

## Comparison of optical and machine learning methods to detect harmful algal blooms in satellite ocean colour imagery

PML supervisors: Dr Gavin Tilstone ([ghti@pml.ac.uk](mailto:ghti@pml.ac.uk)), Dr Peter Miller  
Bristol supervisors: Dr Paul Hill



### Scientific background

Harmful algal blooms (HABs) are naturally occurring phenomena which can result in the release of toxins into the marine environment that can kill fish, shellfish and humans. The frequency and magnitude of HABs are increasing globally, which poses an ever higher risk to human health and shellfish industries. Currently, monitoring of HABs is limited in terms of the spatial and temporal frequency with which samples can be analysed. The latest European Space Agency Sentinel mission data has more visible bands to detect blooms and is available at a higher spatial resolution than was previously possible. Application of state of the art HAB specific algorithms to Sentinel data offers great potential in enhancing the capability of monitoring HABs. In this project, the successful candidate will compare different satellite methods to detect key harmful algal species in European waters.

### Project Aims and Methods

1. Compare optical based and integrated machine learning and image processing methods to evaluate which is the most accurate in detecting harmful algal blooms in satellite ocean colour data.
2. Using the most accurate method, create a satellite time series to evaluate bloom occurrence against toxin concentration and shellfishery closure.

The optical method uses a HAB risk classification method that employs a fully automatic data driven approach to identify key optical characteristics of phytoplankton blooms based on the colour of the water and Linear Discriminant Analysis (Miller et al. 2011; Kurekin et al. 2014). The accuracy of this approach is increased through the use of the spectral signature of water leaving radiances, absorption and backscattering which can be derived from either satellite images or optical field measurements. The Machine learning method use image recognition techniques based on colour to highlight potential areas with HABs (Baseed et al. 2016). Deep learning methods for classifying HABs will be investigated using 2D imaging Convolutional Neural Network (CNN) and time sequence Long Short-Term Memory (LSTM) methods. The student will have the flexibility within the project to collect field data to improve and develop satellite methods of HAB detection, to choose the target phytoplankton species and area based on which species are most problematic to the fish and shellfish industries. The successful student will also have the possibility to produce an extensive archive of satellite data from different and combined ocean colour satellite sensors of the chosen target species and area.

### Training

The supervisory team will provide the expertise necessary to deliver the project. Tilstone (PML) will manage the project and supervise measurement of optical properties of HABs. Hill (UoB) will supervise the machine learning aspects of the project and will train the student in the use of hardware and software within the vision laboratory (VI-Lab). Miller (PML) will provide the expertise in development of optical algorithms. The student will gain experience in a wide range of techniques and disciplines (and have access to state of the art facilities at both institutions).

### Candidate Requirements

We are looking for a student with an undergraduate degree of 2:1 or higher in a numerate discipline, ideally with some experience of working in a research or development environment.



Registered Office:  
Prospect Place, The Hoe,  
Plymouth, PL1 3DH,  
United Kingdom

T +44 (0)1752 633100  
F +44 (0)1752 633101  
W [www.pml.ac.uk](http://www.pml.ac.uk)  
E [forinfo@pml.ac.uk](mailto:forinfo@pml.ac.uk)

Patron: James Cameron  
Registered charity number 1091222.  
PML is a company limited by guarantee,  
registered in England & Wales,  
company number 4178503.