GBROOS – AN OCEAN OBSERVING SYSTEM FOR THE GREAT BARRIER REEF

S.J. Bainbridge[(1)], C.R. Steinberg[(1)], M.J. Furnas[(1)] and M.L. Heron[(2)]

[(1)]Australian Institute of Marine Science, PMB 3 MC, Townsville Qld 4810 Australia, s.bainbridge@aims.gov.au
[(2)]James Cook University, Townsville Qld 4811 Australia, mal.heron@jcu.edu.au

1. INTRODUCTION

The Great Barrier Reef Ocean Observing System (GBROOS) is a geographic node of the Australian Integrated Marine Observing System (IMOS) [1]. GBROOS is an observation system that seeks to understand the impact of the Coral Sea, in particular cool and warm water intrusions, on the Great Barrier Reef (GBR) of north eastern Australia.

Globally coral reefs are under threat. A recent survey [2] shows that 20% of reefs globally are already lost; a further 15% are under immediate threat and another 20% are under longer term threat. A number of climate related coral bleaching events have been observed, notably in 1998 and 2002 [3]. There is evidence that corals are particularly sensitive to climate change and that the long-term sustainability and survival of coral reefs may be under threat [4]. The GBROOS project looks to provide the real-time physical data required to understand the impact of climate change and other environmental factors on the sustainability of the GBR.

2. MATERIALS AND METHODS

The experimental design provides complementary observational data at a range of scales from synoptic remote sensing data down to fine scale sensor network data; that is to link processes occurring at the tens of kilometres down to the environment around an individual coral head. The location and type of observational equipment deployed under GBROOS is shown in Fig. One.

At the largest scale is remote sensing data received from an X and L band receiving station located at the Australian Institute of Marine Science (AIMS) near Townsville in north-east Australia. The data includes NOAA AVHRR data used for Sea Surface Temperature (SST) and MODIS Terra and Aqua data used for measures of ocean colour and productivity. Associated with this is a range of real-time validation data including a radiometer mounted on a commercial ferry, an optical reference station for ocean colour validation and a number of underway systems located on the AIMS research vessels. The outputs are validated daily SST and Ocean Colour maps showing the large scale patterns of ocean flow and coastal processes. The data supports work on modelling and for the development of better satellite atmospheric correction and validation algorithms targeted at tropical coastal systems.

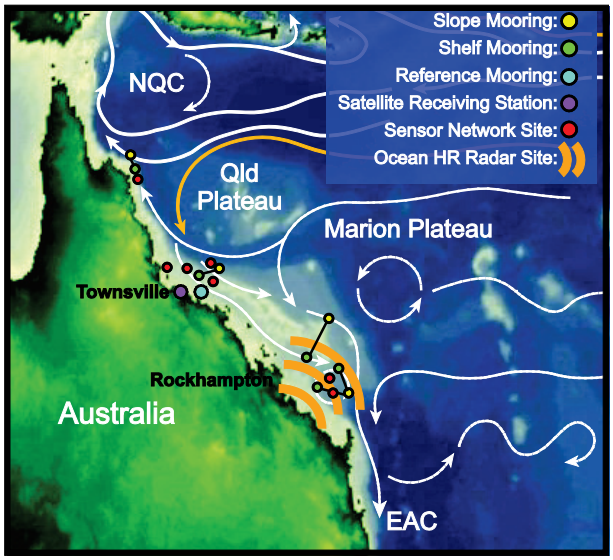

Figure One. Location and type of deployed equipment.

At the next scale is an ocean HF radar installation in the southern part of the GBR that provides real-time information on surface waves and currents. The installation covers around 150 square kilometres at a resolution of four kilometre cells with data collected every ten minutes using Codar *SeaSonde* units [5]. The data is retrieved in real-time and processed into vector plots showing surface currents and waves.

A series of long-term reference moorings have been deployed around Australia as part of the IMOS project [1]. GBROOS maintains the moorings off Townsville in the central Great Barrier Reef and off Darwin in northern Australia. The moorings have a surface Meteorological station (Vaisala WXT520 [6]), bottom mounted acoustic Doppler current profiler for measuring currents and waves and a series of SeaBird SBE39's [7] and WetLabs WQM [8] instruments to give a vertical profile of temperature, salinity, turbidity, chlorophyll and dissolved oxygen. The moorings are serviced every six months. At each mooring monthly water samples are also collected and analysed for zooplankton, pigments, alkalinity and water chemistry.

The heart of GBROOS is an array of moorings along the Great Barrier Reef designed to monitor the flow of oceanic water along and into the reef matrix. The moorings are set up as pairs with one offshore deeper slope mooring and one inshore shelf mooring.

Pairs of moorings are located in the northern, central and southern parts of the GBR (see Fig. One). In the very southern area the design is more complex in order to capture the eddy systems that occur in this region. The shelf moorings are similar to the reference moorings in design although the slope moorings are subsurface delayed mode only.

The finest scale data comes from wireless sensor networks located on seven reefs (see Fig. One). The sensor networks allow for intensive sampling of environments down to very shallow locations giving real-time information about water flows around individual corals as well as inflow and outflows from the reefs themselves. Uniquely the sensor network uses smart controllers and high-speed two-way IP based communications allowing the systems to be controlled and monitored in real time. This allows for adaptive sampling where the systems are able to change how and what they sample in response to events. The deployments mix oceanographic grade instruments (such as SeaBird SBE37's [7]) with smart controllers to give smart adaptable systems returning quality environmental measurements.

3. RESULTS

The design of the deployments is targeted at understanding particular geographic issues. In the south the issues are on how the southern moving oceanic flows that go outside and inside the reef matrix form into a coherent southward flow as the East Australian Current (EAC). This area is one of complex eddies and re-circulation, the variability of which has an impact on the downstream oceanography and climate [9]. As a result the EAC source waters in the Coral Sea have impacts down the populated eastern coast of Australia.

In the central part of the GBR the issue is the direct inflow of oceanic water into the reef matrix and the impact this has on thermal events such as summer warming and associated risks of coral bleaching. Intrusions have been detected across the slope almost to the coast [9] and understanding what forces these events will lead to a better understanding of how oceanic changes will be reflected into the on-shore communities.

In the remote north very little basic information is known and so the systems are designed to collect comparative information to better understand how these areas function. Issues such as climate links to spawning events (such as coral mass spawning) and fish reproduction drive the design of the deployments.

The implementation integrates a variety of technologies and data over a range of ecosystems from open ocean to near shore coastal systems allowing connectivity between scales and systems to be investigated.

4. DISCUSSION

GBROOS is an observing system that looks to measure the connectivity between the oceanic systems that drive the shelf and coastal water flows and the biological systems that rely on the services provided by the surrounding water. The impact of long term changes in the oceans on coastal systems needs to be understood if the long term sustainability and survival of coral reefs is to be assured. Observation systems, such as GBROOS, are a fundamental part of understanding these systems and in developing appropriate responses. GBROOS is unique in linking ocean and coastal processes through the deployment of a range of systems, including some innovative 'smart' systems, in near and off-shore environments not traditionally covered by observing systems.

5. REFERENCES

1. IMOS (2009) *Australia's Integrated Marine Observing System.* www.imos.org.au

2. Wilkinson C (ed) (2008) *Status of Coral Reefs of the World. 2008.* Global Coral Reef Monitoring Network, Australian Institute of Marine Science, Townsville, Australia, 304pp.

3. Berkelmans R, De'ath G, Kininmonth S, Skirving WJ (2004) *A comparison of the 1998 and 2002 coral bleaching events on the Great Barrier Reef: spatial correlation, patterns and predictions.* Coral Reefs 23: 74-83.

4. Hoegh-Guldberg O, Mumby PJ, Hooten AJ, Steneck RS, Greenfield P, Gomez E, Harvell CD, Sale PF, Edwards AJ, Caldeira K, Knowlton N, Eakin CM, Iglesias-Prieto R, Muthiga N, Bradbury RH, Dubi A, Hatziolis ME (2007) *Coral reefs under rapid climate change and ocean acidification.* Science 318: 1737-1742.

5. Codar Ocean Sensors (2009) www.codar.com

6. Vaisala Group (2009) www.vaisala.com

7. Sea-bird Electronics, Inc. (2009) www.seabird.com

8. WET Labs, Inc. (2009) www.wetlabs.com

9. Brinkman R, Wolanski E, Deleersnijder E, McAllister F, Skirving W (2002) *Oceanic inflow from the Coral Sea into the Great Barrier Reef.* Estuarine, Coastal and Shelf Science, 54, 655–668.

6. ACKNOWLEDGEMENTS

GBROOS is funded by the Integrated Marine Observing System (IMOS) - an initiative of the Australian Government being conducted as part of the National Collaborative Research Infrastructure Strategy and the Queensland State Government. The support of the Tropical Marine Network (University of Sydney, Australian Museum, University of Queensland and James Cook University) who run research stations at One Tree, Lizard, Heron and Orpheus Islands, respectively, on the GBR is also acknowledged.