

HIGH-ORDER METHODS FOR ENVIRONMENTAL FLOWS

L. ARPAIA*, G. ORLANDO†

*Consiglio Nazionale delle Ricerche, Istituto di Scienze Marine
Arsenale – Tesa 105, Castello 2737/F, Venezia, 30122, Italy
luca.arpaia@cnr.it

†Institut de Mathématiques de Toulouse, UMR CNRS 5219
Université de Toulouse, INSA, F-31077 Toulouse, France
gorlando@insa-toulouse.fr

ABSTRACT

This minisymposium focuses on modern high-order techniques for the numerical simulations of geophysical and environmental flows. High-order methods have shown great potential for improving the numerical simulation of the compressible or incompressible Euler and Navier–Stokes equations, Boussinesq-type equations, and the shallow water equations, across various geophysical regimes. The minisymposium will cover high-order spatial discretization techniques in the horizontal and vertical directions (e.g., discontinuous Galerkin, semi-Lagrangian, high-order finite volume, spectral element methods, multilayer-moment models) as well as high-order, efficient and stable time integration strategies for multiscale geophysical problems and novel structure-preserving discretizations (e.g., well-balanced, equilibria-preserving, positivity-preserving, energy-conserving, entropy-stable, and asymptotic-preserving schemes). The minisymposium will address the many challenges associated with the application of high-order methods to environmental flows. In particular, while high-order methods implemented on the same mesh as low-order methods remain computationally expensive and therefore require scalable parallel solvers and modular implementations, their use on coarser meshes introduces different challenges, such as representing unresolved flow scales or sub-grid topography/bathymetry scales. Applications include, but are not limited to, coastal, oceanic, and atmospheric flows, as well as coupled problems involving moist advection, cloud resolution, sediment and plastic transport. The goal of this minisymposium is to create a venue where methods developed independently for different environmental applications can be compared and cross-fertilized, encouraging speakers to highlight not only their results but also the modeling assumptions and discretization choices behind them, so

as to stimulate discussion on which techniques generalize across the different flow regimes represented.

The tentative list of the speakers can be found below.

SPEAKERS

1. Maurizio Tavelli (University of Verona): “Efficient high order semi-Lagrangian IMEX discontinuous Galerkin methods on staggered unstructured meshes”
2. Maria Kazolea (Inria Centre at the University of Bordeaux): “A new highly dispersive weakly nonlinear Boussinesq-type model over slowly varying topography”
3. Davide Torlo (Sapienza University of Rome): “How to preserve complex equilibria for hyperbolic balance laws”
4. Jens Visbeck (Technical University of Denmark): “Simulations of nonlinear free surface water waves on unfitted/embedded domains”
5. Michele Girfoglio (University of Palermo): “A novel Large Eddy Simulation approach for the simulation of moist convection”
6. Matthias Maier (The University of Texas at Austin): Title to be provided
7. Simone Marras (New Jersey Institute of Technology): “Jexpresso.jl, a Julia, multi-physics, modular solver for systems PDEs of computational physics: from the atmosphere and clouds, to hypersonic flows”
8. Federico Vismara (RWTH Aachen University): “An extended DG framework for atmospheric dynamics in unbounded domains”
9. Luca Arpaia (National Research Council): “Exploiting high-resolution bathymetric data in high-order finite element coastal models”
10. Josè Garres Diaz (University of Sevilla): “Moment models with general function basis. Application to sedimentation processes”
11. Max Bitsch (DHI Group Denmark): “A CWENO-based finite volume method for the shallow water equations with natural incorporation of high-resolution bathymetry data”
12. Enrique Fernandez Nieto (University of Sevilla): “A multilayer model approach for plastic transport in rivers and coastal flows: from particles to filaments”