Université Lille Nord de France
Pôle de Recherche et d'Enseignement Supérieur

Ecole doctorale régionale Sciences Pour l'Ingénieur
Lille Nord-de-France - 072

**Title: Characterization and forecast of dispersion processes in coastal marine environments from high-frequency radar measurements and Lagrangian tools**

**Fellowship :** PhD scholarship from Université de Lille (label U-Lille), starting in October 2019, 3 years

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**Laboratory**: Laboratoire d'Océanologie et de Géosciences (LOG), Unité de Mécanique de Lille (UML)
**Team:** Télédétection et hydrodynamique (LOG), Mécanique des fluides complexes (UML)

**Context and goal:** Understanding the complex dynamics of coastal oceans is today considered a major scientific challenge with deep implications for the management of environmental risks, the climate system and marine ecology. This project aims to explore an interval of temporal and spatial scales (the submesoscale range) of surface ocean flows that is still poorly known, despite its relevance for oceanic physical processes. Indeed, in this range lie flow features with horizontal scales of order (1-10) km that are associated with strong gradients of properties (such as temperature or chlorophyll, a proxy for phytoplankton concentration) and large vertical velocities. Thus, as suggested by recent theoretical work, these structures should play a leading role in the coupling with atmospheric dynamics and marine ecology.
Taking an interdisciplinary approach, we will focus on the characterization and short-term prediction (a few days) of the distribution of material carried by coastal flows by means of a synergy between high-frequency radar (HF) measurements and Lagrangian diagnostics. In particular, we plan to explore turbulent dispersion properties using statistical approaches based on the Lagrangian tracking of synthetic passive tracers. The carrier flow field is measured by a network of HF radars installed on the coasts. Over the last 20 years, there has been a rapid expansion in the use of offshore HF oceanographic radars for observation and monitoring purposes. Presently, the HF radar is a unique technology capable of providing surface velocities in near real time over large areas extending up to 150 km offshore. Unlike satellite altimetry, it can potentially provide a velocity field with spatial resolution of order 1 km and temporal resolution of about 1 h. These data are considered very useful for a broad range of oceanographic and ecological applications such as: monitoring spreading pollutants, larval transport and fish management, analysis of phytoplankton distribution and dynamics. Several Lagrangian indicators will be used: (a) one-particle statistics, apt to characterize the transport by the mean, most energetic, flow component; (b) multiple particle statistics that can provide access to processes governed by velocity gradients, like relative dispersion. This methodology will allow to determine the statistical properties of the turbulent dispersion process at different (temporal and spatial) scales and to identify different dynamical regimes (i.e. more/less energetic turbulence). It is also envisaged to extend such an approach to obtain dispersion rate maps, which can be used to identify Lagrangian coherent structures characterizing convergence or divergence zones of the flow. Different coastal regions will be examined (Bay of Biscay, Mediterranean, Southeast Asian regions, ...). A particular emphasis will be put on the analysis of seasonal variability and its possible impact on the dispersion process. The Lagrangian tracking method will be validated by independent observations of real surface ocean drifters.
The approach developed will make it possible to forecast the transport and dispersion of substances drifting at the sea surface near the coasts, in the perspective of environmental risks' management. These methodological developments respond to the concern of numerous local studies aimed at controlling pollution of the marine environment, anthropic pressure and its impact on marine ecology.

**Candidate**: Candidate having good knowledge of fluid mechanics or dynamical systems or physical oceanography and an interest for numerical methods; education: Master in Fluid Mechanics, Physics, Applied Mathematics, Physical Oceanography.  Good knowledge of oral and written English is required. Knowing Fortran, C or Python would be a plus.