Center for Interdisciplinary Research in Fluids
Winter 2017 Seminar Series
UCSB

Wednesday, March 15
12:00-1:00pm, ESB 2001

A *k-ε* Model for Flow Through Aquatic Vegetation

Dr. Alexandra (Allie) T. King
Cornell University

Abstract Flow and transport through aquatic vegetation is characterized by a wide range of length scales including water depth (H), stem diameter (d), the inverse of the plant frontal area per unit volume (af), and the scale(s) over which af varies (the most easily identified is the plant height, h). Turbulence is generated both at the scale(s) of the mean vertical shear, set primarily by af, and at the scale(s) of the stem wakes, set by d. 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-epsilon model that accounts for all of these energy pathways. The model is calibrated against laboratory data from beds of rigid cylinders under emergent and submerged conditions. The new model outperforms pre-existing models, none of which include the d scale, both in the emergent case, where pre-existing models break down entirely, and in the submerged case, where pre-existing models fail to predict the strong dependence of turbulent kinetic energy on d. The success of the new model supports our current understanding of the turbulent kinetic energy budget in flow through vegetation. The new model was developed with applications in real aquatic vegetation in mind and performs well modeling laboratory flows through beds of live Eurasian watermilfoil. The model may be easily incorporated into larger hydrodynamic solvers for field applications.

Biosketch Alexandra (Allie) King is a postdoc in the Department of Civil & Environmental Engineering at Cornell University. Her current research, with Professor Edwin (Todd) Cowen, focuses on parameterization of near-field mixing for high-momentum negatively buoyant plumes within a 3D hydrodynamic model applied to Cayuga Lake, one of the Finger Lakes in upstate NY. Another project, with Professor Nelson Hairston, in the Department of Ecology & Evolutionary Biology, involves coupled hydrodynamic/water quality modeling of Honeoye Lake to elucidate mechanisms of internal Phosphorus loading driving harmful algal blooms. Allie received a PhD from Cornell in 2011. During her doctoral program she developed a k-epsilon type turbulence model for flow through aquatic vegetation that transitions smoothly between emergent and submerged conditions. Her masters work focused on measurement of residence time in natural systems using dye tracer techniques. Allie has a BS in Civil Engineering from Rice University in Houston, TX.