THE HONG KONG POLYTECHNIC UNIVERSITY
香港理工大學

DEPARTMENT OF APPLIED MATHEMATICS
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The Hong Kong Polytechnic University
Department of Applied Mathematics

Colloquium

High-Order Multirate Explicit Time-Stepping Schemes for the Baroclinic-Barotropic Split Dynamics in Primitive Equations

By

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Abstract

To treat the multiple time scales of ocean dynamics in an efficient manner, the baroclinic-barotropic splitting technique has been widely used for solving the primitive equations for ocean modeling. In this paper, we propose second and third order multirate explicit time-stepping schemes for such split systems based on the strong stability-preserving Runge-Kutta (SSPRK) framework. Our method allows for a large time step to be used for advancing the three-dimensional (slow) baroclinic mode and a small time step for the two-dimensional (fast) barotropic mode, so that each of the two mode solves only need satisfy their respective CFL condition to maintain numerical stability. It is well known that the SSPRK method achieves high-order temporal accuracy by utilizing a convex combination of forward-Euler steps. At each time step of our method, the baroclinic velocity is first computed by using the SSPRK scheme to advance the baroclinic-barotropic system with the large time step, then the barotropic velocity is specially corrected by using the same SSPRK scheme with the small time step to advance the barotropic subsystem with a barotropic forcing interpolated based on values from the preceding baroclinic solves. Finally, the fluid thickness and the sea surface height perturbation is updated by coupling the predicted baroclinic and barotropic velocities, and the potential inconsistency on the sea surface height caused by the mode splitting is also resolved via a reconciliation process with carefully calculated flux deficits and velocity adjustments. Two benchmark tests drawn from the ``MPAS-Ocean" platform are used to numerically demonstrate the accuracy and parallel performance of the proposed schemes.

Date: 3 November (Wednesday)
Time: 10:00-11:00 (Hong Kong Standard Time GMT +8)
Venue: Online Talk via Zoom (Meeting ID: 918 8276 6930)
Speaker: Prof. Lili Ju, University of South Carolina
Host: Dr. Zhi Zhou, The Hong Kong Polytechnic University
Click to join: https://polyu.zoom.us/j/91882766930?pwd=Sm55SmtucStwZjVmbDErS05GaHdSdz09

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