Dynamics of the Orkney Passage Outflow (DynOPO)

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Project Description
This project will assess the dynamics of the outflow of Antarctic Bottom Water (AABW, a water mass formed near Antarctica that integrates the deepest layers of the global ocean's overturning circulation) at one of its key sites of export from the subpolar Southern Ocean: the Orkney Passage. The project focuses on this passage following recent evidence that it channels the single most voluminous outflow of AABW from the Antarctic subpolar seas, and that it may be centrally implicated in the climatic changes exhibited by AABW in the Atlantic Ocean. The project is exciting because the new way in which we propose to look at the Orkney Passage outflow promises to deliver significant advances in our conceptual understanding of abyssal ocean circulation and its sensitivity to climatic variations in forcing, against a backdrop of remarkably rapid and widespread changes in AABW properties observed to be ongoing over much of the global ocean.

During the last three decades, AABW has exhibited a striking warming and contraction in volume over much of the global ocean abyss, particularly in the Atlantic basin. The causes of these changes are unknown. Possible explanations in terms of a climate-scale perturbation to the properties of the AABW precursor water masses near the Antarctic margins have been tentatively put forward by a number of authors, yet endorsement of these ideas by time series of water mass characteristics near the AABW sources is at best equivocal. In the Atlantic sector, observations strongly suggest a tantalizing alternative (or complementary) explanation: that climatic variations in the basin-scale properties of AABW downstream of its source region are primarily controlled by wind-forced changes in export, via a mechanism involving the modulation of small-scale turbulent mixing in the Orkney Passage. We propose to test this emerging hypothesis by (i) measuring the circulation, water mass transformations and their underpinning physical processes in the passage for the first time, and (ii) assessing the climatic significance of those processes with a cost-effective enhancement of the BAS-supported mooring array presently deployed at the site. On a fundamental level, we expect these measurements to yield unprecedented insight into the mechanisms by which small-scale physics may shape deep-ocean climate.

The project is conceived as a U.K. contribution toward the emerging international Southern Ocean Observing System (SOOS). It relates strongly to two of the six science challenges identified in the SOOS strategy, specifically the stability of the overturning circulation in the Southern Ocean (of which AABW constitutes the lower limb), and the role of the Southern Ocean in global heat and freshwater fluxes.

Project Timeline
October 2013 – September 2016

Key deliverables

Scientifically, the project will provide:

- Quantification of the circulation and transformation of AABW in the Orkney Passage.
- Understanding of the dynamical controls of the rates of flow and transformation of AABW in the Orkney Passage.
- Insight into the response of the AABW outflow through the Orkney Passage to wind forcing on time scales up to interannual.
- an interpretation of decadal-scale change in AABW properties in the Atlantic Ocean, and an assessment/progression of the SOOS strategy to monitor such change.

Key datasets that will enable this science include:

- Cruise-based data, including CTD profiles, LADCP profiles, underway data, and data from free-fall microstructure profilers
- Data from Autosub, and autonomous underwater vehicle, which will be fitted with CTDs, ADCPs and turbulence sensors.

Funding

This project is supported by the Natural Environment Research Council, UK

Linkages with other programmes

The project will be a contribution to the international CLIVAR programme, and will enhance science undertaken via the British Antarctic Survey core programme and US programmes.

Data Management

All data will be submitted to the British Oceanographic Data Centre (BODC), who will make it available to the community via usual channels (including rapid delivery for e.g. Argo calibration, and delayed post-QC mode).