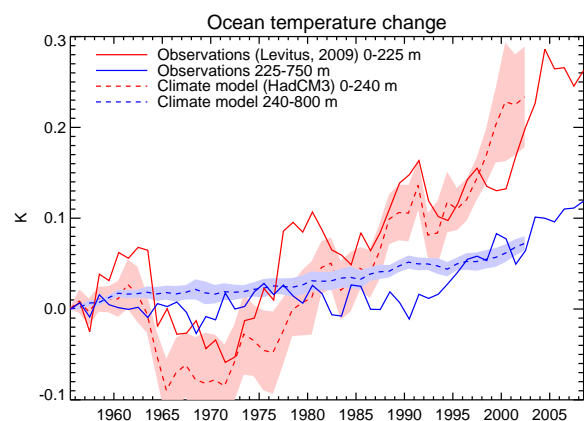


Quantifying and fingerprinting the processes of ocean heat uptake during climate change

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During the 20th century the global-mean climate has become warmer, and much greater warming is projected during the 21st century due to emissions of greenhouse gases. The ocean imparts thermal inertia to the climate system; if the ocean had a negligible heat capacity, the rate of warming would be about 50% greater. The rate of warming at the surface is substantially influenced by the efficiency of vertical heat transport within the ocean, whereby heat is removed from the surface to the deeper layers. State-of-the-art global climate models exhibit a considerable range of results for this efficiency. This leads to substantial uncertainty in the expected rate of global warming, and in the rate of global-mean sea-level rise due to thermal expansion of sea water, which is the largest contribution to projected sea-level rise (it is more important than mass loss by glaciers). Owing to the many impacts of climate change and sea level rise, it is important that we reduce these uncertainties. One way to do this is by comparison of ocean temperature changes observed and simulated for the last few decades. This is the subject of the proposed PhD project.



As a simple example, the diagram compares the rate of warming as observed during the last fifty years (solid lines) in two upper layers of the ocean (red and blue) with the results of a model simulation (dashed lines; model statistical uncertainty is shown by the shading). Models and observations agree quite well for the upper layer, including the sudden cooling that following the eruption of Mount Pinatubo in 1991, but in the lower layer the model indicates a steadier rate of warming than observations.

To proceed further, we will carry out more detailed analyses (in depth, time, latitude and ocean basin), motivated by our understanding of ocean heat transport processes (by the large-scale wind-driven and buoyancy-driven circulations, convection and other turbulent mixing), and apply statistical “fingerprinting” techniques, which are optimal ways to quantify the presence of an expected signal in noisy data. We hope to constrain the processes of ocean heat uptake in the past and thus the projections for the future. Such techniques have successfully and extensively been used to attribute aspects of surface climate change to particular forcings (such as greenhouse gases and volcanic eruptions), but less previous work has been done on ocean climate change and very little on processes of ocean heat uptake, so there are several possible approaches we could follow.

Student profile:

This project would be suitable for a student with a degree in physics or mathematics, and particularly for someone who has interests in the ocean and in climate change.

Funding particulars:

This project will be funded by a NERC quota studentship.