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A $k-\varepsilon$ Model for Flow through Submerged and Emergent Vegetation Accounting for Turbulence at the Stem Scale as Well as the Vertical Shear Scale(s) ALEXANDRA KING, EDWIN COWEN, Cornell University —

Statistics of turbulence in and above vegetation are determined by the action and interaction of the turbulent wakes of plant stems (scaling with the stem diameter), the Kelvin-Helmholtz type vortices that form in regions of high vertical velocity gradient (scaling with the velocity gradient), and boundary layer turbulence (scaling with the flow depth). While turbulence from each of these sources is dissipated through the energy cascade, some shear-scale turbulence bypasses the lower wave numbers as shear-scale eddies do work against the form drag of the plant stems, converting shear-scale turbulence into wake-scale turbulence. We have developed a $k - \varepsilon$ model that accounts for all of these energy pathways. This is the first model of its kind to incorporate the stem diameter explicitly and thus predict the well-established relationship between stem diameter and turbulent kinetic energy in emergent vegetation. The model also performs well in submerged vegetation, where turbulent kinetic energy scales significantly, but to a lesser degree, with the stem diameter, and in real emergent aquatic vegetation, where multiple scales of vertical shear and stem diameter are equally important.

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