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A model for diffusion within emergent vegetation

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Abstract

Detailed velocity measurements made with laser Doppler velocimetry have shown that, except very close to the bed, the production of turbulence within a stand of emergent vegetation is dominated by the stem wakes rather than by the bottom-boundary shear, as in open-channel flows. This observation formed the basis for a modified random-walk model that describes the contribution of stem wakes to the turbulent diffusivity within marsh grasses. The model was validated by comparison to observed diffusivity over a range of population and flow conditions within a simple plantlike array of circular cylinders. The diffusion model was also evaluated for a more complex morphology that included a flexible canopy. Laser-induced fluorescence and image-processing techniques were used to measure the diffusivity as well as to examine turbulence structure within the experimental system. The latter analysis documented changes in turbulence scale that arise as larger eddies are broken apart by the stems and smaller eddies (comparable to the stem diameter) are produced within the wakes.