POST-DOCTORAL POSITION IN OCEANOGRAPHY

Coupling vertical velocities and biogeochemistry to estimate carbon export in the subtropical South Pacific Ocean

Starting date: *between September and November 2025*

The ocean is complex and highly heterogeneous, with fine scale structures (fronts, eddies, 1–100 km in space, day–weeks in time). Such structures influence the vertical transfer of nutrients, the biological production and eventually the ability of the ocean to capture atmospheric CO_2. Horizontal components of 3D-oceanic currents are generally well known but their vertical ones (vertical velocities, VV) are still largely uncharacterized, being often short-lived and one to two orders of magnitude smaller than horizontal velocities. Consequently, **direct *in situ* measurement of VV is currently one of the biggest challenges in physical oceanography** and is of utmost importance for a better representation of the oceanic carbon cycle, especially in the context of increasing global warming. Our team has recently developed innovative technologies to directly measure VV in situ. In the framework of **HOPE-VV (HOw Physical processes affect ocean CO_2 capturE: focus on Vertical Velocities**, AMIDEX Blanc project, 2023-27, PI Anne Petrenko), we have been using these new methods to add a physical component to the ERC HOPE project (2022-2028, PI: Sophie Bonnet) that studies biogeochemical processes involved in carbon export. Hence HOPE-VV provides the ideal context to evaluate the relative contribution of physical and biogeochemical processes influencing the transfer of carbon to the deep ocean, potentially shattering our understanding of CO_2 sequestration mechanisms by the ocean.

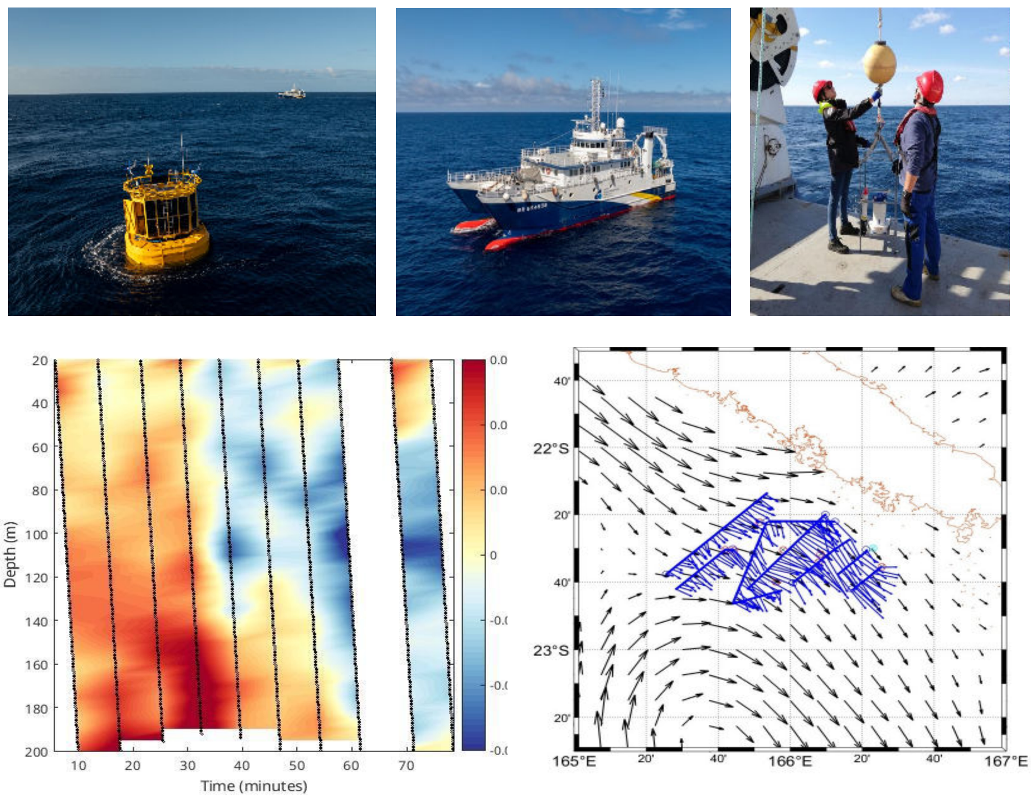

Fig. 1. Top panels: Smart buoy HOPE, R/V Antea and deployment of the Free-Fall (FF)-ADCP. Bottom panels: vertical velocities measured with the FF-ADCP during the HOPE-04 cruise in Sept. 2024 (courtesy M. Gentil); horizontal velocities measured on board Antea vs AVISO during the HOPE-06 cruise in Nov. 2024.

• The candidate will study the temporal variability of VV thanks to the time series analysis of data acquired at 5 physical mooring lines (including a 5-beam ADCP) deployed around an automated biogeochemical profiling smart buoy (Fig. 1) for 2 annual cycles offshore New Caledonia, SouthWest Pacific Ocean. One year of data is already available for processing.

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• She/he will also investigate the spatial variability of VV across physical structures (e.g., eddies' core and edges, fronts) measured with the deployments of our FF-ADCP during seasonal oceanic expeditions onboard the R/V Antea (Fig. 1) in the South Pacific Ocean.
• She/he will also contribute to compare biogeochemical data (for example, but not only, from an underwater video profiler, UVP-6) to the VV derived from the ADCP data to deduce the part of the carbon sinking flux (particles will be translated to carbon) attributed to VV, and the part attributed to gravitational settling.
These data will be exploited in synergy with our colleagues working in the HOPE-VV and HOPE projects (French and international), and IRD colleagues based at IRD Nouméa (S. Cravatte) or LEGOS (M. Gentil). Regular meetings with these consortium researchers will permit comparisons of physical and biogeochemical data as well as experimental data with more theoretical data. The candidate may also participate to a sea cruise in the Pacific end 2025.

LOCATION AND PRACTICAL ASPECTS

The successful applicant will be hosted by the laboratory MIO* within the team OPLC and will work in close collaboration with A. Petrenko, A. Bosse, S. Bonnet and other colleagues. The gross salary will be 2600-3350 €/month (depending on experience), equivalent to a net salary of roughly 2100-2700 €/month.

* MIO = Mediterranean Institute of Oceanography, CNRS, Aix Marseille Université, Campus Technologique et Scientifique de Luminy, 163 avenue de Luminy - Bâtiment Méditerranée, 13288 MARSEILLE, France

QUALIFICATION

The post-doctoral candidate will need to master several techniques as data analysis and statistics, ADCP measurements and analysis, image processing and/or IA. Previous cruise participation is welcome. A solid background in physical oceanography and theoretical/numerical tools is a prerequisite. Language: matlab or python. Curiosity, autonomy and willingness to develop new skills are also necessary.

APPLICATION

Interested candidates should send their CV including copy of PhD and committee final report, list of publications and motivation letter to A. Petrenko (anne.petrenko@mio.osupytheas.fr). Applications will close as soon as a suitable candidate is found and validated by the AMIDEX selection process.

WEB sites

https://www.mio.osupytheas.fr/fr/production/nos-projets/dynamique-oceanique/hope-vv-contribution-des-processus-physiques-au-stockage-du-carbone/
https://people.mio.osupytheas.fr/~petrenko//hope_vv.htm
https://hope-erc-158395.webflow.io/the-hope-project#anchor-link-5

REFERENCES (selected ones from the proposing team)

Barrillon, S., Fuchs, R., Petrenko, A., Comby, C., et al. (2023) Phytoplankton reaction to an intense storm in the north-western Mediterranean Sea.,Biogeosciences, 20, 141-161, doi: 10.5194/bg-20-141-2023.

Benavides, M., Conradt, L., Bonnet, S., Berman-Frank, I., Barrillon, S., Petrenko, A., Doglioli, A.M. (2021). Fine scale sampling unveils diazotroph patchiness in the South Pacific Ocean. ISME Comm., 10.1101/2020.10.02.323808.

Bonnet, S., Guieu, C., Taillandier, V., Boulart, C., Bouruet-Aubertot, P., Gazeau, F., ... & Tilliette, C. (2023). Natural iron fertilization by shallow hydrothermal sources fuels diazotroph blooms in the ocean. Science, 380(6647), 812-817.

Comby, C., Barrillon, S., (...) and A. Petrenko (2022). Measuring vertical velocities with ADCPs in low-energy ocean, Journal of Atmospheric and Oceanic Technology, doi: 10.1175/JTECH-D-21-0180.1, hal-03746757.

Fuda, J-L., Barrillon S., Comby, C., Doglioli, A., Le Gal, P., Petrenko, A. (2023), « Estimating Ocean Vertical Velocities Using an Autonomous Multipurpose Profiler », IEEE MetroSea 2023.

Messié, M., A. Petrenko, A. Doglioli, E. Martinez, S. Alvain (2022). Basin-scale biogeochemical and ecological impacts of islands in the tropical Pacific Ocean, Nature Geoscience doi: 10.1038/s41561-022-00957-8.

Petrenko, A.A., et al.. (2017). A review of the LATEX project: mesoscale to submesoscale processes in a coastal environment. Ocean Dynam., doi: 10.1007/s10236-017-1040-9.

Rousselet L., (…) and Petrenko, A.A. (2019). Vertical motions and their effects on a biogeochemical tracer in a cyclonic structure finely observed in the Ligurian Sea., J.Geophys.Res., 124, doi:10.1029/2018JC014392.

Tzortzis, R., (...), Petrenko, A. et al.. (2021). Impact of moderate energetic fine-scale dynamics on the phytoplankton community structure in the western Med. Sea, Biog. Discuss., doi: 10.5194/bg-2021-38.