Séminaire 22 Fevrier 2013 11h / Seminar February 22nd 2013 11h

Conférencier/Lecturer: Nicholas Kevlahan,
Department of Mathematics and Statistics, McMaster University

Sujet/Subject:A conservative adaptive wavelet method
for the shallow water equations on staggered grids

Présentation/Presentation: Anglais / English

Lieu/Room: Salle des vents (Dorval)

wiki: https://wiki.cmc.ec.gc.ca/wiki/RPN_Seminars

iweb: http://web-mrb.cmc.ec.gc.ca/mrb/rpn/SEM/
web: http://collaboration.cmc.ec.gc.ca/science/rpn/SEM/index.php

Abstract

This talk presents the first dynamically adaptive wavelet method for the shallow water equations on a staggered hexagonal C-grid. Pressure is located at the centres of the primal grid (hexagons) and velocity is located at the edges of the dual grid (triangles). Distinct biorthogonal second generation wavelet transforms are developed for the pressure and the velocity. These wavelet transforms are based on second-order accurate interpolation and restriction operators. Together with compatible restriction operators for the mass flux and Bernoulli function, they ensure that mass is conserved and that there is no numerical generation of vorticity when solving the shallow water equations. Grid refinement relies on appropriate thresholding of the wavelet coefficients, allowing error control in both the quasi-geostrophic and inertia-gravity wave regimes. The shallow water equations are discretized on the dynamically adapted multiscale grid using a mass and potential-enstrophy conserving finite-difference scheme. The conservation and error control properties of the method are verified by applying it to a propagating inertia-gravity wave packet and to rotating shallow water turbulence. Significant savings in the number of degrees of freedom are achieved even in the case of rotating shallow-water turbulence. The numerical dissipation introduced by the grid adaptation is quantified. The method has been designed so it can be extended easily to the icosahedral subdivision of the sphere. This work provides important building blocks for the development of fully adaptive general circulation models.