FIELD OBSERVATIONS OF SETUP OVER TWO FRINGING REEFS:

IPAN REEF, GUAM AND MOKULE'IA REEF, HAWAI'I

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Abstract

Wave and water level observations from Ipan, Guam (July 2006) and Mokule'ia, Hawai'i (April 2004) are used to examine wave-driven setup over fringing reef systems. The Ipan reef is a wide (530 m), shallow (0.5 m) fringing reef with a flat, relatively smooth (<0.1 roughness scale) and featureless platform and an almost vertical reef face. In comparison, the Mokule'ia reef is narrower (~100 m), rougher (vertical scales ~0.5 m), and deeper (1.2 m) than Ipan, with a gently sloping (0.88^{0}) reef face consisting of rugged spur and groove topography. Observed incident swell peaked at 2.5m significant wave height at Ipan, and 4m at Mokule'ia. Wave breaking occurs at the reef edge at Ipan, and over a broader surf zone Mokuleia. Wave breaking and bottom friction result in negligible swell amplitudes at the shoreline (< 90 % of offshore levels). Average (15 minute mean) water levels on both reefs are highly correlated (>0.96) with offshore H_{sig}. Setup at Ipan is uniform across the reef, and scales as $\sim 0.38 H_{sig}$, approximately twice as high as reported over sand bottom beaches and other reefs. Setup at Mokule'ia is roughly three times (~0.11 H_{sig}) lower than Ipan for a given incident wave height. The dynamics of setup are well described by the traditional balance of the radiation stress gradient and the cross-shore pressure gradient observed on sand beaches. Because wave breaking occurs almost exclusively at the reef edge, and because the reef platform is smooth, friction appears to play a negligible role in the setup balance at Ipan. Bottom friction can also be neglected in the setup balance at Mokuleia; however, frictional dissipation is not entirely discounted given the weak setup amplitudes. Changes in tidal height over the reefs of 0.5 – 1 m result in weak (5 %) modulations of the nearshore setup.