Ecole Doctorale Sciences pour l'Ingénieur (ED SPI 072)
Doctoral School Sciences for Engineers

Titre Thèse (subject)	Lagrangian particle dynamics in ocean submesoscale turbulence and future satellite data	
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Equipe (research team)	Mécanique des fluides complexes (MFC)	Web : http://uml.univ-lille.fr/fr/mecanique-des-fluides-complexes-mfc
Financement prévu ☒	Contrat Doctoral Etablissement ☒ Région ☐ – Autre ☐ Contrat de recherche ☐ Préciser :	ULille ☒ UPHF ☐ Centrale Lille ☐ UGE ☐ IMT ☐ Autre ☐
Financement acquis ? ☐	Contrat Doctoral Etablissement ☐ Région ☐ – Autre ☐ Contrat de recherche ☐ Préciser :	ULille ☐ UPHF ☐ Centrale Lille ☐ UGE ☐ IMT ☐ Autre ☐

Résumé du sujet (abstract):

Context. Ocean flows at scales larger than few tens of km are quasi-horizontal due to the pronounced stratification of seawater and Earth's rotation and are characterized by quasi-2D turbulence. At scales around 300 km (the mesoscale range), coherent structures (almost circular vortices) contain most of the kinetic energy and are key for ocean dynamics at climatic scales. At scales around 10 km (the submesoscale range) the flow is host to smaller eddies and filaments associated with strong gradients of physical properties (e.g. temperature) and intense vertical transport, which play an important role in both physical and biogeochemical budgets. Mesoscale and submesoscale flows also shape the physical and chemical environment in which life develops in the ocean. Direct observation of submesoscale surface velocity fields at global scale is still not possible but it should be achieved in the near future by the satellite SWOT (NASA-CNES, launch in 2022).
To compute large-scale horizontal transport, surface energy exchanges or global estimates of other quantities, it is crucial to assess how well the horizontal velocities provided by the satellite compare to actual surface currents and down to what length scale. For this purpose, Lagrangian approaches provide an ideal framework, as, differently from standard Eulerian ones, they integrate in time the signal. Thanks to this property, they may allow a clear separation between fast (ageostrophic) processes, that could contaminate the satellite-derived velocity, and slower (geostrophic) ones.

Work plan and goal. In this thesis, inscribed in the CNES research project "DIEGO: Data and dynamical synergies for SWOT" (https://swot.jpl.nasa.gov/system/documents/files/4184_SWOT-ST-DIEGO_summary.docx.pdf?list=projects), *we will explore Lagrangian transport in models of surface ocean turbulence including ageostrophic dynamics by means of numerical simulations.* In particular, we will focus on the role of the effective compressibility characterizing the 2D surface flows at scales of order 1 km, which is directly related to important vertical velocities. The research work will mainly rely on idealized simulations. Using the SWOT simulator software with the numerically computed flows, it will be possible to examine the effect of the data processing that will be applied to the real observations. Depending on the advancement of the project it could also be possible to use realistic high-resolution models, as well as the satellite data when available. The analysis will be based on the comparison of different statistical indicators of Lagrangian dispersion in the original and processed flows. *The aim is to determine the effect of unresolved motions, and of the data processing procedure, on dispersion features. In particular, this study should allow the identification of a threshold length scale above which the approximate velocity field is accurate enough, at least in a statistical sense, as well as an estimate of the kinetic energy of the missing small scales.*

Research team. The PhD thesis (starting in October 2021) will be conducted at UML, Lille, in tight collaboration with G. Lapeyre at LMD, ENS, Paris. It will also benefit from regular meetings with the staff of LOPS, Brest, involved on other workpackages of project DIEGO.

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

Application. Interested candidates should send their CV, a letter of motivation, and possibly contact information of two references.