ON-REEF CYCLONIC WAVE CLIMATE THROUGHOUT THE GREAT BARRIER REEF

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INTRODUCTION

The Great Barrier Reef is an iconic ecosystem that is collapsing under low lagoon water quality from terrestrial runoff and resulting overly productive crown-of-thorns starfish, coral bleaching from thermal stress and physical destruction from tropical cyclones, to name the top four stresses. This has led to the possible listing of the largest ecosystem on earth, by UNESCO, as "endangered world heritage site", with it currently listed as "in danger". This collapsing is mostly seen in coral coverage declining over time from water quality and starfish stresses combined with episodic large scale drops from thermal stress and tropical cyclones. Action on improved land use would decrease the impact from water quality and starfish and action on climate change would reduce thermal stresses and hence, the frequency of bleaching events. Tropical cyclone impacts, while they may be getting more intense or larger under climate change, their destructive power is significant either way (i.e., before and after climate changes). These stresses have led to the administrative body, the Great Barrier Reef Marine Park Authority, to shift from passive management to active interventions, which are generally extremely costly compared to the income generated by the Great Barrier Reef. Consequently, to ensure the limited resources are deployed to obtained maximum benefit, interventions are being tested across all stresses including cyclonic stresses. This requires fine scale determination of cyclonic wave climates across the entire Great Barrier Reef.

GREAT BARRIER REEF

The Great Barrier Reef is often described in terms of the number of reefs (*ca* 4000 identified reefs, but many of these are made of several reefs separated by tidal channels) and area (2,000 km in length and between 20 and 140 km in width). From a wave modelling aspect, we are seeking wave climate information on these reefs and consequently, the shallow area (less than 10 m mean sea level depth) is more instructive, and this is 17,924 km^2 or 5% of the nominal area of 348,700 km^2. The modelling work is seeking resolution between 10 m and 100 m, which leads to on-reef grids with 23.5 Million spatial points across 301 grids.

TROPICAL CYCLONES

There exist databases of synthetic tropical cyclones that are suitable for estimating wave climate information which in effect is constrained by historical measurements and adjusted for future climate change. In this work, we select Emanuel's database (Emanuel et al., 2008) which contains 6000 years' worth of individual cyclones which allows reasonable convergent wave climate estimations at the 10 and 20 year return period. This database and its effective use in wave modelling was described at length by Callaghan et al. (2020).

MODELLING AND PREDICTIONS

The wave modelling approach used regular grids nested within each other from an outer model covering the Coral Sea and the Great Barrier Reef impacted by the tropical cyclone being simulated with a 6 km spatial resolution and extending at least 100 km offshore of the outer barrier. This grid provides boundary conditions to an 800 m resolution transition grid covering the Great Barrier Reef with at least 17 m/s winds at 10 m above the sea surface. This transition grid is used to supply boundary conditions to the on-reef grids (Fig 1) that are impacted by the cyclone being simulated. The cyclonic winds are modelled using the tried and tested method of Callaghan et al. (2020) which uses Holland et al. (2010) parametric gradient wind field and Kepert (2001) atmospheric boundary layer model. Model bathymetry used satellite observations for shallow regions and a combination of vessel surveys for deeper regions.

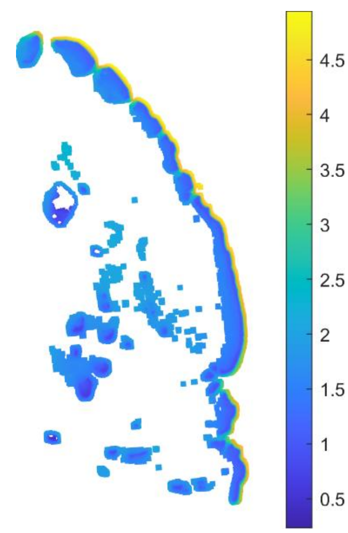

Figure 1 – 10 year return significant wave height in the Lizard Island region, north Great Barrier Reef.

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