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Wave transformation across coral reefs under changing sea levels

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The transformation of swell waves from deep water across reef flats is the primary process regulating energy regimes in coral reef systems. Coral reefs are effective barriers removing up to 99% of wave energy during breaking and propagation across reef flats. Consequently back-reef environments are often considered low energy with only limited sediment transport and geomorphic change during modal conditions. Coral reefs, and specifically reef flats, therefore provide important protection to tropical coastlines from coastal erosion and recession. However, changes in sea level could lead to significant changes in the dissipation of swell wave energy in coral reef systems with wave heights dependent on the depth over the reef flat. This suggests that a rise in sea level would also lead to significantly higher energy conditions exacerbating the transgressive effects of sea level rise on tropical beaches and reef islands.

This study examines the potential implications of different sea level scenarios on the transformation of waves across the windward reef flats of One Tree Reef, southern Great Barrier Reef. Waves were measured on the reef flats and back-reef sand apron of One Tree Reef. A one-dimensional wave model was calibrated and used to investigate wave processes on the reef flats under different mean sea level (MSL) scenarios (present MSL, +1 m MSL, and +2 m MSL). These scenarios represent both potential future sea level states and also the paleo sea level of the late Holocene in the southern Great Barrier Reef. Wave heights were shown to increase under sea level rise, with greater wave induced orbital velocities affecting the bed under higher sea levels. In general waves were more likely to entrain and transport sediment both on the reef flat and in the back reef environment under higher sea levels which has implications for not only forecasted climate change scenarios but also for interpreting geological changes during the late Holocene when sea levels were 1-2 m higher than present.