**Final Cruise Report: RV Falkor cruise 13 April to 4 May 2015**

**Timor Sea Reef Connections (FK150410)**

## Cruise Science party

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## Cruise Purpose

Our overall objective was to quantify the connections between the oceanic waters of the Timor Sea and the coral reef atoll and shoal systems on the western margin of the Oceanic Shoals bioregion. More specifically, the major focus was to quantify the tidally-dominated physical oceanographic processes driving the connections between the surrounding ocean and the coral reef systems, and to integrate this physical understanding with historical and current cruise observations of the seabed biodiversity and productivity in these biological hotspots.

The primary study site of the cruise was the largest and most iconic of the atolls of the region: the Scott Reef emergent atoll. A secondary study objective was to conduct a preliminary examination of related dynamics at some nearby fully submerged atoll systems, to assess any differences between the physical and biological processes here with the emergent coral atoll system at Scott Reef.

## Cruise Outcomes

The cruise involved both deployment and recovery of moorings and extensive-ship based observations. At Scott Reef, a total of 27 different moorings, at depths ranging from 1 m to 400 m, were deployed and recovered with near 100% data return. Ship-based observations used the multibeam echo sounder, fisheries sounder, ADCP, Falcon ROV, CTD and rosette samplers, on-board supercomputer and the TurboMAP profiler. Short visits were made to the nearby Echuca and Vulcan submerged shoals, but only limited data could be collected from Falkor due to the poor weather and sea state. The total amount of data obtained during the cruise was near 15TB, nearly all from the Scott Reef region. Both summarised and raw data is now all archived and accessible through the North West Atlas website (northwestatlas.org) data download link from the SOI website.

The major driving force for flow in the region is the tide, and the strength and time-variability of this flow around Scott Reef and in the lagoonal systems of both North and Scott Reef was accomplished by the combination of mooring data, ship-based observations, and high resolution non-hydrostastic numerical modelling. In the 400 m deep channel separating North and South Scott, flows exceeding 1.5 m/s varying in opposite directions every 6.2 hr were observed, with the peak in flow being subsurface and associated with the topographic channelling of the tidal flow through the steep-sided channel. Strong internal waves were observed in this channel with amplitudes up to 75 m. Intense turbulence and vertical mixing was observed in the channel, with measured vertical mixing rates or diffusivities as high as 100 times more intense than in the oceanic waters surrounding the Scott atoll system (Rayson et al 2016a,b). From a physical oceanography point of view, the region is a flow and mixing hotspot.

These same tidal flows also drive strong exchange into and out of the lagoon systems. The large South Scott Reef lagoon had a mean depth of 45 m and was found to have two major exchange regions via channels at the northwest and southeast. With flow directions reversing, but over just 6.2 hr, water was drawn from offshore depths as much as 50 m deep and transported as far as 5 km horizontally to be pumped directly into the lagoon. During the reverse or ebb phase, the same water is not drawn out of the lagoon, there is effectively a next exchange or flushing time of approximately 12 days. There is thus a clear mechanism for deeper nutrient rich water to be moved from the open ocean into this system on timescale of the order of 10 days. ROV habitat measurements showed strong spatial correlation with lagoonal tidal flows and the occurrence of and transition between major benthic reef and fish communities.

Post to FK150410 cruise, Scott Reef has been affected by a significant and wide spread coral bleaching event. This has lead to a follow up cruise to Scott Reef by AIMS and a revisit of a number of the shallow and deep-water sites surveyed in April of 2015. The data collected by FK150410 in conjunction with this new information has made a significant new scientific contribution to understanding the causes nature and extent of coral bleaching in deeper reef communities.

**Presentations**

Ocean-coral reef connectivity: physics meets biology, G. Ivey, Ecole Normale Superieure de Lyon, Lyon, France (3/7/2015).

Ocean- reef interactions, Scott Reef, Western Australia: physics meets biology, G. Ivey, Scottish Association for Marine Science (SAMS), Oban, Scotland, (8/9/ 2015)

Part North West Atlas presentation, C. Moore, A. Heyward and B. Radford,
Charles Darwin University, Darwin (03/05/2016)

Part of North West Atlas Presentation. C. Moore, A. Heyward and B. Radford
Atlas of living Australia workshop, Perth (27/05/2016)

Innovations in the use of multibeam data for habitat analysis, B. Radford and A. Heyward,
Woodside Science Innovation Workshop, Perth (10/11/2015)

Innovation in spatial analysis using examples from Scott Reef and the Kimberly's, J. Miller, M. Puotinen, M. Thumbs, B. Radford, A. Heyward, Woodside Science Seminar Series Perth (25/11/2016)

Hydrodynamics and thermal regime of a shallow reef-atoll rim, S. Maticka, 2016 Ocean Sciences Meeting, New Orleans, USA, (23/2/2016)

Part of North West Atlas presentation, C. Moore, A. Heyward and B. Radford
PTTEP Australia Science Seminar, Perth (26/03/2016)

Oceanic Drivers of a remote atoll reef system: Browsing Scott Reef, Western Australia, R. Lowe, Shell EMI Seminars, Perth (10/5/2016)

Observations of high-frequency internal waves and strong turbulent dissipation rates generated by a constriction between two coral atolls, M. Rayson, 8th International Symposium on Stratified Flows, San Diego, (29/8/2016)

**Publications**

*List any conference or journal papers, including those planned or proposed, or in draft*

Rayson, M., Bluteau, C.E., Ivey, G.N. and N. Jones (2016a) Observations of high-frequency internal waves and strong turbulent dissipation rates generated by a constriction between two coral atolls. Paper to be presented at 8th International Symposium on Stratified Flows, San Diego, August 2016.

Rayson, M., Bluteau, C.E., Ivey, G.N. and N. Jones (2016b) Observations of high-frequency internal waves and strong turbulent dissipation rates generated by a constriction between two coral atolls. Journal of Geophysical Research Oceans, in preparation.

Green, R. et al. (2016) Internal-tide driven nutrient and heat fluxes to an atoll lagoon. Journal of Geophysical Research Oceans, in preparation.

Maticka, S. et al. (2016) Thermodynamics of a macrotidal shallow atoll reef rim. Journal of Geophysical Research Oceans, in preparation.

Gilmour, J. et al.(2016) The nature and extent of deep water coral bleaching in Scott Reef Lagoon. In prep Cite J and Nature Reports

Cappo, M et al. Hydroacoustic models of primary productivity, habitat and fish assemblages in Atoll lagoon and oceanic shoal environments. (2016) Ecologia , in preparation

Radford, B.T and Heyward, A. (2016) Using repeat multibeam hydroacoustic surveys to measure structural dynamics of deep coral reef environments. Coral Reefs, in preparation

**Preliminary/Potential outcomes**

PhD students working on data:

Montserrat Landero (AIMS/Curtin)
Harriet Davies (UWA/AIMS)
Rebecca Green (UWA)
Samantha Maticka (Stanford University)

Postdoc working on data
Sven Gastauer (AIMS/Curtin)
Matt Rayson (UWA)
Cynthia Bluteau (UWA)

**Media Releases**

ROV Surveys of Scott Reef from the RV Falkor (16/04/2016)

http://eatlas.org.au/data/uuid/6ef94e1e-a739-47b5-9c64-0fe8486fb9ba?_ga=1.93134301.131243098.1441171808

Scott Reef bleaching revisiting sites one year post RV Falkor trip

http://www.aims.gov.au/-/western-australian-reefs-feel-the-heat-from-global-bleaching-event

**Data Sets**

http://q0189.hpc.jcu.edu.au/Falkor/