**Final Report Program LEFE**

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<th>Program LEFE/CYBER</th>
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<td><strong>Dynamics of air-sea CO₂ fluxes in the NW European shelf seas based on novel sensors, time-series, Voluntary Observing Ships, and remote sensing approach (CHANNEL)</strong></td>
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**Objectives:**

*The main objectives of the project CHANNEL were to:*

- Assess the small-scale processes driving the pCO₂ variability in the Western English Channel (WEC) based on high frequency measurements.

- Develop Multivariable Linear Regression (MLR) from in-situ and remote sensing measurements to evaluate air-sea CO₂ fluxes on the NW European shelf.

- Evaluate the impact of natural (NEP, NAO) vs anthropogenic (SST warming, eutrophication, OA) processes on the inter-annual variability of air-sea CO₂ fluxes and carbonate chemistry on the NW European shelf.

**Main results:**

During the period 2013-2015, we investigated partial pressure of CO₂ (pCO₂) dynamics on the coastal margin of north-western Europe using a comprehensive dataset of pCO₂ and ancillary data. This dataset was collected on 2 Voluntary Observing Ships operating between Roscoff/Plymouth (*Armorique*) and Roscoff/Cork (*Pont-Aven*); and 2 automated buoyos one located in the bay of Brest (*MAREL-Iroise*) and the other 5 miles off Roscoff (*ASTAN*).

During CHANNEL we tested 3 new pCO₂ sensors (Contros HydroC CO2/FT, GO, SAMI) on these platforms. Data were refitted and validated with frequent discrete measurements performed at the SNAPOCO2 (LOCEAN, Paris) and combined with satellite data in collaboration with the Plymouth Marine Laboratory (PML).

In the first paper by Marrec et al. (2013) we solved the discrepancies observed in previous studies that investigated the air-sea CO₂ fluxes in the Western English Channel: We demonstrated the importance of the thermal front located approximatively at 49.5°N, which separates the northern stratified WEC, a sink of atmospheric CO₂ of -0.4 ± 0.1 mol C m⁻² yr⁻¹, from the southern homogenous WEC, a source of CO₂ for the atmosphere at +0.5 ± 0.2 mol C m⁻² yr⁻¹ (Figure 1).

In the second paper by Marrec et al. (2014) we showed that high-frequency measurements are necessary to accurately assess air-sea CO₂ fluxes in very dynamic coastal ecosystems. For example, we estimated that a short bloom of 10 days, which resulted in very large and sudden seawater pCO₂ drawdown accounted for 29% of the CO₂ sink during the productive period (from May to mid September).

In Marrec et al. (2015) we combined the high frequency datasets recorded in the WEC with satellite observations from the adjacent Celtic and Irish Seas. Based on the resulting Multilinear Regressions (MLRs) we estimated air-sea CO₂ fluxes on the entire shelf for the period 2003-2013 (Figure 2). Our results were validated against *in-situ* data from the SOCAT and LDEO databases and discrete samples collected by VOS. We scaled the mean annual fluxes over the 3 provinces for the last decade and obtained the first annual average uptake of 1.1 ± 0.3 Tg C yr⁻¹. The pCO₂ data collected within CHANNEL are regularly submitted to the SOCAT database (Bakker et al., 2014) and thus contribute to the global synthesis of CO₂ air-sea fluxes of the international community.
The CHANNEL project did produce a very large dataset and some results have not yet been published. The paper by Salt et al. (Marine Chemistry, in revision) focuses on the multi-annual variability of the carbonate systems in the Bay of Brest and assesses the potential drivers of this variability. Further, a pCO$_2$-SAMI sensor records high-frequency pCO$_2$ data at the ASTAN buoy since 2014 and revealed that on very short scale (12 hours cycles) the tidal cycle is responsible for large pCO$_2$ gradients in the southern WEC. These greatly influence the air-sea CO$_2$ estimates and these data are currently being processed.

The CHANNEL project will continue as part of the JERICO-Next project (EU H2020) in which, the 3 main platforms (VOS Armorique and Pont-Aven and ASTAN buoy) of CHANNEL have been included for the next 2 years. The goal will be, based on long-term observations, to further evaluate the impact of natural (NEP, NAO) vs anthropogenic (SST warming, eutrophication, OA) processes on the inter-annual variability of air-sea CO$_2$ fluxes and carbonate chemistry on the NW European shelf. Finally, as mentioned above, the pCO$_2$ data collected within CHANNEL are regularly submitted to the SOCAT database and thus contribute to the global synthesis of the international community (Bakker et al., 2016, in prep.).

5 publications, 6 communications, 1 thèse

Most significant publications:
