11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20–25, 2014, Barcelona, Spain

ADVANCES IN DISCONTINUOUS GALERKIN-BASED SPECTRAL WAVE MODELING

Rachel Sebian[*1], Ethan Kubatko[1], Angela Nappi[2], and Casey Dietrich[3]

[1] The Ohio State University, 2070 Neil Avenue, Columbus, OH 43210, sebian.1@osu.edu, kubatko.3@osu.edu
[2] AECOM, 125 Broad Street New York, NY 10004, nappi.angela@gmail.com
[3] North Carolina State University, 2501 Stinson Drive, Raleigh, NC 27607, jcdietrich@ncsu.edu

Key words: *discontinuous Galerkin method, spectral wave modeling*

The energy spectrum associated with surface waves in oceans and large lakes spans a broad range of frequencies. A significant portion of the energy in this spectrum is contained in the high-frequency band of wind-generated waves known as the wind-sea. Given the relatively small spatial and temporal scales of these individual waves, it is impractical to directly resolve their scales of motion with a numerical wave model over geographic domains of any appreciable size. Therefore, a statistical description of the wave field is generally sought through the use of so-called spectral wave models, in which the wave variance density (related to wave energy) is conserved.

In this talk, we present the application and further development of a discontinuous Galerkin (DG) spectral wave model based on a parametric approach, in which wave energy evolution is described by a set of advection-type equations for a particular choice of wave energy spectrum. The parametric model has been developed in a high-order DG framework that offers both h (mesh) and p (polynomial order) refinement options. This type of parametric approach aims to reduce the computational expense inherent in many existing spectral wave models that employ discrete spectral approaches, which require the solution of the wave energy conservation equation over a large set of discrete frequency and wave direction components at every point in geographic space. We will present a series of hindcast studies performed on the Great Lakes that demonstrate the computational savings achieved with our new parametric hp DG wave model compared to the well-established SWAN model, which uses a low-order discrete spectral approach, and discuss a number of recent model enhancements that aim to broaden its applicability.