iFADO Best practice:

PLOCAN Glider School: A decade of training and engagement program on ocean-glider technologies

Ways to monitor the ocean: Glider Technology

Significant advances in technological disciplines such as electronics, communications, sensors, new materials, etc. have allowed in the last two decades the development of autonomous platforms addressed to progressively replace the exclusive role that research vessels and associated ship-based technologies have undertaken for decades in ocean observing. Glider technology started its development in late 1980s from the vision that a network of small, intelligent, mobile, and synergetic ocean-observing platforms could fill sampling gaps left by other ocean-observing platforms such ship-based technologies, moorings, floats, drifters, ferry-box, etc.

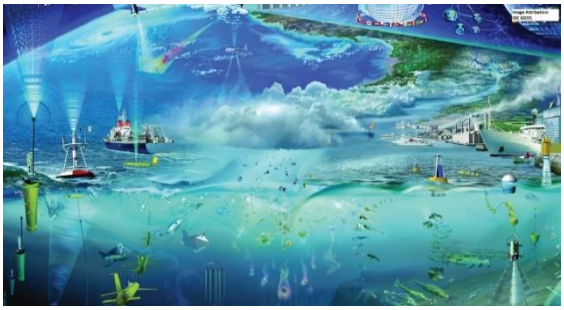


Figure 1 Current conceptual approach of the Ocean-Observing strategy based on autonomous technologies.

Figure 2 AutoNaut as example of ASV commercial technology.

Gliders were considered from the very beginning in the Global Ocean Observing System (GOOS) framework strategy one of the key cutting-edge technologies addressed to improve ocean monitoring in a more efficient and sustainable way.

Figure 3 SeaGlider as example of underwater (buoyancy-driven) glider technology

Ocean-gliders offer nowadays persistent fine resolution observations in both coastal and open ocean areas through two main approaches: buoyancy driven and surface technologies. Common features respond to autonomy, remotely, handy, versatile, reliability, modularity, sustainable, etc. In particular, the buoyancy-driven technologies profile the water column between surface up to 1000 m. depth (improvements for a full-range version -6000 m. depth are underway) while surface technologies are addressed to monitor specifically the upper layer of the ocean, including ocean-atmosphere coupling interaction. Ocean gliders offer a new approach in terms of capabilities and sustainability, allowing observations in spatiotemporal scales hitherto unavailable, with routine missions and deployments of about a year are now possible, with deployments of 3–6 months now routine, and survey tracks extending over 1,000s of kilometres.

Figure 4: Evolution and main milestones of the glider technologies across the last decade.

In some way, ocean-gliders could be defined as set of sensors on mobile autonomous platforms addressed to monitor essential climate and ocean variables such as pressure, temperature, salinity, currents, turbulence, wind speed, dissolved oxygen, irradiance, carbon dioxide, pH, nitrate and hydrocarbon, among others. Gliders have been developed to sample in a wide range of applications such including under-sea ice and ice shelves, to recover data from other deep instruments via acoustic telemetry or to detect acoustic tags on fishes and marine mammals. Improved gliders have reached depths of up to 6,000 m.

All these improvements greatly allow to expand their applications range. Their unique sampling capacities (high resolution and long term) are especially suitable for some key coastal and oceanic phenomena. They have yielded major scientific breakthroughs, revealing new insights into ocean physical, biogeochemical and biological processes.

In particular, there are new results on (1) high latitudes oceanography, air-sea-ice interactions and intermediate/deep convection, (2) the variability of boundary currents, (3) (sub)mesoscale processes, (4) phytoplankton phenology and biogeochemistry, (5) higher trophic levels and biology, (6) shallow and marginal seas, (7) climate and variability of the water column, (8) internal waves, turbulence, tides, diffusivity and vertical mixing, (9) particles fluxes and sedimentology, (10) critical infrastructures surveillance, (11) cross-validation between fix and mobile platforms, (12) marine litter detection and quantification, (13) biodiversity and ecosystems, (14) marine mammal monitoring, etc.

High Specialized Scientific-Technical Infrastructures.

The proper operation and management of cutting-edge technologies for ocean observing such as gliders implies having both facilities and appropriate equipment, as well as accredited technical personnel with the highly qualified training required. In both cases, unique scientific-technical infrastructures such as the Ocean Platform of the Canary Islands -PLOCAN- enabling access to these technologies and training of personnel from the national and international community who require it. PLOCAN is a multipurpose service centre with land-based and novel sea-based infrastructures to support research, technology development and innovation in the marine and maritime sectors. Its mission is to promote long-term observation and sustainability of the ocean, providing a cost-effective combination of services, such as an ocean observatory, a marine test site, a base for underwater vehicles, training and an innovation hub. PLOCAN is a joint initiative between the central government of Spanish and the regional government of Canary Islands, with the contribution of the European Regional Development Fund. PLOCAN is member of the Spanish Map of Unique Scientific and Technical Infrastructures (ICTS). Its main objective is the construction and operation of a fixed offshore platform located both close to the coast and near the edge of the continental shelf in Gran Canaria Island, as part of a wider high-specialized infrastructure addressed to act as test-site facility available for industry and academia/research groups where to conduct trials and experiments in real operational scenarios in a more safe, efficient and sustainable way.

Figure 5: General view of the PLOCAN Offshore platform facility.

PLOCAN has a dedicated installation under the name of VIMAS (Vehicles, Instruments and Submarine Machines) to provide a permanent service of operational support through a multidisciplinary fleet of cutting-edge autonomous ocean vehicles, platforms and instruments, to all those activities with needs related to ocean monitoring from the perspective of technological development, marine sciences, training

and cooperation with institutions and technology-based companies.

Figure 6: Glider lab facility at PLOCAN premises where part of the practicing Glider School activities is conducted.

The VIMAS base has the following facilities, capabilities and service portfolio: A permanent base of underwater and surface autonomous vehicles; Direct, fast and with guarantees access to coastal and open-ocean waters; Technical and logistic support for test and operations both in tank, confined and open waters; Multidisciplinary and sectorial technological cooperation with institutions and companies; Dedicated labs, workshops, boats, control room for testing, setup and repairs; Highly specialized training.

Specialized training

As PLOCAN promotes highly specialized tailored training courses, schools and programs to mainly cover scientific-technical and technology-based needs and profiles from professionals related to academia and business fields. Among the PLOCAN training initiatives, there are youth employment programs, high specialization 2 + 2 and 0.5 + 2, academia and business internships, on-demand courses, Glider School, etc. Specifically, PLOCAN training schools run under Quality Certification procedures. In particular, the PLOCAN Glider School was certified under ISO 9001:2008 standard in April 2015 with the scope of "organization, coordination, implementation and monitoring of training schools". In 2016, the ISO 14001 and OSHAS 18001 standards were integrated into the system, expanding the scope to "marine science and technology services and ad - ministrative management associated with schools for training and management of ocean observation projects, marine energy, sensors and vehicles. submarines, blue economy and growth, and biodiversity and sustainability".

Figure 7: Glider lab facility at PLOCAN premises where part of the practicing Glider School activities is conducted.

After successive updates of standards and versions, at present the management system, and therefore the Glider School, is certified in the ISO 9001, ISO 45001 and ISO 18001 standards. The implementation of the system and its annual review guarantee that training schools are aimed at excellence in customer service (student) and its quality, carried out under the strict protection of the environment and with optimal management of the health and safety of workers.

Figure 8: Students attending a practical session on Slocum glider technology.

PLOCAN Glider School

The idea and main motivation for undertaking the PLOCAN Glider School initiative took shape in 2011 during the 5th edition of the EGO Workshop & Glider School, organized and hosted by PLOCAN at its headquarters in Taliarte, Gran Canaria EGO (Everyone's Gliding Observatories) is a reference biannual forum supported by collaborative frameworks such as EuroGOOS Glider Task Team and OceanGliders, that brings together the international community of operators, users and leading companies in the sector in order to present both the latest advances and scientific-technical results such as the main technological innovations in underwater and surface (ASV) gliders, thus contributing to capacity building strategy worldwide.

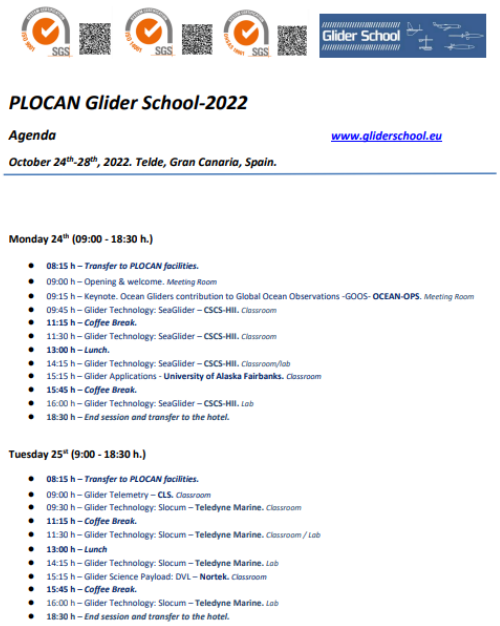
Figure 9: Practical session on glider operations at PLOCAN harbour facilities.

Figure 10: Practical session on glider operations at PLOCAN test-site facility waters.

However, considering the progressive increase in the use of these technologies, it is identified as necessary and of great added-value to design and implement a specific training forum, aimed at offering a better-addressed approach on these state-of-the-art autonomous systems in ocean observation to potential new users from worldwide. PLOCAN Glider School should therefore be understood as basic hands-on training approach, reason why it is sized to a group of only 15 students per edition (annual), selected from a process of curricular merit in compliance with the quality certification criteria under which the PLOCAN Glider School is conducted. The main objective of the PLOCAN Glider School is focused on providing to students an overview of the state-of-the-art on glider technologies, including their wide range of uses and applications from both scientific and engineering perspectives. For its proper development, the PLOCAN Glider School has a fleet of ocean vehicles from the VIMAS facility (Vehicles, Instruments and Underwater Machines) of PLOCAN, where the main commercial glider technologies are represented, in addition to own boats and facilities specifically designed, such technical and testing laboratories, piloting room, as well as direct, quick and easy access to both confined and open waters for practicing in a safe and useful manner.

Didactical contents of the Glider School

The didactic contents taught at the PLOCAN Glider School are carefully selected and dimensioned aiming to keep the goal and purpose of the school, considering aspects such as the hands-on training component, the profile of the attendees, the number of technologies to be shown, the duration of the training, among others. It is not the purpose of the school to overlap with specific training courses that each technology offers through the manufacturing company or official delegate. Through them, it is intended that beginner students and without any experience in gliders, have the opportunity to make an approach to these technologies in a basic and initial way, without delving into any of them but getting the most from the unique scenario of be able to get a state-of-the-art overview of the main commercial technologies available both of profiling and surface gliders (ASV), by having all of them in the school.


Glider School

PLOCAN Glider School-2022

Agenda www.gliderschool.eu

October 24th-28th, 2022. Telde, Gran Canaria, Spain.

Monday 24th (09:00 - 18:30 h.)

- **08:15 h – *Transfer to PLOCAN facilities.***
- 09:00 h – Opening & welcome. *Meeting Room*
- 09:15 h – Keynote. Ocean Gliders contribution to Global Ocean Observations -GOOS- **OCEAN-OPS**. *Meeting Room*
- 09:45 h – Glider Technology: SeaGlider – **CSCS-HII.** *Classroom*
- **11:15 h – *Coffee Break.***
- 11:30 h – Glider Technology: SeaGlider – **CSCS-HII.** *Classroom*
- **13:00 h – *Lunch.***
- 14:15 h – Glider Technology: SeaGlider – **CSCS-HII.** *Classroom/lab*
- 15:15 h – Glider Applications - **University of Alaska Fairbanks.** *Classroom*
- **15:45 h – *Coffee Break.***
- 16:00 h – Glider Technology: SeaGlider – **CSCS-HII.** *Lab*
- **18:30 h – *End session and transfer to the hotel.***

Tuesday 25st (9:00 - 18:30 h.)

- **08:15 h – *Transfer to PLOCAN facilities.***
- 09:00 h – Glider Telemetry – **CLS.** *Classroom*
- 09:30 h – Glider Technology: Slocum – **Teledyne Marine.** *Classroom*
- **11:15 h – *Coffee Break.***
- 11:30 h – Glider Technology: Slocum – **Teledyne Marine.** *Classroom / Lab*
- **13:00 h – *Lunch***
- 14:15 h – Glider Technology: Slocum – **Teledyne Marine.** *Lab*
- 15:15 h – Glider Science Payload: DVL – **Nortek.** *Classroom*
- **15:45 h – *Coffee Break.***
- 16:00 h – Glider Technology: Slocum – **Teledyne Marine.** *Lab*
- **18:30 h – *End session and transfer to the hotel.***

Figure 11: Some of the agenda contents from the edition 2022

The five days of PLOCAN Glider School are divided into eight-hour slots, in which both theoretical and practical sessions in the laboratory, confined and open waters are combined. In these sessions, students have access to learn about Slocum (Teledyne Marine), Seaglider (iROBOT, Kongsberg, HII), Spray (Bluefin Robotics, MRV Systems), SeaExplorer (ACSA, ALSEAMAR), Waveglider (Liquid Robotics), Sailbuoy (CMR and Offshore Sensing) and AutoNaut (Seiche-AutoNaut) technologies.

Each of them includes several theoretical-practical sessions given by technical specialists belonging to the

development companies themselves, in which they are shown from the concepts and basic principles of operation to mission planning and piloting interface, as well as scientific payload configurations, data management, assembly and disassembly, maintenance, ballasting, etc. from a perspective of basic training for beginners.

Figure 12: Theoretical session on SeaExplorer glider technology.

Once the basic knowledge of each and every one of the glider and ASV technologies mentioned has been duly acquired, the fifth day of school is fully dedicated to carry out practices in confined and open waters, which implies deployment and recovery manoeuvres, piloting, which in some cases, it is required to carry out from a boat to which the students have access for a better and more realistic approach to this type of sea operations. Although the main leading role is provided by gliders or ASV platforms themselves, PLOCAN Glider School also includes specific contents referring to certain of their subsystem components that are of special relevance and interest to students, such as science payload (RBR-Global, Seabird Scientific, Rockland Scientific, Ocean Sonics, Teledyne RDI, Wet - labs, AADI, Turner Design, Idronaut, etc.) and telemetry (CLS).

To better frame and reinforce the basic didactic contents specifically related to glider technologies itself, each training day combines sessions where world-renowned skilled operators and users (Memorial University, MARUM, National Oceanography Centre, Rutgers University, MBARI, VOTO-University of Gothenburg etc.) share their experiences with the students, thus showing the potential in terms of related applications of this type of autonomous ocean observation platform.

In the same way, sessions related to the international coordinated management framework for the Global Glider Network strategy (EGO, OceanGliders, EuroGOOS Glider Tast Team, etc.) are given for the student to identify the contribution to the Global Ocean Observation System (GOOS, OceanOPS) that this type of device carries out, as well as to promote and contribute with capacity building.

Figure 13: Group picture of the edition 2022, after a successful five days of learning on glider technologies.

Glider School Attendees

The ten editions of PLOCAN Glider School have allowed the total attendance of 165 students from 32 countries in America, Africa, Asia, Oceania and Europe, with academic and professional profiles mostly related to marine science, ocean technology and engineering. The main motivation and interest of the students refers to access a first experience and training approach from a more practical than theoretical perspective to a large representative number of the main commercial glider technologies simultaneously, although on the other hand aware of insufficient time necessary to achieve a level of knowledge and skills as expert user or operator.

Figure 14: Number and geographical distribution of the Glider School students after ten editions.

The Glider School offers to students be able to identify, understand and compare with certain detail and criteria the particularities and capacities of each techno - logy that the school provides, which in some way brings better knowledge and criteria when a procurement or particular service request of this type of equipment becomes necessary in their institutions

or companies to cover specific needs on ocean monitoring.

Conclusions

The PLOCAN Glider School initiative provides a unique capacity building framework within the context of international ocean-observing initiatives and programs such GOOS or EOOS, as basic hands-on training and state-of-the-art overview forum on underwater glider and ASV technologies, that yearly since 2011 to present has been addressed to people from academia and private sector interested to start learning and work with them.

Leading company-manufacturers and world-renowned ocean-research institutions with the best level of knowledge and expertise possible in the use and application of these cutting-edge technologies, are committed and supporting the initiative with direct involvement as professoriate. PLOCAN and involved partners, attempt to keep ongoing this initiative in the future.