GROOM

Gliders for Research, Ocean Observation and Management

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Deliverable D4.2

Conformity of GROOM glider and multi platform missions with standards

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Executive Summary

The joint operation of European gliders across institutions and countries required a set of standard procedures to be defined. The creation of standards is one of the main arguments for the creation of a research infrastructure. They guarantee the necessary efficiency during deployment, interoperability between institutions and easy access to the technology from outsiders and new glider scientists. The procedures behind the standards cannot be strictly fixed, but should allow adaptation to meet imposed changes in the operation of the joint European glider infrastructure over time – in accordance with changes in the requirements of, and expectation on, the research infrastructure. During the GROOM project standards developed from the scientific work within the project, and aligned with the objectives of the work packages.

They cover:

- Glider inspection, mission planning, deployment
- Operation & Environmental conditions
- Legal aspects (Clearance)
- Recovery Procedures
- Data transfer & data access
- Details on device preparation incl. Compass calibration, Pressure test
- Monitoring & estimating Endurance and Battery status
- Issues related to Sensors (CTD, Oxygen, optical properties, turbulence, passive acoustics)

Here we summarize the acceptance and application of the “standards” linked to selected missions of the partners. The development of the common procedures and practices can be found the WP2 to WP5 deliverables of the project.

The questionnaire revealed that the GROOM partners had developed and followed the best practices defined during GROOM where applicable. Partners endeavoured to follow or apply the best practices in their local operations, for example in safety and in calibration of sensors. Some of the responses reveal that some of the GROOM best practices need further development, where they need to be more flexible as glider technologies develop. Nonetheless the conclusion of the study is that a consensus has been reached when executing glider missions across the European institutions, which in turn suggests the maturity of the network in operating as a joint infrastructure.

Introduction

The standards (or best practices, see discussion in the conclusion) that evolved and were developed from the work within the project cover aspects such as data quality control and accessibility, sensor calibration, device handling and interoperability, or legal aspects (see D5.3 *Best practices for glider missions and sensor use: preparation, operation, calibration, inter-calibration/comparison, and recovery*). In order to facilitate an assessment of a standard set of operations, the GROOM partners where approached to report on the procedures they apply when conducting a glider mission as part of the GROOM infrastructure – planning, device and sensor preparation, execution, data flow, and termination.

Best practice manuals in ocean science are common in large scale programmes such as CLIVAR and GOOS. They are valuable because they summarise the state-of-the-art, to which we should all aspire. They provide a recipe for the novice to follow, and a means of determining the reliability of resulting data sets for analysis of long-term change. We recognize that they will change and adapt as technology advances; they should not be fixed permanently. Nonetheless international bodies such as IOC and SCOR devote much time and effort to drawing up best practices for marine observations and marine technologies. This GROOM report is a contribution to that development of glider best practice documentation. This is the essential first step to establishing global observing systems using ocean gliders.

This deliverable is a combination of the originally planned deliverables D4.02, D4.03 and D4.07. The SC appointed GEOMAR as the partner responsible for this merged deliverable D4.02. This was done since the three deliverables had a high degree of potential overlap. The goal of the merged deliverable was to encapsulate the practical experience with best practices of glider users in the field. For a wide range of representative glider campaigns, the groups' experiences were summarized instead of analysing each individual field experiment. It must be recognized that glider technology and campaign techniques are developing very fast. This Deliverable reports a snapshot of procedures during the period of the GROOM project, 2012-2014.

Methodology adopted

A questionnaire was prepared that covered 10 topics or groups of actions. The groups in turn had certain questions that could be answered with yes or no and further explanation, if required. Each group chose one representative glider campaign, since it would have been unworkable to include all the hundreds of glider deployment during the GROOM project. The questions are listed in the following:

GROOM Standard questionnaire

Group 1: Glider inspection, mission planning, deployment

Question: Did you use a checklist for this activity? If yes – which one? (Please provide a name of the partner, or note if you used a checklist (which one?) and changed it (how?)) If no – why not?

Group 2: Operation

Question: Did you made yourself familiar with the operating environment (ocean depths, currents, user activity, dominant processes)? If not – why?

Group 3: Clearance

Question: Did you apply for a clearance to operate the glider? If not – why?

Group 4: Recovery

Question: Did you use a checklist for this activity? If yes – which one? (Please provide a name of the partner, or note if you used the one from??? but changed??) If no – why not?

Group 5: Data

Question: Did you transmit data in Real time? If yes – was the data (semi) automatic being forwarded to the Glider Data Portal (Coriolis)? (Did you follow the recommendation outlined in deliverable D3.3 “Data Organization for Gliders”. If no – why not?

Group 6: Compass calibration

Question: Did you calibrate the compass? If yes – how? and why? If no – why not?

Group 7: Pressure test

Question: Did you carry out a high pressure leak test in lab and/or field before/near start of mission? If no – why not?

Group 8: Endurance

Question: Did you Constantly monitor battery voltages and energy usage? If yes, how? (website, visual inspection? threshold alert?) If no – why not?

Group 9: Battery handling

Did you follow any safety Guidelines for maintaining and monitoring battery stability? If no – why not?

Group 10: Sensors

Subgroup: CTD

Question: Did you calibrate the CTD sensor? If yes – how? (CTD cast nearby, shipping to manufacturer) Was the CTD being calibrated with water samples? If no – why not?

Subgroup: Dissolved oxygen (DO)

Question: Did you calibrate the oxygen sensor? (e.g. CTDO2 cast nearby, Winkler titration?) If no – why not?

Optode: Did you record your data in raw red/blue phase measurements for improved delayed-mode calibration?

Subgroup: Optical sensors (Chlorophyll a fluorescence, Chromophoric dissolved organic matter (CDOM), Turbidity/backscatter, PAR

Question: Did you record dark count values? (black tape?), Range calibration via artificial, coloured sea water? Nearby CTD mounted sensors which can provide reference values? If no – why not?

Subgroup: Turbulence

Did you deactivate the servo by fixing the center battery pack position in order to reduce the noise in turbulence measurements? If no – why not

Subgroup: Passive acoustics (e.g. wind)

Question: Did you command the glider to a buoy bearing an anemometer for intercomparison of acoustic signals with wind speeds? If no – why not?

Answers to Questionnaire:

Numbers in the answer column in the table refer to the following institutes:

1) Devision Technique d'Institut national des sciences de l'univers et Le Centre national de la recherche scientifique (DT INSU – CNRS)

2) Oceanic Platform of the Canary Islands (PLOCAN)

3) University of East Anglia (UEA)

4) Scottish Association for Marine Science (SAMS)

5) Instituto nazionale di oceanografia e di geofisica sperimentale (OGS)

6) Oceanography Center, University of Cyprus (OC-UCY)

7) Helmholtz-Zentrum Geesthacht (HZG)

8) GEOMAR Helmholtz Centre for Ocean Research Kiel

9) Finnish Meteorological Institute (FMI)

10) Mediterranean Institute for Advanced Studies (CSIC-IMEDEA)

11) Centre for Maritime Research and Experimentation (CMRE)

12) Alfred Wegner Institut (AWI)

Component/activity	Question	Answer (please add a short sentence for clarification)
Glider inspection, mission planning, deployment	Did you use a checklist for this activity? If yes – which one? (Please provide a name of the partner, or note if you used the one from ??? but changed??) If no – why not?	1) Yes – WebbTeledyne official checklists + internal checklists 2) Yes, we use our own check list, developed from different checklist models provided/used by Rutgers University and Teledyne Webb Research. RANK:9 3) Checklist used during refurbishment, ballasting and packing (provided on the refurbishment course). No checklist used for mission planning and deployment. Planning is an iterative process and not suited to checklists. On deployment, we have not felt the need for a checklist as the log files provided by the glider act as a checklist themselves. RANK:10 4) Checklist not used for: • pre-deployment inspection • bench-tests • compass calibration. • Reason: there is only one performing those tasks in the team, and I do not feel the need for a checklist to remind me what needs to be done. When/if different people carry out these tasks in the future I will make a checklist. • Checklist used for: • packing list for deployment • deployment procedure • These are checklists I have written myself for SAMS.

		We use them for deployments as several people are involved (sometimes including less experienced users). RANK:8 5) Yes, our checklist was designed from the seaglider manual. 6) Checklist not used for: • pre-deployment inspection • bench-tests • compass calibration. • Reason: there is only one performing those tasks in the team, so no need for a checklist. When/if different people carry out these tasks in the future we may adopt a checklist of other group (e.g. SOCIB). • Checklist used for: • deployment procedure (UW supplied) RANK:9 7) … 8) TWR Glider functional checkout Document #4095-FCP Nothing for mission planning, work in progress Personal instruction list for deployment, work in progress 9) I am not sure, because the glider was from PLOCAN. They may have had, but we in FMI had the check list in our heads this time. 10) Yes. The SOCIB/CSIC checklist. RANK:10 11) No. Gliders have different payloads, they are from different generations (G1-G2), and different depth rating 12) Yes, our checklist was designed from the seaglider manual.
Operation	Did you made yourself familiar with the operating environment (ocean depths, currents, user activity, dominant processes)? If not – why?	1) Yes – Glider deployed off Toulon, close to lab, well-known user activity and oceanographic environments 2) Yes, the area of operation is being studied since early 90’s through different observing platforms (fix and mobile) as reference ocean-site (ESTOC). Nowadays, we conduct seasonal studies by research vessels, there is a permanent and multidisciplinary ocean mooring (3600 m. depth), among other devices (drifters, XBT, etc.) RANK:9 3) Investigated depth and currents. Verified availability of vessels of opportunity in case of emergency. Regular monitoring of ship AIS as in a busy shipping area. RANK:10 4) Yes. The site has been studied by literature review, we conducted a scientific cruise a few months before the glider deployment, and have also used data from gliders previously deployed in the same area. RANK:9 5) Yes, the site is usually studied before the mission using the available in situ data (drifter, floats, satellite

		altimetry, colour, sea-surface temperature) and forecast models. 6) Yes. The site has been studied by literature review, consulting of remote sensing fields and flow forecast models. We conduct scientific cruises annually since 1995 in the region which assists in planning as well as data from gliders previously deployed in the same area. No for user activity: no existing way to get historical ship traffic, or planned operations from other sectors. RANK: 9 7) … 8) Yes 9) Yes. We planned the operation carefully taking into account the topography, fishing activities and traffic intensity. 10) Yes. Satellite data, model outputs and in-situ historical information have been used to plan the mission. This mission is performed every two months since 2012 (endurance line), plus 6 missions in 2011 from January to July 2011. RANK:10 11) Yes 12) Yes, we used information from Argo floats (hydrography and currents), CTD surveys (hydrography), analyses of ADCP secrtions (currents) and Sea Ice Concentration maps for preparation and now during the mission.
Clearance	Did you apply for a clearance to operate the glider? If not – why?	1) No- Not necessary necessary 2) Not at all. There is an specific agreement with authorities in this regard. RANK:6 3) No, but deployment done in association with the local marine monitoring agency (Marine Scotland). Was not considered necessary in the region and no risk of entering another country's EEZ. RANK:5 4) Yes, Irish diplomatic clearance. This was obtained for a period of several months (possibly 2 to 3 years) and covered all gliders and AUV operations included in the project. RANK:10 5) Yes, if we operate in international or other country waters 6) No. We state to customs that we are taking equipment outside national waters and leaving it there for a period of time. Need to check if further notification is needed to other bodies. RANK: 7 7) no comment 8) no comment 9) Yes. The glider came from another institute in another country.

		10) No, we have a protocol with customs service to inform that we are taking equipment to perform a mission in the ocean for a period of time. Moreover, we send information on the planned mission to Port Authority and Search and Rescue Service. They inform trough daily radio warnings to all boats (recreational, fishing, etc…) on the area of the glider activity. RANK:9 11) Yes. It is mandatory at CMRE 12) Yes, we did that within the Notification for the Polarstern cruise. During the cruise the gliders were deployed.
Recovery	Did you use a checklist for this activity? If yes – which one? (Please provide a name of the partner, or note if you used the one from??? but changed??) If no – why not?	1) Recovery checklists always used after recovery 2) Yes, we use our own check list, developed from different checklist models provided/used by Rutgers University and Teledyne Webb Research. RANK:7 3) No checklist for recovery due to simplicity of the process. Provide QUIT command, await position, find glider, bring glider back on board, celebrate. RANK:6 4) No checklist used. The tasks carried out at recovery on the boat were thought to be few and simple and therefore not requiring a checklist. In hindsight a checklist would have been useful as the field team omitted a task (doing the CTD cast). There was only one person overseeing the recovery piloting + post-recovery tasks so again, the need for a checklist was not felt. Same comments as for deployment that if more people were to be involved we would set up a formal check-list. RANK:8 5) No, because after the recovery the glider is switched off and no tests are carried out other then a visual inspection. 6) No. The tasks carried out at recovery on the boat are few and simple and therefore do not require a checklist. There was only one person overseeing the recovery piloting-recovery tasks. If more people were to be involved we would set up a formal, very short, check-list. RANK:8 7) .... 8) No, work on checklist in progress. 9) I am not sure, but maybe not. 10) Yes. The SOCIB/CSIC checklist. RANK:10 11) No. Not needed 12) No, because after the recovery the glider is switched off and possibly will be send to the refurbishment before the next mission.

Data	Did you transmit data in Real time? If yes – was the data (semi) automatic being forwarded to the Glider Data Portal (Coriolis)? (Did you follow the recommendation outlined in deliverable D3.3 “Data Organization for Gliders”. If no – why not?	1) Yes- automatic transmission 2) No. We operate in delayed mode at this moment in time. QC is performed only at basic level –range checking-. We follow GROOM recommendations for data format conversion (NetCDF) and expecting to provide data in NRT to Coriolis soon, as part of the PLOCAN’s compromise within the framework of GROOM. RANK:8 3) Data was transmitted in real time back to the UEA basestation and forwarded to the UK data centre (BODC). No data forward to Coriolis by UEA, but there may be a link between Coriolis and BODC. RANK:7 4) Yes. The data was forwarded automatically to our DAC (British Oceanographic Data Centre), unsure if they forwarded it to Coriolis in NRT. - exception if the data transmission puts the glider at risk, e.g.: - low battery remaining → limit transmissions to GPS locations only in order to maximize battery life - area with heavy ship traffic → wait until the glider is in a quieter area to transmit the data RANK:8 5) Yes, the data are transmitted in real time to the basestation at the institute, but at the moment they are not forwarded to the data portal because of the program to produce the netcdf files is under development. We are in contact with Kongsberg to update the firmware (from the iRobot to the Kongsberg) to have a better handle of the data. 6) Yes. The data was forwarded automatically to Coriolis in NRT. MedAtlas format is used (vertical profiles), which is converted to NetCDF by Coriolis. RT QC is done only at basic level (range check) for these files, but our manufacturer (UW) netcdf files have a full suite of RT QC processes included. We are working on a reader to translate these to EGO netcdf as part of our Regional DAC commitment. RANK:8 7) ... 8) Yes, according to GROOM standards. Data is automatically transmitted to Coriolis. 9) Yes. The glider seems to be in Glider Data Portal. 10) Yes. We used the distribution system (via DT-INSU) to send glider data to Coriolis. Moreover, as discussed and agreed in the GROOM data management meetings and following D3.3, SOCIB/CSIC has developed a regional data portal for data distribution (different levels: L0,L1) : http://thredds.socib.es/thredds/catalog/auv/catalog.html RANK:8 11) Yes. Only data during the GROOM-REP13 trial was uploaded to the Glider Data Portal following the outline

		of D3.3 12) Yes, the data are transmitted in real time to the basestation at Kongsberg. The data are yet not forwarded to Coriolis, because we first have to develop a program to produce the netcdf files. The data format provided last year was different (bpo-files).
Compass calibration	Did you calibrate the compass? If yes – how? and why? If no – why not?	1) Yes, built-in method for TCM3 compass 2) Yes. Before every mission. We have a specific facility for that. RANK:9 3) "Spinning" dives were performed in the field to perform a post-mission *in situ* compass calibration. Data is available for the compass calibration but this has not been done yet. Method used was developed at University of Washington and distributed by Kongsberg/iRobot. RANK:7 4) Yes.The compass was checked ahead of deployment by laying the glider flat in its aluminium cradle, in an area away from magnetic variations, and rotated in 30 degrees increments. An error of up to 30deg (+/- a few deg) was found. Following re-calibration the error dropped to 3deg (+/- a few deg) which was deemed acceptable. In general we re-calibrate the glider compass if the error found is over 10 degrees. When possible, we also check the compass post-recovery to ensure there was no change in the compass readings between the calibration and the end of the mission. RANK:8 5) No, but it was calibrated by the manufacturer. 6) No, but it was calibrated at the manufacturer. In the future, we will run the in-mission protocol developed by UW. Up to now, we found good performance of the compass in practice. RANK:7 7) ... 8) No proper setup and location for compass calibration available yet. No obvious and large problems with glider control have yet been discovered with uncalibrated compasses. Derived currents have however not been thoroughly checked for problems. 9) I am not sure, but I expect that it was done. 10) Yes, we follow methodology described in Merckelbach et al., (2008). We consider important to know the compass error to estimate the cross-tack velocity error in the depth-average currents derived from glider. RANK:8 11) Yes. Procedure established in the User Manual with homemade infrastructure. To improve current estimation 12) No, but it was calibrated by the manufacturer.

Pressure test	Did you carry out a high pressure leak test in lab and/or field before/near start of mission If no – why not?	1) No pressure chamber available 2) Yes, at the beginning of the mission, consisting in progressive dives using a safety buoy attached to the glider. RANK:8 3) No, we do not have the facilities available, so we perform dives of gradually increasing depth and monitor internal pressure/humidity. RANK:5 4) No, no high pressure tank available. RANK:5 5) Yes, in the field. We progressively increase the depths of the mission. 6) Yes. The first 2 days of the mission consists of progressively deeper dives (50m, 200m, 500m, 1000m) RANK:6 7) ... 8) No large pressure test chamber available. 9) I am not sure, but I expect that it was done. 10) Yes. We use a 1000 m pressure chamber to perform in laboratory a high-pressure leak test before each glider mission. RANK:8 11) Yes. Always for deep gliders 12) N/A
Endurance	Did you Constantly monitor battery voltages and energy usage? If yes, how? (website, visual inspection? threshold alert?) If no – why not?	1) We do. We will also monitor real amp-hrs consumption during all future missions. 2) Yes, as a key variable during mission. We use website and threshold alert. RANK:9 3) Estimated battery consumption and estimated remaining capacity are plotted automatically on the website and verified systematically when piloting. RANK:7 4) Yes. Visual inspection using Matlab plots (automatically generated at every dive). We use the Seaglider low voltage cut-off value as alert (the glider would go into recovery if that voltage was reached which would send an alert to the pilot). RANK:10 5) Yes, we monitor the battery voltage through our website, we set a threshold alert. 6) Yes. Visual inspection using Matlab plots (automatically generated). We use the Seaglider low voltage cut-off value as alert (the glider would go into recovery if that voltage was reached which would send an email to the pilot). Finally, we used the parameters in the Seaglider log file that track consumption to periodically calculate endurance. RANK:10 7) ... 8) Yes, displayed online, visual inspected, no treshold

		alert. http://gliderweb.geomar.de 9) Yes 10) Yes. Website visual inspection and threshold alerts. RANK:10 11) Yes. Website 12) Yes, we monitor the battery voltage and energy usage as part of our real-time data processing in the institute. We produce plots for visual inspection.
Battery handling	Did you follow any safety Guidelines for maintaining and monitoring battery stability? If no – why not?	1) Yes 2) Yes. We monitor battery values avoiding run them to end of life. We also store carefully battery packs in a dedicated storage facility. RANK:8 3) Batteries stored in dry cool area in the lab. RANK:5 4) We did follow the manufacturer's recommendations, but I am unaware of any "official" guidelines. If this question is about handling the batteries during refurbishments then this does not apply to SAMS as we do not do our own refurbishments. RANK:10 5) Yes, we check for internal high pressure and we never run the battery to the end of life. 6) Yes, we check for high internal pressure before handling the vehicle (recovery). We do not run to end of life. So far, we send to manufacturer for further handling/disposal in general. In some cases we have contacted local recycling facility to handle a lithium primary pack (seaglider 10V). RANK:10 7) ... 8) Lithium batteries are shipped and treated as dangerous goods according to UN3090/1 specifications. 9) I am not sure, but I expect that it was done. 10) Yes, we follow the guidelines given by the battery manufacturer. For safety reason, we plan the mission to optimize the battery capacity but we do not run to end of life. RANK:10 11) Yes 12) N/A
CTD	Did you calibrate the CTD sensor? If yes – how? (CTD cast nearby, shipping to manufacturer)	1) No 2) We calibrate the sensor every two years (manufacturer) and we validate before/after each mission with at-sea CTD cast nearby, ballasting pool CTD cast, sampling bottles. RANK:9 3) Calibration against a ship-borne CTD. CTD also sent to manufacturer a few months before. RANK:10 4) The CT sensor was calibrated by the manufacturers

		before this deployment. We try to conduct CTD casts when possible. Only a surface CTD cast (top 10m) was conducted during this deployment (due to lack of time and rough conditions). No CTD cast was performed at recovery due to team forgetting about it (note that this is a one-off and is not typical of our deployments / recoveries). 5) No, we have never calibrated the CTD of the seaglider, but in the past on the Slocum we followed the procedure described in Medeot et all. 2011. *) 6) The CT sensor was calibrated by the manufacturers before this deployment. We try to conduct CTD casts when possible (typically only shallow ones from RHIB). In this case 20 m casts were done. 7) N/A 8) The glider's CTD sensors are factory calibrated only. Post recovery, the glider CTD data is compared to other gliders and nearby calibrated regular CTD casts. If deviations larger than 0.01 degC or PSU are found, these are corrected as offsets. Such large deviations are however rare. 9) If the glider were ours, we would calibrate the CTD in our annual CTD inter-calibration cruise. 10) Yes, we calibrate CTD sensors by manufacturer every two years and we calibrate periodically (every 3 months) glider CTD sensor with independent measurements from ship CTD casts nearby and water samples. For this particular glider mission (April 2014) there was not simultaneous ship cruises (they were performed in February and May 2014). RANK:10 11) Yes. Always before a deployment Using CMRE calibration facility 12) The CTDs were calibrated during the refurbishment prior to the mission. At the deployment position a CTD station was carried out. During the mission the two gliders dive on the same section almost at the same position and time, thus we can use the dives for cross checking.
	Was the CTD being calibrated with water samples? If no – why not?	1) No, but checked on single point in seawater tank against a newly-calibrated SBE37 CTD 2) (included above) 3) No samples taken on this mission. 4) We did not have any opportunity to collect water samples in the vicinity of the glider this time as we deployed and recovered from small RHIBS, but water samples were collected for that CTD on other occasions. RANK:

		9 for at least a calibration or one CTD cast near glider at deployment or recovery 6 for the full procedure mentioned in the D5.3 report. 5) – 6) We did not have any opportunity to collect water samples. RANK: 9 for at least a calibration or one CTD cast near glider at deployment or recovery 6 for the full procedure mentioned in the D5.3 report.- 7) – 8) – 9) (included above) 10) – 11) –
Dissolved oxygen (DO)	Did you calibrate the oxygen sensor? (e.g. CTDO2 cast nearby, Winkler titration?) If no – why not? Optode: Did you record your data in raw red/blue phase measurements for improved delayed-mode calibration?	1) Yes-recalibrated by the manufacturer before mission 2) We calibrate the sensor every two years (manufacturer) and we validate before/after each mission with at-sea CTDO2 cast nearby, ballasting pool CTDO2 cast, sampling bottles for Winkler titration RANK:9 3) Calibration against a ship-borne CTD O2 sensor. • No samples taken on this mission. • TCPhase measurements (red-blue difference) kept for improved DO calculation in delayed mode calibration. RANK:9 4) The O2 sensor was calibrated by the manufacturers before this deployment. • We did not have any opportunity to collect water samples in the vicinity of the glider this time as we deployed and recovered from small RHIBS. • We did not have the opportunity to conduct a CTD cast with O2 sensor as this is a fairly large CTD system, too big for the small RHIBS we deployed and recovered from. We did not record the optode raw red/blue phase data (not aware of that method of calibration). • RANK: • 9 for at least a calibration or one CTD cast near glider at deployment or recovery • .6 for the full procedure mentioned in the D5.3 report. 5) No, the sensor was calibrated by the manufacturer. 6) The O2 sensor was calibrated by the manufacturers before this deployment. No water samples or cast with O2 sensor. RANK:

		- 9 for at least a calibration or one CTD cast near glider at deployment or recovery. - 6 for the full procedure mentioned in the D5.3 report. 7) N/A 8) Prior deployment and after recovery: - 0% and 100% calibration at room temperature and in cold room - Optodes are removed from glider and with an autonomous logger attached to a regular CTD which is calibrated via winckler titration of water samples - From the comparison with 0%/100% data and the regular CTD data, a new set of Optode calibration coefficients are derived. - Optode sensor delays are optimized to minimize differences between down and up measurements. phase measurements are recorded 9) If the glider were ours, we would calibrate the oxygen sensor in our annual CTD inter-calibration cruise against other CTD's and titration. 10) The O2 sensor was calibrated by the manufacturer. We do not perform independent measurements of O2. RANK:6 11) Not applied 12) At the moment we do not sample oxygen data but concentrate on the CTD data..
Optical properties: Chlorophyll *a* fluorescence Chromophoric dissolved organic matter (CDOM) Turbidity/backscatter PAR	Did you record dark count values? (black tape?), Range calibration via artificial, coloured sea water? Nearby CTD mounted sensors which can provide reference values? If no – why not?	1) Yes for dark count values – No for nearby CTD sensors 2) We calibrate the sensor every two years (manufacturer) and we validate before/after each mission with at-sea cast nearby, ballasting pool optical cast, sampling bottles for lab analysis (Chla, CDOM, Turbidity). PAR not yet. RANK:8 3) Dark counts calculated statistically based on all data obtained by the sensor. Chlorophyll a not calibrated for this mission as not the primary interest. RANK:9 4) Dark count values recorded during the pre-deployment bench tests (self-test with sensor caps on). No CTD conducted – same reasons as above (small RHIB). RANK: ? not enough experience with those sensors to judge 5) No, we did not have the opportunities. 6) Dark count values recorded during 300 m dives during

		the mission (600 m sampling at end). RANK:8 7) N/A 8) No. The measurement is a fluorescence measurement which is not always well correlated with the CHL-a content. Thus there are inherent problems with the calibration, in particular when the glider travels large distances and encounters different plankton communities. We have thus not yet developed a proper procedure to treat this data. 9) N/A 10) Not for this mission because it was out of the scope of the scientific objectives. In other recent missions (e.g. Alborex experiment), the scientific objectives was different and independent measurements were collected to calibrate glider Chl-a sensor. Not PAR sensor on glider. RANK:9 11) Yes. Optical sensors are also calibrated in CMRE calibration facility 12) At the moment we do not sample oxygen data but concentrate on the CTD data..
Turbulence	Did you deactivate the servo by fixing the center battery pack position in order to reduce the noise in turbulence measurements? If no – why not	1) N/A 2) Not a measured parameter 3) N/A 4) No turbulence measured . 5) N/A 6) no turbulence measured 7) N/A 8) Yes. 9) N/A 10) No turbulence measured. 11) Not applied 12) N/A
Passive accosutics (e.g. wind)	Did you command the glider to a buoy bearing an anemometer for intercomparison of acoustic signals with wind speeds? If no – why not?	1) N/A 2) Not a measured parameter 3) N/A 4) No passive acoustics used (Seaglider) . 5) N/A 6) no passive acoustics used 7) N/A 8) No, as we have no acoustic sensors.

		9) N/A 10) No passive acoustics used. 11) Not. We perform other passive acoustic applications 12) N/A
Comments		1) N/A 2) N/A 3) N/A - Energy endurance estimates – dependent on water depth, stratification, water temperature (reduction of battery capacity in colder waters), currents (higher energy usage to go against currents), etc. - In case this is not included in the pre-deployment checks: - Argos tag testing ahead of deployment (tag independent of glider on Seagliders). - Acoustic pinger testing in water ahead of deployment (for Seaglider, unsure about Slocums). - Paperwork: - Diplomatic clearance for ship if deployment / recovery occur in foreign waters. - On one occasion we have been asked to complete a Scottish Marine License application ("Sediment Sampling and Scientific Instrument Deployment" form). - We also try to compile a list of possible boat / ship contacts ahead of deployment in case we have an emergency recovery situation. 4) N/A 5) This was an endurance mission, intended to maximize presence at sea in order to capture long-term evolution of the circulation and mesoscale features. Because of this, it is very important that the pilot tune the buoyancy engine and sensor sampling very early in the mission to conserve energy. Perhaps it is embedded in the mission planning question, but it is critical to do a full autonomous self test before the mission, preferably 1-2 days before in order to fully test all aspects and update GPS almanacs. This could be done in the lab, or near the field site (at port or on board if deploying from a large vessel). Then, in the field, much time can be saved by doing only the basic launch procedure 6) … 7) N/A 8) N/A 9) N/A

		10) N/A 11) In remote areas it seems to be the biggest issue to organize deployment and recovery according to season and available mission time (battery lifetime). Possibilities for deployment and recovery will highly influence the effective mission time, i.e. the amount of data sampled in the area of interest.

*) Medeot N., Nair R. and Gerin R. (2011). *Laboratory evaluation and control of Slocum Glider C-T sensors.* J. Atmos. Oceanic Technol., 28, 838-846, doi: 10.1175/2011JTECHO767.1.

Discussion of Responses

The summary of responses is very interesting and provides valuable lessons for the future in designing glider infrastructure. Here we add some comments to synthesise the responses to each question and make some suggestions for possible future modifications:

Group 1: Glider inspection, mission planning, deployment

Question: Did you use a checklist for this activity? If yes – which one? (Please provide a name of the partner, or note if you used a checklist (which one?) and changed it (how?)) If no – why not?

The use of a checklist is highly variable. Some glider operators find it useful; others do not. Probably much depends on the type of glider, the experience of the operator and the type of activity. A standard checklist is clearly not desirable. Groups must develop their own approach to careful planning. A repository of different checklists used by different glider groups might be useful to new users.

Group 2: Operation

Question: Did you made yourself familiar with the operating environment (ocean depths, currents, user activity, dominant processes)? If not – why?

The responses show that everyone assesses the environment before deployment as far as possible. Many groups report checking shipping activity and lanes. In remote areas such as Polar Regions, there is often no prior knowledge of currents, stratification or ocean depths. So the best practice procedure should be to investigate whether such information exists for each deployment location.

Group 3: Clearance

Question: Did you apply for a clearance to operate the glider? If not – why?

Half of the groups sought clearance and half did not; this is entirely dependent on the location of the glider deployment. For many deployments such clearance is unnecessary. However checking whether clearance is required should certainly be routine procedure.

Group 4: Recovery

Question: Did you use a checklist for this activity? If yes – which one? (Please provide a name of the partner, or note if you used the one from??? but changed??) If no – why not?

The majority of groups do not use a checklist. For most users/gliders this is because the procedure is very simple. Often the recovery is undertaken by complete novices (for example coastguards) with no training needed. This item may not be necessary as part of the GROOM best practice.

Group 5: Data

Question: Did you transmit data in Real time? If yes – was the data (semi) automatic being forwarded to the Glider Data Portal (Coriolis)? (Did you follow the recommendation outlined in deliverable D3.3 "Data Organization for Gliders". If no – why not?

The responses show an interesting variety here. UK users tend to send glider data automatically in real time to the UK oceanographic data centre (BODC) and thereby to the GTS. We recommend that BODC send the data on to Coriolis automatically. Many of the users do send their data to Coriolis. These are primarily the Slocum glider operators. From the responses, there is clearly additional work necessary to facilitate the transfer of netcdf files in a more straightforward fashion.

Group 6: Compass calibration

Question: Did you calibrate the compass? If yes – how? and why? If no – why not?

There is a wide range of responses here. Much depends on the location of the launch location (e.g. a compass calibration is not possible on a large research vessel where you cannot be away from ferrous material), the type of glider, and whether the user can afford the major investment in compass calibration equipment. Now that gliders’ compasses can be calibrated by sending them on specific types of dive (spiralling), this may not be such an issue as it was in the past.

Group 7: Pressure test

Question: Did you carry out a high pressure leak test in lab and/or field before/near start of mission? If no – why not?

The majority of groups do not do this. It is probably less applicable to Seagliders than to Slocum gliders. Very few groups have access to a high pressure tank. Most operators gradually increase the depth of dives and monitor carefully. Using a high pressure leak test should not be listed as a ‘standard’ since it is not necessary for all gliders, and will put off groups from getting involved with gliders.

Group 8: Endurance

Question: Did you Constantly monitor battery voltages and energy usage? If yes, how? (website, visual inspection? threshold alert?) If no – why not?

All users do this. The most common method seems to be to automatically generate the required information (e.g. using Matlab) and display this online. This is a useful item to include in the best practice manual.

Group 9: Battery handling

Did you follow any safety Guidelines for maintaining and monitoring battery stability? If no – why not?

The majority of groups follow safety procedures specified by battery manufacturers.

Group 10: Sensors

Subgroup: CTD

Question: Did you calibrate the CTD sensor? If yes – how? (CTD cast nearby, shipping to manufacturer) Was the CTD being calibrated with water samples? If no – why not?

This question gave perhaps the most unexpected and varied results. A surprisingly large number of the respondents do not calibrate their CTD in situ, relying entirely on manufacturers’ calibrations. Some groups do not even have the CTD calibrated regularly by manufacturers (e.g. Seabird). Of course in situ calibration with CTD casts and salinometer analysis of water samples is only possible when using a research vessel for deployment and recovery. The wide variety of responses probably reflects the wide variety of deployment types. Short deployments of only up to a month or so may not require CTD calibrations between each deployment. Deployments far afield where the glider may be away for up to a year would usually have a sensor calibration during refurbishment.

Subgroup: Dissolved oxygen (DO)

Question: Did you calibrate the oxygen sensor? (e.g. CTDO2 cast nearby, Winkler titration?) If no – why not?

Not all groups measure dissolved oxygen. Again there is a wide variety of responses indicating different requirements for the highest accuracy of O2 measurements. Open ocean measurements probably require the greatest accuracy. Some users reply on manufacturers’ calibrations; several calibrate against in situ samples and Winkler titrations, which is the recommended procedure for good absolute measurements. Often users may only need relative values if using oxygen as a tracer.

Optode: Did you record your data in raw red/blue phase measurements for improved delayed-mode calibration?

One group reports doing this.

Subgroup: Optical sensors (Chlorophyll a fluorescence, Chromophoric dissolved organic matter (CDOM), Turbidity/backscatter, PAR

Question: Did you record dark count values? (black tape?), Range calibration via artificial, coloured sea water? Nearby CTD mounted sensors which can provide reference values? If no – why not?

Very few of the groups report doing this. Some measure dark counts directly though the measurements in deep water.

Subgroup: Turbulence

Did you deactivate the servo by fixing the center battery pack position in order to reduce the noise in turbulence measurements? If no – why not

This question refers only to Slocum gliders. Only one group reports measuring turbulence on a Slocum.

Subgroup: Passive acoustics (e.g. wind)

Question: Did you command the glider to a buoy bearing an anemometer for intercomparison of acoustic signals with wind speeds? If no – why not?

No groups report a mission using passive acoustics.

Discussion and conclusion

From the questionnaires it can be seen that some of the listed items are common practice whilst others are not; some are glider specific or mission specific. The word "standards" is perhaps unfortunate. It implies that anyone who does not meet the standards has failed and cannot be included. This is not the intention of the GROOM project. A glider deployment that does not follow the GROOM standards to the letter can still be an extremely valuable deployment. A parallel can be drawn here to the Argo float network. For Argo, there is a very low threshold for a float to be accepted into the Argo network and data base. This encourages a sense of inclusivity and involvement of all, regardless of their resources. For example, in situ calibrations are not required on float deployment; rather, cross-calibration between floats is undertaken in post processing as part of the quality control. Floats that are parked at a different depth, or which profile more frequently, are welcomed into Argo. Future infrastructure designs for profiling gliders should ensure that "standards" do not put off the contributions of valuable partners in the glider community. It is suggested that the word "standards" is replaced by "best practice" as is common in other aspects of GOOS.

In order to being able to summarize the results of the questionnaire the groups have been asked, on a volunteer basis, to rank the importance of certain activity (table 1).

The ranking itself also has to be seen in relation to the mission. For example the execution of certain missions may not require the partners to ask for clearance and in turn "clearance" is ranked low, while in other cases it is very much of importance. The pressure testing was also ranked relatively low, mainly because only few have the facility to do a pressure testing and as such integrate this procedure into their standard procedure during the deployment by diving successively to deeper depth – bearing the risk that the device will drain and could get lost.

Almost all questions were answered out of the work-flow of the partners when preparing and executing a glider mission. This shows the homogeneity achieved in the execution of glider missions across the European institutions, which in turn suggests the maturity of the network in operating as a joint infrastructure.

Table 1: *Summary ranking matrix*

Institute	Inspection	Operation	Clearance	Recovery	Data	Compass calibration	Pressure test	Endurance	Battery handling	CTD	Dissolved Oxygen (DO)	Optical Properties	Turbulence	Passive acoustics
DT INSU - CNRS	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PLOCAN	9	9	6	7	8	9	8	9	8	9	9	8	-	-
UEA	10	10	5	6	7	7	5	7	5	10	9	9	-	-
SAMS	10	9	10	8	8	8	5	10	10	9/6*	9/6*	-	-	-
OGS	8	-	-	-	-	-	-	-	-	-	-	-	-	-
OC-UCY	9	9	7	8	8	7	6	10	10	9/6*	9/6*	8	-	-
HZG	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GEOMAR	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FMI	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CSIC-IMEDEA	10	10	9	10	8	8	8	10	10	10	6	9	-	-
CMRE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AWI	-	-	-	-	-	-	-	-	-	-	-	-	-	-

*) 9: at least a calibration or one CTD cast near glider at deployment or recovery
6 for the full procedure outlined in the GROOM D5.3 report

Appendix:

Questionnaire contact Information for the Institutions

NO. Used above	Institute	Contact	
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