Motivation

As atmospheric models are pushed towards finer resolutions, there is a need for accurate and robust numerical methods which are effective for modeling flows on large-scale parallel systems. The next generation of atmospheric general circulation models will also need to support a range of features. They will be expected to solve the non-hydrostatic equations of motion on grids and dynamically adaptive meshes and support physics/land coupling on separate, process-dependent time scales. To better understand which technologies are best suited for the next generation of global models, Tempest seeks to provide a framework for easy intercomparison and testing of these features.

Mesh and Refinement

Tempest uses non-conformal block-based mesh refinement on the cubed-sphere grid. This approach allows for dynamic adaptation of the mesh to follow features of interest and sub-cycling in time to improve performance (that is, the coarser resolution mesh uses a larger time step than all finer resolutions).

Numerical Methods

Tempest provides a framework for several high-order compact numerical methods within a single code base, including spectral element (SE), discontinuous Galerkin (DG), flux reconstruction (FR) and staggered nodal finite-element (IFEM) methods. These compact methods have been shown (Ulrich, 2013) to have among the best linear span-capturing properties among all known local numerical discretizations. High-order coupling in time is provided via an implicit-explicit adaptive Runge-Kutta (ARK) method. This formulation vertically propagating sound waves are captured implicitly and so do not affect model stability.

Component Architecture

To allow for easy interexchange of model components and physical parameterizations, the architecture is formulated using object-oriented C++ at the highest level with interconnections to ForTRAN for low-level processing. Remapping is hand-sourced on parallel or local processors to avoid overhead due to extraneous communication with the coupling.

References


Software

All software is freely available and licensed under the Apache 2.0 Open Source License (OASL). Tempest's source code is hosted on GitHub, where the latest versions can be found at https://github.com/tecest/tempest.github.io

Contact

paul.ullrich@ucdavis.edu