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 \degree) reef face consisting of rugged spur and groove topography. Observed incident swell peaked at 2.5 m significant wave height at Ipan, and 4 m 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 $H_{\text{sig}}$. Setup at Ipan is uniform across the reef, and scales as $-0.38 H_{\text{sig}}$, approximately twice as high as reported over sand bottom beaches and other reefs. Setup at Mokule‘ia is roughly three times ($-0.11 H_{\text{sig}}$) 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.