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High Order Schemes for Biogeochemical Ocean Dynamics

Mattheus P. Ueckermann and Pierre F.J. Lermusiaux
MIT, Mechanical Engineering, Cambridge, MA 02139, United States (pierrel@mit.edu)

Accurate modeling of often highly nonlinear and multiscale biogeochemical ocean dynamics is essential for numerous applications. We provide computational requirements for such simulations, analyzing the dynamics of a 3 component (nutrient-phytoplankton-zooplankton) biogeochemical model in different regimes: one with a single stable point and two with stable limit cycles. We utilize standard and Hybrid discontinuous Galerkin Finite element methods and compare various discretization properties including high and low orders. We quantify the smoothness of the solution by the decay rate of coefficients of a modal orthogonal polynomial basis, and show that high-order schemes performs best in resolved regions. We also investigate slope limiting and filtering approaches to improve the performance of the high-order schemes. We find that higher-order schemes are needed to simulate biological patchiness. Finally, we outline our efforts towards a high-order three- dimensional, free-surface, non-hydrostatic coastal ocean simulation code.