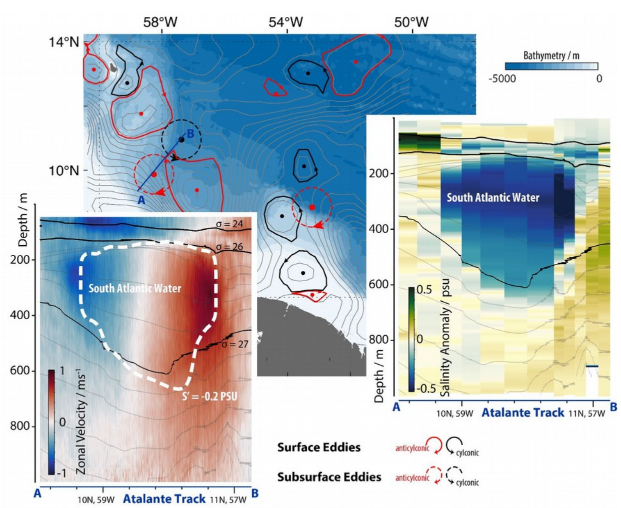
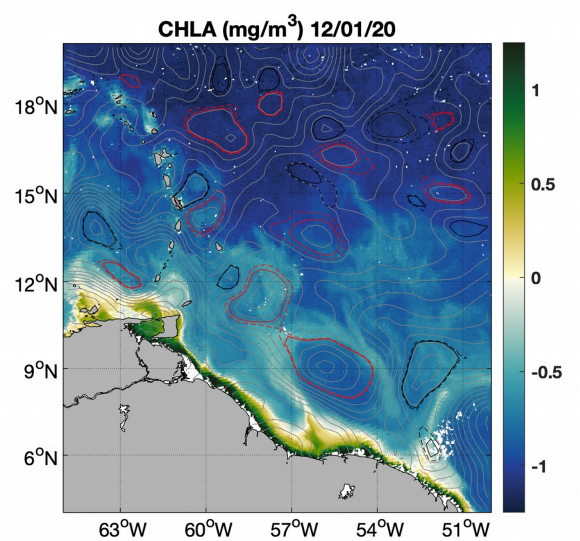
PROPOSAL OF M2 INTERNSHIP – ACADEMIC YEAR 2021
PHYSICAL OCEANOGRAPHY – GEOPHYSICAL FLUID DYNAMICS

Dynamics of river plumes and their interactions with vortices in the Northwestern Atlantic Ocean

The interaction of river plumes with neighboring eddies in the coastal domain has been shown to modify the fate of these low-salinity, nutrient rich, riverine waters in the ocean (Corredor et al., 2004; Schiller et al., 2011). The stratification and dynamical contrast of these waters with the oceanic waters leads to the formation of steep fronts bounding the plume associated with sheared currents. The effect of neighboring eddies can be to modify the local shear and thus to trigger barotropic or ageostrophic instability of the fronts, or to induce nonlinear filamentation of the plume via vortex patch interaction. Shear instability of these filaments can lead to their fragmentation and/or roll-up into small eddies.

The EUREC4A-OA experiment took place between Barbados and the Guyanas in January 2020. Using 4 ships and 4 research planes, it collected numerous data in the upper ocean and lower atmosphere. In particular, high resolution measurements of temperature, salinity, velocity and microscale were performed with UCTD, MVP, VMP and SADCP. On the other hand, a very high resolution model of the North Atlantic Ocean (GIGATL: https://vimeo.com/349272734) is available on this region to fully describe the 3D structure of currents, water masses and their time evolution. The images below show the wrapping of Amazon River water around an anticyclonic eddy (see the near surface structure of the salinity plot).





Using the EUREC4A data, and the output from the numerical model, we will assess the influence of the mesoscale eddies (the North Brazil Current rings) on the Amazon River plume (the Orinoco River plume might also be considered, time permitting). The river plume frontal instabilities, the filamentation of this plume and small eddy generation will be studied. These instabilities will be characterized via energy transfers and GFD-type instability criteria. The role of the coastal irregularities (e.g. capes) in triggering instabilities on the plume will be considered. The dispersion of the freshwater and its rationalization in terms of turbulent dispersion regimes will be assessed.
Time permitting, a process model based on SQG dynamics will allow the parametric investigation of eddy-plume interaction.

These processes will be studied in collaboration with Pr Sabrina Speich, Dr Gilles Reverdin and Dr Pierre L'Hegaret.

References

R.V. Schiller, V.H. Kourafalou, P. Hogan, and N.D. Walker, 2011: The dynamics of the Mississippi River plume: Impact of topography, wind and offshore forcing on the fate of plume waters. J. Geophys. Res., 116, C06029, doi:10.1029/2010JC006883

J. E. Corredor, J.M. Morell, J.M. Lopez, J.E. Capella and R.A. Armstrong, 2004: Cyclonic eddy Entrains Orinoco River plume in Eastern Caribbean, EOS, 85, 20, 197-208.

Supervision

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Collaboration with Dr Gilles Reverdin (LOCEAN), Dr Pierre L'Hegaret (post-doctoral researcher) will take place during the course of this work.

Location of the internship : LOPS ; scientific exchanges with LMD Paris

Duration 5-6 months in spring-summer 2021

Pre-requisite: M2 courses in physical oceanography with emphasis on GFD and geophysical turbulence

Internship grant funding is applied for.