Treatment of model bias in marine biogeochemistry forecasting

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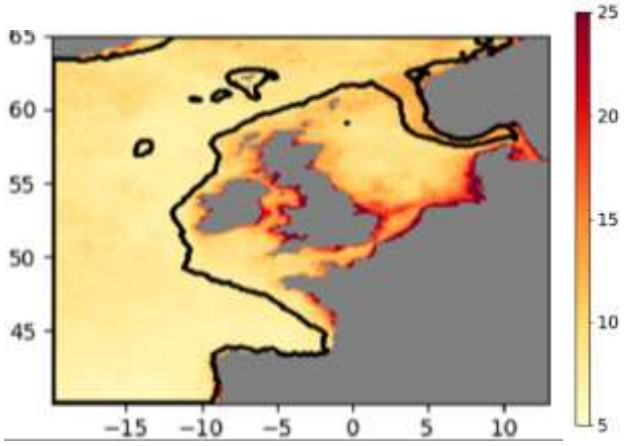

The monitoring and forecasting of the marine biogeochemistry in the shelf seas is essential for understanding the present and future health of our seas and its many associated environmental, economic and societal impacts. The forecasting includes long-range forecasts addressing the impact of climate change on ocean biological production and acidification, as well as shorter time-scale forecasts predicting sudden dangerous events, such as harmful blooms, or hypoxia. To enable numerical models of the marine biogeochemistry to stay in line with the true underlying system a technique known as data assimilation is used to systematically blend the model with observations made from a myriad of instruments. One rich source of observations comes from satellite derived sea surface chlorophyll concentrations (see inset figure), a proxy of how much life there is in the ocean.

Data assimilation algorithms are based on mathematical principles that make approximations about the errors in both the model and observations. One of the most fundamental approximations is that both are unbiased estimates of the true underlying system. Unfortunately, in many applications biases in the model remain significant and so the data assimilation is suboptimal. The magnitude of the biases in marine biogeochemistry are particularly large and a known limitation in the forecast skill. Different approaches to treating bias within the assimilation exist, but in order to apply these techniques an estimate of the bias or its statistics are needed. This is particularly challenging given that the biases are likely to have high variability in space and time. Utilising machine learning techniques, this project aims to develop parameterisations of model bias that allow for their estimation from the model and observation data available. Different state-of-the-art techniques for the correction of the bias during the assimilation will then be applied to idealised models in which their sensitivity to the accuracy of the estimated bias is assessed, before then being applied to an operational model of the marine biogeochemistry in the shelf seas surrounding North West Europe.

Training opportunities:
This studentship is a joint project with the Plymouth Marine Laboratory (PML). The student will have the opportunity to spend time working at PML over the lifetime of the project. The student will also have the opportunity to attend ECMWF training courses on data assimilation and advanced training courses at Reading organized by the Data Assimilation Research Centre and the National Centre for Earth Observation.

Student profile:
This project would be suitable for students with a good honours degree in a subject with strong mathematical content and programming experience.

https://research.reading.ac.uk/scenario/