MERCATOR OCEAN INTERNATIONAL

Internship Master Project M/W

5-6 months (starting early 2025)

How to apply:

Send your cover letter and detailed resume with the following reference 202410/RD/Optical-Modelling to the supervisors.

Deadline for applications: 30/11/2024

Date of publication: 10/10/2024

Project title: Improving the light scheme in Mercator Ocean's coupled physical-biogeochemical model

About the project:

Light is the main source of energy for the ocean. It controls heat distribution, water column stratification, and ocean circulation. Light is also essential for the life and functioning of marine ecosystems, affecting the growth of photosynthetic organisms, species distribution, and many biogeochemical processes that maintain the balance of the ocean and the planet.

Recent advances in satellite radiometric data have enabled the analysis of how functional groups of phytoplankton (PFTs) interact with light. Their unique spectral signatures allow for the discrimination and identification of these species. A sufficiently detailed description of light penetration in the water column (absorption, scattering and reflection of light at different wavelengths), combined with an appropriate biogeochemical complexity (PFTs and other elements with optical properties), therefore seems necessary in ocean models, which have become essential tools for monitoring ocean conditions and marine ecosystems.

Some coupled physical-biogeochemical models already incorporate complex radiative transfer models, including an atmospheric component (OASIM; Gregg and Casey, 2009) and an oceanic component impacted by the properties of the main optical constituents, such as PFTs, detritus and coloured dissolved organic matter (CDOM), derived from the work of Dutkiewicz et al (2015) and Gregg and Rousseaux (2016).

As part of the Copernicus Marine Service, Mercator Ocean International (MOi) is in charge of developing operational systems for the global ocean and European waters. Both systems are based on the coupled physical-biogeochemical model NEMO-PISCES, which uses the standard 3-spectral band scheme of Lengaigne et al. (2007) to describe light penetration, and chlorophyll is the only optically active constituent.

During this internship, we propose to analyze the impact of a more complex optical model on the main biogeochemical features and improve our knowledge on optical properties in relation to PISCES variables. The study will be conducted on a 1D configuration of the NEMO-PISCES model (Aumont et al., 2015), in the open ocean (e.g. PAPA station in the North Pacific, BOUSSOLE station in the Mediterranean), and in the coastal ocean (e.g. L4 station in the English Channel). For each station, you will carry out two simulations by modifying the optical scheme:

1) one simulation with the standard optical scheme;
2) another with the multi-spectral radiative module (based on Skakala et al., 2020), which includes an atmospheric component (based on OASIM) and an ocean bio-optical module (based on Gregg and Rousseaux, 2016).

Then, you will perform a sensitivity analysis to identify the impact of each optical constituent, identify the most important constituents, and refine the optical properties in relation to the PISCES PFTs. In addition, you will test several formulations to represent the impact of CDOM. Finally, the influence of particulate inorganic carbon (PIC) on light propagation will be tested.

This internship will be carried out at Mercator Ocean. After an initial bibliographical phase, you will become familiar with the modelling tools, and the results will be analyzed and interpreted using Python. This work will be finalized by the writing of a report.

Prerequisites:

- Bac +4 in oceanography or applied mathematics
- Knowledge of programming languages (Python, Fortran, etc.) and the Linux environment
- Knowledge of physical oceanography and biogeochemistry
- Knowledge of numerical analysis
- Good level of English

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Supervisors:

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Useful references:

Aumont, O., Ethé, C., Tagliabue, A., Bopp, L., and Gehlen, M.: PISCES-v2: an ocean biogeochemical model for carbon and ecosystem studies, Geosci. Model Dev., 8, 2465–2513, https://doi.org/10.5194/gmd-8-2465-2015, 2015.

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Who are we?

Mercator Ocean International has been developing operational oceanography activities for nearly 25 years, as part of its public interest mission to preserve the ocean.

Many scientific and societal challenges must be met to ensure a sustainable ocean, whether they concern the environment, biodiversity, climate change, the blue economy or education. To meet these challenges, Mercator Ocean designs, develops, operates and maintains state-of-the-art digital systems capable of describing, analysing and forecasting the state of the ocean in 3D, continuously and in real time. The scientific information is then translated

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to be accessible to all, whether they are public or commercial services, political decision makers, industrialists, associations, NGOs, teachers or citizens. Mercator Ocean International thus combines scientific excellence and social commitment on a daily basis.

As a non-profit company under multinational governance (ES, FR, GB, IT, NO), we work in a climate of trust with our ten shareholder partners, all key players in the development of European oceanography.

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