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Breaker-generated turbulence in and above a seagrass meadow

D. Pujol (1) and H. Nepf (2)

(1) Universitat de Girona, Department of Physics, Girona, Spain (mdolors.pujol@udg.edu), (2) Massachusetts Institute of Technology, Department of Civil and Environmental Engineering, Cambridge, Massachusetts, USA

In shallow water the turbulence generated by wave breaking can reach the bed, so that the interaction between breaker-generated turbulence and submerged aquatic vegetation (SAV) can be important. The aim of this study is to understand this interaction. A model submerged aquatic vegetation meadow was constructed based on dynamic and geometric similarity to natural plants. The model meadow was subject to an isolated breaker generated within a wave packet, which mimics transient wave breaking in the ocean. In our study the wave packet was generated by a vertical paddle driven by a Syscomp WGM-101 arbitrary waveform generator. The wave signal was designed to create short period waves at the beginning of the packet and longer period waves at the end of the packet. Based on linear wave theory, the waves with longer period travel at a higher celerity than those with a shorter period. Therefore, the longer period waves catch up to the shorter period waves and their constructive interference produce a breaking event at a prescribed position and time. The evolution of the turbulent flow field was measured by an Acoustic Doppler Velocimeter (Nortek Instrument).

The observations suggest that near the water surface, i.e. above the meadow, the turbulent kinetic energy (TKE) without seagrass meadow remains elevated longer than with vegetation, and this is attributed to the damping of breaker-generated turbulence by the seagrass. In contrast, the TKE near the bed is always higher and more persistent with seagrass than without, roughly twice the values observed at unvegetated zones. This is attributed to the generation of stem-wake turbulence by the elevated near-bed orbital velocity during the passage of the wave packet. Within the meadow TKE decays as t^{-1} power law. The generation of stem-wake turbulence is associated with a greater loss of wave energy. Specifically, the wave energy loss associated with the breaking event is 24%, whereas about 8% of energy losses can be associated with dissipation by meadow drag.