INTERNAL DOCUMENT

No. 192

POL Glider Facility (July 2009)

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July 2009

Proudman Oceanographic Laboratory
NATURAL ENVIRONMENT RESEARCH COUNCIL

www.pol.ac.uk

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Overview

The Slocum Glider was tested in POL's Glider Facility between 6-17 July 2009 in order to acquire the necessary skills and to identify outstanding requirements before deploying the glider in a scientific mission.

See Appendix 1 for daily diary of activities during two week testing period.
See Appendix 2 for the original start up document and for further information.

Fig.1 Glider tank and A-Frame

Fig.2 Glider in tank during ballasting

Fig.3 Dry preparation area

Fig.4 Dock server communications set up

Figures 1-4 show photographs of the Glider Facility at Vittoria Dock, Birkenhead.

Summary of progress

We have successfully upgraded the internal software on the mission control Persistor on the glider. Furthermore we are confident that we can now ballast the glider correctly for different sea water salinities and are able to adjust the glider H-distance (distance between the centre of gravity and the centre of buoyancy: should be greater than 4mm and less than 6mm) to an acceptable value.

Recommendations

- Require at least one week for in-house ballasting & H-distance checks
- Additional training is required to further develop skills (Webb/Rutgers course)
- All team members should attend 4th Glider Workshop in Cyprus (Nov 2009)
- Links should be made with SAMS for glider testing

- Links should be followed up with NOCS for knowledge sharing
- Investigate options for initial missions in the docks (dock water 25PSU)
- Investigate building customised weight rail for the lower Science Bay (See Figs. 5/6)
- Minimum team for ballasting/H-distance is two people
- Running a mission will require at least three people in the field and one at base

Identified requirements before scientific mission

- fully test mission control scripts with glider simulator
- Go through and understand the Rutgers missions files used during the Irish Sea test
- Change glider iridium SIM card from standard dialup to RUDICS
- Test the Argos system
- Additional boat handling skills will be required (training requirement)
- Investigate replacement batteries (UK supplier or return to Webb)

Time estimates

- Dock test - 1 week
- Upgrade to RUDICS
    - To take apart & add new Sim - 1 day
    - To test over network and firewall - 1 week
- Scotland 1st trip - 2 weeks (1 week preparation, 1 week trial)
- Scotland 2nd trip - 2 weeks (1 week preparation, 1 week trial)

Additional infrastructure items which are required

Glider consumables and items

- Four additional wings
- Additional O-rings for sealing hull compartments
- USB to Serial multiplex/expander (Edgeport/Keyspan)

Fieldwork infrastructure

- Nissan Navara if launching Rib, otherwise POL van
- AC Generator to power PCs and communication system
- Portable bench and chairs
- In-field dry area for computers (e.g. Tent structure or Van)

Glider facility at Vittoria Dock

- Door dust cover to be fitted to dry lab
- Shelves required for dry lab
- Bench work surfaces need sealing with paint or varnish
- Beams need painting white
- White board for dry lab
- Tank cleaner & pool net
- A-frame bar should be cut to fit
- Fixed length bars for scales to be made by workshop

Appendix 1

Daily diary of progress

Day 1 – Monday 06/07/09
Upgrade Glider internal software to take in to account problem identified by Webb. The following link describes the process followed to carry out a software upgrade and addition of a resistor to the control electronics:

(http://www.glider-doco.webbresearch.com/glider-servicebulletins/Digifinjune2009.pdf)

In parallel, trial missions were tested using the glider simulator.

Day 2 – Tuesday 07/07/09
Continued upgrade and test of software upgrade.

Glider tank at Vittoria Dock was filled with fresh water and salt added to take the concentration to 19.0 PSU. A SeaBird CTD was suspended in the tank to measure the salinity during the mixing process. The tank was setup to take the electronic scales and the crane system (See Fig. 1).

Day 3 – Wednesday 08/07/09
More salt was added to take the salinity concentration to 25.5 PSU. An aluminium bar was used to suspend the electronic scales and various tests done to find out the best way of attaching them to the Glider. Once in the tank the glider was switched on and comparisons made between the SeaBird and Glider conductivity sensors. The freewave communication with the glider was used from the dry lab (See Fig 4.) The ballasting was started (The Glider had been setup by Webb for 28.8 PSU and fully balanced with a H-distance of 5.3mm). In 25.5 PSU the Glider had a front weight of 84g and an aft weight of 216g. For the glider to be neutrally buoyant at the surface these measurements suggested that 84g be removed from the front and 216g be removed from the aft compartments.

Day 4 – Thursday 09/07/09
The Glider was taken apart in the dry lab (See Fig. 3) after releasing the vacuum. The POL Glider contains three bottles (two in a high parallel position, one in the lower port position) of lead shot in front, one in aft. Each bottle was removed, marked and weighed. 84g was removed from the two front upper two bottles (42g each). 216g taken out of the aft bottle.

Day 5 – Friday 10/07/09
Four O-rings were checked and lubricated and the Glider closed. The vacuum was applied and then the Glider was taken back to the tank. It was weighed again with front and aft suckers on hull (See Fig. 2). This resulted in a relatively well ballasted Glider with a small tilt to port.

The A-frame was then setup for carrying out the H-distance test. Ideally this distance should be between 5mm & 6mm. Greater than 6mm results in a ***stiff glider*** (dive too shallow; too much energy expended to attain correct dive angle). Less than 4mm results in an ***unstable glider*** (struggles to dive at correct angle, oscillates; poor performance). The setup was altered to carry out the H-distance calculations using measurements and Webb spreadsheet.

Day 6 – Monday 13/07/09
The first calculation gave an H-distance around 3mm which is too low for a deployment. Via email Webb suggested moving one of the 500g lead weights from the science bay from the upper compartment to the lower compartment.

The glider was taken apart again as previously done for ballasting. In addition, the Science Bay was taken apart (30 minutes). A bar containing three weights was removed and the forward weight taken off (See Fig.5 & Fig. 6). This process identified a problem since there was no location in the lower compartment to attach the weight. Holes in hull separators would accommodate another bar, however the CDOM sensor was in the way. A custom bar would be required in this area to add additional weight or to move weight down. For testing Velcro was used to stick the 500g weight to the top of the blank puck (black cylinder in Fig. 6) next to the CDOM unit. This was located in the front /bottom part of the Science Bay.

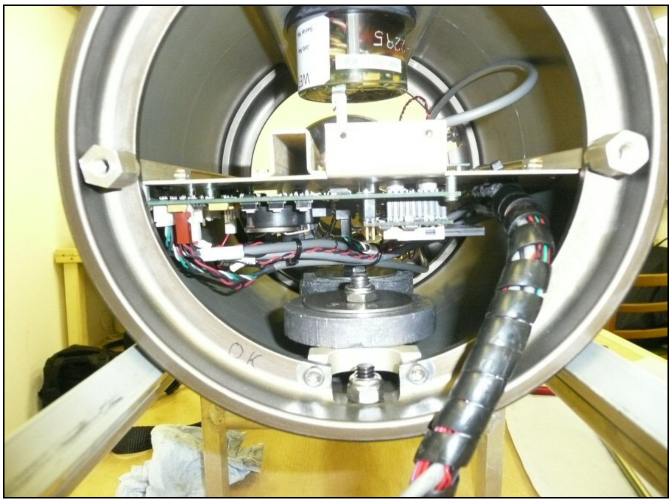

Fig. 5 Science Bay (upside down)
(a) CDOM electronics are contained in cylinder (see upper part)
(b) Weight rail can be seen at the bottom of the photograph with two of the three attached weights showing.

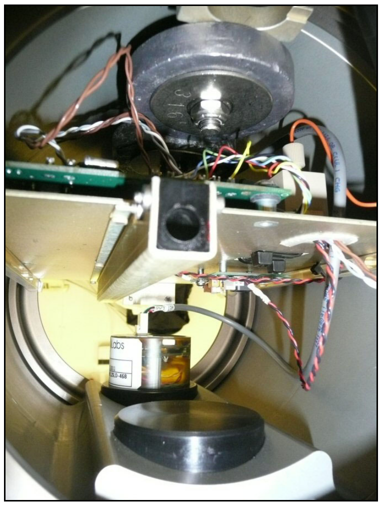

Fig. 6 Puck in lower part of Science Bay
(a) Puck is black cylinder in lower part
(b) Weight rail can be seen in the upper part with one of three attached lead weights showing.

A physical battery check was carried out on each Glider battery set using a voltmeter. The Glider was put back together and vacuum added. It was taken back to tank for another H-distance calculation. The H-distance increased from 3.88 to 4.99mm.

Day 7 – Tuesday 14/07/09
The glider was again taken apart. The weight disk was put back to its original position and the original amount of lead shot added back to the bottles. The O-rings were lubricated and the vacuum added.

Originally the Glider was balanced before shipment from Webb to salinity of 28.8PSU and with a H-distance of 5.3mm. The tank was made up to 28.8 PSU. The Glider was placed in tank, however it sank to the bottom indicating too much ballast. The Glider was ballasted again, resulting in front 70g too heavy and aft 85g too heavy. The H-distance was carried out however it was too large.

Day 8 – Wednesday 15/07/09
Repeated H-distance checks were carried out using two methods and using different positions to suspend the weight and scales. This resulted in conflicting results between methods and positions. A table of results was created and sent to Webb.

Day 9 – Thursday 16/07/09
The data supplied to Webb led them to inform us that the distance from the hull to the sucker is critical in the calculation as we suspected. This led us to alter part of the spread sheet to accommodate this difference

Now the H-distance was repeated with the suckers at 3.5cm from the hull and the results were more in line with the original Webb setup (spring/weight method 5.82mm, pitch method 5.47mm). Webb indicated that the pitch method should be around 0.2mm less the spring/weight method.

Day 10 – Friday 17/07/09
The glider was put back in the tank and switched on. Using Freewave Communication, commands were issued to the Glider to report science data to the dock server. Successful attempts were made to download the science data from the Glider and to experiment with the Glider View software. The dock water within the Vittoria Dock behind the POL building was tested for salinity and found to be 25 PSU.

Appendix 2

<u>Glider Project Review Meeting Summary</u>

<u>Present:</u> Phil Knight (PJK), John Kenny (JLK), Chris Balfour (CB) & Danny McLaughlin (DM).

<u>Project title</u>

Incorporation of Glider Technology into shelf sea science.

<u>Scope of work</u>
This project has its aim the incorporation of Glider Technology into POL shelf sea science, including the Coastal Observatory (COBS – Irish Sea, also known as ISO, Irish Sea Observatory). The project includes all stages from purchase of all the necessary accessories, developing operational running skills, producing data delivery software and testing the Glider on the bench and in field trials.

<u>General Project Overview</u>
The glider was originally purchased for Coastal Observatory use with the intention of six deployments per year on an approximate month on month off basis. Restructuring of the observatory and current staffing levels dictate that no one can make a full time commitment to the project, although this still remains an aspiration for COBS. This means that the glider is more likely to be used in a 'responsive mode'. Therefore, it is considered more practicable that measurements from the glider are used to address particular scientific questions such as the measurement of oceanographic parameters during algal blooms, shelf edge measurements etc.

<u>Project Management, Reporting, Risk Assessment etc</u>
PJK is the project manger and budget holder who is responsible for overall management of the project. CB, JLK and DM will provide primarily technical support for the project as and when they can under the guidance of PJK. Work will be allocated to try and build up the required expertise (IT, ballasting and buoyancy, mission planning etc) within the entire group. The general consensus was that due to the part time and sporadic nature at which people can commit time to the glider project, management of the project is difficult. Perhaps the most appropriate compromise was to hold regular meetings, which are documented and follow a subset of PRINCE 2 methods and techniques. This will help to review each project development phase in order to keep all team members and interested parties up to date with the current project status.

Beyond the usual requirements for risk analysis and assessment the use of expensive and autonomous vehicles such as gliders carry an inherent risk of being unable to recover the vehicle after a deployment. It was considered that this is a general risk with oceanographic sensors. Provided that appropriate procedures and check lists were followed this risk can be minimised. The result of this is that in the event of a glider loss no one person should be singled out to carry the blame or responsibility for this. It is therefore essential that sufficient experience has been gained to operate the glider effectively before a practical deployment is attempted.

Staffing Levels
Due to the inability of anyone to commit to the project full time and it is unlikely that additional staff will be recruited, the following options were discussed:

- Use of a PhD student based at POL to work on the glider project full time. This could act as a mechanism to build up the required level of expertise although the long term commitment of this person to POL and the project could be questionable.

- A NERC wide glider 'hub' from which a particular institute could call upon to provide staff and gliders in response to particular scientific needs. Questions were raised about the cost of such a service and how glider resources would be prioritised. The general feeling was that in house glider expertise was required at POL.

In the meantime, PJK, CB, JLK and DM will commit time as and when possible for glider project development. This will help to work towards developing the required level of expertise at POL to support the use of gliders for particular scientific demands.

Further Training and Practical Trials:
In terms of further glider training, the following options were all considered appropriate, should funding be available to support this:

- An additional training event at Webb Research, USA in conjunction with the purchase of the microstructure sensor based glider for POL.

- Attend a glider training course at Rutgers University, where a facility exists that has extensive glider expertise available.

- Visit NOC for several days to discuss technical issues etc relating to gliders with relevant NOC staff.

- Attend the glider school in November.

- Someone from either NOC, Webb Research or Rutgers University to visit POL to primarily deal with glider related IT problems if these persist.

It was considered that as much experience of glider operational work should be gained at POL before this training is attended. This will allow the training to be tailored to cover particular areas of need based upon practical experience (e.g. concentrate on ballasting and buoyancy work if this proves to be difficult and so on).

Due to the unavailability of a glider test area (enclosed, easily accessible, saline area of water > say 10m in depth), close to POL a series of possible locations for test deployments were discussed such as lakes, offshore close to Conway etc were discussed. Perhaps collaboration with SAMS for a test deployment at Lock Etive (reasonably sheltered water close to a marine laboratory with the possibility of boat handling support) would represent an appropriate choice in the short term to gain practical deployment, mission planning, operation and recovery experience.

Scope of the Glider Work for July:
Two weeks in July to work exclusively on the glider project were originally scheduled by the POL glider team. The current status is that:

- PJK and CB are available for the weeks beginning on Monday 6th and Monday 13th July

- DM is available until Wednesday 15th July

- JLK is available apart from Friday 10th July.

For the July glider work, PJK has requested that CB and JLK initially work at Vittoria Docks with the glider. This will involve setting up and testing of required facilities, starting work with ballasting, buoyancy etc. PJK and DM will concentrate on working on IT related issues such as the correct configuration and testing of the glider simulator and resolving various IT related problems. The general idea is to have daily communication regarding progress at POL (IT) and Vittoria (glider) so all team members are up to date with developments.

At the conclusion of the two weeks of glider work in July a review meeting will be held. The structure and timing of future work will then be decided and circulated.

Other General Requirements Discussed:

- Equipment required for fieldwork trials still needs to be organised – portable 240Vac mains generator, portable workbench with a weatherproof cover, cables etc

- RUDICS an internet based service to more efficiently deal with multiple Iridium devices (gliders) than an acoustic modem to connect with Iridium for remote monitoring. A RUDICS service will be set up at POL in the near future.

- Boat handling – due to other commitments CB and PJK are reluctant to allocate the required time for advanced level training. Perhaps basic boat handling and radio operation would be more appropriate. JLK and DM are more willing to undertake full boat handling training to advanced level on the understanding that if out of office hours or weekend training were required, overtime would be paid for this.