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in the field of Scientific
and Technical Research
- COST -

Secretariat

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COST 269/09

MEMORANDUM OF UNDERSTANDING

Subject :	Memorandum of Understanding for the implementation of a European Concerted Research Action designated as COST Action ES0904: European Gliding Observatories Network (EGO)

Delegations will find attached the Memorandum of Understanding for COST Action ES0904 as approved by the COST Committee of Senior Officials (CSO) at its 176th meeting on 1 December 2009.

MEMORANDUM OF UNDERSTANDING
For the implementation of a European Concerted Research Action designated as

COST Action ES0904
EUROPEAN GLIDING OBSERVATORIES NETWORK (EGO)

The Parties to this Memorandum of Understanding, declaring their common intention to participate in the concerted Action referred to above and described in the technical Annex to the Memorandum, have reached the following understanding:

1. The Action will be carried out in accordance with the provisions of document COST 270/07 "Rules and Procedures for Implementing COST Actions", or in any new document amending or replacing it, the contents of which the Parties are fully aware of.

2. The main objective of the Action is the European coordination of ongoing research using gliders, and the conception of future research, to operate fleets of autonomous underwater gliders in order to provide cost-effective methods for the discovery and monitoring of the ocean at global, regional and coastal scales with benefit to both basic oceanographic research and operational applications for marine activities.

3. The economic dimension of the activities carried out under the Action has been estimated, on the basis of information available during the planning of the Action, at EUR 48 million in 2009 prices.

4. The Memorandum of Understanding will take effect on being accepted by at least five Parties.

5. The Memorandum of Understanding will remain in force for a period of 4 years, calculated from the date of the first meeting of the Management Committee, unless the duration of the Action is modified according to the provisions of Chapter V of the document referred to in Point 1 above.

A. ABSTRACT AND KEYWORDS

Underwater gliders are intelligent and affordable platforms useful for long term multi parameter marine observations. They play an important role for present and planned marine observation networks. Deployed in swarms, they provide near real-time high spatial and temporal resolution data that will efficiently fill the gaps left by existing in-situ observation networks based on other marine platforms such as the profilers in the ARGO network. This will be beneficial for both academic oceanographic research and especially operational oceanography systems on which a large number of marine activities now rely. However, the deployment of swarms of gliders requires highly skilled operators and a sophisticated level of cooperation. The objective of the "European Gliding Observatories" proposal for this COST Action is to build cooperation at the *technological*, *scientific* and *organizational levels* for a European capacity for sustained observations of the oceans with gliders.
Keywords: Gliders, Autonomous Underwater Vehicles, Operational oceanography, Marine observations networks, Sensor technology and integration

B. BACKGROUND

B.1 General background

There is a growing public awareness of the oceans' role in our lives. Many aspects of our environment, such as the characteristics and changes of the global/regional climate, the weather, ecosystems, the living resources and the biodiversity are strongly linked to the ocean. The ocean also plays a major role in human activities like science, education, defence and security, search and rescue, coastal protection, shipping, fisheries, offshore industry, and tourism.

This is the reason for the emphasis by the Marine European Policy on availability and easy access to the wide range of natural and human-activity data on the oceans as the basis for strategic decision-making. The "Blue Book" and the "Marine Strategy Directive" clearly stress the need for multi-dimensional mapping of Member States' waters. The corresponding European Marine Observation and Data Network should be built in cooperation with the Global Monitoring for Environment and Security (GMES) initiative (www.gmes.info/).

The impacts of the ocean on the environment are a result of its storage capacity for heat, carbon and other substances as well as the degree to which it moves them around as a result of external physical forcing, internal dynamics, and biogeochemical cycles. This gives rise to remote effects in space and time on currents such as shifts or reversals of the ocean circulation, physical and biogeochemical properties, and marine ecosystems that could be dramatic.

The marine environment is a complex and turbulent system, characterized by strong interactions between physical, chemical, and biological processes. The study of these processes with meaningful observations is difficult because of their high spatio-temporal variability (1-1000 km horiz. ; days-years-decades+). There is a need to measure physical, chemical, and biological parameters simultaneously, because their variability can differ significantly. And the wide range of scales makes it important to carry out in-situ observations at high spatial and temporal resolutions over long periods.

After some major initiatives, such as the World Ocean Circulation Experiment (WOCE), a reasonable understanding of the base physical state of the oceans was achieved. An important question that remains however is how much of the global change induced by human activities can be absorbed or moderated by the oceans. Therefore, the focus of much ocean research is now on trends, variability and predictability. For example, the international Global Ocean Observing System (GOOS) has become one of the most valuable tools for climate assessment and prediction. At the same time, ocean observing systems have developed at regional/coastal scales for local survey purposes. Improvements and optimization of GOOS and of the regional/coastal OOS, will come from an increase of the spatial and temporal coverage of temperature and salinity (T/S) profiles. In addition, other parameters that allow the characterization and monitoring of the marine ecosystem are needed, and new sensors are now becoming available for that question.

Observations of the marine environment have been traditionally carried out by oceanographic ships, moorings, and floats. All these observing platforms are tools for multidisciplinary measurements of the ocean, but not always with the required spatio-temporal resolution. The key point here is to avoid any aliasing effect leading to erroneous conclusions. The last 30 years have seen an increasing number of actions dedicated to estimate the ocean state or observe how climate change has unfolded in the ocean. Among those, one can distinguish four in-situ observing strategies:

- Process studies: many oceanic processes require further investigation mainly with in-situ observations that are able to resolve variations at small and (sub)meso scale (1-100 km, day/weeks), in relatively large areas (regions/basin). This has been done in selected places for a better understanding of the ocean, in regional seas that are generally important for the global functioning of the ocean (e.g. convection sites, eddy-focused studies, oligotrophy processes).
- Observing systems for specific scientific objectives: many scientific projects aim to address the oceanic variability at low frequency and have set up observing systems on a relatively long term (years) such as repeated transoceanic hydrographic sections or mooring arrays such as the UK-US 26^{o}N RAPID-WATCH moored array and annual hydrographic cruises.
- Observatories: often with a multidisciplinary approach, observatories are intended to be set for decades in specific areas to focus on particular processes over regions that are in general characterized by a strong interannual variability and where trends are likely to be best monitored. The "Mediterranean Ocean Observing Site for Environment" (MOOSE) is a typical example of such observatories (www.obs-vlfr.fr/moose).
- Operational oceanography: the main focus is the real time (RT) data coverage and flow as well as archiving with the major constraint of RT and delayed-mode quality controls. Data centres collect these data and distribute them over the Global Telecommunication System (GTS). Operational forecasting models use these data to provide an up-to-date estimate of the physical and biogeochemical state of the ocean.

These strategies share a large number of observing methods and most often synergies are obvious. The widest variety of interdisciplinary measurements can be obtained from oceanographic ships. Unfortunately, logistical and economical aspects involved in oceanographic ship usage invalidate them as platforms able to carry out continuous and sustained ocean observations, which causes a sampling bias problem for hydrographic sections because they cannot be repeated so often. With less capacity concerning the measured parameters, ships of opportunity can be used for ocean monitoring but most of the time they need to be manned on each trip and are constrained to existing maritime routes so they do not always pass the sections of maximum scientific interest.

Unlike oceanographic ships, moorings provide interdisciplinary data with very high temporal resolution over long periods but poor spatial resolution in the horizontal. Results from moored systems at key locations have documented large variability but it is difficult to extract trends because of the poor resolution and consequently it is often impossible to separate spatial and temporal variability.

The international ARGO program is a global array of profiling floats that has been recently implemented and it is a network capable of monitoring the global ocean in a full operational way. The ARGO program has been very successful in providing the first intensive data coverage of T/S in the upper 1000 to 2000m of the world ocean. About 3000 floats are scattered around the world's oceans, providing profiles every 10 days. The drawback is that floats are subjected to the currents, which leads inevitably to uncontrolled gaps in the data coverage. There are regions of strong divergence and strong currents, where floats have to be reseeded frequently. Another drawback is that the original design of the ARGO array also excluded marginal seas due to technical difficulties (mainly grounding and stranding).

Significant advances in the knowledge of the oceans have been achieved with all these in-situ observations that combine well with satellites, and are able to be assimilated into ocean models, resulting in a demonstrable increase in their predictive skill. Unfortunately, satellites cannot deliver any direct information about the vertical structure of the ocean. In addition, they do not perform well in coastal areas (ocean colour, altimetry) or when there is a cloud cover. In-situ observations are definitively needed to extend our synoptic vision from satellites below the surface.

Autonomous underwater gliders come from the idea that a network of small, intelligent, and cheap ocean observing platforms can fill these gaps left by other observing systems. With the help of technological developments, these new platforms have been designed to allow continuous, remotely commanded ocean measurement programs at high spatial and temporal resolution.

B.2 Current state of knowledge

Gliders enhance the capabilities of profiling floats by providing some level of manoeuvrability and hence navigational control. Gliders are propelled by a buoyancy engine (but no propeller!). The gliders perform saw-tooth trajectories from the surface to depths of 1000-1500m, along reprogrammable routes using hourly to daily two-way satellite link. They achieve forward speeds of up to 40 km/day and have an endurance of a few months. In contrast to profiling floats, gliders are designed to be recovered and redeployed.

The glider idea emerged over 20 years ago and development was spurred on by a futuristic article (Stommel, *Oceanography*, 1989). Now, after a “teenager” period, gliders are being incorporated into the operational technology portfolios of many research institutions and agencies. It has been demonstrated that gliders are able to carry out high resolution measurements covering specific areas of hundreds of km on a long term basis (several months), of physical (T/S and velocity of the currents that will be soon measured directly) and also biogeochemical parameters such as dissolved oxygen and fluorescence/optical backscattering (e.g. Chla, CDOM, phycoerythrin, turbidity).

Gliders have also flown in coordinated fleets and into severe storms/hurricanes and strong currents. Since gliders are active they can cover a wide range of missions and complex sampling strategies. Numerous possibilities have been demonstrated: virtual mooring (quasi-Eulerian sampling by collecting profiles at the same location), quasi-Lagrangian (profiling following the currents, i.e., behave like a profiling float until manoeuvrability is necessary), flying perpendicular to the oceanic depth average currents they measure, to name a few. There are many possible configurations, especially when one considers several gliders working together. They could be commanded to stay in a region for a while - around a mooring array for instance - or to follow an oceanic feature such as an eddy or even living creatures such as penguins as they forage. Robust algorithms to perform such complex piloting have already been tested at sea and tools to adapt the waypoints using the environment sensed by satellites or forecasted by operational models have been developed to optimize the glider path.

It is clear that gliders can be combined into networks of small and intelligent platforms that are able to fill the gaps left by other observing platforms by delivering high resolution and near real time (NRT) in-situ observations of physical and biogeochemical properties along their paths. The utilization of glider technology will allow scientists to reach a level of coverage and accuracy never reached before in ocean monitoring for such parameters. Glider deployments in concert with other observing networks (satellites, ships, floats, moorings) can significantly enhance the ocean observing capabilities for the upper 1000-2000m of the ocean.

Gliders are relatively slow and that obviously raises some issues about whether the observations can be treated as synoptic: how representative of the ocean state are the collected profiles? This problem is a major one but it can be solved by increasing the number of instruments at sea (point measurements) at the same time. As such, this is the float/glider philosophy but it demands a collective coordinated approach. But above all, the problem of synopticity can be solved because operational models are now mature and 4D evaluations of the state of the ocean can be performed with suitable data assimilation techniques.

Gliders open wide perspectives but some disadvantages and logistical constraints must be considered. Currently, the endurance of 3-7 months limits deployments and despite current technological developments, an increase of endurance by an order of magnitude in the coming decade is not foreseen. Constraints are due to not only endurance but also to the need for local support expertise and logistics. Gliders are complex systems that can be in operation for several years but they need to be serviced regularly by highly proficient marine engineers and technicians. Periodic maintenances include exchange of primary batteries, calibration of sensors and updating the hardware and software. These tasks are technologically demanding and require expertise and dedicated devices (e.g. calibration tanks) that are available only in a few places.

Glider activity in Europe has started a few years ago in the framework of the MFSTEP (www.bo.ingv.it/mfstep/) and MERSEA (www.mersea.eu.org) operational oceanography R&D projects. In parallel, some national initiatives by small groups (Cyprus, France, Germany, Norway, Spain, UK) have focused on process-oriented studies with one or more gliders. As a result, small fleets of gliders have been formed in a limited number of oceanographic institutions, whilst the technical and scientific skills to operate them and to use the large data fluxes collected by these platforms have started to grow.

B.3 Reasons for the Action

The main reason for this Action is the absolute need for structural trans-national cooperation at technical, scientific and organizational levels, in order to be able to operate *fleets* of gliders safely with scientific benefits for both fundamental marine research and operational oceanography. It is now clear that *networking* and *capacity building* for the glider community are essential to gather together and operate fleets of possibly hundreds of gliders needed for the future ocean observing networks. The institutions of the Action intend to play a leading role in establishing gliders as a key element of the existing and future ocean observing networks. The skills acquired and needed for gliders in the European institutions, the numbers of gliders that have been purchased, and the timing imposed by the MyOcean and EUROARGO European major programs that are particularly relevant for gliders, are clearly in favour of the COST networking philosophy rather than other R&D programmes. However, some complementary specific problems will certainly be approached through dedicated national or international R&D projects and the Action will certainly help define these problems and point the way toward their solution.

B.4 Complementarity with other research programmes

Complementarities with the GMES MyOcean programme and the FP7/ESFRI EUROARGO project have been outlined above. However, the implementation of gliders into existing operational systems to improve these systems is a large and multifaceted problem where coordination of individual efforts is essential. Several national research projects, such as TWISTED (www.locean-ipsl.upmc.fr/TWISTED/), which aims at considering the role of submesoscale activity onto the primary production, operate gliders in a fleet and they show that are perfectly suited to map the required parameters over large areas at the right resolution. This Action will enable the gathering of glider fleets which is needed for such experiments essential to understand the role of physics onto marine ecosystems. The likely benefit of gliders for deep sea observatories developed within the ESONET NoE (www.esonet-emso.org/) has also to be established. See also E3.

C. OBJECTIVES AND BENEFITS

C.1 Main/primary objectives

The main objective of this COST Action is the European coordination of ongoing research using gliders, and the conception of future research, to operate fleets of autonomous underwater gliders in order to provide cost-effective methods for the discovery and monitoring of the ocean at global, regional and coastal scales with benefit to both basic oceanographic research and operational applications for marine activities.

C.2 Secondary objectives

Related to this main objective, the following secondary objectives will be addressed during the Action:

- Provision of specifications for new prototypes, for gliders of different size, operation range and complexity with respect to specific observational requirements. This includes the cooperation with laboratories and companies that are planning to conceive and develop new gliders.
- Development and enhancement of sensors specifically designed to operate on gliders.
- Development of reliable protocols for sensor calibration (at sea and laboratory, in particular for parameters other than temperature and salinity) and the definition of standards for methods and algorithms used for glider measurements, data analysis and error investigation to ensure high data quality and intercomparability. This will be in close coordination with the ARGO community, which has experience with temperature and salinity protocols.
- Glider specific data management and distribution in near real time and delayed mode in relation with the major data centres for operational oceanography.
- Development and standardization of infrastructures (main “gliderports”) through which fleets of gliders can be maintained, deployed and overall operated for the benefit of the whole glider community, including the cooperation with developing countries.
- Selection and standardization of appropriate sites to establish secondary “gliderports” in European regional seas and all over the world to facilitate the deployment, maintenance/refurbishment and retrieval of glider.

- Improvement of glider data assimilation methods for global general circulation models as well as for high resolution coastal models.
- Improvement of Observing Systems Simulation Experiment (OSSE) methods to design the shape and location of gliders fleets for process studies and for monitoring networks.
- Development and test of glider fleet deployment strategies for temporally and spatially highly resolved measurements. This includes in particular adaptive sampling methods. This will allow the community to test methods during concerted/coordinated field campaigns during which an adequate/required numbers of gliders could be achieved by sharing among members of the Action.
- Promotion of gliders to the wider oceanographic and user community, and the provision of training for new users.
- Homogenization of national rules/regulations on a European basis with respect to glider operations from the legal and marine safety perspectives. This includes the link with international groups of experts established by organizations such as the International Oceanographic Commission (IOC/UNESCO), the Joint World Meteorological Organization-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) and the International Maritime Organization (IMO).

C.3 How will the objectives be achieved?

It is essential for the realization of the objectives described to strengthen the interdisciplinary research environment, to bring together marine sciences researchers and engineers in marine operations, optical and electrochemical marine sensors, as well as those interested in robotics. At the present maturity stage of the European groups active with gliders, there is a risk of unnecessary duplication of researches while also leaving important aspects uncovered. It is crucial to bring together *now* the relevant expertise in these fields already available in the member states.

Most of the technical and scientific objectives will be achieved through coordination and cooperation among the members that will take place with the usual instruments of COST networks (see E1, E2 below). In particular, regular working group meetings will be complemented by short-term mission-funded travels for both researchers and engineers, especially toward the main "gliderports" where large facilities are present. Regular "Glider Schools" will be organized for newcomers in order to shorten the average two-years period that is presently necessary for preparation, training, tests, … before a new team can safely and efficiently deploy a glider!

It is likely that the Action will promote the same wide open data policy as ARGO in the frame of GOOS recommended practices. In this way, any glider deployed with a given observing strategy (e.g. process studies, observatories) even in a regional context and in the Exclusive Economic Zone (EEZ), can contribute to ocean observations at global scale and be distributed over the GTS.

This data policy could also help resolution of the complex legal issues raised by gliders, which are similar to some extent to the ones raised by profiling floats. The discussion has started in the framework of UNCLOS in a recent ABELOS/IOC/UNESCO workshop. Marine safety issues are also central, as gliders contrary to profilers are likely to be steered in crowded coastal waters. Members of this Action have already started to raise these questions to their national authorities. The Action will help harmonize the present applicable rules (and will help with defining new ones if needed) in close contact with the national and trans-national marine authorities. External experts on legislation and on marine navigation have to be involved in the process especially for this task by e.g. invitation to working group meeting.

C.4 Benefits of the Action

Deployed by numbers, gliders can perform intensive and controlled in-situ sampling for the deep ocean (presently upper 1000-1500m), similar to what satellites do for the surface. Fleets of gliders deployed in the frame of existing networks will definitively improve their efficiency. Generally stated, benefits are seen as improved marine environment monitoring with a focus on the European regional seas and coastal regions, and the increased competitiveness of research institutes/agencies and maritime industries, as clearly stated in the "Blue Book".

More precisely, benefits are:

- Improved technology and sciences for the use of autonomous unmanned vehicles dedicated to monitoring the environment. This involves the capability of operations in remote and severe environments at a low cost.

- Improved oceanic databases by an order of magnitude both qualitatively and quantitatively, in particular in the field of operational oceanography, bringing concrete benefits for the MyOcean GMES and similar projects. This concerns in particular filling the gaps in spatial and temporal scales left by the existing networks for physical parameters and above all for biogeochemical ones.
- Improved efficiency of early warning systems for accidental pollution events and harmful algal blooms. Dedicated sensors for specific pollutants can easily be added to gliders and deployed with high flexibility for such warning systems.

C.5 Target groups/end users

As for the other existing ocean monitoring activities, targeted groups can be identified as:

- The scientific community in ocean and climate sciences by providing access to a new type of measurement system and corresponding simultaneous physical, biochemical and biological measurements of a large range of oceanic phenomena over long periods, with data delivery to the desktop. This will be crucial for improving e.g. climate databases, validation of models, fine scale process studies and related parameterisation.
- The oceanographic agencies and companies that produce RT and near RT operational maps of the ocean state. The business related to "ocean weather" and "green ocean" forecast, especially those producing high resolution products, will gain access at the right resolution for the first time to in-situ data for validation of products/models and assimilation into numerical models.
- The local authorities and companies that will use improved operational oceanography products for managing the coastal zone. Policy makers, public authorities and non Governmental Organizations will also benefit of improved ocean climate scenario, including for marine resources.
- Environmental protection agencies and non Governmental Organizations will have access to instruments suitable for monitoring recurrent and assess accidental pollution. This is of particular interest because of the large increase in populations of large coastal cities in the next decades, especially on the southern bank of the Mediterranean Sea.
- Gliders will be a key technology for agencies in charge of the implementation of the observational component sketched in the recent Marine Strategy Directive.

D. SCIENTIFIC PROGRAMME

D.1 Scientific focus

Due to the interdisciplinary nature of the project, three different, but strongly interacting, scientific foci can be defined for the research coordinated by the Action.

1) Marine Research

- Process studies. Because of the high spatial resolution and the wide range of parameters that gliders can collect simultaneously, they are appealing for fine scale process studies, in particular those where physics, biogeochemistry and biology are strongly coupled. There are several plans in Europe to perform glider swarm experiments in environments where jets strongly control the exchanges between offshore and coastal waters. For example, the Atlantic inflow to the Alboran Sea (Mediterranean) is associated with a highly variable system of two gyres that trigger an enhanced primary production and a productive coastal upwelling off the coast of Malaga (Spain). A 3D mapping of this system by conventional means is very difficult and swarms of gliders offer the right strategy. Other research cruises are/will be planned in the Eastern boundary upwelling systems, in the Equatorial upwelling region, in the sub Arctic seas and in European Seas for the coupling between physics and biology in oceanic eddies where adaptive sampling with gliders appears to be a very promising technique.
- Assessing the variability around long-term time series sites. Taking the "pulse of the ocean" and in particular monitoring the changes of the overturning circulation remains one of the biggest challenges for the oceanographic community. Gliders will be used between the moorings of the existing trans-oceanic arrays, such as the RAPID array, to enhance their observing capabilities. The objective is to evaluate the scales of correlation of these fixed-point measurements and to assess the significance of the signals at these locations/dates with respect to a whole region. In addition, gliders are will be used in the cocktail of technologies deployed for the NRT acquisition of deep long-term time series such as the deepwater reference stations of the OceanSites network (www.oceansites.org/ and www.eurosites.info/).

- Observing and Modelling. Major progress of the still young discipline of operational oceanography is expected from the ever increasing accuracy of oceanic models (physical and biogeochemical), which are now able to assimilate a large number of observations of different kinds. Today, several operational systems run to analyse and forecast the state of the ocean. Every day or so, they assimilate altimetry data from satellites and profiles from floats and XBTs, to produce nowcasts and forecasts of the physical state of the ocean at a resolution of about 1-50km horizontally, on regional or global scales. Primary production models with assimilation of biogeochemical data is work in progress towards a "green ocean" forecasting system. Major enhancements with respect to data assimilation in these operational systems are expected from the inclusion of gliders into the observing systems. Now the assimilation of glider data is already operational for T-S in regional models but they are treated as conventional data. However, suitable assimilation methods – for T/S and velocity - taking into account the strong anisotropy of glider data along their tracks could significantly enhance the capabilities of the forecasting systems by introducing coherence at the mesoscale.
- Gliders and the ARGO array. The data coverage (both in time and space) of the existing RT and NRT in-situ observing systems is a known limiting factor of the oceanic forecasting systems and up to now, most of the in-situ data assimilated in ocean models are T/S float profiles from the ARGO program. However, together with satellite information, the present array can characterize only the relatively low frequency and large scale processes. The ARGO resolution of 300km and 10days is enough for a number of purposes related to the global oceanic heat and salt content and variability as well as large scale transports, at seasonal to decadal scales which were indeed the objectives of ARGO. However, better data coverage at relatively small (even meso and submeso) scale is needed to constrain models if the transport at mesoscale is to be resolved. This is particularly critical for areas at the regional/coastal scale that are important for the physical and biogeochemical functioning of the ocean (e.g. convection areas, upwelling, current on the

continental slope, …). ARGO floats never stay long in such areas often characterized by energetic currents or run aground if they drift too close to the coast. In fact, the quality of any operational products, is strongly dependent on the distribution of data in such areas. As already stated, gliders are presently the sole platforms acquiring routine data with a controlled sampling and ability to fill the gaps left by the ARGO array. "Filling the gaps", which is the connecting thread driving the main objective of this Action, can be illustrated as follows. A glider repeat-section of about 300km length provides around 50 (250) profiles down to 1000m (200m) along this section in 10 days and this can be repeated for several months. Global and regional operational models would have different usage of these glider profiles. In 10 days, the global model with lower resolution would likely use only two of the collected profiles, likely the ones that are the furthest from each other in time-space - because 10 days is about ~300km which is also the ARGO "scale". Instead, the regional model will use most of the profiles because it is able to resolve much finer scale processes. The key aspect is the focus on the glider data that is in coherence with the model that assimilates those data.

- Gliders and remote sensing. Similar to what has successfully been achieved by the complementarities between the JASON altimetry programme and ARGO for the large scale, synergies between gliders and satellite measurements at high resolution represents a potential benefit for a better understanding of the dynamics in the upper ocean. In the longer term, high-spatial resolution of the ocean surface topography will be available (e.g. SWOT mission) and the methods providing results of the motions associated with eddy fields in the open ocean and coastal regions will be improved by combining this high resolution remote sensed data with in-situ ones. Obviously, glider data also are of crucial importance for remote sensed data validation and several space agencies already support the glider activity.

2) Gliders platforms and sensors.

- The present glider technology developed in the USA is robust and perspectives for applications are open with developing technologies. Acoustic data telemetry and acoustic navigation are also envisaged as well as combining gliders with facilities due to sea-floor cables and docking sites. Higher specific energy batteries or new glider hardware (such as the thermal engine), can provide additional energy and so, an increase of the glider range and/or more sensors to be carried. The development of composite hulls (with a compressibility close to that of sea water) for deeper gliders is work in progress. Gliders able to dive to 6000m depth are being developed (98% of the ocean is less than 6000m deep!). Projections of mission endurance and range for this vehicle suggest year long missions covering 10,000 km while diving continuously to 6000 m. The concept of expendable gliders should also be considered, while gliders are "reusable" but anyway their fate is to be lost at some time because of marine risks and ageing/fatigue.
- In terms of scientific payload, a glider will not be able to carry all possible sensors. Its payload capacity is limited in size, weight and power but using several gliders with different payloads could overcome this problem. The present development of various, smaller, and smarter sensors for gliders is very promising. Direct current measurements (small ADCP) or nutrient (e.g. nitrates) sensors will be available soon. Optical particle counters and active/passive acoustic sampling for higher trophic levels have already been tested. In fact the concept of "heterogeneous cluster" has been introduced for a glider swarm able to collect a large number of ecosystem parameters, each glider being equipped with a dedicated payload having specific capabilities. Such an approach enables to studies of the dynamical interaction between e.g. the atmospheric forcing, the physical mixing and transport, and the phytoplankton concentration, metabolism and diversity.

3) Remote control, glider ground segment infrastructure, “network design”

Today, one single glider can require a group of a few people to steer it day and night while the same group could certainly perform well for a small fleet. However, there is a limit to the number of devices a human being can control at the same time. Currently, about 20 gliders are flying at the same time in the world, with missions managed by 4-6 different teams at the same time and sampling about 4-8 different areas. No doubt this global glider capacity will increase rapidly in the next coming years. Several fleets of glider deployed at sea for years will require extended facilities and automation to be efficiently and safely kept at sea.

It must be noticed here that the evolution of the ARGO programme is toward more complex and reprogrammable profilers, which implies to develop very similar tools as for gliders. This point will be considered by this WG in coordination with the ARGO communities.

- The development of software and Internet tools to steer swarms of gliders is one expected major innovation that will help to generalize the use of gliders together with increasing the number of “gliderports” where gliders could be deployed/recovered and refurbished. A few numbers of the main “gliderports” will provide extended facilities (ballast tanks, pressure tanks, calibration tanks) and computing and communication facilities that will compose a distributed “ground segment”, similar to what exists for satellites. This has to be based on a tight networking, on efficient man-machine interfaces and tools from artificial intelligence, as well as on at-sea experience. Gliders are autonomous but relatively simple robots with limited intelligence as they need very low-power hardware. On the other hand, added intelligence can come from supervision on land. Presently the supervision is generally a number of human beings organized in shifts who decide on waypoints and action items. Human capacities are limited and designing a land robot to help control fleets of gliders is attractive. For example, adaptive sampling opens new and wide perspectives but this can only be achieved with automated waypoint selection, and information systems that allow better navigation. In practice, given a specific mission for a glider fleet, the land robot will generate and send the right number of individual commands for the gliders. In addition, information from weather forecasts, ocean model outputs, satellites images and positions/profiles of other moving platforms to the glider pilots and land robots are definitively necessary to fly gliders in a better defined context and consequently, more efficiently.

- The deployment of fleets of gliders for specific campaigns, specific monitoring and regional observing networks will require reliable methodologies to design optimal topologies and sampling strategies. Because these in-situ observing systems composed by fixed or moving platforms are inherently dependant on the positions of the platforms, the main problem is to find the optimal topology for the gliders networks in relation with the gaps of the pre-existing networks (in-situ and satellites). Obviously this depends on the objectives of the networks in terms of spatial and temporal resolution, the nature and variability of the parameters to be monitored as well as on the estimate of the ocean state used for the decision. An evolution of a glider fleet in terms of data coverage could also be dictated by the model needs in real-time, through error maps. Documenting beforehand the impact of such observing systems is possible, generally with scale considerations - or if too complex, via simulations and OSSEs. These “network design” facilities need the same geophysical information facilities set up for the “ground segment”.

D.2 Scientific work plan methods and means

Five working groups (WG) will work the scientific, technical and organizational goals of the proposal. They are detailed in tasks and deliverables in the following. Some tasks – mainly the “organizational” ones – could be worked by several WGs. For clarity, they are mentioned once.

WG1: Support for glider deployments and data dissemination

Presently, there is not any glider network in the same sense that there is an XBT network, an ARGO network, an OceanSites network etc. This WG will undertake any general task to make the glider a platform suitable for being networked, such as:

- The definition of operating data flow system, with agreed protocols, to deliver all of the glider network's data in NRT and delayed mode. There has been some discussion of integrating glider data into the ARGO Data Management Systems, but this is work in progress.
- The definition of an international infrastructure (steering team, technical coordinators, data managers, etc) to develop the community consensus, to oversee the planning and implementation of the network and its data system.

As the legislation regarding gliders has not yet been developed nor standardized among different countries, an initial task on this work package will be to asses the legal conditions needed for flying gliders in the national waters or EEZ waters of Action's participant countries or non participants countries.

Deliverables

- Recommendations for a glider data management and distribution system.
- Recommendations for priority works related to oceanic operations by gliders.
- Legal studies documentation and position papers for possible evolution of the legal/regulation frameworks.
- New operation scenarios beyond those available with state of the art gliders.

WG2: Glider vehicle, sensors, and "gliderports" infrastructures

Investigations on the technical developments possible for the existing platforms (engines, hulls, embedded energy, other hardware and on-board software) as well as fully new gliding vehicles is the first task of this WG. Even if the Action includes the few European early stage projects that are now developing new glider platforms, the Action will be mainly active as available scientific and technical expertise and in assessing the usefulness and implementation of these new developments for the updated gliders or new gliding vehicles as measuring oceanic platforms. Some of these developments could be pointed as recommendations for the members – in particular the main "gliderports" (see below) where the technical skills are available – to conduct specific actions.

The second task concerns an accurate survey concerning existing oceanographic sensors applicable for gliders will also be performed. Three groups of sensors will be described:

- Sensors for physical measurements: pressure, temperature, salinity, horizontal and vertical currents, as the gliders imposes strong constraint on the existing measuring techniques.
- Bio-optical sensors: this is the ability to retrieve from water Inherent and Apparent Optical properties (IOP and AOP), the concentration of biogeochemical parameters (phytoplankton classes, nutrients, non algal particles such as contaminants) combined with the sampling capabilities of the gliders. For gliders, energy consumption and miniaturization for integration on the vehicle payload are the main challenges that this WG will work out.

- Other sensors: passive acoustics (such as for whale watch, wind intensity and precipitations from acoustic noise), active or passive acoustics for underwater positioning (we include here active acoustics for data telemetry) and other measuring techniques such particle counters, video for zooplankton and jellies, … for biologically oriented measurements.

The “sensor” activities will focus on recommendations, based on experience gathered by partners of COST Actions and available literature, for use of particular sets of sensors, with their energy consumption and advice on how to achieve best performance on gliders. Results of several ongoing R&D “sensor” projects by the partners will be also investigated.

The last objective of this WG is the development of “gliderports”. Main “gliderports” are selected sites with the technical staff and relevant infrastructure needed for complete preparation, maintenance (including sensor calibration) and evolution (in particular for adaptation of new sensors in the scientific payload) of large fleets of gliders can be achieved. This also includes a logistic chain for shipping of the instruments, spares and refurbishment developed in close relation with the companies. These main “gliderports” will also include the computing facilities to host the “ground segment” for piloting as described in WG3. This will be also the place for the “glider’s husband”, the manager of the fleet attached to this gliderport.

In order to help operations at sea all over the world, a network of worldwide local supports or “secondary gliderports” where the basic expertise for glider safe deployment/recovery/first maintenance is available, will be developed. It is likely that several partnerships with marine institutions of developing countries will be developed, which implies a training support activity that could be partly supported by the Action.

Deliverables:

- Compilation of fields of attention and promising new technologies for gliders.
- A support system for glider deployment and retrieval actions (wide range of research institutions, ships operators, ships of opportunity) to increase range and effectiveness of glider operations, especially in remote regions.

- Database with the oceanographic sensors applicable to gliders, their characteristics, advantages and limitations.
- Recommendations for selection of the sensors for each type of measurements.
- Glider safety procedures handbooks for deployment, recovery for the secondary gliderport.
- A support system for glider deployment and retrieval actions (wide range of research institutions, ships operators, ships of opportunity) to increase range and effectiveness of glider operations, especially in remote regions.
- Extended procedure handbooks and tutorials for piloting and exploiting the main gliderport facilities.

WG3: Piloting gliders and artificial intelligence

It must be stressed that control of the gliders via the Internet from all over the world through the main "gliderport" piloting infrastructure is essential. It is easy to imagine that hundreds of glider at sea for months requires manpower. This will be feasible only with easy and ergonomic access to piloting facilities, auto-pilot systems, flight control systems, automated fault diagnosis and environment information systems (e.g. maps of bathymetry, sea surface temperature, ocean color, currents). To integrate more groups and institutions, it is essential to allow the widest access to these facilities.

A set of existing software interfaces, including those provided by the manufacturers, will be integrated in a peer to peer structure where distributed services can interact. Interoperability of the existing glider types will be guarantied. As explained above, automation to easy the final decision-making by the human pilots will be central in this WG.

Deliverables:

- Development and integration of tools to steer fleets of gliders.
- Strategies for automated fault diagnosis assistance and solutions.
- Developments of techniques for retrieval of 4-D oceanic parameters from operational products to help piloting gliders.

- Portable Web based infrastructure open to any owner of gliders willing to include its instrument into coordinated fleets serving ocean observatories.
- Assessment of these tools for reprogrammable ARGO profilers.

WG4: Networks, links with the other observing systems and OSSEs

Gliders have been designed as low-cost platforms to improve the ocean observing systems. The question "how gliders can be optimally combined with other observing systems" is posed. The answer needs to be provided by a global community consensus. By using OSSEs and "network design" methodologies to assess the feasibility and optimality of the possible configurations, the objective of this working group will be to give objective elements to answer this question and develop consensus.

Deliverables:

- Developments of OSSEs and "network design" methodologies for assessment of the aimed network topologies.
- Proposals to the ARGO steering groups of optimal missions, distribution, location of glider sections in the ARGO array at global scale and for regional/marginal seas.
- Proposals of optimal missions, distribution and location of glider sections in specialized regional observatories (such as the above mentioned MOOSE or the ADRICOSM for the Adriatic Sea, see http://gnoo.bo.ingv.it/adricosm/), including deep sea ones (e.g. link with ESONET).

WG5: High resolution 4D oceanic measurements by gliders and process studies

This WG will focus on the way to conduct fields operations with fleets of gliders to gather detailed and accurate 4D oceanic data sets related to different specific research requirements. Of particular interest here are the large trans-oceanic sections (such as in the above mentioned RAPID section) or boundary current sections (often referred as "Endurance lines") for large scale or regional budgets as well as the investigation of mesoscale and submesoscale phenomena in specific areas. This task will use the piloting facilities developed by WG3, including adaptive sampling techniques together with associated data analysis tools. Part of this work will be done in cooperation with the community of operational modelling that will provide both the forecasts to assess the distribution of glider over the sections or shape of the fleet to cover as well as the modelling platforms themselves in order to perform detailed post processing of the collected data.

Deliverables:

- Glider fleet field campaigns methodologies and reports on the performed campaigns.
- Development and tests of data analysis tools for registering and fusing data gathered from multiple gliders with other source of data.
- Assessment on techniques (including data assimilation into operational systems) for retrieval of 4-D oceanic parameters from high resolutions surveys for physical and biogeochemical parameters.

E. ORGANISATION

E.1 Coordination and organisation

This Action project is currently the first coordination network in Europe of the few research and development programmes pioneering the field of gliders for ocean sciences and applications. The aim is to ensure that Europe’s research community is able to play a major role in the field of ocean science with automated platforms for present applications (ranging from survey of climate change to coastal management) and for future applications in the fields of marine ecosystems research and management. At the present stage of maturity of the concerned community, COST provides the right framework to achieve this: open mechanisms able to attract and coordinate all the needed competences to start building a major capacity for in situ observations.

The project will be organised with the following structures:

- The Management Committee (MC) as described in Rules and Procedures for implementing COST Actions.
- The five Working Groups (WG) described above with Working Group leaders.
- The Short Term Scientific Missions (STSM) manager for the coordination of scientific personal exchange.

During the first year, the MC will define the detailed implementation plan of the tasks of the WGs. During the course of the Action, the MC will supervise the overall progress of work, coordinate the WG activities and monitor their progress. The MC will also ensure wide dissemination of results. The MC will be also coordinated the organization of the “Glider Schools” and the production of related educational support.

A dedicated preparatory phase will also be implemented to identify and compile Web and other tools available by the partners to conduct gliders missions, for data processing and visualization tools, for circulation/ecosystem models and related tools (OSSE methodologies, assimilation techniques, …) to avoid unnecessary duplication. Attention will be paid also to the existing data sets to avoid difficult data rescue in the future. The data gathering and synthesis of existing tools by the partners will be directed by the relevant WGs.

Because of the importance of the US, Canadian and Australian glider communities, external experts from these countries will be invited to some of the MC meetings to seek advice and to coordinate with similar actions at their national level. Other experts will be invited as well, for example database managers, representatives of industry related to submarine technologies and representatives of marine authorities.

STSMs are essential as being the main mechanism to involve young researchers, engineers and technicians for fostering the collaboration between different research teams. STSMs are particularly needed toward the main “gliderports” that the Action intends to promote, as these main “gliderports” will be the location where most of the results of the researches conducted by the members will be integrated and tested. A person will be in charge of the STSM in close relation with the coordinators of the WGs and the MC.

E.2 Working Groups

In order to achieve the above mentioned objectives, the Action will be structured along five Working Groups detailed in D2:

- WG 1: Support for glider deployments and data dissemination
- WG 2: Gliders, sensors, and “gliderports”

- WG 3: Piloting gliders and artificial intelligence
- WG 4: Networks, links with the other observing systems and OSSEs
- WG 5: High resolution 4D oceanic measurements by gliders and process studies

A Chairperson, who will report to the MC, will coordinate each WG. If necessary, coordinators will also be allocated for specific tasks in WGs (e.g. “gliderports”). The WG chairpersons will also have to suggest STSM needs to the MC and the person in charge, to provide reports to the MC and to supervise the preparation of reports and deliverables of their WG.

E.3 Liaison and interaction with other research programmes

Besides its specific objectives concerning glider technology and implementation, this Action is structurally linked to two main groups of existing research programmes where national and international agencies play a key role: Operational Oceanography and sustained Ocean Observing Systems for Climate. Obviously, these two fields are linked but their organization relies on quite separate schemes of organization and networks.

At the European level, operational oceanography is being established mainly through the MyOcean project. MyOcean is the implementation project of the GMES Marine Core Service, aiming at deploying the first concerted and integrated pan-European capacity for Ocean Monitoring and Forecasting. MyOcean Service aims at providing the best information available on the Ocean for the large scale (worldwide coverage) and regional scales (European seas), based on the combination of space and in situ observations, and their assimilation into 3D simulation models: temperature, salinity, currents, ice extent, sea level, primary ecosystems, … During the years 2009-2011, MyOcean is leading the setting up of this new European service, grown on past investments in research and development, system development and international collaborations. Past programmes such as MFSTEP, MERSEA, ongoing programmes like ECOOPS (www.ecoop.eu), networks such as MOON (www.moon-oceanforecasting.eu), and other national similar ongoing projects for coastal operational systems have established active research communities in the field of operational modelling, data assimilation and, to a less extent, “network design”. This COST Action will be connected with these existing communities and will coordinate the WG activity whenever related to these projects. Attention will be paid to "network design" because of the role that is anticipated for gliders as "gap fillers". As already stated, since gliders are now the unique instruments able to provide spatially coherent in-situ data for assimilation and validation at high resolution in these models, coordination with communities active in coastal operational modelling systems R&D is essential.

In the field of handling, quality checking, archiving and distributing RT data, the CORIOLIS project (www.coriolis.eu.org/) is now playing a leading role in Europe for ARGO data and other RT data. Glider data clearly fall into the CORIOLIS competences and most of the existing gliders groups already send their data to CORIOLIS. Coordination with CORIOLIS and similar projects will be an essential part strongly related to the WG2 activity.

Here, coordination will take place through dedicated workshops proposed by the Action or planned elsewhere by the above-mentioned projects. It must be stressed that some of the potential members of the Action are already active in these fields and part of these projects.

The big challenge of the next decade will be to ensure that a Sustained Ocean Observing System for Climate can be deployed and maintained over decades in the global ocean. Most of national agencies are now embarking on a comprehensive implementation plan to work together to complete the needed global system for climate. The plan is based on the concept of extending the building blocks that have been put in place by the research programs, and on the international plan drafted by scientists that met at the OCEANOBS 99 Conference (October 1999) and at the OCEANOBS09 Conference (September 2009, www.oceanobs09.net). This conference proposed a role for gliders as a main building block beside the existing ARGO and called for a worldwide coordination mechanisms. Most of the members of this Action are active participants to the OCEANOBS09 Conference and will participate as experts committed by the national and international steering groups.

Concerning the objectives in glider and sensors technologies and implementation, the general philosophy of the Action is to help the members making progress in the fields that are essential: miniaturized robust sensors for the environment, and marine robotics. Actually, they are not central now in the skills of the groups that have indicated a willingness to participate in this Action. This will be done by attending the international and national workshops organized by the leading groups in Europe in these two fields and by a proactive approach of the MC to set up new projects between the members and the laboratories and companies expert in these fields. The main "gliderports" will certainly have the responsibility to gather and develop the relevant technologies because they are place where additional resources could be deployed by the national agencies that are willing to develop such an expertise.

It must be stressed again that the field of smart sensors for the environment has grown and will continue to grow in a dramatic way. The Action will mainly coordinate with the active communities in this field by investigating the potential of these sensors for the gliders payloads. WG3 will be in charge to establish the coordination with the existing European research networks such as the SENSEnet EU Network (www.eu-sensenet.net), the national programmes such as the Ruggedised MicroSystems Technology for Marine Measurement in the UK (www.southampton.ac.uk/~mcm/rmst) and with companies active in the integration of micro sensors on marine platforms. Some members already conduct research with optical sensors suitable for profilers/gliders and the Action will encourage for dissemination of the results to the members and for tests at sea during the field campaigns whenever possible.

In the fields of robotics, it is likely that automation of the steering of a fleet of gliders will rely on standard inference rules and methodologies. Here, the main difficulty lies in the highly asynchronous communication process with the gliders in severe environment and the way to handle failures in the hardware at sea: it is the sea that dictates! It is also clear that the Action will have to take advantages of existing algorithms for adaptive sampling that have been developed in the recent past by "artificial intelligence" laboratories that have found attractive the problem of steering swarms of gliders taking into account adaptation to the moving environment. Several existing European projects are dealing with similar problem for generic AUVs or existing propelled ones (e.g. "Cooperative Cognitive Control for Autonomous Underwater Vehicles" (Co3-AUVs) funded by FP6, "Coordination and control of cooperating heterogeneous unmanned systems in un- certain environments" funded by FP7, …). The Action will look for an active cooperation with these projects to promote the specificities of the "glider swarm" problem. It must be noticed that synergies with the ongoing COST Action ES0802 "Unmanned aerial systems (UAS) in atmospheric research" are straightforward in this field of robotics and artificial intelligence.

E.4 Gender balance and involvement of early-stage researchers

This COST Action will respect an appropriate gender balance in all its activities and the Management Committee will place this as a standard item on all its MC agendas. The Action will also be committed to considerably involve early-stage researchers. This item will also be placed as a standard item on all MC agendas.

Currently, from the groups that have indicated a willingness to participate in the preparation of this Action, only 20 % are female researchers. It is therefore considered important to promote gender balance within the Action.

Although most of the groups that have indicated a willingness to participate in this Action are formed of young researchers, the Action also intends to actively involve them in the decision making in the WGs. The Action will also be committed to involve young engineers and technicians since most of the success of any work at sea strongly rely on their know-how.

F. TIMETABLE

While glider observatories will obviously continue beyond this Action, four years is the time required to achieve the specific goals of this COST Action. Actually, within these four years, the field campaign activity will be growing since the first year (REP10 experiment is likely to take place in late summer 2010 in the Alboran Sea and the first year-long over-winter glider campaign in Fram Strait is planned on 2009-2010) and others will be scheduled later. Besides their own scientific own objectives, they will be devoted to test the “gliderports” organization, tools and methods whose development will have been coordinated by the WGs. Parts of these campaigns will be test phases for the implementation of the “endurance lines” of the future observatories that the Action is intending to establish. Hence, here phasing between the WGs achievements and field campaigns schedule is crucial and the following timetable is mostly indicative with respect to this.

The duration of the Action can be divided into three phases:

- First phase (Year 1):
  - Convene Management Committee (MC)
  - First MC meeting to establish Working Group members and initiate Action
  - Action website launched
  - STSMs conducted
  - Meeting of all WGs during the annual EGO* workshop including a “Glider School”
  - First coordinated field campaign
- Second phase (Year 2 and 3)
  - One MC meeting every year to review progress, plans for the future, and during year 3 to prepare publications
  - STSMs conducted
  - WGs meetings
  - Annual EGO meeting
- Third phase (Year 4):
  - One MC meeting to review progress, to prepare publications and deliverables in final form
  - WGs meetings
  - Final Action conference*

Note: Since the EGO workshops are becoming the world “rendezvous” of the glider community, it is likely that Action and MC annual meetings will take place before or after these workshops to gain efficiency. The final meeting of the Action will likely be scheduled as a specific session at one of the large international conference to present the Action results in a condensed form to a broader scientific audience.

G. ECONOMIC DIMENSION

The following COST countries have actively participated in the preparation of the Action or otherwise indicated their interest: BE, CY, DE, FR, EL, IS, IT, NO, PT, ES, TR, UK. On the basis of national estimates, the economic dimension of the activities to be carried out under the Action has been estimated at 48 Million € for the total duration of the Action. This estimate is valid under the assumption that all the countries mentioned above but no other countries will participate in the Action. Any departure from this will change the total cost accordingly.

H. DISSEMINATION PLAN

H.1 Who?

As identified in Section C5, the main groups of end users will be those using routinely or for decision planning data from ocean monitoring systems. In these areas, end-users spans from scientific researchers in universities and national marine and environmental institutes; to governmental and non governmental organizations/agencies and to local authorities (cities, …) with interests in the environmental management of the oceans and coastal waters. These groups will be interested in the scientific results and datasets that the Action will provide. The organizational activity of the Action will also interest governmental agencies as this will allow them to dimension the manpower and functioning costs of the glider component in the future observing operational networks.

The Action will dedicate a specific effort to investigate to what extend gliders are a suitable marine monitoring technology for developing countries. Examples are already available of strong interest from developing countries and current involvement as “secondary gliderport” (Peru, Republic of Cape Verde, …). The low cost, the fact that they could be serviced by one trained person if remote support is available, the willingness to be involved in marine monitoring activities because of the IOC/UNESCO commitments, make gliders attractive and affordable for Marine Sciences/Fisheries Institutions of these countries. This can be possible if efficient training is provided with the help of the Action and if the Action network incorporates some “developing countries” from the beginning. Fortunately, several members have already good experience of oceanographic collaboration with developing countries and they will certainly allow accessing their networks by the Action. Tunisia is a special case since its main Marine Institute is part of the Action as being an active participant for years of most of the marine research programs in the Mediterranean Sea. Plans are presently being done by France, Italy and Tunisia to deploy gliders as part of an ocean observatory in the Channel of Sicily.

Finally, because of their nice concept, gliders are very attractive for public outreach and scholars. This Action will investigate into details all the possibilities toward this audience. To produce useful material, all possibilities including one STSM in a relevant academic institution will be investigated.

H.2 What?

As mentioned above, most of the target audience are already using operational products for which websites and well-organized data portal are now standard in particular because popular search engines are so efficient at spreading such information.

Therefore, the central web site of the Action will have a basic component offering general information and objectives about gliders, their application for marine research and ocean observing networks. As the acronym chosen for this Action emphasizes, building the marine observatories in the form that is being elaborated by several recent position papers, will be an important contribution of this Action. The website will thus act as a portal (including the access to databases) for the glider component (European at least) of these observatories spread over the world ocean. It is expected that the static information will be retrieved by the whole target audience and the general public.

The website will also offer more specific free access resources for gliders communities, ranging from links to the relevant projects and programs all over the world to more technical references, online tutorials, … as these types of information may also be of interest to all the target audience and the general public. A special section for scholars as well as a more artistic section (e.g. submarine videos) could be envisaged depending on the resources available.

The web site will also have its restricted area with several interactive services. The delivery of internal information for discussions and feedback will be supported by a wiki which is now a standard tool for that. Under the supervision of an editorial board, the wiki will also include editorial facilities for the public area of the Action website. A forum for interactive discussions will be available. Above all, the website will be the portal for all the Web based tools for controlling and steering glider fleets as these tools are one of the major outcomes expected from this Action as described in D2 WG2 and WG3.

A special section will be devoted to the RT status of the glider fleets for information to marine authorities, including national Navies. A common agreement is starting in Europe that a first stage to secure gliders at sea is a full open access to this status information in order to allow more specific steps like "broadcast to the navigators" and similar marine bulletins.

Because of the nature of this Action, scientific and technical papers will be released, including technical manuals and guidelines, articles in peer-reviewed scientific or technical journals. Such papers will address in particular the different methodologies to include glider data in the present climate datasets and operational models and for design and optimisation of the monitoring networks. Technical reports will also present guidelines and recommendations for processing, quality checking and storing data, etc. Even if the main position papers will be presented soon at the OCEANOBS09 conference, additional ones may be needed in particular for the selection of multi-parameters operational measurements by gliders. Publications will also include non-technical papers with the objective to raise awareness of fishermen and yachtsmen as well as popular scientific articles and press releases.

H.3 How?

- The annual EGO workshops have started in an informal way in 2006 on a pure European basis. At the last EGO workshop in October 2008, most of the US and Australian community active with gliders, as well as the major US glider and sensor manufacturers, were present. The objectives of these WSs are to gather all experts in the field of the young glider sciences. These WSs are open to the fundamental and applied research communities including manufacturers, hence results achieved in the glider community are widely presented there. It is likely that specific issues, such as the development of standardization for the data and command interface of the gliders to ease their integration in the monitoring systems, will be addressed during the next WSs because the Action will help formalizing such questions.
- An open symposium, at the end of the Action, will be organized to disseminate results to a broader audience. It is likely that in the coming years, the need for special "glider sessions" at large international ocean or geophysical conferences will grow. This will also be the place where the Action achievements will be discussed, in particular the stabilization of the "glider building block" in the Ocean Observing System.

- Specific workshops with the operational agencies or companies will prepare the transfer of tools and methods to the pure operational circuit. Although contact with these operational agencies or companies are already established because this is a core activity of the Action, such workshops will be needed for better specifications and harmonization of the methodologies.
- "Glider schools" will be organized on an annual basis to present the main concepts and to teach glider practice to newcomers. These schools will include field practice with all the type of gliders available from the members.
- Peer review papers in physical, biogeochemical and biological oceanography will be written as this is the best way to establish new methodologies and demonstrate the interest of a new technology for fundamental science as well as to present scientific results and discovery in marine science. Non-specialized supports will be used as well.
- The open part of the Action website, brochures and a newsletter and press releases will be used to provide information on the Action, with special emphasis on education for the public. A special section – in addition to some meeting with the professional organisation - will be devoted to the fisheries as well as the local marine authorities as this is presently the best way to secure the instruments at sea.