New approaches to ocean state analysis for climate and forecasting applications.

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Reconstructing present-day and past ocean temperature salinity and circulation states is critical both to making long-range weather and climate forecasts and for understanding how the ocean has responded over the last century to imbalances in the Earth's energy budget due to global warming. However most observations of the oceans are only available at the surface and widespread subsurface observations have only become available in the last 15 years. If we could understand better how to use surface and subsurface ocean observations to complement each other more effectively we could greatly improve reconstructions of ocean phenomena such as the Gulf stream and the Antarctic circumpolar current in the southern ocean, and the eddies and vortices that develop around strong currents and fronts between colder and warmer waters. We would also be able to reconstruct better records of changes in ocean heat and salinity distributions using the sparse ocean observations from the past which could help us understand how the oceans have warmed due to climate changes over the past century.

In this project you will work with Reading and Met Office staff to develop and compare a range of new methods for reconstructing the ocean state using satellite observations of sea level and sea surface temperatures, along with profiles of subsurface temperature and salinity, T(z), S(z), observed by autonomous "Argo" robotic profilers (https://argo.ucsd.edu/). Satellite altimeters provide a record of global sea level starting in 1992, with areas of higher sea level generally indicating warmer waters below, but they do not give information on the vertical heat distribution. In-water profile measurements give detail of the subsurface ocean structure but are much more limited in spatial extent. You will investigate how best to combine these data, as well as the impact of the reconstructed ocean states on computer forecasts of changes in ocean temperatures and associated weather. You will also investigate how to use results obtained from the greater volume of current surface and subsurface ocean observations in order to better reconstruct ocean states in the past when less data were available.

This project has a strong focus on data analysis and you will develop new methods of combining observations with modelled ocean data which is required for making all ocean and atmospheric forecasts. These skills are of great importance for developing improved forecasting methods and are in great demand at operational forecasting centres such as the Met Office. You will learn about the role of the oceans in both marine and weather forecasting. There is also growing interest in using novel Machine Learning methods for understanding large climate datasets and you will explore how these methods can be brought into use for analysis of the ocean circulation.

Training opportunities:

The student will benefit from in-house training in oceanography and especially data assimilation methods where the Reading Meteorology and Maths departments have a world-renowned centre. The Computer science department is also part of our university school providing training in novel data science methods.

The student will have regular meetings with Met Office staff and will spend several periods working in the Met Office marine forecasting group in Exeter. They will also benefit from extensive research training opportunities through the SCENARIO Doctoral Training program.

Student profile:

We are looking for a strongly motivated individual with an interest in the oceans and climate and in data analysis, and a background in the physical sciences, meteorology or oceanography, applied mathematics or computational sciences to take on this project. We will provide training on modelling and computer programming to motivated candidates as needed, however confidence in solving numerical problems computationally would be an advantage.

Funding particulars:

This project has CASE sponsorship from the UK Met Office.

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