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Effects of seagrass structure on a wave dominated flow

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Shallow coastal areas are characterized by the presence of seagrass which occupy $\sim$ 10% of the zone. In natural systems flows are a combination of steady, oscillatory and turbulent flows. Turbulence significantly affects the bottom boundary, therefore the interaction between turbulence and plant canopies is particularly important. In an effort to understand the dynamics of these complex flows we isolated each physical process in a laboratory study. We studied the progressive waves generated by a wavemaker situated at the beginning of the tank impinging on a simulated seagrass meadow. Our experiment is aimed at studying the relationship between flow structure and canopies in terms of a wide variety of parameters. We quantified the vertical distribution of mean current (u_c), oscillatory velocity (u_w), turbulent kinetic energy (TKE) and shear stress (<u'w'>) above and within different types of vegetation, measured by an Acoustic Doppler Velocimeter (Sontek Instruments). Different experimental conditions were considered: two vegetation models (rigid and flexible), vegetation heights (14 and 30 cm, corresponding to submerged and emergent vegetation), plants densities (SPF = 1, 5, 10%) and three oscillatory frequencies (f = 0.8, 1 and 1.4Hz).

Our observations suggest that the presence of submerged vegetation alter the flow structure within and above the canopy when the ratio of orbital excursion above the canopy to stem center-center spacing is higher than 1, corresponding to SPF = 5 and 10%. Above the vegetation, the mean current is always higher than without vegetation, whereas within the canopy the mean current is damped by submerged vegetation. The TKE decreases with depth and above the canopy it is higher with vegetation until 2 cm below the top of the canopy, compared to what it is found without vegetation. The presence of vegetation produces a peak of shear stress at the top of the canopy. High levels of shear stress together with fast mean current near the top of the canopy could speed up the rate of water renewal within the canopy, therefore it could enhance the mass transport such as nutrients, seeds, pollen or sediments. Unlike submerged vegetation, experiments carried out with emergent vegetation show that well inside the canopy the mean current is higher than without vegetation. Oscillatory velocity is modified for SPF = 5 and 10%, whereas SPF = 1% and experiments without vegetation show the same graph. Measurements of TKE and shear stress with emergent vegetation do not show differences with unvegetated due to the fact that the whole water column is obstructed by vegetation.