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Vertical structure of wave-current turbulence within coral-reef colonies

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We present in situ measurements of waves, currents, and turbulence to study the vertical structure of turbulence within a channel that is surrounded by coral-reef colonies of a fringing reef in Hobihu, Nan-Wan Bay, southern Taiwan. Turbulence was measured using a dual velocimetry technique, and wave bias contamination in the turbulence is controlled using ogive curve testing of the turbulent shear stress (TSS). The observed turbulent dissipation rate is approximately 5 times greater than simultaneous observations over the nearby sandy bottom site, which indicates stronger mixing in the coral reef than on sandy bottoms. The low ratio of the TSS to the turbulent kinetic energy (TKE) and sweeping events indicate that energetic momentum is transported downward into the channel of the coral-reef canopies. The observed value of turbulent dissipation rate exceeds the shear production rate, which suggests that transport terms or other source terms might be important. Direct evaluation of the transport terms suggests that vertical turbulent transport and advection are significant mechanisms that diffuse and convect the TKE downward into the channel. The observed TSS can be described well by the Prandtl–von Kármán eddy viscosity model and a two-equation turbulent model. This study may contribute to other theoretical, observational, and numerical studies in pursuing more understanding and modeling for turbulent mixing of wave-current flows in coastal zones.