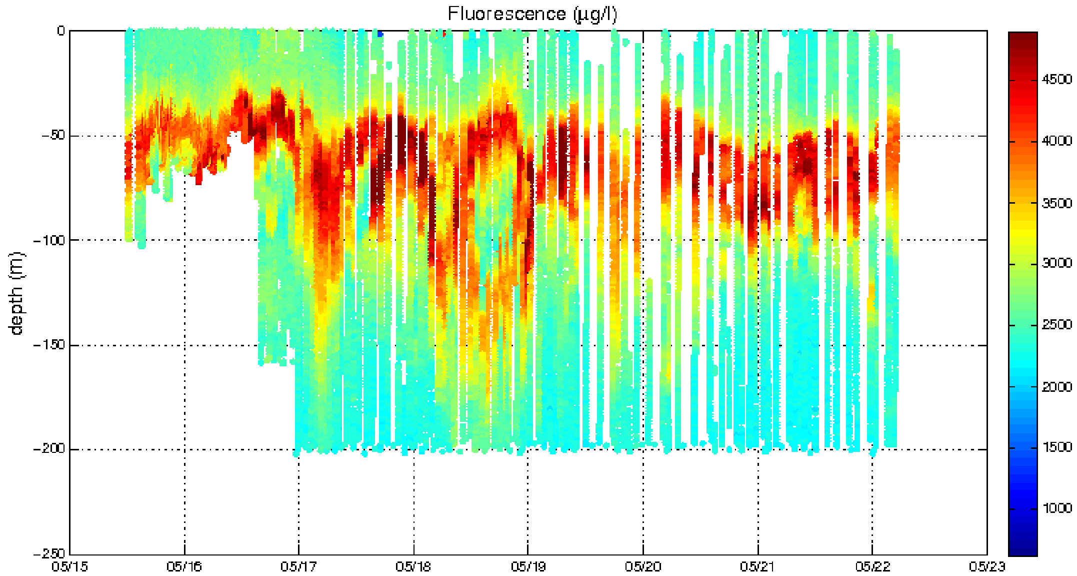

Fig. 20. Fluorescence.

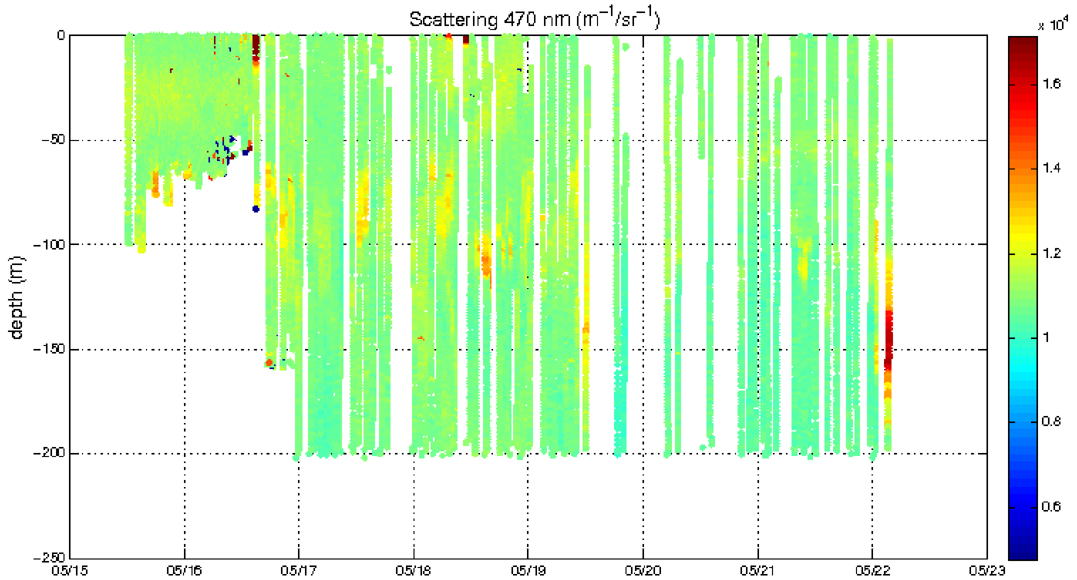

Fig. 21. Scattering at 470 nm.

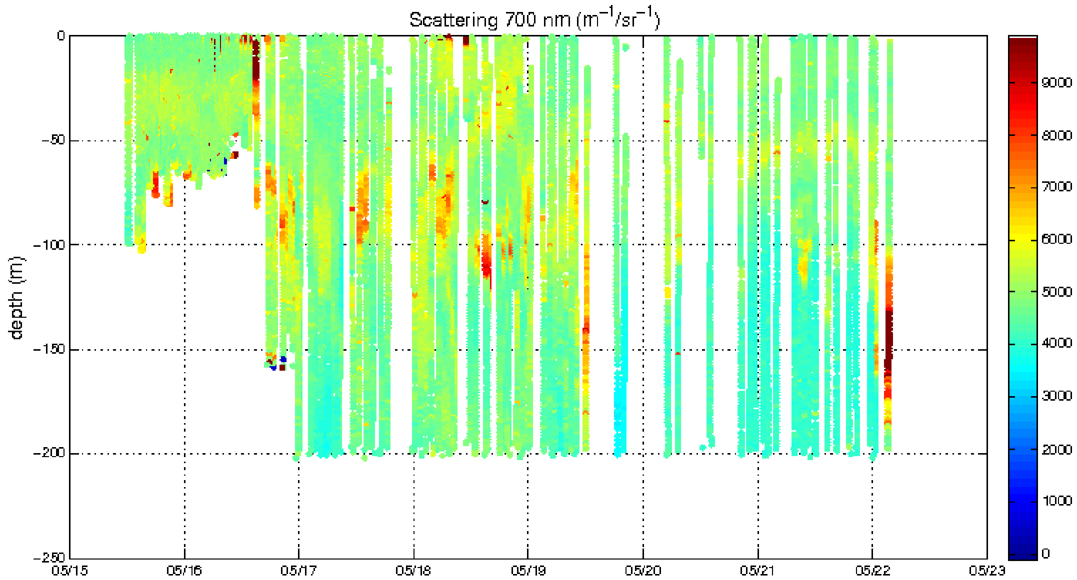

Fig. 22. Scattering at 700 nm.

8. Acknowledges

The authors would like to thank Caterina Fanara for helping with the permission and all the people involved in the deployment and recovery of the glider and in particular Paolo Mansutti, Antonio Bussani, Carlo Franzosini from the Natural Marine Reserve of Miramare, Antonio Altomare and all the crew of the fishing boat “Pasquale e Cristina”. A particular thank goes to Simò Cusì (IMEDEA, Spain) for the precious help during the glider trimming.

9. Appendix

The manual procedure to restart the icrond service consist of:

1. grep unhandled /var/log/cron to show the crashed service;
2. service incrond restart or /etc/init.d/incrond restart to restart the crashed service.

In order to check if the service is on or off one can use this command:

service incrond status or /etc/init.d/incrond status

The procedure was automated and in the root crontab (in both pcglider-irobot and oceano servers) the following line was inserted:

```
*/10 * * * * /root/auto_restart_incrond
```

The script (described here below) is executed every 10 minutes and it restarts incrond daemons if it is stopped.

/root/auto_restart_incrond

```
#!/bin/bash
#AB20130314
RIAVVIA="/sbin/service incrond restart"
#path assoluta del comando pgrep
PGREP="/usr/bin/pgrep"
#nome del demone
NOMEDEMONE="incrond"
#trova il PID del demone
NUMEROPID=$($PGREP $NOMEDEMONE)
# if che vede se il programma/servizio/demone non e' avviato
if [ -z $NUMEROPID ]
then
# se non e' avviato lo riavvia
$RIAVVIA
Fi
```

10. References

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