FINAL REPORT PROGRAM LEFE

Program LEFE/ IMAGO	Project Title Observing Deep Lagrangian Dynamics in the Northwest Atlantic (OBLADY)	Years 2018 – 2019
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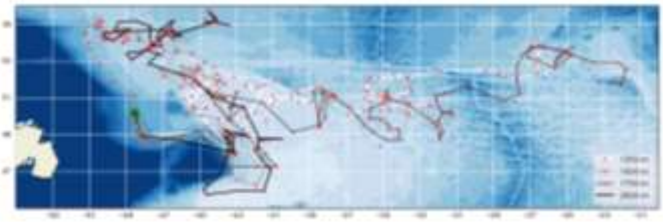
Context. The subpolar-subtropical connectivity of the North Atlantic Ocean is currently receiving much attention. In particular, a process-focused understanding of the equatorward flow of cold and dense water masses along the western boundary is crucial for achieving a robust modelling of large-scale climate changes in the region (e.g. ocean heat content and meridional overturning circulation). This connectivity is likely to be greatly influenced by the deep dynamics of the Newfoundland area, which was the focus of the OBLADY project.

Objectives / scientific questions. The general objectives of the OBLADY project were to (1) study the physical oceanic properties (temperature, salinity, velocity) of the Newfoundland region with a focus on their export along the deep western boundary current across the subpolar-subtropical transition zone, and (2) initiate and consolidate international collaborations with the Canadian Ocean and Fisheries Department (DFO) for the upcoming CROSSROAD project (*Climatic Role of Subpolar-Subtropical exchanges : a Regional Observing Array off NewfoundlanD* – see below). This collaboration was concretized by the participation of the project leader (D. Desbruyères) in an oceanographic campaign of the AZMP ("Atlantic Zone Monitoring Program") in November/December 2018. Four Argo floats were made available by LEFE/GMMC for the OBLADY project and successfully deployed during that cruise within the deep western boundary current that encircles Flemish Cap and Newfoundland. These four floats were parameterized to drift at these distinct depths (1250m, 1500m, 1750m and 2000m) to study the vertical coherence of subpolar water mass export. They were complemented by the deployment of a Deep-Argo float drifting at a depth of 2500 m, which unfortunately suffered a premature death due to a leakiness problem.

Main results. The monitoring of these floats (Figure 1) confirmed the large dispersion of intermediate and deep-water masses in this deep transition zone between subpolar and subtropical basins. It showed above all the tendency of these water masses to recirculate towards the north (2 floats) or towards the east (2 floats), regardless of their drifting depth, suggesting that southward export is more likely to occur deeper in the water column (i.e. below 2000m). This preliminary result must yet be confirmed with larger Lagrangian (e.g. Deep-Argo) and Eulerian (e.g. mooring) datasets. In parallel, a rank A scientific paper built upon Argo observations and numerical modelling and describing the importance of the "intergyre" region for deep ocean heat uptake in the North Atlantic has been published in September 2020 (Figure 2, Desbruyères et al 2020, Journal of Geophysical Research). A second publication further demonstrated that the decadal variability of the deep meridional circulation at 45°N – dominated by boundary-focused processes within the transition zone – was strongly influenced by air-sea interaction and water mass transformation processes upstream in the eastern subpolar gyre (Desbruyères et al, 2019, Ocean Science).

***Figure 1**. The trajectories of the four Argo floats deployed as part of the AZMP2018 cruise within the*



deep western boundary current upstream of Flemish Cap. Green dots indicate deployment location and blue dots the last profile locations. Distinct drifting depths were used to test the vertical (non-) coherence of the deep-water southward export along the boundary.

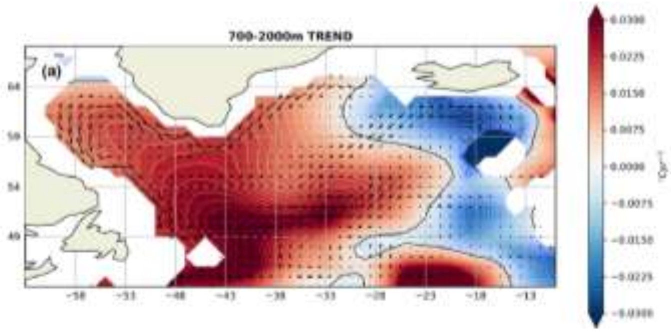


***Figure 2**. The 2005-2014 temperature trend averaged in the intermediate layer (700 – 2000 m) from the Argo-based ocean analysis product ISAS15. The mechanisms responsible for the large-scale warming signal centered around the transition zone of Flemish Cap and Newfoundland were investigated in Desbruyères et al (2020). Arrows show geostrophic velocities at 1000 m as derived from Argo float displacements. Black line shows zero trend isoline.*

Future of the project. An important objective of the OBLADY project was to initiate (as a preliminary study) a larger project entitled “Climatic Role of Subpolar-Subtropical exchanges: a Regional Observing Array off NewfoundlanD” (CROSSROAD). This project, which will rely heavily (but not exclusively) on experimental work at sea, has been submitted to the ANR JCJC 2021 call. A first deep-sea cruise, dedicated to hydrographic measurements and deployments of moored instruments and autonomous floats is envisioned for the summer of 2023. The CROSSROAD project will build on international collaborations, with DFO as already mentioned, but also with the German GEOMAR and British NOCS teams. Finally, we can note that a second preliminary project supporting the experimental design of the CROSSROAD project is being supported by LEFE GMMC during 2021-2022 (project acronym: Configuration of an Experimental in Situ Array in a high-Resolution simulation (CROSSROAD-CESAR)).

Nombre de publications, de communications et de thèses

Desbruyères, D. G., Sinha, B., McDonagh, E. L., Josey, S. A., Holliday, N. P., Smeed, D. A., et al. (2020). Importance of boundary processes for heat uptake in the subpolar North Atlantic. Journal of Geophysical Research: Oceans, 125, e2020JC016366. https://doi.org/10.1029/2020JC016366

Desbruyères, D. G., Mercier, H., Maze, G., and Daniault, N.: Surface predictor of overturning circulation and heat content change in the subpolar North Atlantic, Ocean Sci., 15, 809–817, https://doi.org/10.5194/os-15-809-2019, 2019.