Contribution ID: **42** Type: **Invited Talk**

3D TIGAR: Vertical spectral representation of a global atmospheric primitive equation dynamical core based on Hough harmonics

Tuesday 8 October 2024 18:00 (30 minutes)

TIGAR is a general circulation model aimed at studying Rossby and gravity wave dynamics, which is based on hydrostatic primitive equations. It is a spectral model that employs Hough harmonics, which are eigensolutions of the linearized rotating shallow water equations on the sphere as the basis function set for the horizontal representation of dynamical variables. This leads to the description of dynamics in terms of physically identifiable structures naturally associated with Rossby and gravity waves, which are fully separated at the level of linearization. In the vertical, the model employs spectral representation in terms of vertical structure functions (VSFs), which are eigensolutions of Sturm-Liouville equations. The additional structure provided by Hough framework compared to traditional spectral models can be leveraged on analytical, modelling and computational side. For instance, TIGAR allows to study wave-wave interactions and energy fluxes directly in the model.

Several dynamical cores differing in the vertical representation were developed for TIGAR. We present two of those:
1) VSFs with Neumann boundary conditions at surface, represented in terms of Laguerre polynomials coupled with Simmons and Burridge (1981) inspired vertical advection scheme (Neumann hybrid core)
2) VSFs with homogeneous Dirichlet boundary conditions at surface, represented in terms of Legendre polynomials coupled with fully spectral vertical scheme (Dirichlet core). Dirichlet VSFs, which were not previously used in atmospheric modelling and data analysis, improve the rate of convergence for spectrally expanded data.

We present TIGAR solutions of some classical tests for dynamical cores, including baroclinic instability test and compare them to the solutions of the dynamical core based on spherical harmonics and finite differences in the vertical (PUMA). The TIGAR solution represent well the dynamics of a baroclinic cycle even at a low vertical resolution. In comparison with PUMA, both dynamical cores exhibit much stronger tendency to shock formation which needs to be balanced by carefully chosen dissipation scheme. Dirichlet VSFs facilitate the use of vertical spectral truncation in TIGAR, thus paving the way for development of high resolution dynamical cores.

Primary author: Dr VASYLKEVYCH, Sergiy (University of Hamburg)

Co-authors: Dr LUNKEIT, Frank (University of Hamburg); Prof. ŽAGAR, Nedjeljka (University of Hamburg)

Presenter: Dr VASYLKEVYCH, Sergiy (University of Hamburg)

Session Classification: Numerical Mathematics B