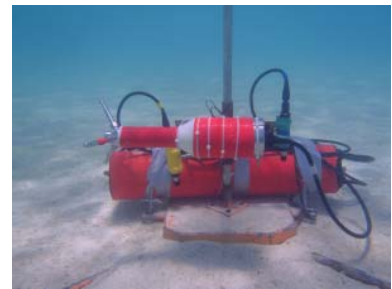


***Possible research projects to be undertaken in the Geocoastal Research Group (GRG) under Jody Webster and Ana Vila-Concejo's main supervision. Most projects can be tailored to suit your time-frame and expertise (i.e., Honours, Master's, Phd). Come and talk with us if you are interested in any of them.***

***By undertaking a research project with us, you will become a member of the Geocoastal Research Group; our research students participate in our field campaigns. So even if your project does not specifically include fieldwork, you will have plenty of opportunities to go to the field should you wish to do so. Only in 2014/2015 we have had students participating in field work in Hawaii, Seychelles, French Polynesia and the Great Barrier Reef and travelling to One Tree Island and Heron Island Research Stations. Come joins us on the Geosciences of Beautiful places!***

<http://grgusyd.org/>

<https://www.facebook.com/GeocoastalResearchGroup>



### **Coral reef geomorphology**

1. Quantitative geomorphology of the modern Great Barrier Reef (JW)
2. Morphologic evolution of the rubble cays at One Tree Reef (AVC)

### **Coral reef evolution**

1. Controls on the evolution of the Great Barrier Reef: linking 4D numerical modeling and observational data. (JW)
2. Understanding the Holocene & Pleistocene evolution of the Southern Great Barrier Reef (JW)

### **Physical processes and sediment dynamics on reefs**

1. Sediment transport of coral sand (AVC)
2. Wave climate and wave modelling in the Great Barrier Reef (AVC)

### **Shelf and margin evolution**

1. Sediment architecture and evolution of Halimeda mounds in the Northern Great Barrier Reef (JW)
2. Sediment architecture and evolution of the upper slope of the Great Barrier Reef margin. (JW)
3. Great Barrier Reef phase shift: Gardner Bank to Gardner Reef? (JW)

### **Morphodynamics of temperate coasts**

1. Morphodynamics of low-energy estuarine beaches (AVC)
2. Morphodynamics of embayed beaches (AVC)

### **Paleoenvironmental change**

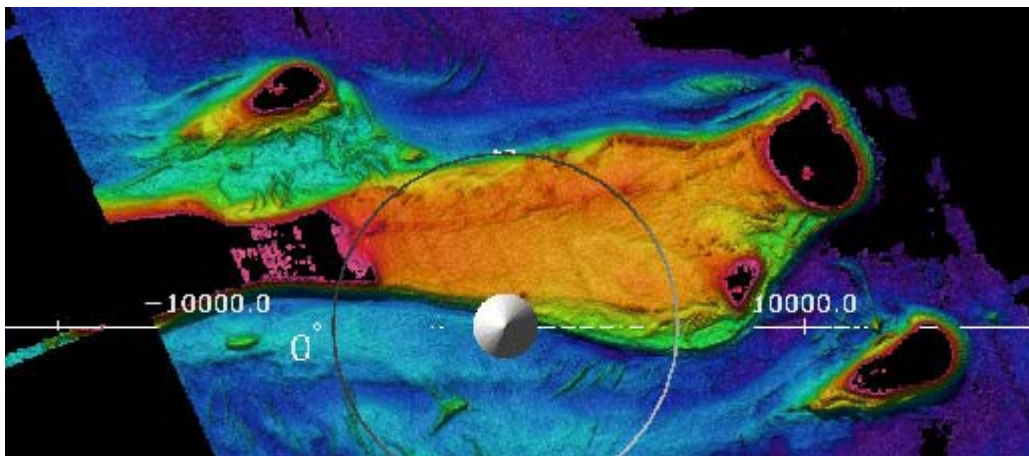
1. Reconstructing paleoclimate variability using fossils corals in the western tropical Pacific Ocean (JW)
2. What caused the lag in the initiation of the Great Barrier Reef during the early Holocene? An investigation of water quality and reef response (JW).

## CORAL REEF GEOMORPHOLOGY

### Quantitative geomorphology of the modern Great Barrier Reef

Supervisor: Jody Webster (USYD) [jody.webster@sydney.edu.au](mailto:jody.webster@sydney.edu.au)

The project will investigate new and existing high-resolution remote sensing data (LADS & LADS & multibeam bathymetry data, aerial photographic imagery) to understand the main processes controlling the geomorphic variation of reef and associated environments in Great Barrier Reef. Using advanced GIS and 3D visualization tools, we will develop a new quantitative morphologic characterisation of the reef and inter-reef areas (ie. sediment wedges, banks, channels, shoals, sand wave/dunes). We will also explore the relationships between the benthic habitats/sedimentary facies, the quantitative geomorphic data and physical processes operating in the GBR. The project will have implications for improving our understanding modern reef environments and processes as well enhancing ancient carbonate petroleum reservoir models. **This project is part of the Geocoastal Research Group's ARC Discovery funded project to investigate fossil reef cores from One Tree and Heron Reef.**



High-resolution LADS bathymetry data from southern Great Barrier Reef showing reef and inter-reef areas (data source <http://www.hydro.gov.au/aboutus/lads/lads.htm>).

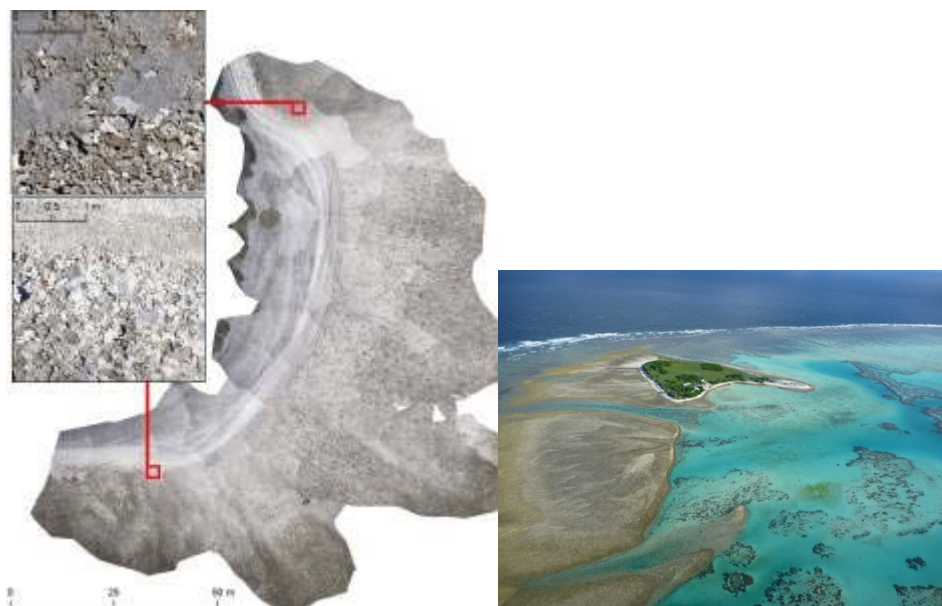
## CORAL REEF GEOMORPHOLOGY

### Morphologic evolution of the rubble cays at One Tree Reef

Supervisor: Ana Vila-Concejo [ana.vilaconcejo@sydney.edu.au](mailto:ana.vilaconcejo@sydney.edu.au)

One Tree Reef in the Southern Great Barrier Reef has two rubble cays: One Tree Island is located on its SE corner, and Two Tree Island is located on its NE flank. They are both composed of unconsolidated sediment that is deposited under high energy conditions. We have a collection of remotely sensed images that can be used to determine the decadal evolution of the islands; we also have some annual measurements taken over the last few years using state-of-art techniques such as real time kinematic positioning systems and structure from movement remote sensing using kites. This project encompasses analysing the decadal and annual evolution of One Tree Island in relation with the wave climate and cyclonic events.

**This project is related to Ana Vila-Concejo ARC funded Future Fellowship. Collaboration with Dr Mitch Bryson from the Australian Centre for Field Robotics.**



[Photo credit: S Duce (left) D. Kauffman(right)]

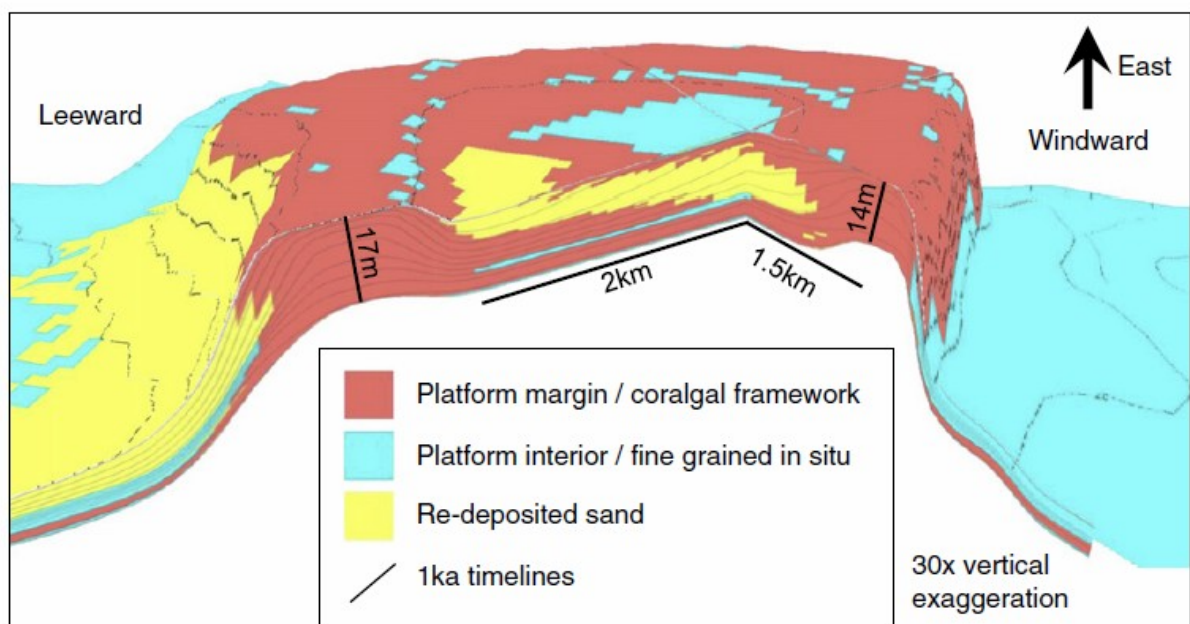


## CORAL REEF EVOLUTION

**Controls on the evolution of the Great Barrier Reef: linking 4D numerical modeling and observational data.**

**Supervisor: Jody Webster (USYD) [jody.webster@sydney.edu.au](mailto:jody.webster@sydney.edu.au)**

This project will investigate the relationship between biological and geological processes controlling the evolution (stratigraphic ages, residence times and geometries ('architecture') of coral reef systems. We will construct new 4D numerical models using state of the art software (eg., CARBONATE 3D, ReefSAM, DIONISIS) and compare them against observational reef data sets from the Great Barrier Reef. We aim to assess the sensitivity of coral reef systems to various environmental stresses (eg. sea-level rise, subsidence and sediment flux) acting on different timescales, magnitudes and rates. The project may also involve field work to One Tree Reef in the southern GBR to calibrate model parameters and processes against real world sedimentary and biological examples. **This project is part of the Geocoastal Research Group's ARC Discovery funded project to investigate fossil reef cores from One Tree and Heron Reef.**



**Fig. 5.** 3D visualization looking east through the best estimate model output.

Modelling of One Tree Reef using CARBONATE 3D (Barrett and Webster, 2012; Sedimentary Geology).

## CORAL REEF EVOLUTION

### Understanding the Holocene & Pleistocene evolution of the Southern Great Barrier Reef

**Supervisor: Jody Webster (USYD) [jody.webster@sydney.edu.au](mailto:jody.webster@sydney.edu.au)**

As global climates change the modern Southern Great Barrier Reef (Capricorn Bunker Group) will likely record the first and most marked biologic and geologic changes. Therefore it is crucial, now more than ever, to develop a comprehensive geological framework with which to interpret these possible changes. The project will focus on a major event in the evolution of this sensitive region of the GBR – the Holocene “turn-on” between 8-9 ka and the growth of the reef during the Last Interglacial Period (~125 ka). We will investigate a suite of new and existing fossil coral cores from the region to: (1) establish the precise timing of reef initiation and early growth using new C14-AMS and U/Th ages; (2) assess the sedimentologic and biologic composition (ie. corals, coralline algae) of the reefs; and (3) reconstruct the paleoceanographic conditions during these important periods in Earth History. The project may involve field work to One Tree Reef in the southern GBR in order compare modern sedimentary and biological environments to those observed in the fossil reef cores. **This project is part of the Geocoastal Research Group’s ARC Discovery funded project to investigate fossil reef cores from One Tree and Heron Reef.**

<http://grgusyd.org/2015/09/01/core-on-deck>



A representative massive fossil coral from the One Tree Reef cores and below image of the “Jack-Up” platform used to collect new fossil reef cores on Heron and One Tree Reef (Photo credit: B Dechnik and J. Webster)



## PHYSICAL PROCESSES AND SEDIMENT DYNAMICS ON REEFS

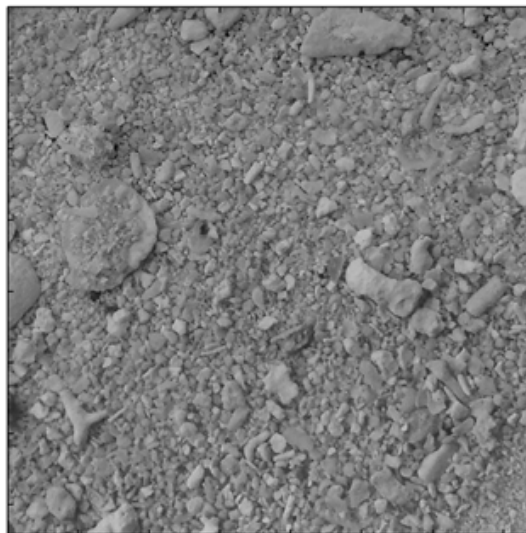
### Sediment transport of coral sand

**Supervisors:** Ana Vila-Concejo [ana.vilaconcejo@sydney.edu.au](mailto:ana.vilaconcejo@sydney.edu.au) ; Tristan Salles [tristan.salles@sydney.edu.au](mailto:tristan.salles@sydney.edu.au)

Coral sand has a range of properties that greatly differ from siliciclastic (mostly quartz) sand. It is typically less rounded and more angular; density can vary from very dense solid carbonate sand to softer carbonates or hollow grains; finally, coral sand is typically not very well sorted when compared to siliciclastic sand.

Sediment transport can be calculated using equations which take into account density and average grain size; these equations have a large uncertainty when used for siliciclastic sediments. This uncertainty is even larger for carbonate/coral sand. With this project, we want to examine coral sand and characterise it; we want to look at the physical properties and see what the typical density is; we will determine size and textural parameters; we will examine existing sediment transport equations and see how we can adapt them to better represent coral sand. Physical modeling in flumes is also included in this project.

**This project is related to Ana Vila-Concejo ARC funded Future Fellowship.**



[Photo credit: Louise Nott]

## PHYSICAL PROCESSES AND SEDIMENT DYNAMICS ON REEFS

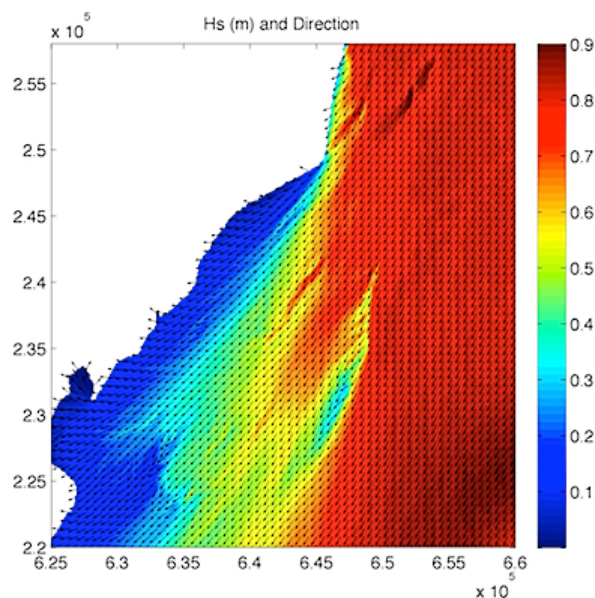
### Wave climate and wave modelling in the Great Barrier Reef

Supervisors: Ana Vila-Concejo [ana.vilaconcejo@sydney.edu.au](mailto:ana.vilaconcejo@sydney.edu.au)

Historically there has been no offshore wave data acquired at the Great Barrier Reef (GBR). We have had to rely on world models such as WW3 which use hindcasting techniques to obtain wave data. Only recently we have obtained the first wave measurements offshore the GBR.

With this project, the student will extract and analyse wave data from WW3 and recent measurements to characterise the wave climate for the GBR. The student will then analyse historic cyclones and incorporate them to the wave climate. Using existing bathymetric data from LADS, the student will then create a bathymetric grid that can be used to propagate waves in the GBR and simulate high-energy events such as cyclones using widely used models such as SWAN and Delft3D.

**This project is related to Ana Vila-Concejo ARC funded Future Fellowship. In collaboration with Delft University of Technology (The Netherlands)**



[Source: <http://www.geog.ucl.ac.uk/admissions-and-teaching/postgraduates/msc-environmental-modelling> ]

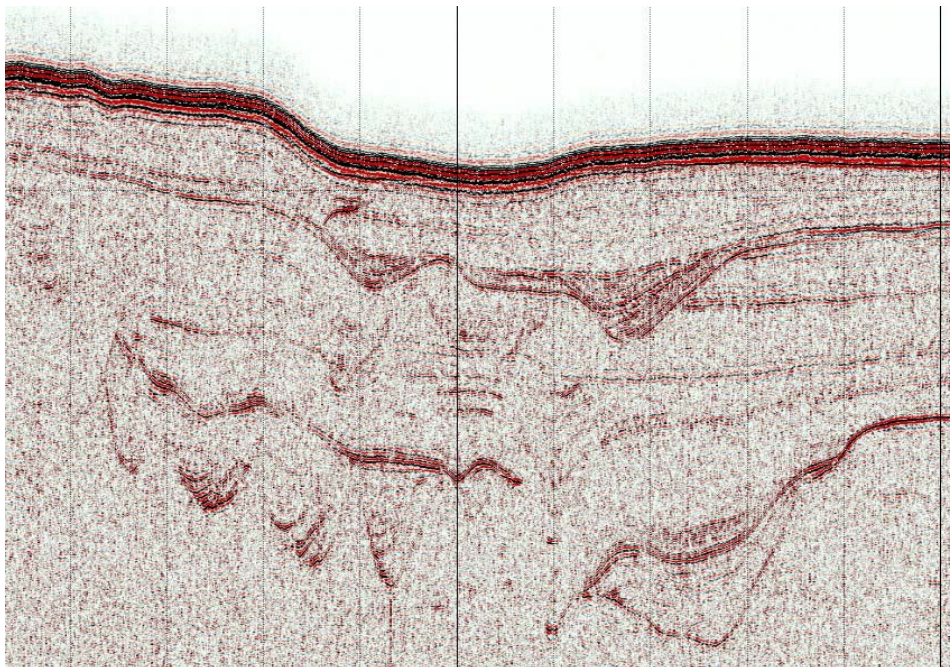


## SHELF AND MARGIN EVOLUTION

**Sediment architecture and evolution of the upper slope of the Great Barrier Reef margin.**

**Supervisor: Jody Webster (USYD) [jody.webster@sydney.edu.au](mailto:jody.webster@sydney.edu.au)**

The project will investigate the sediment architecture and evolution of the upper slope (~- 150-500 m) of the Great Barrier Reef margin. The project will involve the analysis of new high-resolution multibeam bathymetry and seismic data from four different sites along the GBR margin. Multibeam bathymetry data will be used to generate high-resolution 3D maps of the upper slope and investigate morphologic characteristics of the margin. Seismic reflection data will be used to investigate the nature of the subsurface including internal structure and geometry of subsurface reflectors and large scale sediment slope architecture. We will use the state-of-the-art industry KINGDOM™ software suite to fully integrate all bathymetry, seismic, and available sediment core data sets. This will provide the comprehensive 3D spatial framework needed to build new models of the sediment architecture and evolution of the upper slope in response to sea level variations. **This project is part of the Geocoastal Research Group's ARC Discovery funded project to support work on IODP Exp. 325**  
[http://publications.iodp.org/preliminary\\_report/325/index.html](http://publications.iodp.org/preliminary_report/325/index.html).



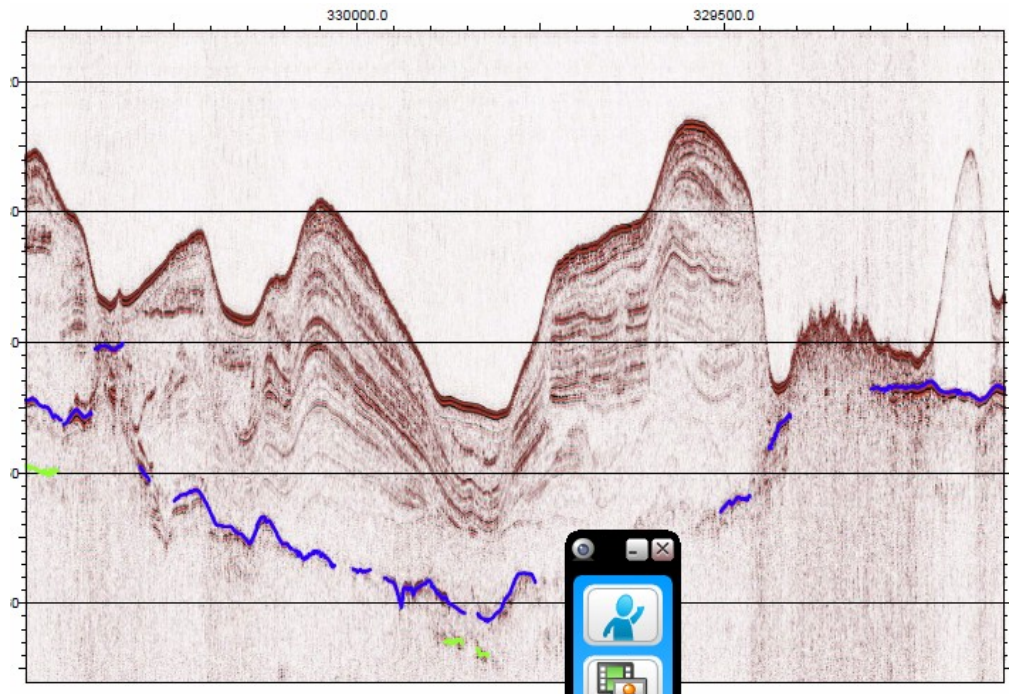
A high resolution Topas seismic reflection profile showing a cross section through the upper slope of the central Great Barrier Reef. Note the complex system of stacked fluvial? channel systems [GRG: Unpublished data]

## SHELF AND MARGIN EVOLUTION

### Sediment architecture and evolution of Halimeda mounds in the Northern Great Barrier Reef

Supervisor: Jody Webster (USYD) [jody.webster@sydney.edu.au](mailto:jody.webster@sydney.edu.au); Rob Beaman (JCU) [robin.beaman@jcu.edu.au](mailto:robin.beaman@jcu.edu.au)

The project will investigate the sediment architecture and evolution of abundant but poorly studied Halimeda mounds in the Great Barrier Reef. The project will involve the analysis of new high-resolution multibeam bathymetry and seismic data from four different sites along the GBR margin and sediment cores through the mounds. Multibeam bathymetry data will be used to generate high-resolution 3D maps of the mounds. Seismic reflection data will be used to investigate the nature of the subsurface including internal structure and geometry of subsurface reflectors and large scale sediment architecture. Sediment cores will be used to understand their sedimentologic and chronologic evolution. We will use the state-of-the-art industry KINGDOM<sup>tm</sup> software suite to fully integrate all bathymetry, seismic, and sediment core data sets. This will provide the comprehensive 3D spatial framework needed to build new sedimentary models of the evolution of the Halimeda mounds in response to environmental changes.



A high resolution Topas seismic reflection profile showing a cross section through the Halimeda mounds of the northern Great Barrier Reef. Note the complex system of internal seismic reflectors [GRG: Unpublished data].

## SHELF AND MARGIN EVOLUTION

### Great Barrier Reef phase shift: Gardner Bank to Gardner Reef?

Supervisor: Jody Webster (USYD) [jody.webster@sydney.edu.au](mailto:jody.webster@sydney.edu.au); Rob Beaman (JCU) [robin.beaman@jcu.edu.au](mailto:robin.beaman@jcu.edu.au)

The project will investigate modern benthic habitats and the geomorphic evolution of the Gardner Bank off Fraser Island. This represents a unique sub-tropical setting that could be affected by future global climate changes that could see the extension of the Great Barrier Reef southwards. The project will involve the analysis of recent high-resolution multibeam bathymetry and seismic data collected from a RV Southern Surveyor cruise.



## MORPHODYNAMICS OF TEMPERATE COASTS

### Morphodynamics of low-energy estuarine beaches

**Supervisors:** Ana Vila-Concejo [ana.vilaconcejo@sydney.edu.au](mailto:ana.vilaconcejo@sydney.edu.au) ; Jack McCarroll [jak.mccarroll@sydney.edu.au](mailto:jak.mccarroll@sydney.edu.au)

Despite the ubiquitous distribution of low-energy beaches little is known of the short to long term morphodynamics of these systems when compared to open coast environments. This is due to the oft complex nature of their geomorphic setting in fetch-limited or protected environments which are frequently associated with complex sedimentary features such as flood tide deltas and spit formations. In this project the student will survey the hydrodynamics and topography of low-energy beaches in the Sydney region and will determine the processes inciting geomorphic change and evolution of these systems.



[Source: [http://www.geosci.usyd.edu.au/research/re\\_portstephens.shtml](http://www.geosci.usyd.edu.au/research/re_portstephens.shtml)]



## MORPHODYNAMICS OF TEMPERATE COASTS

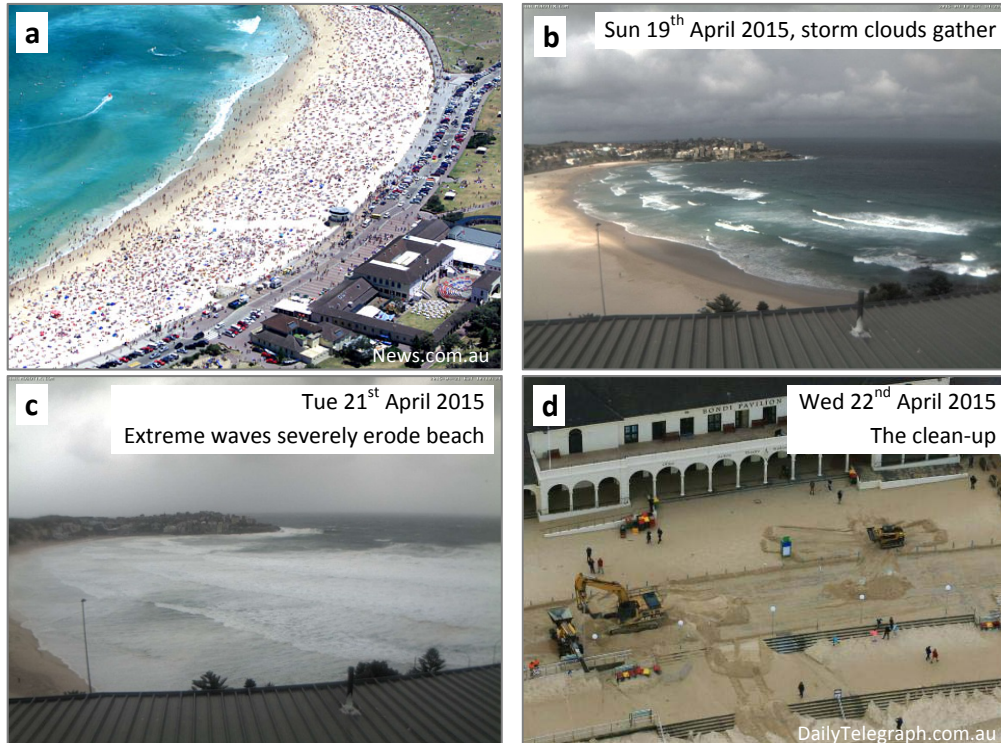
### Morphodynamics of embayed beaches

**Supervisors:** Ana Vila-Concejo [ana.vilaconcejo@sydney.edu.au](mailto:ana.vilaconcejo@sydney.edu.au) ; Jack McCarroll [jak.mccarroll@sydney.edu.au](mailto:jak.mccarroll@sydney.edu.au)

This project involves monitoring of beaches on selected Sydney Eastern suburbs including Bondi Beach. The student will measure the topography of selected beaches monthly and after storms. The student will use the video cameras located on Bondi beach to assess daily morphodynamics and data from hydrodynamic deployments.

This project seeks to understand the morphodynamics and headland effects of open-ocean embayed beaches. Climate change will affect this beaches and in order to adequately plan for both the short and long-term future, we need to understand the morphodynamics of these beaches. Current models do not predict the behavior of this type of beach.

**This project is the result of current collaboration with UNSW (A/Prof Brander 'aka' Dr Rip).**



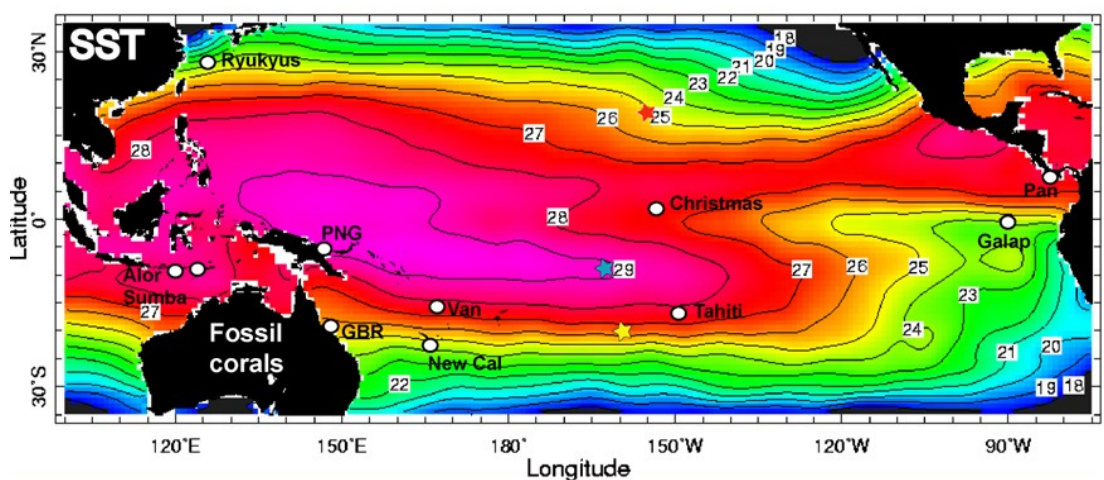
[Source: Jak McCarroll]

## PALEOENVIRONMENTAL CHANGE

### Reconstructing paleoclimate variability using fossils corals in the western tropical Pacific Ocean

**Supervisor: Jody Webster (USYD) [jody.webster@sydney.edu.au](mailto:jody.webster@sydney.edu.au)**

The climate of the tropical Pacific has a far reaching influence on global climate, delivering large amounts of heat to the atmosphere, playing a leading role in driving global atmospheric circulation, and influencing climate far from the Pacific through the El Niño- Southern Oscillation (ENSO). This project will involve reconstructing short, seasonally resolved paleoclimate “windows” (eg., sea surface temperature and salinity) from fossil corals during the last deglaciation (20-10 ka). The project will be conducted jointly with Dr. Helen McGregor (UOW) and Dr. Mike Gagan (ANU) at and the student will learn advanced techniques in geochemistry (eg. paleoclimate proxies - stable isotopes and trace elements) and paleoclimate data analysis. **This project is part of the Geocoastal Research Group’s ARC Discovery funded project to support work on IODP Exp. 325 [http://publications.iodp.org/preliminary\\_report/325/index.html](http://publications.iodp.org/preliminary_report/325/index.html).**



Modern sea surface temperature in the Indo Pacific [Mean annual SSS/SST: Levitus, 1994].

## PALEOENVIRONMENTAL CHANGE

**What caused the lag in the initiation of the Great Barrier Reef during the early Holocene? An investigation of water quality and coral reef response**

**Supervisor: Jody Webster (USYD) [jody.webster@sydney.edu.au](mailto:jody.webster@sydney.edu.au)**

As global climates change the modern Southern Great Barrier Reef (Capricorn Bunker Group) will likely record the first and most marked biologic and geologic changes. Therefore it is crucial, now more than ever, to develop a comprehensive geological framework with which to interpret these possible changes. The project will focus on a major event in the evolution of this sensitive region of the GBR – the Holocene “turn-on” between 8-9 ka. Previous work suggests there is a significant time lag of 1-2 ka between the flooding of the older reef platform and the initiation of coral reef growth. We will investigate the possible reasons for this lag by analyzing suite of new and existing fossil coral cores from the region to: (1) establish the precise timing of reef initiation and early growth using new C14-AMS and U/Th ages; (2) assess the sedimentologic and biologic composition (ie. corals, coralline algae) of the reefs; and (3) reconstruct the paleoceanographic and water quality conditions during the initial growth phase. The project may involve field work to One Tree Reef in the southern GBR in order compare modern sedimentary and biological environments to those observed in the fossil reef cores. **This project is part of the Geocoastal Research Group’s ARC Discovery funded project to investigate fossil reef cores from One Tree and Heron Reef.**

<http://grgusyd.org/2015/09/01/core-on-deck>



A “Jack-Up” drilling platform used to collect new fossil reef cores on Heron and One Tree Reef (Photo credit. J. Webster)

