Project Title: Quantifying the Marine Bio-Physical Feedbacks During Severe Weather Events in a High-Resolution Coupled Earth-System Model

Lead Institution/Department: University of Bristol, School of Geographical Sciences
Primary Supervisor: Fanny Monteiro, School of Geographical Sciences
Co-Supervisor: Dr Sana Mahmood, UK Met Office, and University of Bristol
Co-Supervisor: Dr Dale Partridge, Plymouth Marine Laboratory

Scholarship: A fully funded PhD studentship including UK fees, annual stipend, and a research budget, is available at the University of Bristol. Study will begin in September 2025 and is funded for four years. The deadline for applications is 31st January 2025.

Project aims and methods
Regional marine and weather forecasting is crucial in managing the economy and protecting marine life in our coastal and open waters. Forecasting severe weather events such as marine heatwaves and storms is particularly critical, as they can significantly impact human activities and ecosystems, with large uncertainties for the latter. For example, weather forecasts (and climate projections) assume that the ocean colour is fixed. However, satellite observations show that the ocean colour varies significantly over the Northwest European shelf due to phytoplankton activity. Skákala et al. (2022) have shown that accounting for changing ocean colour due to phytoplankton significantly impacts the sea surface warming in the spring: during a phytoplankton bloom, light gets trapped closer to the surface, increasing the near-surface warming and shallowing the mixed-layer depth. This effect then feeds back on the phytoplankton, advancing its bloom by a few days. During extreme heat events, the impact is likely to be significantly higher.

Additionally, nutrient river runoffs can highly impact ocean colour by increasing coastal phytoplankton activity. However, ocean models typically use climatological rivers, which fail to capture significant variations in flow due to severe weather events. Combining a fully coupled atmosphere-ocean-wave biogeochemical set-up for the Northwest European shelf with improved riverine inputs will improve the forecast ability of this regional system.

The Regional Environmental Prediction (REP) modelling system is a state-of-the-art kilometre scale prediction system coupling models of the atmosphere, land-surface, ocean and waves over the UK and Northwest European shelf (Lewis et al., 2019). The PhD project will draw on recent advances in the REP model, developed in collaboration between Plymouth Marine Laboratory and the UK Met Office, which allows a biogeochemistry model (Butenschön et al., 2016) to interact with the other components in weather and climate regional coupled forecasting. The PhD will consist of:

1. Building on the work done by Skákala et al (2022) to introduce the ocean phytoplankton colour feedback on the atmosphere and ocean of the REP model.
2. Performing a series of model simulations within the REP system with different feedback mechanisms to quantify the impact of phytoplankton on the atmosphere and ocean, including analysing the feedback associated with the marine heatwave from summer 2023.
3. Investigating the impact of river flow calculated by the atmosphere and land surface models on the phytoplankton activity due to heavy rainfall events from storms like Agnes, Babet and Ciarán in Autumn 2023.

Candidate Requirements
We are looking for a highly motivated and independent candidate interested in understanding the interactions of marine biogeochemistry, ocean physics and weather forecasting. The ideal candidate should have good computational skills with some programming knowledge and hold a degree in one of the following topics: Oceanography, Atmospheric Sciences, Earth Sciences, Environmental Sciences, Geography, Chemistry, Geophysics, Physics or Mathematics. We welcome and encourage applications from under-represented groups.

References
Butenschön et al. (2016). ERSEM~15.06: a generic model for marine biogeochemistry and the ecosystem dynamics of the lower trophic levels. *Geoscientific Model Development*, *9*(4), 1293–1339. https://doi.org/10.5194/gmd-9-1293-2016

Lewis et al. (2019). The UKC3 regional coupled environmental prediction system. *Geoscientific Model Development*, *12*(6), 2357–2400. https://doi.org/10.5194/gmd-12-2357-2019

Skákala, et al. (2022). The impact of ocean biogeochemistry on physics and its consequences for modelling shelf seas. *Ocean Modelling*, *172*, 101976. https://doi.org/https://doi.org/10.1016/j.ocemod.2022.101976

Useful Links
Please contact f.monteiro@bristol.ac.uk and sana.mahmood@metoffice.gov.uk for informal enquiries.

- https://www.bristol.ac.uk/geography/courses/postgraduate/
- https://www.bristol.ac.uk/study/postgraduate/research/geographical-sciences-physicalgeography/
- https://research-information.bris.ac.uk/en/persons/fanny-m-monteiro
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How to Apply:. Please apply to the “Geography (PhD)” programme at https://www.bristol.ac.uk/study/postgraduate/apply/