Job Title : Post Doc / Impact of the meso and submesoscale dynamics on the fate of exported particles in the deep ocean

Main Research Field : Environment and Geosciences (ENV)

Sub Research Field : Physical oceanography ; Marine Biogeochemistry

Key words :Ocean Dynamics, Turbulence, Lagrangian, Particles, Ocean carbon pump, Modelling

Job Description :

The Earth climate deeply depends on atmospheric concentrations of greenhouse gases, such as CO_2. A variable ratio of the biogenic matter produced at the surface (atmospheric CO2 sink) is exported towards the deep ocean (biological carbon pump). It is fundamental to correctly describe the processes driving the transport and the transformation of this export biogenic matter in the water column in order to better quantify the carbon storage in the ocean.

Mostly through particles, the export flux is historically estimated from observations using sediment trap moorings at depths from 200 to 3000m during periods of several days to one/two years (with a time resolution from several hours to a week). These observations are interpreted using a very simple underlying statement: the collected matter comes vertically from the surface. Yet, not only the ocean is a tridimensional fluid (with a strong horizontal component), which is variable with time, but it is inherently turbulent. Small scales (eddies, fronts, filaments) play an important role as they not only create a very strong heterogeneity on the particle production at the surface, but they can convey particles on long distances and can generate significant vertical velocities, which control for the most part exchanges between the surface layer and the ocean interior. This complexity is intensified by sinking rates varying by two orders of magnitude (from 10 to 500 m/day), the smallest being able to be advected on long distances before reaching the trap. Besides, these velocities lead to time lags between the surface source and the deep ocean. Finally, within the water column, particles interact (aggregation, breaking up, …), which implies that the size spectra, and thus the sinking velocities, vary with depth.

Based on a modelling approach, the Marie Curie fellowship aims at exploring and quantifying the (de)correlation of the particle flux sampled in the traps in the deep ocean with the spatio temporal distribution of surface particles, generated by biological production interacting with the small scales of the ocean dynamics. The assessment of the representativeness of a punctual observation of a sediment trap makes the general framework of this study (e.g. what is the surface ocean area sampled by a sediment trap and what is the time lag between surface production and deep observation, in terms of ocean turbulence and particle size spectra?). This work will rely on a high resolution (1 km) simulation of the North Atlantic and regional simulations (< 500m), resolving the small scales and enabling to analyze different dynamical and biological production regimes. It will use a code of Lagrangian trajectories, suited for particles, e.g. taking into account behavior rules (sinking, particle interaction). In order to take into account the role of small scales on the production and on the particle spectrum, empirical relationships linking size spectra and hydro-dynamical patterns will be used. Moreover, the particle interactions will be considered with non linear relationships of variable complexity: this will enable the

quantification of the role of this particle dynamics on the decorrelation between the surface signal and the signal in the deep ocean.

Supervisor: Laurent Memery is a CNRS Directeur de Recherche at the Marine Environmental Science Laboratory. He's mostly involved in modelling the coupling between ocean tracers (carbon cycle), microbial community and ocean dynamics from regional (North Atlantic, Arctic) to small (fronts) scales. Besides a strong expertise in modelling, in biogeochemistry as well as in ocean dynamics, Laurent Memery has also been PI's of important pluri disciplinary programs, either in the open ocean, or in coastal environments.

Mémery, L., G. Reverdin, J. Paillet, and A. Oschlies (2005), Introduction to the POMME special section : thermocline ventilation and biogeochemical tracer distribution in the northeast Atlantic Ocean and impact of mesoscale dynamics, *J. Geophys. Res.*, *110*, C07S01, doi: 10.1029/2005JC002976.

Karleskind, P., M. Lévy, and L. Mémery (2011), Modifications of mode water properties by sub-mesoscales in a bio-physical model of the Northeast Atlantic, *Ocean Model.*, *39*, 47-60.

Cadier, M., M. Sourisseau, T. Gorgues, C. A. Edwards, and L. Memery (2017), Assessing spatial and temporal variability of phytoplankton communities' composition in the Iroise Sea ecosystem (Brittany, France): A 3D modeling approach Part 2: Linking summer mesoscale distribution of phenotypic diversity to hydrodynamism, *Journal of Marine Systems*, *169*, 111-126, doi:10.1016/j.jmarsys.2017.01.004.

Department/Research: Marine Environmental Science Laboratory (LEMAR)
https://www-iuem.univ-brest.fr/LEMAR/LemarLab
Access to regional and national computing centers
PI of the modeling Work Package in ANR project GREEN EDGE (Bloom in the Arctic Ocean), of the LABEX Mer project M2BIPAT (**M**arine **M**icrobial **BI**odiversity **PAT**terns).

Suggestion for interdisciplinary / intersectoral secondments
This study is directly linked to sea cruises on the Carbon Biological Pump (CBP), more specifically in the North Atlantic ocean (program APERO **A**ssessing marine biogenic matter **P**roduction, **E**xport and **R**emineralisation : from the surface to the dark **O**cean). This program is associated with the US EXPORT project (D. Siegel, Univ. Santa Barbara) and is based on European collaborations (NOCS, UK ; AWI, D; Univ. Berlin, D.; Univ. Sevilla, E).

Skills Requirements (optional) :
The study is strongly inter-disciplinary. It is driven by issues in marine biogeochemistry (biological carbon pump), but is clearly oriented towards problems in ocean dynamics at meso and submeso scales. Therefore, the applicant must have a strong expertise in ocean physics with some knowledge and interest in biogeochemistry.