Western Australian Marine Science Institution (WAMSI) Project 6.3 - Final Report Summary

Ocean glider deployment as part of the West Australian Integrated Marine Observation System (WAIMOS).

The development of an integrated marine observing system (WAIMOS) for Western Australian was been funded through the National Collaborative Research Infrastructure Scheme (NCRIS) and EIF the Super Science as part of the Integrated Marine Observation System (IMOS) for Australia. In excess of $32 million has been invested in Western Australia. An emphasis is made on the multi-disciplinary real-time data to allow the development of each discipline and their integration. Under this project, multi-disciplinary marine data streams are provided through the deployment of a range of instrumentation such as HF Radar, Ocean Gliders, Ocean moorings and acoustic observatories. This project was developed to provide funding to facilitate the deployment of ocean gliders in Western Australia and to provide a top-up for a PhD student.

Traditionally, oceanographic sampling has been undertaken from ships; however due to the significant costs of operating an ocean research vessel (of the order of $50,000 per day) and limitations of working in poor weather conditions this has resulted in difficulties in data collection, particularly where sustained, long term, observations are required to examine long term variability. Ocean gliders, autonomous instrument platforms designed to efficiently operate throughout the water column in water depths of up to 1000m, provide an excellent alternative measurement tool. Due to their relatively low cost and extended deployment durations, gliders will allow for the collection of sustained long term observations, even during periods of extreme weather conditions. The resulting long term data sets will enable researchers to better document the variability of the ocean and of coastal ecosystems. Gliders descend and ascend through the water column by changing their volume and hence their buoyancy; this momentum is converted to forward motion by wings resulting in an average horizontal velocity of 0.25 - 0.40ms-1. Dive pitch is controlled by moving an internal mass (battery pack) and steering is achieved through the use of an active rudder (Slocum) or by the rotation of an off-centre internal mass (Seaglider). Using GPS, internal dead reckoning and altimeter measurements the glider autonomously navigates its way to a series of waypoints. Near real-time data can be uploaded to a base computer via two way Iridium satellite communication, which also allows for remote updating of glider control parameters and waypoints. The ocean gliders used in this project consisted of a similar suite of sensors to measure temperature, conductivity, dissolved oxygen (DO), turbidity, coloured dissolved organic matter (CDOM) and chlorophyll-fluorescence. The Slocum glider, which has a maximum depth of 200m, was deployed off Two Rocks undertaking repeat transects since January 2009 to date (ongoing to June 2013. The aim was to traverse along the SRFME Two Rocks line past the IMOS mooring locations and transect into Perth canyon and then return through the axis of the canyon. A total of 20 Slocum deployments were completed between January 2009 and August 2011. The Seaglider has a maximum depth of 1000m and an endurance of up to 4500km (up to 6 months). Deployments of Seaglider be deployed from Dampier was undertaken along the west coast between North-west Cape and Rottnest Island. A total of 10 Seaglider deployments were completed between January 2009 and August 2011.

The major research finding of the project to date is the discovery and documentation of dense shelf water cascade along the Rottnest continental shelf. Dense shelf water is formed when the density of the inner shelf water is increased either due to a decrease in temperature through cooling and/or an increase in salinity due to either evaporation or ice formation. This water is transported near the sea bed across the continental shelf. Formation and propagation of this buoyancy driven current, known as dense shelf water cascade: DSWC has been documented in over 60 locations globally, with the majority located in Polar Regions where DSWC results from ice formation. The DSWC provides an effective mechanism for the exchange of water, heat, salt, phytoplankton, nutrients and pollutants between shallow coastal regions and the deep ocean as well as an understanding of the impacts of climate change being transferred to the deep ocean and the supply of organic matter to deep-sea ecosystems. In Australia where evaporation is dominant, DSWC has been documented in shelf regions such as in the Great Australian Bight, offshore Sydney and the northwest Australian Shelf and from inverse estuarine systems such as Spencer Gulf, Shark Bay and Hervey Bay. These studies have been limited to data collected during a single season (e.g. a single cruise) and therefore the seasonal variation of DSWC due to changing atmospheric conditions were not addressed. The repeat ocean (Slocum) glider transects offshore Two Rocks provided high-resolution temperature and salinity data to describe the seasonal evolution of the stratification and formation of dense shelf water along the Rottnest continental shelf which had not been identified previously. The use of ocean gliders as an observational platform enabled the shelf waters to be sampled at high temporal and spatial resolution and also under weather conditions which precluded traditional shipborne measurements. The data revealed that formation of dense water inshore and its transport across the shelf as a near bed gravity current was a regular occurrence, particularly during autumn and winter months. In autumn, the dense water is mainly formed through changes in salinity resulting from evaporation, whilst in winter; temperature change through surface cooling was the dominant factor. The mean wind speeds also decrease during the transition during autumn. The speed of the DSWC was estimated to be 0.01-0.02 ms^{-1}, and similar to that measured in other selected regions globally. The offshore transport from the shelf is a significant component of the alongshore wind-driven transport.

The analysis of Seaglider data is ongoing with ocean glider deployments continuing at least until June 2013 with additional deployments in the north-west shelf.

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