1. Project Information

Proposal reference number[1]	21/1002073
Project Acronym (ID)[2]	CBONDEX
Title of the project[3]	Coastal BOuNDary EXchanges
Host Research Infrastructure[4]	PLOCAN
Starting date - End date[5]	April 2022 - April 2024
Name of Principal Investigator[6] **Home Laboratory** **Address** **E-mail address** **Telephone**	Joao Vitorino Instituto Hidrografico Rua das Trinas, 49 - 1249-093 Lisboa-Portugal joao.vitorino@hidrografico.pt (351) 210943043

2. Project objectives[7] (250 words max.)

CBONDEX aimed to improve the present understanding on the processes of interaction between the deep ocean and coastal ocean areas along the western Portuguese margin. These include the development of the Iberian poleward slope current (which can transport southward influences by thousands of kilometres along the slope, impacting the conditions in the Bay of Biscay and French margin), the shedding of mesoscale eddies as a consequence of interactions of the slope/outer shelf circulation with the shelf/slope topography or the impacting of large upwelling filaments from the W Iberian upwelling system. To fulfil this objective, the project proposed to articulate glider observations from the PLOCAN glider facility, with Instituto Hidrográfico (IH) own systems in operation along the coastal ocean area of W Portugal. Two missions were initially planned, with glider observations extending from the area of Nazaré (39.5ºN) to the southward extreme (about 36.5ºN, southwest of Cape St. Vicente). Due to the different problems that occurred from 2022 to beginning of 2024 (described below), this objective was only partially accomplished.

[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.

A second major objective of CBONDEX was the transfer of knowledge in the operation of gliders, with IH team profiting from the direct contact with PLOCAN team during the different phases of the CBONDEX operations to expand their own capacities. While not including the visits of one IH team to PLOCAN (as initially planned), this objective was largely accomplished.

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

CBONDEX was affected by several factors. The difficulty of purchasing batteries for gliders (due to COVID19 crisis) delayed to December 2022 the first deployment, which occurred offshore Nazaré. Once in the water, the glider presented several technical problems and was recovered. During 2023, the PLOCAN and IH teams worked together to try to solve the technical problems. In October 2023 the teams were finally able to conduct the second deployment operation. Again, the glider was affected by technical problems when in the water. In November 2023 it was decided to send the glider back to PLOCAN. In February 2024, a new glider (SeaExplorer) was sent to IH. The deployment operation was conducted on the 5th April 2024, in an area offshore Sesimbra (south of Lisbon). The glider was successfully deployed and initiated the planned track. On the 14th April, however, the glider surfaced reporting technical problems and the mission was aborted. The glider was recovered on the 22 April by a vessel from the Portuguese Navy. CBONDEX profited from the fact that in April, IH also deployed for the first time one of the two first gliders (SeaExplorer) received at this institute. The two sets of simultaneous glider observations combine to provide a comprehensive view of the covered geographical area. The intense collaboration between IH and PLOCAN, from 2022 to 2024, provided a robust training of the IH team in the challenges of glider operation. This is now being used in the operation of the institute own gliders.

4. Dissemination of the results[9]

CBONDEX data from the PLOCAN glider, once processed and converted to NetCDF, will be available at the PLOCAN threeds server: http://data.plocan.eu/thredds/catalog.html . Even before completed the processing stage, the data can be requested by general public through PLOCAN access https://plocan.eu/en/access. Complementary data collected by IH systems integrating the MONIZEE infrastruture are publically available at the Hidrográfico+ webportal: https://geomar.hidrografico.pt/ .

The processing and analysis of the glider data as well as the integration with other available data collected by IH own systems (HF radar, multiparametric buoys) or with complementary information (remote sensing, numerical model results) will continue in 2024. A publication synthesizing the

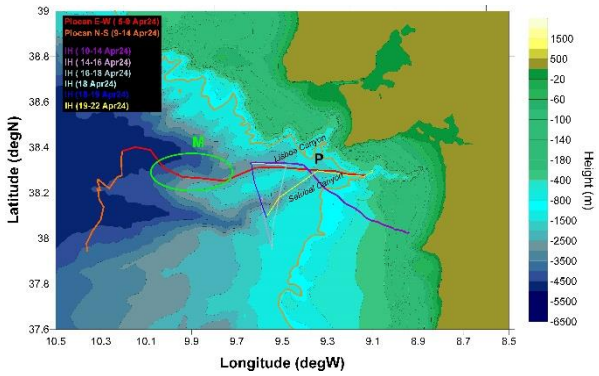
[8] Describe briefly the main achievements obtained and possible impacts, as well as possible difficulties encountered during the execution of the project. Use no more than 250 words.

[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.**

observation program and main results is planned to be submitted in early 2025 to a peer review journal.

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

The observations collected in the framework of CBONDEX focussed on the area offshore the Setubal Bay area. Located in the central part of the W Portuguese continental margin (figure1), this area is impacted by the presence of large coastal population centres such as Lisbon (about 50 kilometres to the north) and Setubal (about 50 km to the east). The topography of the area is characterised by the large inflexion of the shelf/slope from the region south of 38.3ºN (where the bathymetric contours have a meridional alignment and the shelf presents a width of about 25 km) to the area north of 38.3ºN (where the shelf projects offshore, forming the large Estremadura Plateau with a width of about 100 km). A second major characteristic of this area is the presence of important submarine canyons – such as the Lisbon Canyon and the Setubal Canyon- that can potentiate the interactions between the deep ocean and the shelf environment. The study area is under the influence of seasonal forcing conditions. A well-defined upwelling season occurs during the summer months, promoted by persistent northerlies, leading to the development of large upwelling filaments (particularly in Cape da Roca, which extend to the area). Energetic conditions, which frequently are associated with downwelling, are typical of the winter months. During winter and spring the area can also be under the influence of the Tagus river plume (river mouth just north of the study area) and, in less degree, of the Sado river plume (river mouth just east of the study area).



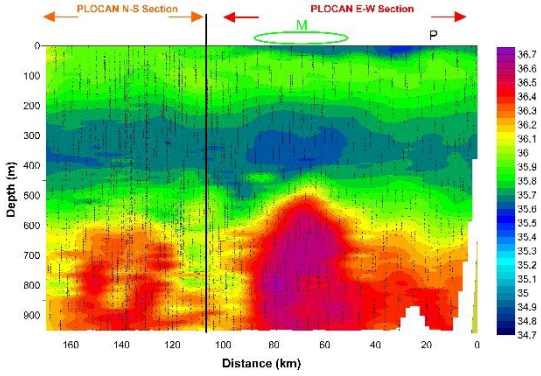


Figure 1 (top left). Tracks of the PLOCAN and IH gliders contributing to CBONDEX over the bathymetry of the Setubal Bay and adjacent areas. For comparison with figures 2, point P and region M are indicated. The 1000m isobaths is coloured in thick gold for reference.

Figure 2a (top right) Salinity section collected by the PLOCAN glider during CBONDEX. Profiles where MW salinity maximum was observed indicated as region M. For comparison with figure 2b, point P is also indicated.

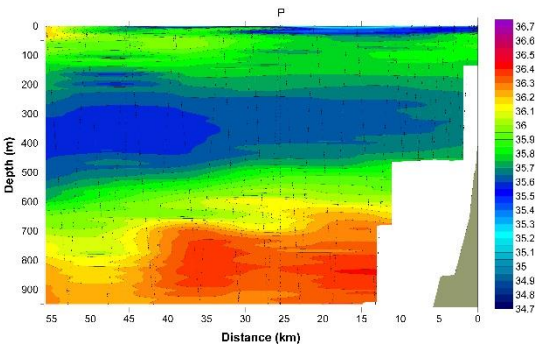


Figure 2b (bottom right)) Salinity section collected by the IH glider from 19 to 22 April (yellow track in figure 1). For comparison with figure 2a, point P is also indicated.

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

The CBONDEX glider section conducted by PLOCAN (figure 2a) started in a position over the Setubal Canyon, inside the Setubal Bay, and progressed from there to the Lisbon Canyon. This segment of the track was particularly prone to allow to detect, in the upper layers, the influences from the shelf located to the north. Lower salinity waters are found in the upper 30-50m, particularly between 9.3ºW and 9.7ºW, perhaps more indicative of upwelling conditions developing on the coast to the north (and of Cape da Roca filament) rather than associated to Tagus river outflow. The glider then progressed offshore (westward), covering the complete coastal transition zone (CTZ) from the surface to about 950m depth. This provided a comprehensive view of the main water masses influencing the outer boundary of the coastal ocean in this region. To about 200m depth a relatively saltier and warm water mass corresponds to the influence of the subtropical component of the Eastern North Atlantic Central Water ($ENAW_{st}$) which carries to this region influence from the open ocean regions SW of the Portuguese coast. Below, the progressive influence of the subpolar component of the Eastern North Atlantic Central Water ($ENAW_{sp}$) is expressed by the decreasing of salinity until the salinity minimum observed at about 400m. Below 500m depth the salinity significantly increases as the glider entered in the layer of influence of the Mediterranean Water (MW), which extends from about 500m to 1500m depth. An interesting aspect was the maximum salinities observed between 600 and 800m, in the region indicated as M in both figure 1 and 2a, which seems to correspond to the expression of the Mediterranean Water upper core in this area. A more detailed analysis (to be followed) would help to clarify why this signature is presented in this area with such high values of salinity. After reaching about 10.2ºW the PLOCAN glider then head southward, starting the N-S section along the outer part of the SW Portuguese CTZ, showing the continued presence of the different waters masses described below. The fact one of the two IH gliders (the first of these systems acquired by IH) was available to be deployed, for a test period, at the time of the deployment of the PLOCAN glider, provided a supplementary source of observations in this area that could be integrated in the CBONDEX project. By navigating in the closer area of the continental slope that is cut by the Lisbon and Setubal canyons, IH glider could provide a more detailed view of the conditions promoted by the deep ocean forcing measured by PLOCAN glider. IH glider was only deployed on the 14 April, so about 10 days after the start of the PLOCAN glider observations. Since the planned track for this glider had segments that corresponded to the tracks followed by the PLOCAN glider, this opened the opportunity to integrate both data sets in the detection of adjustments of the coastal ocean conditions in response to rapid changes in the forcing conditions (e.g. wind forcing, riverine input). This seems to be the case of the low salinity layer that appears in the upper 30m of IH glider observations, to about 9.3ºW (to point P), which seems to express the influence of the Tagus plume transported to south under northerly (upwelling) wind conditions. This aspect needs to be confirmed by integrating complementary observations. The ongoing work comprises the processing of the different data sets. This will be followed by the integration of complementary data from IH (such as surface currents from HF radar stations or from multi parametric buoys) as well as remote sensing and numerical model results.

Lisbon, 11/06/2024

Location and date

Signature of principal investigator