COUPLED CONTINUOUS AND DISCONTINUOUS FINITE ELEMENT METHODS FOR THE SHALLOW WATER EQUATIONS

Clint Dawson

Institute for Computational Engineering Sciences
The University of Texas
Austin, Texas 78712
clint@ices.utexas.edu

Finite element methodologies have long been used in modeling circulation in coastal and oceanic waters. Many codes in wide use today, e.g., the QUODDY and ADCIRC simulators, are based on continuous Galerkin (CG) finite elements for both elevation and momentum. Because continuous elements applied to the primitive continuity equation are subject to spurious oscillations and/or phase errors, these codes utilize a reformulation of the continuity equation into a so-called generalized wave continuity equation (GWCE). Moreover, these finite element codes are not "locally conservative," that is, they do not produce mass conservative fluxes. In recent years, finite element methods based on discontinuous basis functions have been developed (the discontinuous Galerkin or DG method). These methods are locally conservative and generally provide sharper resolution of fronts with minimal oscillation and phase error. However, these methods can involve more degrees of freedom than their continuous counterparts. In this talk, we will present a multi-algorithmic finite element strategy based on utilizing both continuous and discontinuous Galerkin methods. For example, given a system of coupled equations, we may choose to solve some of them using DG and some using CG methods, or we may couple CG/DG within the same equation through boundary conditions. We will focus on recent developments in the ADCIRC simulator, where we have replaced the GWCE CG formulation with a DG formulation based on the primitive continuity equation. Numerical results will be presented for this new approach. We will also discuss the recent development and analysis of a coupled CG/DG formulation for continuity based on coupling the GWCE with the primitive continuity equation.