# Postdoctoral position
# machine learning application on biogeochemistry and Climate projections

**Starting Date:** **01 May 2024** 12 months fixed-term contract

**Application deadline:** **15 March 2024** (or until the position is filled)

**Supervisors:**
E. Martinez (elodie.martinez@ird.fr) biogeochemistry/ocean color (LOPS Brest),
P. Brehmer, marine ecologist (LEMAR Brest).

**Collaborators:**
T. Gorgues, biogeochemistry/numerical modeler & E. Pauthenet, physicist/machine learning (LOPS),
R. Fablet & L. Drumetz, machine learning (Lab-STICC Brest),
M. Lengaigne, oceanographer/climate physicist & H Demarcq, oceanographer (MARBEC Sète).

**Salary**: 34,52 k€ (gross) /year

## Host institution

The position is affiliated with the Physical and Space Oceanography Laboratory (LOPS), a Joint Research Unit associated with the University of western Brittany (UBO) both belonging to the European University Institute of the Sea (IUEM). Recently recognized as one of the world's premier oceanographic centers (ranked 5th in the Shanghai ranking 2023), LOPS spearheads cutting-edge research in ocean dynamics across various temporal and spatial scales. Our four LOPS research teams (Coastal Ocean, Ocean and Climate, Oceanic Scale Interactions, and Satellites and Air-Sea Interface) pioneer programs contributing to the advancement on the relationships between the ocean and other compartments of the Earth system such as the atmosphere, ice and living organisms.

Based in Plouzané (France), the postdoc opportunity is within the "Ocean and Climate" team.

## The project

NextGEMS is a collaborative European project (https://nextgems-h2020.eu; PI Bjorn Stevens at the Max Planck Institute for Meteorology and Irina Sandu at the ECMWF). Funded by the EU's Horizon 2020 program, it will tap expertise from fourteen European Nations to develop two next generation Storm-Resolving Earth-system Models (SR-ESMs). Through breakthroughs in simulation realism, these models will allow us to understand and reliably quantify how the climate will change on a global and regional scale, and how the weather, including its extreme events, will look, like in the future. The much finer grid of nextGEMS' models allows them to explicitly represent essential climate processes – storms, associated with precipitating deep convection, the effects of the landscape on the atmosphere, the effects of ocean eddies on the ocean heat transport, and its interaction with ice-sheets – that existing climate models now either ignore, or represent empirically. Past research has shown that the physically based approaches nextGEMS exploits are effective in reducing systematic and long-standing errors in conventional climate models, thereby creating a better – more physical – foundation for projections. Because nextGEMS's SR-ESMs will increase simulation realism on

many fronts, they are expected to open new scientific frontiers and shine new light on how the Earth system responds to human activities.

This postdoctoral position falls under the "Storms and Ocean" theme, led by Noel Keenlyside (UiB Norway). The focus lies in evaluating the ability of the SR-ESMs to accurately represent the surface energy budget over tropical oceans and atmosphere-ocean coupling.

Within this thematic framework, our objective is to employ advanced machine learning techniques to derive climate projections of phytoplankton biomass from oceanographic and atmospheric physical predictors from SR-ESMs in order to ultimately deconvolute and investigate the influence of the anthropogenic signal from that of the natural low-frequency variability. Specifically, our proposed research includes:

1) Using advanced machine learning methods to establish relationships between oceanographic/atmospheric physical predictors and biogeochemical components, such as the concentration of Chlorophyll-a ("Chl", a proxy of phytoplankton biomass) from satellite observations and the SR-ESMs outputs over the last 20 years;

2) Reconstructing future multi-decadal time series of these biogeochemical variables from the physical outputs from the SR-ESMs using the identified machine learning methods;

3) Investigating the spatio-temporal variability of these biogeochemical variables and exploring the underlying physical processes.

Selected references:

Roussillon, J., Fablet, R., Gorgues, T., Drumetz, L., Littaye, J., & Martinez, E. (2023). A Multi-Mode Convolutional Neural Network to reconstruct satellite-derived chlorophyll-a time series in the global ocean from physical drivers. Frontiers in Marine Science, 10, 1077623.

Martinez, E., Gorgues, T., Lengaigne, M., Fontana, C., Sauzède, R., & Fablet R (2020a). Reconstructing Global Chlorophyll-a Variations Using a Non-linear Statistical Approach. Front. Mar. Sci., 7:464. doi: 10.3389/fmars.2020.00464.

Martinez, E., Brini, A., Gorgues, T., Drumetz, L., Roussillon, J., Tandeo, P., ... & Fablet, R. (2020b). Neural Network Approaches to Reconstruct Phytoplankton Time-Series in the Global Ocean. Remote Sensing, 12(24), 4156.

## Your activities

- Utilize machine learning tools and methods (supervised, unsupervised, reinforcement, etc.) already in use within our team to learn the relationships between Chl and physical oceanographic and atmospheric predictors (temperature, wind, etc.). This learning process will be performed using satellite observations and reanalysis outputs over the period 2002-2024.
- Apply these machine learning schemes using physical predictors from several oceanic and atmospheric variables from the two nextGEMS SR-ESMs climate projections over the next decades.
- Assess the relative importance of the predictors.
- Following an initial global assessment, focus specifically on the North West African region.
- Disseminate your findings through publication in peer-reviewed "rank A" journals and effective communication of results.

## Candidate profile

We seek candidates with a PhD in ocean science, preferably with a background in numerical modeling and/or climate projections. Additionally, candidates should possess:

- Proficiency in numerical tools and big data algorithms, including Python, Keras, etc.
- Technical aptitude for adopting and operating machine learning methodologies.
- Relevant skills such as the use of satellite earth observations and/or numerical model outputs, knowledge in fluid mechanics and/or atmosphere and/or ocean,
- Proficient English language skills (level 2).

The collaborative and intellectually stimulating work environment requires individuals who demonstrate:

- A penchant for teamwork, skill-sharing, and involvement in ambitious projects.
- Adaptability and a willingness to collaborate across interdisciplinary boundaries.

## Application procedure

The position is for a one-year contract, preferably starting in May 2024. Interested applicants are encouraged to submit the following documents via email to Elodie Martinez (elodie.martinez@ird.fr) by March 15, 2024:

- Letter of motivation
- CV
- Recommendation letters of two referees