UNIVERSITY OF SOUTHAMPTON

ABSTRACT

FACULTY OF NATURAL AND ENVIRONMENTAL SCIENCES

Ocean and Earth Sciences

Doctor of Philosophy

UNRAVELLING HIGH FREQUENCY AND SUB-SEASONAL VARIABILITY AT KEY OCEAN CIRCULATION 'CHOKE' POINTS: A CASE STUDY FROM GLIDER MONITORING IN THE WESTERN MEDITERRANEAN SEA

By Emma Elizabeth Heslop

A quiet revolution is taking place in ocean observations: in the last decade new multi-platform ocean observatories have been progressively implemented in forward looking countries with ocean borders of economic and strategic importance. These developments are designed to fill significant gaps in our knowledge of ocean state and ocean variability through long-term science and society led monitoring. These new ocean observatories are now delivering results, not only the headline results of single issue experiments, but careful and systematic improvements in our knowledge of ocean variability, and thereby, increasing ocean forecast skill, the ability to link physical process to ecosystem response and to detect the impact of future climatic change.

This PhD has used data from a recently initiated glider monitoring program to characterise variability in key components of the Mediterranean circulation that act through the Ibiza Channel. The Ibiza Channel is a key 'choke' point in the Mediterranean basin scale circulation and governs an important north/south exchange of different water mass that is known to impact regional ecosystems, in a zone of high biodiversity. The quasi-continuous glider sampling at this critical location has enabled important sub-seasonal to seasonal variability to be captured, and models to be developed to characterise the previously described 'complex' pattern of exchange. For the first time, glider monitoring revealed high frequency variability in the transport of water mass, of the same magnitude as the previously characterised seasonal cycle, but occurring over timescales of days to weeks. Although previous ship surveys had noted high cruise-to-cruise variability, they were insufficient to show that in fact water volumes exchanged through the Ibiza Channel vary on 'weather' timescales. Using the glider data in combination with an 18-year record of ship missions, long-term seasonal cycles in the north/south exchange were characterised. New month-by-month patterns were defined for the southward transport, while generally held views regarding the seasonality of the northward transport were revised. The pattern of the exchange was further characterised by 4 proposed seasonal 'modes', which reflect an annual interplay between vigorous mesoscale and basin scale dynamics.

Restricted 'choke' points between our ocean basins are critical locations to monitor water transport variability, as they constrain the inter-basin exchange of heat, salt and nutrients. The Ibiza Channel is one such location. In addition to characterising key components of the regional circulation, this PhD also provides insight into use of glider monitoring at such critical locations, which can be used to inform multi-platform ocean observation strategy. This study is part of the quiet revolution.