PhD thesis proposal in cotutelle at ISMER and ULCO:

Relative dispersion in the surface layer of the coastal ocean

Predicting the drift and dispersion of contaminants such as oil and microplastics, or biological species such as phytoplankton and fish larvae, is essential for the sustainable management of the coastal ocean environment and maintaining the proper functioning of marine ecosystems. Predictions of the drift and dispersion of materials rely on numerical models of ocean circulation, which are generally limited to horizontal scales greater than a few hundred meters or even several kilometres. However, ocean drift and dispersion depend on interactions between flow structures, such as eddies, at all scales, including those that are not resolved by numerical models. In practice, ocean drift and dispersion prediction models add a stochastic component to the current velocities predicted by the circulation models in order to represent current variations at scales not resolved by the models. A parameterization of this stochastic component must be chosen so that the effects of unresolved scales on ocean drift and dispersion are adequately represented. The choice of parameterization should therefore be based on real observations of the drift and dispersion of real tracers and under various environmental conditions (winds, waves, stratification, etc.).

This doctoral thesis project aims to characterize the statistical parameters of oceanic dispersion at the surface of the coastal ocean at different spatial scales and under variable environmental conditions by analyzing observations collected in different coastal environments: the maritime estuary of the Saint-Lawrence in Canada, the English Channel and the Bay of Biscay in France. Observations come from drifting buoys, dye spills (rhodamine-WT), aerial images, temperature, conductivity and rhodamine sensors, acoustic current meters, wave buoys, and high-frequency radars. Diagnostics that will be used to characterize the dispersion regime (statistical parameters of ocean dispersion) include relative dispersion, current structure functions, and Lyapunov exponents. As a result, the dispersion regimes will be characterized and a technique of mapping of transport and dispersion patterns will be proposed. These maps can be extremely useful for analysis of spatial distribution and space-time variability of biological quantities (e.g., phytoplankton, larvae) in the study regions.

This thesis subject is proposed jointly by two universities, which implies stays in France and Canada, necessary for the realization of the research project. Potential applications of this research are multiple in themes such as larval transport, the dispersion of microplastics, and water quality.

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