Three Ph.D. opportunities at Université du Québec à Rimouski (UQAR) and Laval University (UL)/IRL Takuvik, Canada

Three highly motivating PhD fellowship positions are currently offered in the context of an inter-university research program dedicated to Advancing our **Understanding of Ocean Biological Carbon Pumps of the Arctic and Sub-Arctic seas, using hyperspectral observations of the Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission**. The project will take place in eastern Canadian water from the Gulf of St Lawrence to the Canadian Arctic (northern Baffin Bay). Numerous fieldwork opportunities will be available (e.g., onboard the [CCGS Amundsen](#)) in the context of the [Transforming Climate Action](#) (TCA) involving [UQAR](#), UL, Dalhousie University and Memorial University of Newfoundland.

PhD project 1 - Improve satellite-based phytoplankton biomass and PP (Primary Production) estimation using hyperspectral data *(Laval University; Thesis direction: Dr Marcel Babin; UL Dr Erin Bertrand, Dalhousie U.; Dr Emmanuel Devred, DFO)*

The overall objective of this project will be to improve the currently used biomass and Primary Production estimation models, by working on developing an improved inversion model for phytoplankton biomass expressed in terms of chlorophyll *a.* There will also be a need to improve the PP model parameterisation, while exploring the relationship between Phytoplankton Functional Types (PFTs) and photosynthetic parameters with the aid of PACE's high spectral resolution (1.25 nm) of the sun-induced fluorescence (~ 683 nm) data products. The student will also have the opportunity to work on a novel, protein-based approach to estimate the phytoplankton taxon-resolved PP and physiology from mass spectrometry-derived measurements of carbon fixation protein concentrations (Rubisco). Following these aspects, it will then be important to apply the new biomass algorithms and improved PP model parameterization to PACE data to estimate the annual PP of the eastern Canadian waters.

PhD project 2 – Determining Phytoplankton Functional Types (PFTs) from hyperspectral remote sensing (UQAR; *Thesis direction: Dr Simon Bélanger; Dr Emmanuel Devred, DFO; Mathieu Ardyna UL; Dr Julien Laliberté, DFO***):**

The first objective of this project is to describe the PFTs of the eastern Canadian waters using HPLC and phytoplankton light absorption spectra. The selected candidate will initially review the *in-situ data* previously acquired by the Department of Fisheries and Oceans Canada (DFO), Takuvik and UQAR, and build an extensive data set covering the three regions of interest (Gulf of St Lawrence, Scotian Shelf, Newfoundland and Labrador Shelf / Grand Banks). An aspect of the project will also require an evaluation of the distribution of phytoplankton pigments and their absorption properties in response to environmental conditions in these areas. The above data will be used to inform hyperspectral remote sensing Reflectance (R_{rs}) using a forward radiative transfer model (HydroLight) and allow to study variations in R_{rs} in response to changes in phytoplankton absorption. The second objective will be to develop a hyperspectral-based algorithm to retrieve the PFTs. Finally, the PFTs algorithm will need to be applied to PACE data to

assess the spatio-temporal distribution of PFTs in the regions of interest. This novel research will lead to a better understanding of seasonal phytoplankton taxonomic group succession in relation to physical forcing, and help understand the possible impact of climate forcing in primary producers.

PhD project 3 - Carbon Export rate from space: a new integrated approach (Laval University) *(Laval University; Thesis direction: Dr Mathieu Ardyna; UL Dr Erin Bertrand, Dalhousie U.; Dr Simon Bélanger, UQAR)*

The overall goal of this PhD will be to evaluate which are the most appropriate satellite-derived products (Chla, POC, PP, PFTs) to predict carbon export from space. Specifically, the first objective will be to adapt a new plankton assemblage model with BGC-Argo floats to Canadian subpolar and polar waters. Specifically, these oceanographic instrument platforms (BGC-Argo floats) allow time series of bio-optically-derived measurements, particle concentration and size observations in the productive zone, their export and transfer efficiency into the underlying mesopelagic zone. The above work will help determine whether phytoplankton-associated carbon export patterns occur in the deeper ocean of Canadian subpolar and Arctic waters and elsewhere in the Southern Ocean. In a second objective and based on PACE-derived products (developed in PhD projects 1 and 2), and the new plankton assemblage estimated with BGC-Argo (PhD 3), a coupled satellite-BGC float parameterization will be adapted to Canadian waters to reduce uncertainties on carbon fluxes measurements. BGC-Argo platforms will be used to improve uncertainty in satellite-based PP estimates in polar waters, which are known to suffer from persistent cloud and ice covers. The project will thereafter require the student to provide large-scale estimates for the first satellite-Argo-derived export budget for polar waters.

Application details:

Qualifications: Master's degree in remote sensing or oceanography or environmental sciences, or equivalent research experience.

Application closure date: **May 1st, 2024** (but will remain open *until positions are filled*)

Position Length: 4-year fellowship of $25K per year starting in September 2024

Travel costs for fieldwork, inter-institutional collaborations and national or international conferences are covered by Principal Investigators.

Location: Depending on the specific project, candidates will be located at one of the indicated universities. Students will be highly encouraged to visit and experience research in collaborating labs. Some projects may require field work and/or time at collaborating universities.

Applicants must submit:

- A detailed CV, including the e-mail and phone number for three references and the grades for the master's and bachelor's degree, if applicable.

- A short cover letter explaining the applicant's experience related to the position and motivation. Applicants with atypical academic backgrounds are encouraged to include details of their learning experiences in their cover letters;

For any questions and application submission, please contact the Principal Investigator, Prof. Simon Bélanger or any of the following Co-Investigators:

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PhD 3 : Mathieu Ardyna : Mathieu.Ardyna@takuvik.ulaval.ca