

1. Project Information

Proposal reference number¹	
Project Acronym (ID)²	AMBO
Title of the project³	Autonomous Multiplatform Biophysical Observations
Host Research Infrastructure⁴	ALSEAMAR glider (in collab. with CNRS)
Starting date - End date⁵	April 14 - April 28, 2022
Name of Principal Investigator⁶ Home Laboratory Address E-mail address Telephone	Maristella Berta CNR-ISMAR Forte Santa Teresa s.n.c. 19032 Pozzuolo di Lericci (SP) Italy maristella.bera@sp.ismar.cnr.it +393391251613

2. Project objectives⁷ (250 words max.)

AMBO is a transnational collaborative effort involving Italian partners (CNR-ISMAR and ENEA) and French partners (CNRS and ALSEAMAR) providing the use of the glider infrastructure. The aim of AMBO is to carry out a comprehensive study of the water masses exchange and overall dynamics through a multi-platform and multidisciplinary approach, focusing on the inter-comparison and combination of essential physical variables measured through different observing systems, as well on the link between circulation patterns and biochemistry, in the North-Eastern Ligurian waters. Therefore, the period chosen for the AMBO experiment is spring, season typically associated with higher biological and frontal activity. AMBO focuses on the development of methodologies to combine surface and water columns observations, the development of metrics to study vertical transport associated with frontal structures, as well as on the investigation of submesoscale frontal dynamics and associated vertical processes, which play a key role in the transport of nutrients and biological particles with significant consequences on the marine ecosystem. AMBO relies on the

¹ Reference number assigned to the proposal by the TA-Office.

² User-project identifier used in the proposal.

³ Title of the approved proposal. The length cannot exceed 255 characters

⁴ Name of the installation/infrastructure accessed with this project. If more than one installations/infrastructures are used by the same project, please list them in the box.

⁵ Specify starting and end date of the project (including eventual preparatory phase before the access).

⁶ Fill in with the full contact of the Principal Investigator (user group leader).

⁷ Write the short-term, medium and long-term objectives of the project. Use no more than 250 words.

collection of independent and complementary in-situ and remote observations of the physical and biochemical components using coastal HF radars continuously measuring high resolution surface currents, glider transects highly resolving physical and biochemical variability along the water column, drifters observations to track surface currents passive transport, water column CTD casts, oxygen, turbidity and chlorophyll samplings, as well as very surface physical observations from Ferrybox.

3. Main achievements and difficulties encountered (250 words max.)⁸

AMBO represented a unique opportunity to explore new international collaborations that put into system complementary sea technologies and expertise from the partners involved. It was a very positive collaboration from the planning of the activity to the actual experiment that covered a wide sea area nearby the Cinque Terre Marine Protected Area, providing an unprecedented collection of coordinated biophysical measurements. Difficulties encountered fall within the usual range of logistical issues of a sea experimental activity, nothing related to our specific collaboration, on the other hand the cooperative attitude of the group allowed to run smoothly the whole experiment made of multiple phases and including remote coordination among partners for autonomous platforms management.

4. Dissemination of the results⁹

So far, a general account of the experimental activity has been disseminated through some interviews to newspapers and TV channels. During 2023, we plan to submit a high-impact publication informative on the experimental strategy and another peer-reviewed paper focusing on the data analysis and the overall description of the local dynamics captured by the combined multidisciplinary and multiplatform observations.

5. Technical and Scientific preliminary Outcomes (2 pages max.)¹⁰

The AMBO experiment took place in the Eastern Ligurian Sea (Mediterranean Sea), an area encompassing the Cinque Terre Marine Protected Area and located within the marine mammals Pelagos Sanctuary. This fragile natural environment coexists with intense anthropogenic activities (as marine traffic, nearby ports, fisheries and tourism) and such conditions motivate the interest for monitoring the local sea state and for investigating its dynamics and variability. In fact, the area is already monitored by specific remote and autonomous systems, such as the CNR-ISMAR HF radar

⁸ Describe briefly the main achievements obtained and possible impacts, as well as possible difficulties encountered during the execution of the project. Use no more than 250 words.

⁹ Describe any plan you have to disseminate and publish the results resulting from work carried out under the Transnational Access activity in JERICO -S3: scientific articles, books - or part of them -, patents, as well as reports and communication to scientific conferences, meetings and workshops. Highlight peer-reviewed publications. **Note that any publications resulting from work carried out under the JERICO -S3 TA activity must acknowledge the support of the European Commission – H2020 Framework Programme, JERICO -S3 under grant agreement No. 871153.**

¹⁰ Describe in detail results and main findings of your experiment at the present stage.

network providing hourly surface current maps with a resolution of 1.5km and covering a sea area up to approximately 40km from the coast. In the same area, the LABMARE mooring, made available from the collaboration among many Italian institutions and entities (DLTM, CNR-ISMAR, ENEA, INGV, IIM), monitors the water column physical properties (mainly temperature, salinity, currents) down to 600m depth. The availability of these background measurements and knowledge, together with satellite observations of the sea surface temperature and surface chlorophyll distribution in the area gave strategic guidance for the AMBO planning and for the definition of the activity location and timing. These complementary observations are also fundamental for the interpretation of the data collected during the AMBO activity itself, that will be resumed in the following.

The AMBO experiment took place in spring, from April 14 to April 28, 2022, a period characterized by enhanced sea biological activity and intensified water column dynamics variability. The transnational collaboration involves the deployment of a glider, provided by CNRS and ALSEAMAR, equipped with physical and biogeochemical sensors, plus an ADCP, to monitor water column properties at very high resolution along a 500m-depth transect across the HF radar coverage continuously repeated for the whole duration of the experiment. The activity was organized with three boat surveys of the area at different days, on board of the M/B Santa Teresa, provided by ENEA.

During the first site visit, the ALSEAMAR glider was deployed in front of Levanto and concurrent water column measurements were performed by ENEA with CTD casts, ADCP, oxygen and turbidity samplings. Along the boat track, sea surface water observations of temperature, salinity, oxygen, turbidity and chlorophyll were collected through a Ferrybox system provided by ENEA. During the first site survey, 20 CARTE drifters (gps-tracked buoys spanning the first 60cm water layer) were deployed by CNR-ISMAR to monitor the surface currents pattern and variability across the HF radar field coverage. The observations made available in near-real time by the glider, HF radars and drifters evidenced the presence of a front associated with a mesoscale anticyclone (visible from satellite images). On April 14, both HF radars and drifters showed a surface divergence pattern at the edge of the anticyclone, indication of frontal activity and enhanced vertical dynamics, that is as well confirmed by the glider survey in the following days (April 15-21) showing the presence of a subducting water filament, down to 250m depth, associated with the surface signature of the front. The second boat site visit, in April 19, was dedicated to further water column measurements in order to cover the area with CTDs, ADCP, oxygen and turbidity samplings at different depths. During boat transit Ferrybox measurements were taken, analogously to the first visit, and 12 more CARTE drifters were deployed up-wind with respect to the glider transect location. In the next two days, the drifter trajectories crossed the glider transect location, complementing the water column picture with surface currents passive transport information. Around April 21-23 the drifters sampled a cyclone within the HF radar coverage and in the same area of the glider transect. The cyclonic feature was also evident from chlorophyll satellite observations.

The third and last boat visit was dedicated to the ALSEAMAR glider recovery coordinated with CTDs, ADCP, water samplings of oxygen, chlorophyll and turbidity in the same location of the glider for intercomparison purposes. All along the boat path, continuous Ferrybox observations were collected as well. The overall glider transect timeseries evidenced high-resolution variability of surface features but as well an interesting warming process of the whole water column down to 500m depth.

The targeted observations collected in the Eastern Ligurian Sea during AMBO represented an unprecedented opportunity for biophysical monitoring, with the added value of the international cooperation among many Italian and French partners. The multiplatform and multidisciplinary set of measurements will be deeply analysed and discussed through a joint effort of the partners involved and published in dedicated peer-reviewed journals.

Lerici, 23/12/2022

Location and date

Signature of principal investigator