Modeling Flow Encountering Abrupt Topography using Hybridizable Discontinuous Galerkin Projection Methods

by

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Submitted to the Center for Computational Engineering
in partial fulfillment of the requirements for the degree of

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Abstract

In this work novel high-order hybridizable discontinuous Galerkin (HDG) projection methods are further developed for ocean dynamics and geophysical fluid predictions. We investigate the effects of the HDG stabilization parameter for both the momentum equation as well as tracer diffusion. We also make a correction to our singularity treatment algorithm for nailing down a numerically consistent and unique solution to the pressure Poisson equation with homogeneous Neumann boundary conditions everywhere along the boundary. Extensive numerical results using physically realistic ocean flows are presented to verify the HDG projection methods, including the formation of internal wave beams over a shallow but abrupt seamount, the generation of internal solitary waves from stratified oscillatory flow over steep topography, and the circulation of bottom gravity currents down a slope. Additionally, we investigate the implementation of open boundary conditions for finite element methods and present results in the context of our ocean simulations. Through this work we present the hybridizable discontinuous Galerkin projection methods as a viable and competitive alternative for large-scale, realistic ocean modeling.

Thesis Supervisor: Pierre F.J. Lermusiaux
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