Notes on joint GROOM-JERICO meeting – 22-23 May 2012

Session 1. Review of present/future needs for gliders in Europe

Chair Elena Mauri, Reiner Onken. Presentation by Pierre Testor

1.1 Scientific challenges: key hot topics, long term monitoring
1.2 Environmental challenges: MSFD/ GES, emergency response
1.3 Gliders as a new component of a European Ocean Observing System

- The benefits of using gliders were discussed. They are a very good platform to sample sub-surface biological and physical variables at the sub-mesoscale and can be deployed in swarms. There is a growing list of publications (see EGO website) but it was suggested that glider users need to publish more papers to demonstrate the benefit of glider data. The added value of using gliders in specific areas of coastal and open seas for assimilation in predictive models needs to be shown.
- It was also noted that only a small proportion of European gliders (of which there are about 60) have been in the water at any one time. There is a need to show that the research community is making use of these resources.
- Following on from GROOM the EGO community has an opportunity to propose (about 2 years from now) a coordinated network of glider observations in the same way the profiling float community setup the ARGO program. To do this requires a strong scientific purpose for such a network. Cross shelf-edge and satellite calibration and validation were suggested.
- Some MSFD requirements could perhaps be addressed using a network of glider observations. In particular Descriptor 7 'Hydrographic change' and also 11 'Noise' and 5 'eutrophication' are areas in which gliders could make important contributions.
- It was noted that the EC has an intention to build an EOOS (European Ocean Observing System) that would be similar to the US IOOS (Integrated ocean Observing System) which has a strong glider component. FP7, Horizon 2020 and JPI Oceans could be the EC means to set up an observation network.

Session 2: Review of existing glider facilities and technology
Chair Alberto Alvarez and Lucas Merckelbach
2.1 Gliders: existing platforms and sensors
2.2 Workshops: ballasting, repairing, pressure testing
2.3 Ground segments: computer infrastructures (glider communications, data processing)
2.4 Calibration facilities
2.5 Coastal Ships

In Session 2 each participating country was given the opportunity to give a 15 minute overview of glider facilities in use in their country. As to be expected, the development of glider facilities varied substantially between the presenting countries. Below is a summary with the highlights of each presentation.

Cyprus

The oceanographic institute at Cyprus runs two Seagliders, equipped with optical sensors for chlorophyll a (Chl_a), fluorescence, 470 and 700 nm.

New sensors will be installed for dissolved methane and pCO2. They have a small laboratory, and no facilities for calibrating CT (conductivity temperature) sensors, or pressure testing. Battery changes are done externally (iRobot).

- One technician and 2 part-time IT personnel keeps the gliders running.
- The lab experience problems with shipping batteries (incl. gliders) to US.
- Four out of five missions ended problematic.

Scientific aim is to use glider data for data-assimilation in a regional model.

France

France uses a different model to run their glider fleet: one institute DT-INSU maintains the whole fleet at their base in Toulon. Currently the fleet consists of 13 Slocum's, 2 Seagliders and 1 Spray.

The gliders are equipped with sensors to measure dissolved oxygen, Chl_a, CDOM, nitrate and backscatter at 412, 470, 532, 710 and 880 nm.

Through the IRD (Institut de recherche pour le développement) France has several bases in the world to work from. Some of the gliders are operated in these overseas areas and remain there. In France two larger ships that stay in the area of the French coasts are available for glider operations, augmented by 6 smaller vessels.

Toulon is the major centre where battery exchanges are done for Slocum gliders only.

Engineers at DT-INSU have developed the GFCP (Glider Fleet Control Panel) and a database for keeping track of gliders' histories. Faced with a large fleet (and limited personnel resources) a system is in development to send alarms to glider pilots if parameters get out range, and autopiloting systems are also proposed.

Germany

In Germany four groups (AWI, Geomar, HZG, and the German Navy) are active with gliders and operate separately, but gather once a year to exchange information.

In addition to the institutes, three companies offer services to glider operations in Germany: Optimare (piloting of Seagliders for AWI and soon to be certified to perform battery exchanges, BatterieLaden (building of custom alkaline and Lithium battery packs for Slocum gliders) and KUM ballasts the gliderfleet of Geomar.

Geomar has 9 gliders, three of them with microstructure probes. Glider piloting is done on an ad-hoc basis. For the deployment and recovery of gliders in the area of interest (Cape

Verde Islands) local boats are used. The personnel involved are 3 technicians and 2 scientists.

AWI has three Seagliders and relies on external resources for maintenance: piloting is done by Optimare. Soon battery exchange and ballasting will also be performed by Optimare. The gliders are equipped with RAFOS beacons for navigating under the ice. Two gliders have been lost form the AWI fleet.

HZG owns 2 Slocum gliders which are used in a coastal region (German Bight, North Sea). The gliders are equipped with optical sensors for Chl_a, turbidity and optical backscatter at three wavelengths. Three part-time technicians and one scientist run the gliders. The scientific aims are to look at process studies related to suspended sediment transport and data-assimilation in a regional model of the German Bight. The deployment of gliders in this area is tightly controlled by the maritime authorities and currently only one glider can be deployed at any one time.

WTD71 (German Navy) has one glider and an equipped glider lab. Due to problems acquiring iridium and ARGOS products (recently solved), no missions have yet been flown, but their first mission will take place soon. Long-term goal is to use gliders for data-assimilation.

Italy

In Italy two institutes are active with gliders, OGS and NURC. At OGS one (Slocum) glider has been lost, but a replacement will be delivered soon (Seaglider?). At NURC the glider fleet consists of 8 Slocums and 1 Spray glider. Two more are scheduled to be purchased. The NURC gliders can carry optical sensors (Irridiance (504 Satlantic), Backscatter Attenuation Meter, wave pack motion sensors, and passive acoustic sensors.

AT OGS considerable effort has been put in developing calibration procedures for CT and Chl_a sensors. At NURC a glider-containing CT calibration facility is available as well optical calibration rooms for various optical sensors. Furthermore, NURC uses CTD-frames for in-situ calibrations.

OGS has no ships but uses Zodiacs. NURC has two larger research vessels (90 and 30 meters).

Two Pilots are available at OGS and 5 at NURC.

Norway

Norway has a fleet of 6 Seagliders and 3 Slocum gliders, intended for use in the Norwegian Atlantic Current Observatory. The gliders have not been used yet, but workshops and calibration facilities are under construction.

The scientific aim is to connect gliders to existing monitoring projects (standard sections) and to use gliders instead of moorings.

Spain

Spain has three institutes: PLOCAN, CSIC and SOCIB, of which CSIC and SOCIB work closely together. The Spanish Armada consists of 6 Slocums, 3 Seagliders and 1 Spray.

CSIC/SOCIB has a new laboratory, a lab-in-a-van, pressure chamber, 2 ships (24 m coastal vessels) and a high-speed zodiac.

The team has further a vast amount of experience in data processing, profile identification, thermal lag correction.

PLOCAN has a fully equipped lab, close to the sea, with several boats and a waveglider.

UK

The UK has four institutes running gliders: NOC, BAS, UEA and SAMS.

The NOC fleet is operated by the Marine Autonomous and Robotic Systems (MARS) facility. MARS maintains 7 Slocum, 3 Seaglider and 3 Wavegliders. They have a full lab, and usually deploy from small boats, but experience from larger vessels is in NOC Liverpool. At NOC Liverpool, the focus is on coastal areas, which is more complicated in terms of shipping, currents and shoals. New sensors are being developed at NOC (lab-on-a-chip), for nitrate and other variables Two engineers have been accredited to do Seaglider battery changes.

BAS has 2 Slocums and 1 Seaglider.

UEA has four Seagliders which have been used in the North Sea, equatorial seas and in the Antarctic ocean. One of the main problems faced is getting ships to remote locations, which has caused one glider to be lost.

Gliders can be equipped with Dissolved Oxygen, Chl_a, CDOM, and OBS. A Nortek ADCP has been integrated on a glider along with an echosounder to monitor krill from acoustic backscatter.

SAMS runs a facility called the North Atlantic Glider Base, and have direct access to the sea. They own 2 Seagliders, which are deployed from a RIB or coastal research vessel. The ballasting and refurbishments will be done by NOC. SAMS has direct access to sheltered waters that make it well-suited for trial deployments and experiments. These facilities are offered to external organisations.

Greece

Greece has no gliders, but can contribute at the interface of GROOM and JERICO (WP4 Jerico). The aim is gather elements of best-practices and facilitate:

- harmonisation of calibration procedures
- sharing calibration facilities
- disseminatation best-practices
- study of biofouling in sensors

Poland

Poland has currently no gliders, but is interested in acquiring some. Their focus is in the Arctic. Using conventional observation platforms they have collected long time series, but only covering the summer period. They hope that gliders will fill in the gaps during the harsher winter period. In addition they have plans to work in the Baltic, currently challenging because of large density variations.

Session 3. Review best practices in glider operations (one glider/fleet)

Chair: Laurent Beguery, Carlos Barrera

3.1 Glider platforms and sensors in the laboratory - *Lucas Merckelbach*
3.2 Glider Mission – Alberto Alvarez
3.3 Glider Data Management - Sylvia Pouliquen

3.1 Glider platforms in the lab

i. Platform maintenance

Maintenance is typically done differently for each type of glider:

- For the Slocum, the refurbishment is typically done by the user. In theory there is only the batteries to be changed but in practise a lot of time is spent in repairs. Some additional tools are handy (degassing pump, ballasting facilities)
- For the Seaglider, the manufacturer (iRobot) expects users to use iRobot's refurbishment service. But this can be expensive and requires sending the glider to the USA. In response to users requests it iRobot offer a training course to teach engineers how re-battery and ballast a Seaglider in their own laboratory.
- There is very little experience with Spray gliders in Europe.

For all gliders keeping records of maintenance is very important. Depending on the size of the fleet (fleets in operators in Europe vary between 1 and 14 gliders), the tools can vary from a notebook to a maintenance database.

Different battery cell types have been used in gliders and users have found some variability in the energy that can be derived form battery packs. A suggestion was made to setup a common database to analyse battery performance in gliders. Laurent. Beguery, David Smeed, and, Carlos Barrera expressed an interest in forming a working group on this topic.

ii. Sensor maintenance

Sensors on gliders need to be maintained as they would be on other platforms but there are some particular issues associated with the glider platform. In particular it is often not practical to obtain coincident water samples for calibration, and gliders remain at sea for extended periods of time.

Typical practise for the most commonly used sensors are:

- CTD (pumped or unpumped), a method for maintenance is given in the article Medeot et al 2011
- For Oxygen sensors, it is important to protect the foil from UV and to keep them hydrated. The foil can be changed in house if needed
- Optical sensors and Oxygen sensors are sent back to the manufacturer for calibration and maintenance

iii. Sensor calibration and inter-calibration for glider fleets

There are 2 ways of cross calibrating the gliders at sea

- A direct calibration can be done with a glider mounted on a frame with a reference sensors close by
- An indirect calibration can be done by using a cast with references sensors in waters near the glider. This method can be problematic in shallow or coastal waters.

It is very important to know the correct timestamp of data acquisition. On gliders this is not always straightforward because of the way data are recorded. With the Slocum glider CTD it is very important to add c_ctd41cp_num_fields_to_send 4 in the autoexec file to have the real timestamps for CTD data.

The problem of time stamping the CTD data on Slocum was well known and, after Lucas presentation, Sunke Schmidtko (University of East Anglia) explained in more detail the data acquisition on Seagliders. He will provide the community with a Matlab toolbox to correct the data time stamps. All agreed on the importance to have a good timestamp for samples.

For the following sensors:

- CTD: a method of calibration in the laboratory is described by Medeot et al. 2011.
- O2 : on Slocums and Seagliders, the sensor can be easily unplugged from the glider and plugged in a separate sensor frame, the sensor can be sent to a calibrating facility or Winkler titrations on several replicates from samples can be done at sea.
- Optical sensors: on Slocum they cannot be easily removed. Either the sensor is sent to the manufacturer or are calibrated during field work. The Satlantic irradiance sensors are calibrated in a dedicated dark room at NURC.
- The glider compass also needs to be calibrated in order to make accurate estimates of depth-averaged currents. Calibration can be done either prior to deployment or may be deduced from field measurements if glider trajectory permits.

In summary glider and sensors users need to know

- How various sensors relate,
- How sensors drift due to aging,
- How sensor sensitivity changes in time due to change in the environment
- When exactly a sample is taken.

3.2 Glider missions

There was discussion about the risk of glider deployments. A number of groups have been looking at the risk of ship collision based data from AIS (Automatic Identification System for tracking vessels at sea).

A Working Group on the use of AIS was proposed. Bartolomeo Garau, Lucas Merckelbach, Phil Knight, Laurent Beguery, and Gerd Krahmann volunteered to participate in the group.

It is difficult to use the AIS data in real-time to try to avoid collisions. However, risk could be assessed form historical data. The idea is first to assess the risks for gliders with maps of ships density. This should concern all EU waters. Peru and equatorial Atlantic are also of interest to EGO members. Density maps could be produced for each month of the year. Starting from now or using past data. We should not have to pay much for AIS data and maximum only once. There are options to get some AIS data for free.

The topic of third party insurance was discussed. Some operators have managed to arrange insurance for gliders.

3.3 Glider Data Management

Sylvie Pouliquen agreed to head a Working on Group on data management. Following discussion at the meting the key topics to be addressed by this group are:

- Organisation of the Glider Data Management activities :
  - Who does what? the respective role of the PIs, DAC, GDAC,
  - Definition of the different data Streams (Realtime, Post recovery)
- Definition of the improvement that need to be provided to the OceanSites Data Format (http://www.oceansites.org/docs/oceansites_user_manual.pdf) to handle properly Glider data
  - What Static metadata
  - How to handle mission changes
  - How to store the observation from surface to depth
  - What technical information should be included with the scientific data?
- How to define the Real Time QC procedures for the main parameters sampled and transmitted in RT in agreement with what exist in EuroGOOS/MyOcean/SeaDataNet
  - What exists already (Argo, OceanSites, Ferrybox,...)
  - Why should it be different for Gliders?
  - Define priorities on a list of parameters
  - Define working groups on RTQC for these priority parameter list (eventually split in parallel sessions for 2hours to progress on each set of parameters ? TBD)
- How to define the Post Recovery QC procedures for the main parameters sampled and transmitted in RT
  - How to correct the parameters provided in RT
  - What technical information we provide
  - Define working groups on Post recovery processing
- How to interact with the EGO international partners ?

Discussion

Joint working and sharing information amongst EGO partners

There was a consensus that the EGO website is a good platform for sharing information and making visible the activities of European partners. All participants are strongly urged to record their gliders and deployments on the website even if no other data is given.

An editorial board was proposed: Emma Heslop, Estelle Dumont, Bastien Queste, Reiner Onken, and Simon Ruiz volunteered. There is perhaps too much on the site and it was suggested that four key areas should be identified for improvement and then make these more visible.

The EGO forum is a valuable means of communication but need to be re-animated. There was some discussion about why it has not been used. Often quick answers are required to solve technical issues and glider operators tend to use the forums provided by manufacturers for these problems. However, it was felt that an EGO forum could be more open and provide a more independent view than those hosted by manufacturers. Some effort is required by everyone to get some 'momentum' in the EGO forum. A suggestion was made to create an email (e.g. log@ego-network.org) that could be used as a cc when emailing manufacturers to get information on to the forum.

There is a strong need for sharing our scripts and tools for path planning, visualization, calibration. For this we need to have a clear list of repositories to these tools.

Questionaires

Several questionairres were proposed for gathering data for some of the deliverables for GROOM and JERICO. Although there is some overlap between these, all were supported by the meeting

- JERICO Glider Survey – to catalogue glider resources and facilities of all GROOM and JERICO participants. Joaquin Tintore and Emma Heslop have used a created an online survey http://imedea.uib-csic.es/glidersurvey/.
- A Gliderports survey is to be developed by Lucas Mercklebach. It was proposed to use a database of information gathered form the JERICO survey so that information did not need to be entered again.
- A questionnaire on the costs of glider operations (Laurent. Beguery). For JERICO G. Petihakis also proposed a spreadsheet for each partner to log their costs during one year in order to estimate the real costs. It was pointed out that further information on the size of the fleet and number of deployments would also be needed
- A risk survey will be prepared by Mario Brito and David Smeed. One entry will be required for each glider deployment. The survey will be used to calculate the risk of glider failure or loss. This is an important step to understanding the full costs of operating gliders.

Other suggestions were made to gather information about glider operations. It was proposed to collect all technical reports (ideally but not necessarily in English) and put them on the EGO website, or the GROOM website or possibly use the EGO forum to post message with a few keywords and the report as an attachment.

Session 4. Recommendations for glider contributions to a European Coastal Observatories
4.1 Science: key topics to be addressed using gliders (Matthew Palmer)
4.2 Technology: future directions, operations, sensors, platforms and support (Pierre Testor)
4.3 Society: contributions to: European Marine Policy, emergency response, etc.
4.4 Coordination: glider contribution to a European Coastal Observatory Strategy

4.1 Science: key topics to be addressed using gliders

Some examples were presented of scientific topics addressed using gliders in UK science programmes.

- Freshwater pathways in coastal environments (Liverpool Bay) (extreme environment); reaction of chlorophyll 2 fold increase with flume; increased turbulent mixing
- Testing of ocean models
- Filling gaps in mooring data: OSMOSIS Ocean surface mixing sub-mesoscale interaction study: improved parameterization of mixed layer depth
- Ocean Shelf exchange in the FASTNET (Fluxes across the Slope Topography of the North East Atlantic) programme.

4.2 Technology: future directions, operations, sensors, platforms and support

Six areas in which GROOM community needs to develop were discussed.

1. Better visibility of our community
   - The need for a common scientific objectives (could be MFSD or cross-slope exchange)
   - All showing glider deployments and data on a common website (EGO)
2. Demonstrating to the EU that our group can function as a distributed organization like IOOS, IMOS
3. The establishment of a legal framework
   - WMO provides numbers as for any profiling floats. Would this be possible for gliders too? Should there be a WMO section for gliders
   - IOC diplomatic protocols for operating gliders in territorial waters
4. Better sharing of technical information. Does this require a MOU between EGO partners on the sharing of data?
5. Improved analysis of technical data and publication of studies. Suggestion of perhaps publishing datasets with a DOI.
6. Sharing best practice for glider operations. For example:
   - deployments in rough conditions,
   - making use of AIS, models or satellite data
   - recovery (BUGS for providing information to third party vessels sued for recovery)
   - piloting
   - communications (backup land stations)
   - processing and calibrations (need for a common repository for scripts.)