Boulder Fluid Dynamics Seminar Series

Tuesday, December 10, 2013
3:30pm-4:30pm (refreshments at 3:15pm)
Bechtel Collaboratory in the Discovery Learning Center (DLC)
University of Colorado at Boulder

Multiscale Investigations of Stirring and Mixing Processes in Broadcast Spawning by Benthic Invertebrates

John Crimaldi, *University of Colorado at Boulder*

Many benthic invertebrates utilize broadcast spawning as a reproductive strategy: to spawn, adult males and females extrude sperm and eggs into the surrounding flow. The resulting fertilization success depends on the physics of stirring and mixing across a range of spatial scales; these scales may span five orders of magnitude. In this talk, we describe the different physics that govern this biological process at each end of the spatial scale range, and we summarize a holistic experimental and numerical modeling approach designed to understand and quantify the effect of these physics on fertilization success. We demonstrate that large-scale structured stirring by unsteady or turbulent flow fields selectively aggregates egg and sperm into localized regions to form local hotspots for fertilization efficacy. We show the effect of small-scale mixing on the deformation of chemoattractant plumes released by eggs, and on the resulting chemotactic response of motile sperm navigating within these complex plumes. Our results suggest that sperm motility and taxis acts as an evolutionary adaptation that takes the place of molecular diffusion in traditional mixing and reaction problems. During the course of this talk, I will highlight the various numerical and experimental approaches that we use to explore this problem.

Characterizing Turbulence Anisotropy, Coherence, and Intermittency at a Prospective Tidal Energy Site

Katherine McCaffrey, *University of Colorado at Boulder*

As interest in marine renewable energy increases, observations and models are crucial to understanding the environments encountered by energy conversion devices. Data obtained from an acoustic Doppler velocimeter in the Puget Sound, WA are used to perform a detailed analysis of the turbulent environment that is expected to be present at a turbine placed in a tidal strait. Metrics such as turbulence intensity, coherent turbulence kinetic energy, and a new scalar measure of anisotropy are used to characterize the turbulence coherence, intermittency and anisotropy. The results indicate that the scalar anisotropy magnitude can be used to identify and parameterize coherent, intermittent turbulent events in the flow. An analysis of the anisotropy characteristics leads to a physical description of turbulent stresses as being dominated by only one- or two-dimensions, and parameterized best by anisotropy magnitude. Furthermore, turbulence generated by the National Renewable Energy Laboratory's TurbSim model is analyzed with these characteristics of anisotropy, testing the ability of the model to create realistic turbulent environments.