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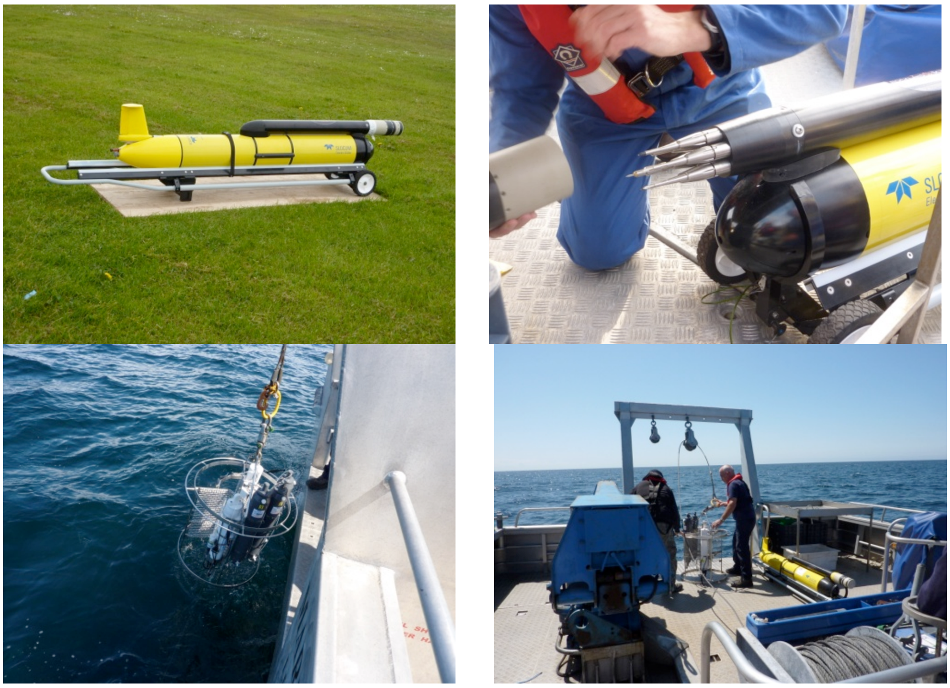
Research & Consultancy Report No. 11

NOC turbulence glider deployment report
for the Liverpool Bay Coastal Observatory
June 2011 Deployment

C Balfour, P Knight & D McLaughlin

2011



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ABSTRACT

A summary of the NOC Liverpool turbulence glider deployment that occurred between Tuesday 28th June and Monday 4th July 2011 is provided in this document. The general objective of the deployment was to hold the glider on station at a nominal GPS location of 53^{o} 48"N, -4^{o} 00"W to provide a series of glider based turbulence probe and CTD data profiles. These profiles were initiated when the glider reached a nominal depth of 40 metres and continued until the glider approached the sea surface. The glider deployment site was selected to be away from the influence of fresh water influx into the Liverpool Bay and in a position that avoids scheduled shipping routes. The recorded glider data was compared with a seabed instrumentation frame that was deployed at the same nominal location. The instrumentation frame had a Seabird CTD and a 5 axis upward measuring ADCP with a vertical turbulence measurement capability installed. During the glider deployment cruise reference water samples and independent CTD measurements were collected for deployed instrumentation and glider sensor calibration purposes.

KEYWORDS:

ISSUING ORGANISATION

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Not generally distributed - please refer to author

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Terms and Definitions

Turbulence Glider	A 200 metre depth rated Slocum Electric Glider (AUV) for oceanographic survey work that is manufactured by Teledyne Webb Research, America. The glider has an externally mounted micro-Rider turbulence probe fitted with an internal data recording capability. The micro-Rider is manufactured by Rockland Scientific International, Canada.
Coastal Observatory	The Liverpool Bay Coastal Observatory is a project that integrates (near) real-time measurements with coupled models into a pre-operational coastal prediction system whose results are displayed via the NOC internet site (http://cobs.pol.ac.uk/). The concept is founded on obtaining data in (near) real-time, using telemetry from underwater systems to the sea surface to land to this web site. In addition to this the observatory is accumulating a long term (years) time series of measurements. The primary objectives are to study the impacts of storms, variations in river discharge (especially the Mersey), seasonality and algal blooms.
FreeWave	Wireless short range radio link based glider communications
Iridium	Wireless data transfer based upon the Iridium low earth orbit satellite constellation.

Abbreviations

NOCL	National Oceanography Centre, Liverpool
ADCP	Acoustic Doppler Current Profiler
AUV	Autonomous Underwater Vehicle
CTD	Conductivity Temperature and Depth sensor
VHF	Very High Frequency
COBS	Liverpool Bay Coastal Observatory
TWR	Teledyne Webb Research
RSI	Rockland Scientific International
GPS	Global Positioning System
GMT	Greenwich Mean Time

1. Turbulence Glider Deployment Requirement Overview

This report describes the key features of the turbulence glider deployment undertaken by the National Oceanography Centre, Liverpool (NOCL) from Tuesday 28th June and Monday 4th July 2011. The key features of the NOCL turbulence glider are shown in Fig. 1. The general objective of the deployment described in this document was to evaluate the performance of the turbulence glider for an extended period of time. In addition to this the CTD and turbulence measurements undertaken by the glider were be compared with data recorded by a seabed based recoverable instrumentation frame.

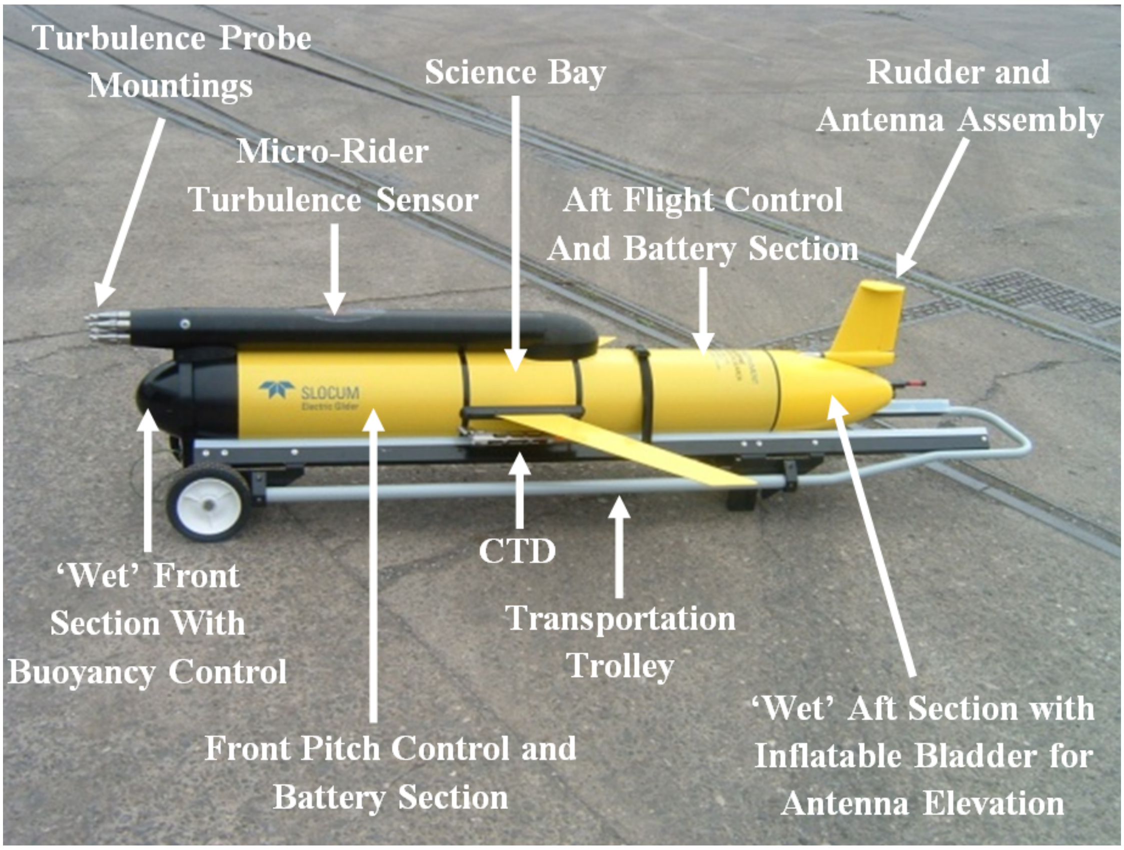


Fig. 1. Turbulence Glider configuration

The general objective of the deployment was to hold the glider on station at a nominal GPS location of 53^{o} 48"N, -4^{o} 00"W (Fig. 2) to provide a series of glider based turbulence probe and CTD measurement profiles. The glider deployment site was selected to be away from the influence of fresh water influx into the Liverpool Bay and in a position that avoids scheduled shipping routes. The glider based measurement profiles were initiated when the glider reached a nominal depth of 40 metres during its normal underwater undulations. When initiated, the glider based turbulence and CTD measurements continued until the glider approached the sea surface. The result of this was to build up a progressive series of 'up cast' measurements from the glider during the climb phase of the glide profile that is regularly repeated while the glider is underwater for navigational purposes. The recorded glider data was compared with a recoverable seabed instrumentation frame that was deployed at the same nominal location. The instrumentation frame had a Seabird CTD and a 5 axis upward measuring ADCP with a vertical turbulence measurement capability installed. During the glider deployment cruise reference water samples and independent CTD measurements were collected for deployed instrumentation and glider sensor calibration purposes.

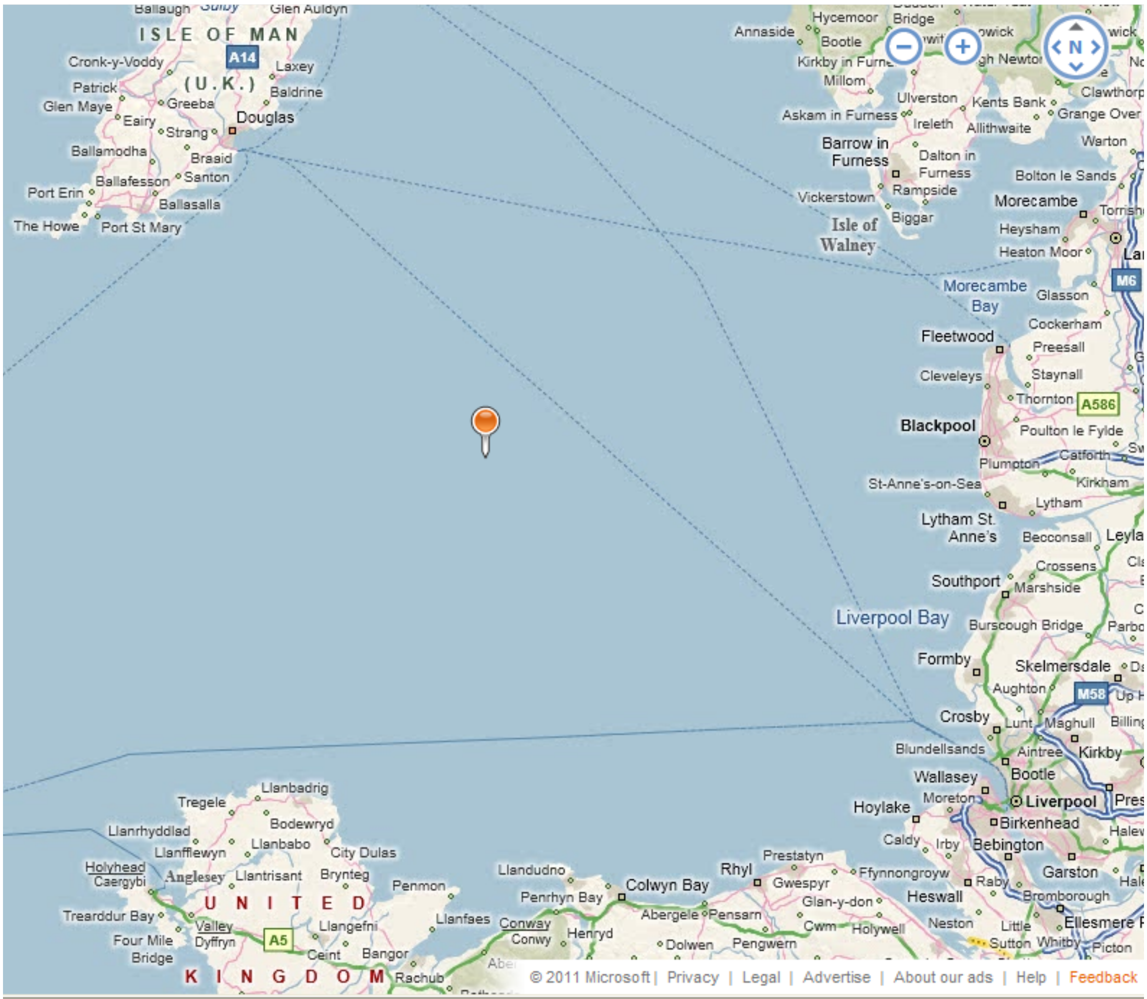


Fig. 2. Nominal Location of the June 2011 NOCL Turbulence Glider Deployment

This report provides a review of the key features of the glider deployment in addition to providing an overview of the initial recorded glider data evaluation. Some technical problems were encountered during the glider survey operations that resulted in shorter deployment than the originally planned two weeks. The reasons for this and some of the key observations and lessons learned from this are discussed in the summary section of this document.

2. Microstructure Glider Deployment – 28th June 2011

Participants: RV Marissa: David Annett (skipper) and Phil Robson
NOCL: Chris Balfour, Danny McLaughlin and Geoff Shannon

2.1 Deployment Aim

The University of Liverpool research vessel the RV Marissa was chartered to undertake a turbulence glider deployment and initial operational evaluation. The general requirement was to collect two weeks (or more if possible) of turbulence data using the Glider at a fixed location; the identified site is located away from the fresh water influence of Liverpool Bay and from most shipping traffic. The Glider data will be compared with data from a 5-beam ADCP and Seabird CTD both located on a bottom frame. CTD measurements are required to be carried out during the deployment for calibration purposes. These operations include the collection of water samples for salinity calibrations.

2.2 Deployment Site Details

Glider to keep position (nominal 53° 48"N -04° 00"W) around and within two waypoints:
53° 47.536"N -4° 01.613"W
53° 48.599"N -3° 58.732"W
with 1000m cuts offs and the distance between the waypoints is approximately 3700m

2.3 Pre Cruise Preparation and Instrumentation Configuration

The Glider, ADCP frame, Seabird 19+ CTD Carousel etc were loaded onto the ship and initial checks performed on the glider communications and instrument setup. The glider based turbulence probe was configured as shown in Fig. 3.

ADCP Frame

Frame acoustic release details:

SN: 69676, RX 11.5, TX 12.0, Release C SN: 72863, RX 13.5, TX 12.0, Release A

CTD: SBE 16+ with DigiQuartz, SN 5309, 10 minute sample interval, the instrument clock reset to 16:00 GMT on 27/06/11, delayed logging at 07:35GMT on 28/06/11

5 Axis ADCP SN10705, clock reset to 16:05 GMT on 27/06/11, delayed logging at 07:00 GMT on 28/06/11. Scripts for master and slave units configured for 45 x 1m sample bins.

Other Instruments Used

SBE 19 plus SN6650, RS232 interface with strain gauge pressure sensor fitted and used on the water sampling carousel for up and down cast measurements.

SBE Microcat SN 4966, RS232 interface with strain gauge pressure sensor fitted. Used for near surface density checks for glider ballasting verification and as a backup calibration CTD.

No flow through sampling possible due to fault with RV Marissa flow through CTD + fluorimeter system.

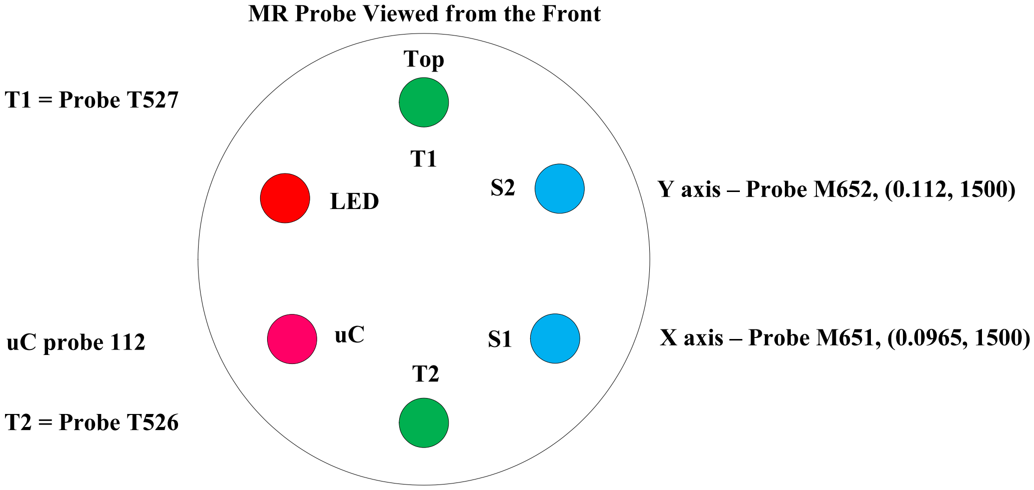


Fig. 3 RSI micro-Rider – Glider Mounted Microstructure Probe Configuration

2.4 Cruise Summary – Tuesday 28th June (all times are GMT)

The cruise started at 07:00 by the ship using the appropriate locks to exit the Liverpool dock area.

07:21 A Garmin GPS recorder was started and fitted on the upper deck mast of the ship to provide a GPS and time log during the cruise.

07:35 A test of the ADCP frame showed that the ADCP was running and pinging correctly and the SBE 16+ CTD was manually started to internally record at 10 minute intervals.

08:15 The turbulence glider (unit 175) was switched on with communications occurring over Freewave. The internal glider vacuum was 6.18inHg and a battery voltage of 14.579V. Tests of wiggle on/off, all science sensors, GPS reception and then an iridium dialup of the NOCL dockserver were completed successfully.

<u>At COBS Site 29 – Cruise Station</u>

11:51 On station at 53° 48”N and 4° 00.043”W, water depth was 44.4m. CTD frame was then prepared for deployment using the ships winch for calibration measurements.

12:00 A additional ADCP frame instrument check completed to confirm the instruments were logging. The frame was deployed at 53° 47.994”N and 4° 00.291’”W, at a water depth of 44m.

12:08 The Microcat was deployed over the side of the ship with 5 second sampling for a near surface density check and then recovered. At 12:18 the water density was calculated as 1025.26Kg/m^3. The glider is ballasted for 1025.66Kg/m^3, confirming the correct ballasting of the glider for the deployment location.

12:19 The Microcat was then re-deployed over the side of the ship with 5 second sampling for additional reference CTD measurements.

12:29 CTD1 - Carousel deployed at 53^o 47.949"N and 4^o 01.246"W, at a water depth of 44.3m. Bottle 1 set to trigger at 38m depth and bottle 3 was set to trigger at 2m depth. The CTD was lowered to 40m using the ships winch for 6 minutes to commence the sample collection, before beginning the up cast to the surface.

12:29 The glass salinity reference sample collection bottles were then rinsed with de-ionised water.

12:40 CTD1 - Carousel recovered at 53^o 47.936"N, 4^o 01.569"W. Carousel bottles appeared to have triggered correctly. Glass bottle samples taken as follows:

Glass Bottle S1 – 40m, bottom salinity reference sample for ADCP frame
Glass Bottle S2 – 2m, surface salinity reference sample for ADCP frame

12:43 The Microcat was then recovered and the data downloaded successfully.

<u>13:00 – Commence Unit 175 Turbulence Glider Operations</u>

13:02 Glider communications tested OK, tether plus pellet float was then attached and the glider was aligned for deployment.

13:07 Glider deployed with tether and float attached.

13:08 - 13:10 Status.mi mission run and completed successfully.

13:11 – 13:17 Completed ini0.mi test dive to 3m and back to surface

13:25 At a GPS position of 53^o 47.939"N and 4^o 02.689"W, and a 44m water depth, the ship was manoeuvred to recover the glider float. The glider was then carefully moved to side of ship using the tether and the float. The tether line and float were then removed. No obvious damage to the micro-Rider probes occurred during this operation.

13:26- 13:30 Completed ini0.mi test dive to 3m and surface without a float or tether attached to the glider

13:35 Run mr_test.mi glider mission to undertake a series of 40m dives and subsequent climbs to near to the surface with servo mode (automatic pitch control) enabled for a period of 30 minutes. This allows pitch parameters for a glider dive and climb to be determined.

13:38 CTD2 - Carousel deployed at 53° 47.902"N, 4° 02.933"W, at a water depth of 44.6m. Bottle 1 set to trigger at 38m depth and bottle 3 was set to trigger at 2m depth. The CTD was lowered to 40m using the ships winch for 6 minutes to commence the sample collection.

13:39 The Microcat was then deployed over the side of the ship with 5 second sampling for additional near surface reference CTD measurements.

13:47 CTD2 - Carousel recovered at 53° 47.892"N, 4° 03.173"W. Carousel bottles appeared to have triggered correctly. Glass bottle samples taken as follows:

Glass Bottle S5 – 40m, bottom salinity reference sample for glider

Glass Bottle S3 – 2m, surface salinity reference sample for glider

13:55 The CTD3 - Carousel was deployed again at 53° 47.908"N, 4° 03.494"W at a water depth of 45.8m to take the final water sample, S4 for the remaining glass bottle. The CTD was lowered to 40m using the ships winch for 6 minutes to commence the sample collection.

Glass Bottle S4 – 40m, bottom salinity reference sample for glider

14:10 mr_test.mi mission completed successfully. Downloading of the required glider data files from the glider was started and data plotting was undertaken with the glider dockserver based datavisualizer software.

14:12 CTD Carousel repeated casts were then started at 53° 47.908"N, 4° 03.494"W at a water depth of 44m. Repeated CTD down and up casts were then started to a maximum depth of 40m to gather additional reference CTD data.

14:15 Analysis of the plots of the glider data shows that the glider was diving to a depth of 40m as required. The pitch battery setting on a dive was ~0.26 inches with a dive angle of ~26°. The climb pitch battery setting was -0.1 inch resulting in a climb angle of up to and sometimes slightly beyond ~35°. This resulted in an asymmetric dive profile with a steeper climb angle as required for micro-Rider based turbulence measurements.

14:35 Run mr_serv1.mi glider mission to undertake a series of 40m dives and subsequent climbs back to near the surface with fixed pitch motor settings for a period of 30 minutes. The pitch motor settings used were 0.26 inches for a dive and -0.1 inch for a climb.

15:06 mr_serv1.mi mission completed successfully. Downloading of the required glider data files was started and data plotting was undertaken with the glider dockserver based datavisualizer software. A dive angle of ~26° was observed with a climb angle of ~35°. Based upon advice from TWR a climb angle >~35° may cause problems with the glider attitude sensor. Therefore the climb pitch motor setting was reduced to 0.0 inches and the glider dive and surface control file was updated and sent to the glider.

15:30 Run the glider mission mr_serv2.mi glider mission to undertake a series of 40m dives and climbs near to the surface with fixed pitch motor settings for a period of 2 hours between each surface. The pitch motor settings used were 0.26 inches for a dive and 0.0 inch for a climb. This is the glider deployment mission that will cycle between the following waypoints:

Waypoint 1 53° 47.536"N, 4° 01.613"W
Waypoint 2 53° 48.574"N, 3° 58.732"W

15:56 CTD3 - Carousel recovered and the final glass bottle sample, S4 was taken (previously collected at 53° 47.908"N, 4° 03.494"W).

15:55 Microcat CTD recovered.

<u>The cruise objectives were completed at this stage</u>

16:00 Begin the return to Liverpool for a 19:30 lock. CTD carousel and Microcat data was then downloaded.

19:00 Garmin time and GPS logger stopped and preparations for demobilisation started.

2.5 Reference Water Sample and Seabird 19+ Carousel CTD Data Summary

The SBE 19+ CTD only recorded the first 2 casts and the CTD clock is incorrectly set to 10th September 2010, making the post processing of the data difficult. The first 2 casts show a downcast to 40m depth, a delay and then an up cast. The near surface CTD readings compare well with the Microcat near surface readings. No SBE 19+ data appears to have been generated by the repeated CTD casts during the cruise, which occurred after all of the water samples had been collected. A summary of the water samples collected during the cruise is shown in Table 1.

Table 1 – Reference Water Sample Bottle Summary

Glass Bottle Ref	Depth (m)	Location	Comments
S1	40	53° 47.936"N, 4° 01.569"W	ADCP frame calibration
S2	2	53° 47.936"N, 4° 01.569"W	ADCP frame calibration
S5	40	53° 47.892"N, 4° 03.173"W	Glider calibration
S3	2	53° 47.892"N, 4° 03.173"W	Glider calibration
S4	40	53° 47.908"N, 4° 03.494"W	Glider calibration

3. Summary

An overview has been provided of the turbulence glider deployment that occurred as part of the NOCL Coastal Observatory survey operations from June to July 2011. Although a less than ideal sea state was evident during the RV Marissa based deployment cruise all of the required operations progressed well under tight time constraints. The instrumentation frame was deployed first. Calibration data was then generated with Seabird 19+ CTD profiler and water sample collection carousel arrangement. This allowed reference water samples to be collected at the required locations and depths. A set of near surface Microcat CTD calibration measurements and a GPS positional record was also recorded during the cruise. The glider was deployed with a surface float and tether line during initial performance evaluation to confirm that the required ballasting has been implemented and the glider was operating correctly. The float and tether line were then removed from the glider tail base attachment point with no obvious damage occurring to the fragile turbulence sensor probes. Following this a series of test dives and subsequent data retrieval from the deployed glider was used to trim the glider dive profile to the required values using fixed pitch motor control positions. This was required to limit the mechanical and electrical noise generated by the glider during climbs that is likely to interfere with up cast based turbulence measurements. All of these operations were completed successfully by the end of the cruise. Time constraints dictated that the RV Marissa needed to head back to port at this stage. The decision to deploy the glider for an extended period of time was then subsequently made based upon the initial evaluation of the glider performance during the cruise.

Several hours after the glider deployment it became evident during initial piloting that the glider was no longer searching for the programmed east to west navigational waypoints and aborting its planned survey mission. Investigation revealed that the glider mission waypoint files had been corrupted. Iridium based satellite telemetry was used to remotely re-instate these files. After restarting the glider the anticipated glider navigation was resumed and the exact reason for this file corruption problem is not clear. During subsequent piloting of the glider the glider aborted the planned mission a total of fourteen times during a six day deployment due to ‘Iridium Driver Errors’. The advice received from TWR was that this was due to an intermittent electromagnetic compatibility error between the glider internal wiring and sub-systems that will need to be investigated. In addition to this the measured glider internal battery voltage reduced at a higher than anticipated rate. The cumulative reported internal measurement of the glider battery charge consumption increased at a higher than anticipated rate for the standard alkaline batteries that were installed in the glider. This continued until mission aborts were generated when the total measured charge drawn from the battery reached the standard trigger threshold of 720 ampere hours. This is an exceptionally high value that is normally used to determine when a glider running on higher endurance lithium primary (expendable) batteries should be recovered. The result of this was that during day six of the glider deployment the glider was surfacing regularly due to mission aborts and drifting with surface and tidal currents. These problems were becoming increasingly difficult to manage by remotely piloting the glider using Iridium based communications. With a forecast of poor weather after 4th July the decision was made to perform an emergency recovery of the glider approximately 40 nautical miles offshore at short notice using a local charter vessel. Consultation with TWR revealed that the incorrect overestimation of battery charge usage and subsequent glider mission aborts was due to a glider firmware problem.

Subsequent testing of the glider after the recovery revealed that the pitch motor (fore) battery connector had vibrated loose during glider transportation. The glider runs with the fore and aft battery packs wired in parallel. These battery packs are monitored with one common voltage measurement that results in difficulties determining the source of accelerated battery depletion problem. The disconnection of the pitch battery pack resulted in a reduction in the glider battery capacity of ~60% and accounts for the faster than anticipated reduction in the glider battery voltage during the deployment. This problem has been reported to TWR and a temporary repair has been installed to encourage the pitch battery connector to remain seated during glider transportation. The glider (unit 175) has been updated to the latest available firmware release to deal with the problems that occurred with the internal measurement of the charge drawn from the glider batteries. Post deployment analysis of the micro-Rider turbulence probe data showed that there was a problem with this sensor during the deployment. Noise and spiking were evident in the recorded data that ultimately compromised the quality of the turbulence measurements that were recorded. RSI were consulted and the micro-Rider was sent back to the manufacturer in Canada for repair.

The glider deployment and subsequent operation described in this document have served to illustrate some of the considerations that must be made before deploying a turbulence glider. The presence of fragile measurement probes means that extra precautions must be made when operating such a glider. Incorporating a turbulence function with a coastal glider represents a novel measurement system that must be operated with care. Favourable weather and a water depth of at least 10 metres are required to evaluate the glider performance in advance of a proposed extended deployment. To allow turbulence measurements to be recorded successfully a series of incremental test dives must be undertaken to trim the dive profile to the required settings. This allows an optimised set of parameters to be derived to operate the glider correctly with fixed pitch motor positions in the intended deployment area. A timescale of between several hours and one day is usually required to complete this work by an experienced operator. This represents a significant operational overhead that must be considered when planning deployment and recovery operations with a turbulence glider. It is also desirable for a trained operator to undertake the glider configuration in close proximity to the glider to allow any problems that arise to be dealt with in a timely manner. The normal initial evaluation arrangement would be for the glider operator to communicate with the deployed glider while onboard the deployment vessel. This can be achieved using the FreeWave short range VHF data communications link that exhibits a higher bandwidth than Iridium based telemetry. A computer is also required to host the appropriate communications and visualisation software.

For the deployment and recovery operations a vessel with a low freeboard (~1 metre above the sea surface or less) is desirable. This allows the glider to be deployed, manoeuvred and recovered by an operator or operators close to the glider to reduce the possibility of damaging the glider and the turbulence probes. It is also desirable to have a vessel with a sheltered area, preferably with an ac mains power source, and suitable facilities for and extended stay onboard that is likely to occur during daylight hours.

Acknowledgements

The authors acknowledge the help and support provided by staff from the University of Liverpool and the RV Marissa. Thanks are also expressed for the technical support from Rolf Lueck, Fabian Wolk and the staff at Rockland Scientific International (RSI). Acknowledgement is also due Ben Allsup and the staff at Teledyne Webb Research (TWR) for the rapid response to requests for technical advice during the turbulence glider preparations and the subsequent deployment from June 28th to July 4th 2011 as part of the NOCL Liverpool Bay Coastal Observatory project.

Appendix A – Initial Recorded Glider CTD Data Evaluation

The microstructure glider has been programmed to record CTD data during glider climbs. As indicated by the plots in Figs 4 to 6 a comprehensive record of CTD data has been achieved throughout the deployment, which lasted approximately 6 days. There is evidence of some of the raw measured CTD values for temperature, conductivity and pressure occasionally resetting to zero. This is most probably occurring during system restarts after problems such as mission aborts, glider surfacing for dialog etc, as shown in Fig. 7. Filtering was used to remove these values during the initial CTD data analysis.

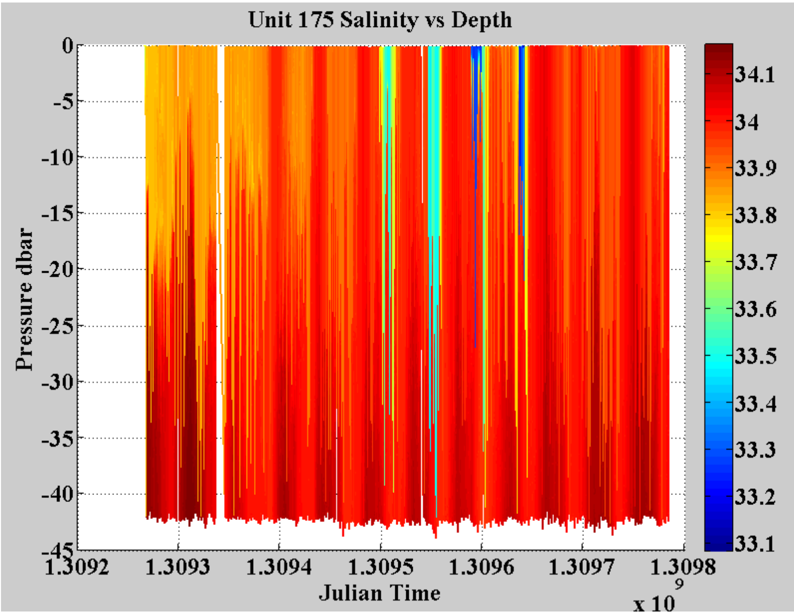


Fig. 4 CTD Salinity profile for the microstructure glider deployment from 28th June to 4th July 2011

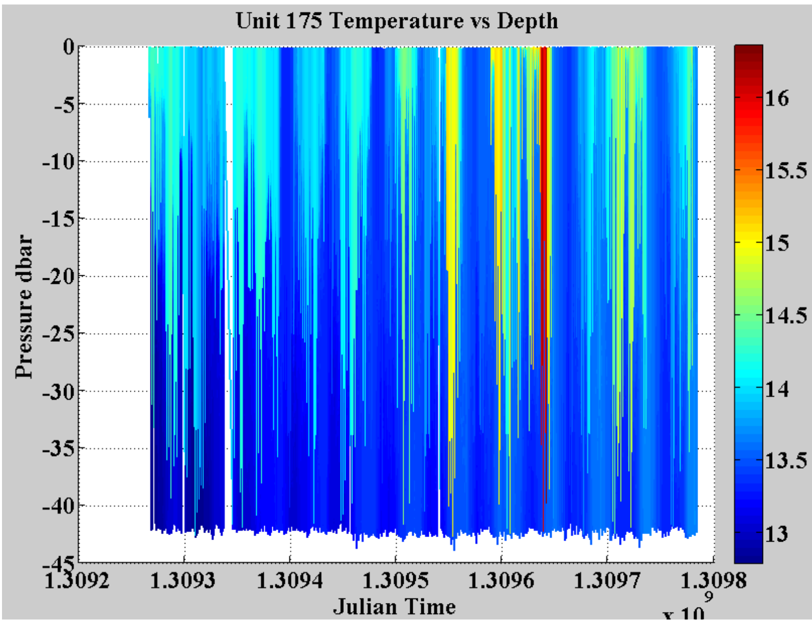


Fig. 5 CTD Temperature profile for the microstructure glider deployment from 28th June to 4th July 2011

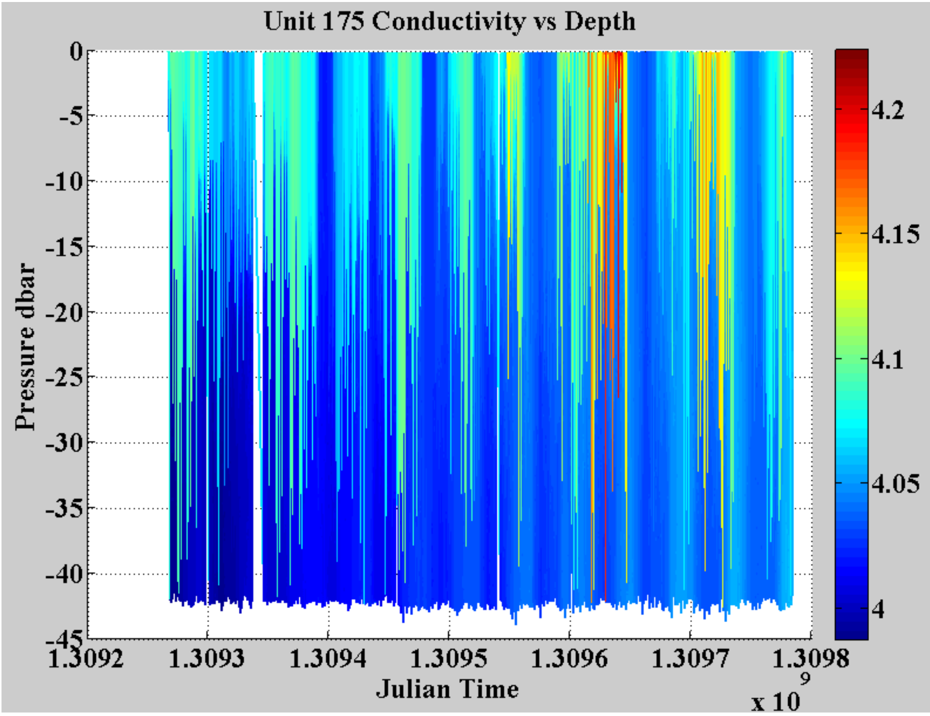


Fig. 6 CTD Conductivity profile for the microstructure glider deployment from 28th June to 4th July 2011

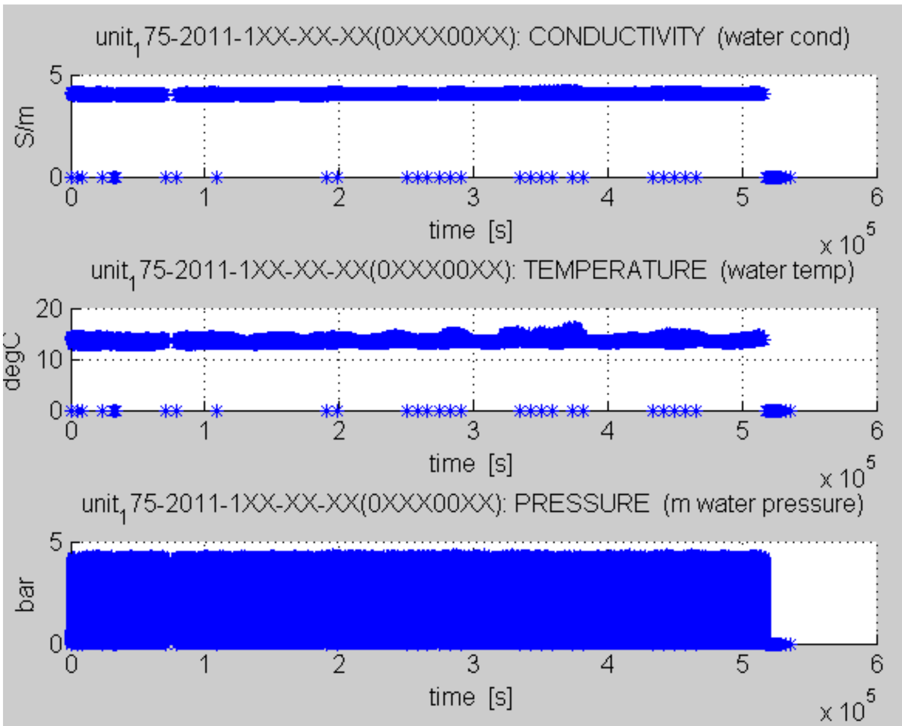


Fig. 7 Plot of the recorded raw glider data

Appendix B – Initial Recorded Microstructure Data Evaluation

The data plots in this appendix present a series of normalised plots of the raw microstructure data on a common scale. The general intention is to provide a graphical aid that acts as an initial review of the quality of the turbulence measurements. The pressure record in Figs. 8 to 10 shows an up cast and then inflection at the surface and there seems to be signal activity on all channels indicating the microstructure probes are all recording data. What is evident in all of the turbulence measurements that were recorded is that there is a high degree of noise and spiking in the data. Regular and sudden excursions to high amplitude values are occurring in each channel across the full recorded data set. The glider 'comatose' mode was used periodically during the deployment. This mode is used to shut down the glider actuators during dives and climbs to limit mechanical and electrical noise affecting the quality of the turbulence measurements. Noise and spiking was still evident when the comatose mode was used (fig. 9) indicating a potential problem with the RSI micro-Rider turbulence probe. RSI were contacted for advice and it appears that this spiking and data quality problem affected all of the turbulence data recorded during the deployment. After consultation with RSI the micro-Rider turbulence probe was returned to Canada for evaluation and repair.

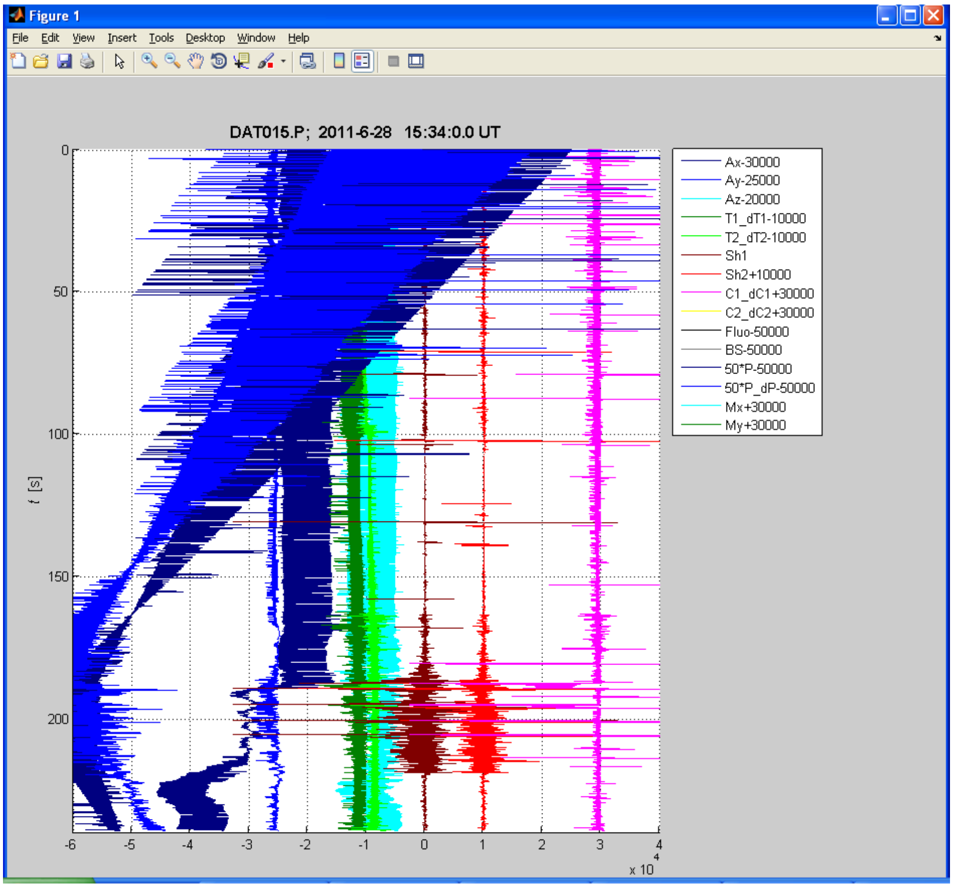


Fig. 8 DAT015.P – One of the First Up Cast Measurements When The Mission Started

(date and time stamped at 16:34 on 28th June 2011)

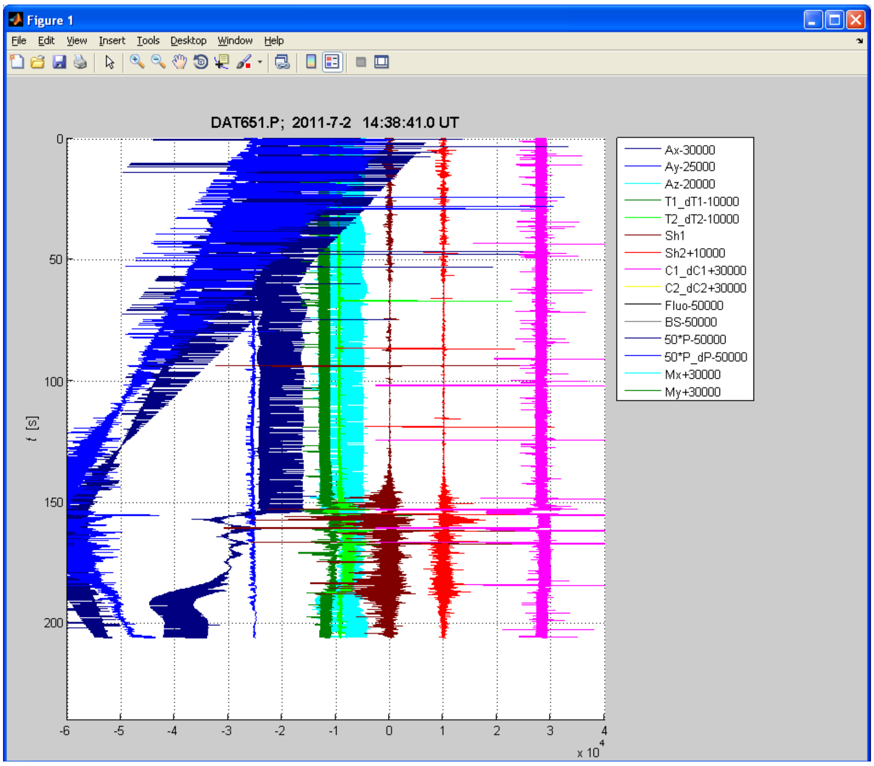


Fig. 9 DAT651.P – Recorded With The Comatose Mode (glider motors and fin silent) Enabled
(date and time stamped at 14:38 on 2nd July 2011)

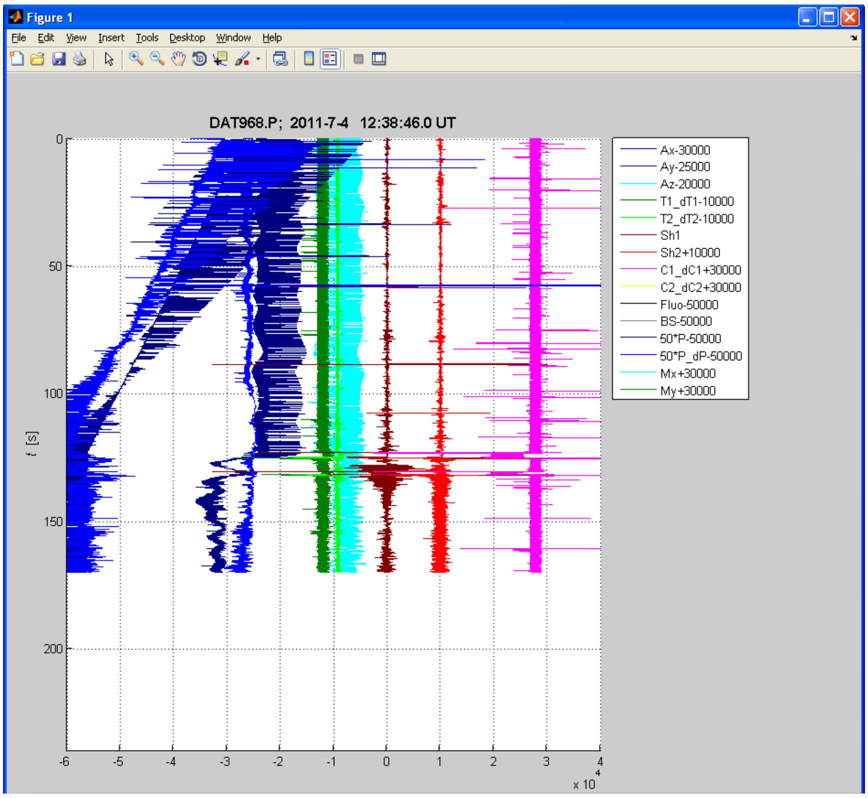


Fig. 10 DAT968.P – The Last Recorded Data File During the Deployment.
(date and time stamped at 12:38 on 4th July 2011)

Appendix C – Captured Image from the Glider Piloting Software

A plot from the glider 'GLMPC' visualisation software is shown in Fig. 11. This image illustrates the reported glider positions from the deployment on 28th June until this plot was generated on 1st July 2011. The red line links the two target waypoints (red rectangles) either side of the ADCP seabed instrumentation frame position. The green rectangles represent the reported glider positions during the deployment. The glider is being cyclically driven from east to west and then west to east in tandem with the phase of the tidal current. Although the tidal currents will affect the navigational abilities of the glider the area of operation has been successfully confined to within several kilometres of the instrumentation frame deployment site. This presented a good opportunity to generate the required collocated glider and seabed instrumentation frame based measurements, as required.

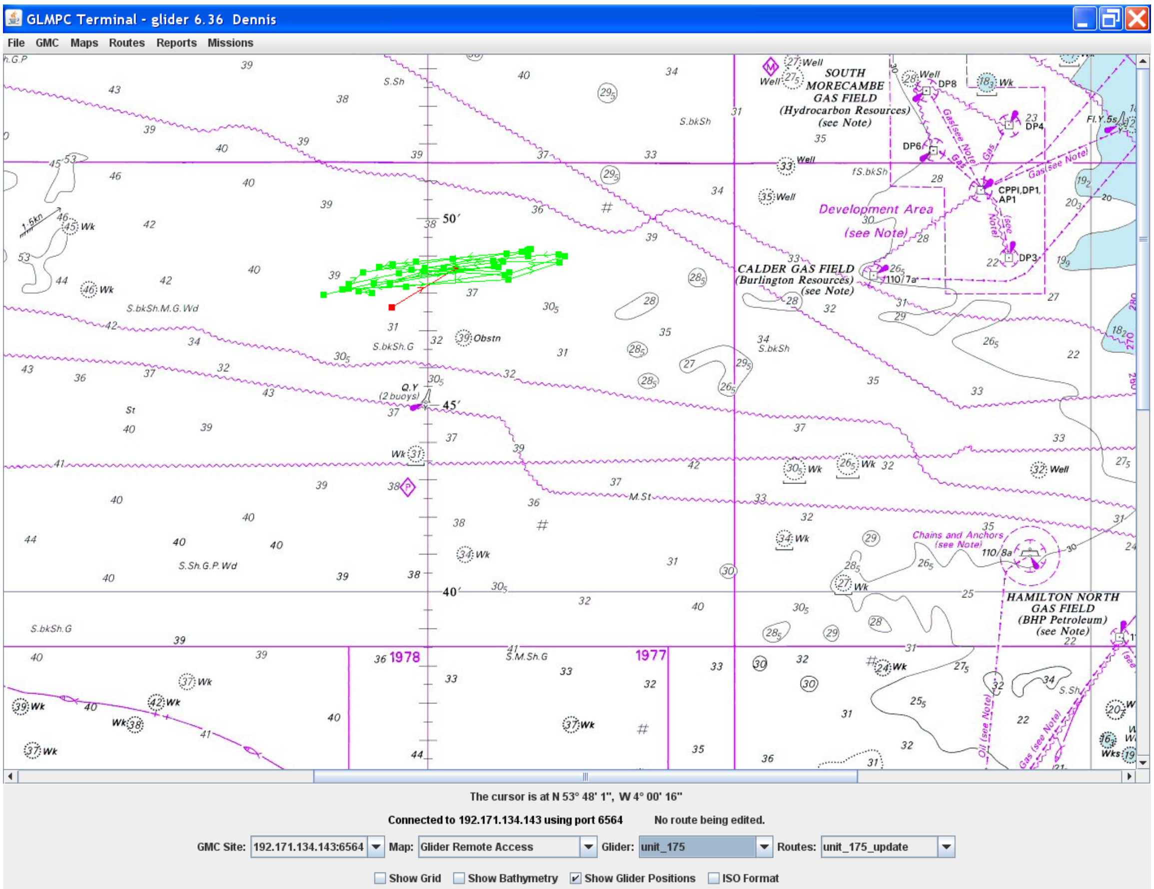
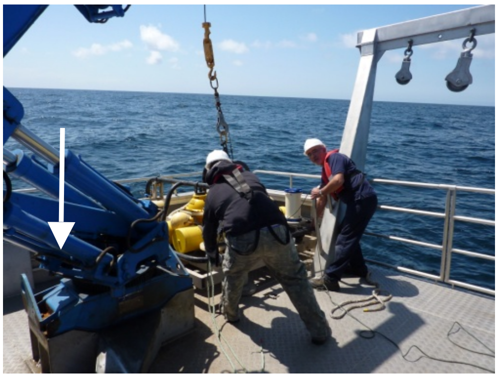


Fig. 11 - GLMPC Glider Position Plotting Software – Screen Capture From 1st July 2011

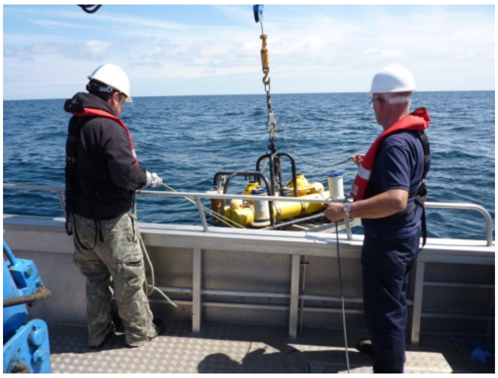
Appendix D – Glider Preparation and Deployment Cruise Photographs

Glider on the Transportation Trolley with the Probe Cover On for Compass Testing

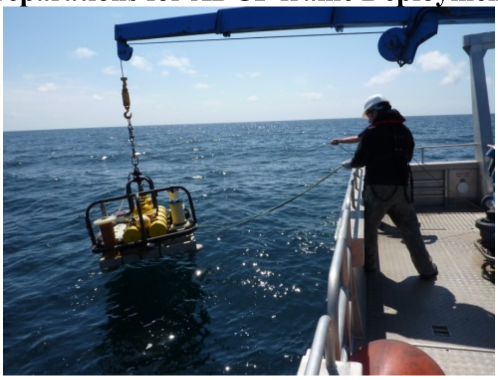
Fragile Microstructure Probes Close Up



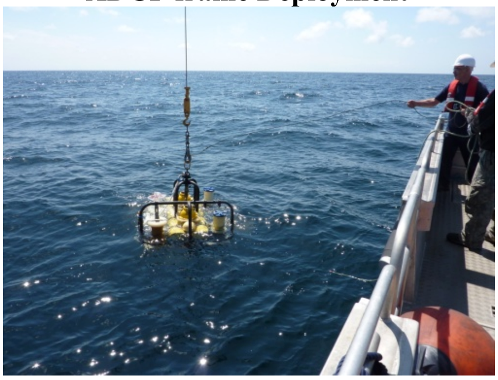
Preparations for ADCP frame Deployment



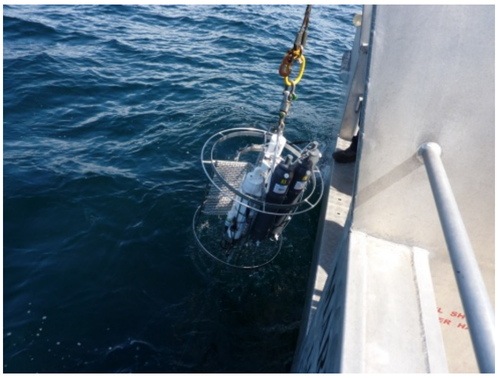
ADCP frame Deployment



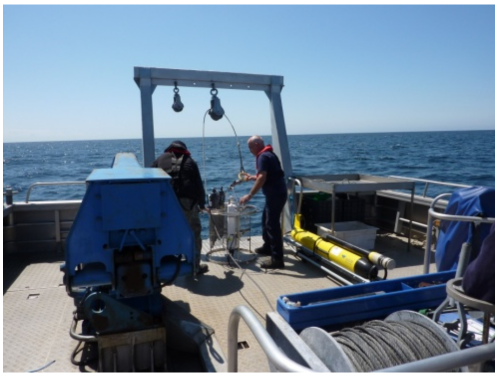
ADCP frame Deployment



ADCP frame release



CTD Carousel Recovery

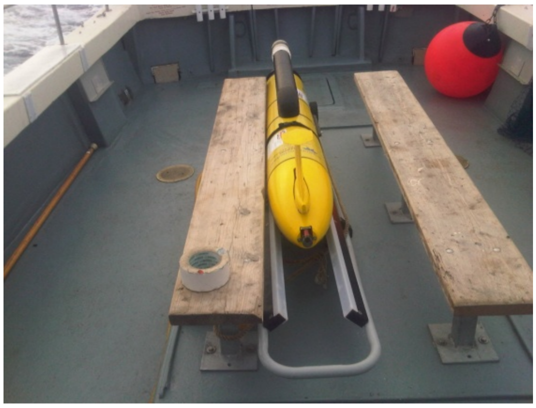


Recovered CTD Carousel

Appendix E – Glider Recovery Photographs

The glider recovery used the local charter vessel Tuskar (www.tuskarcharters.co.uk) to travel out to pick up the glider at short notice. The glider was located approximately 40 nautical miles offshore.

Turbulence glider just after recovery without the probe cover in place



Turbulence glider stowed for the return to the NOCL Vittoria Dock Store at Birkenhead

Sunset During the Return of the Recovered Turbulence Glider to Birkenhead