SPITFIRE Doctoral Training Partnership (DTP)

Research Experience Placement Project 2019

Lead Supervisor:	Dr Dan Jones
Email:	dannes@bas.ac.uk
University/Research Organisation:	British Antarctic Survey
Department:	Polar Oceans Team
Project Title:	Finding boundaries: using machine learning to identify sharp transitions in the Southern Ocean

Total Student Support Costs: £	Student based at BAS will undertake an 8 week placement, working 30 hours a week. The successful candidate will be required to complete further local paperwork and internal BAS processes. The hourly rate paid, will be no less than the legal minimum wage.

Proposed Start Date: 8 July 2019	Proposed End Date: 30 August 2019
Projects should run over the summer vacation and we recommend that projects will have terminated by 25 September 2019.	

Brief Summary

This should include:

- *Project outline;*
- *Links to staff/School/Centre activity as appropriate;*
- *Supervisory arrangement;*
- *How space/equipment/supporting resource demands will be met;*
- *Elements of the project that will incorporate elements other than computer/modelling e.g. fieldwork and data collection;*
- *How the project will enhance the skills of the appointed student;*
- *Any intellectual property rights concerns that may arise from the work.*

The Southern Ocean (SO) is a critical component of Earth's climate system, having thus far absorbed roughly 90% of the extra heat added to the climate system via anthropogenic greenhouse gas emissions. The Antarctic Circumpolar Current (ACC), a powerful current consisting of many deep-reaching jets, is a key feature of SO circulation; its sharp fronts separate the warmer subtropical regime from the colder polar oceans. Even small shifts in jet position can change ACC transport, heat uptake, and the behaviour of sea ice. In this project, we will use machine learning to develop a robust, algorithmic method for identifying fronts in the ACC. We will apply unsupervised classification techniques to existing Southern Ocean data, using the unique properties of these tools to define the relative sharpness of ACC fronts. The result will be an objective method for quantifying front position and the associated uncertainties.

The student will work as part of the BAS Polar Oceans Team under ORCHESTRA, the five-year, cross-centre NERC project on Southern Ocean heat storage and transport. The student will have

opportunities to interact with scientists involved in oceanographic field work, high-level numerical analysis, and ocean/climate modelling. They will be supervised by Drs Dan Jones, Andrew Meijers, and Emma Boland – BAS oceanographers with expertise in SO circulation and machine learning methods. The student will have a desk at BAS and access to BAS/NERC HPC facilities.

The student will gain competence with important machine learning methods, as well as familiarity with handling, visualising, and analysing large oceanographic datasets. They will also learn about oceanography as an active area of scientific research. The student will retain ownership of their work and will be credited in any publications that use their results.

Please give an indicative timescale for the student's work over the length of the project:
This should include:

- *The broad tasks the student will undertake;*
- *An indicative timescale for these tasks.*

Suggested timetable:

- Week 1: Get oriented at BAS and conduct literature review.
- Week 2: Learn how to read, manipulate, and visualise Southern Ocean State Estimate (SOSE) data.
- Week 3: Learn about unsupervised classification methods (e.g. Gaussian Mixture Modelling, MeanShift) and try simple examples (e.g. in scikit-learn). Select an appropriate unsupervised classification method for the front identification problem.
- Weeks 4-6: Write and implement code to apply unsupervised classification to SOSE data.
- Weeks 7-8: Finalise results, plots, and analysis. Write up a summary and give a short presentation to a small group at BAS and U. Cambridge.

Proposed procedure for appointing students, including selection criteria:
Please identify specific criteria that should be considered for the selection of placement students e.g. specific quantitative skills that may be required, subject knowledge etc. If a student has been pre-selected, or the research area has been led by the student, please provide the student's contact details, and a summary of their suitability for the SPITFIRE DTP REP programme.

The ideal student has strong mathematical and computing skills, including some experience with machine learning methods. Experience with python, especially the scikit-learn package, is an advantage.