ABSTRACT:
Though we inhabit three space dimensions, it is undeniable that exploiting naturally occurring symmetry and multiple scales can reduce many three-dimensional problems to one, two or “2.5” dimensional problems that are easier to solve. These reduced problems are the basis for many effective engineering problem solving tools as well as the basis for much understanding and intuition. Nevertheless, irreducibly three-dimensional (and time-dependent) problems arise often enough in real-world applications that effective tools for their solution are needed. The Proteus toolkit is a problem solving environment that extends the Python programming language to support research on new models for coastal and hydraulic processes and improvements in numerical methods, particularly models and methods for fully three-dimensional hydrodynamics and “multi-physics” processes. These processes include interaction of waves and currents with coastal and hydraulic structures and subsurface air/water dynamics in heterogeneous materials. In this talk I will discuss examples of fully three-dimensional engineering problems and methods for solving them directly in three dimensions, particularly finite element and level set methods.