A Cubed Sphere model for wave propagation on long
dynamical time scales

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ABSTRACT
We describe a new computational dynamical core for
global-scale atmospheric and oceanic models. It is based
on a new area-preserving dynamical core, using an
hermitian compact cubed sphere (HCCS) mesh. The
HCCS is based on the sinh approach with a
Cubed-Sphere grid.

1. Space discretization

The scheme HCCS (Hermitian Compact Cubed Sphere)
is based on the fourth order hermitian scheme
\[ \frac{\partial}{\partial t} q + \nabla \cdot (\gamma q) = 0 \]
where subscript \( t \) stands for the tangential operator.

2. Time discretization

The semi-discretization of (1) is
\[ \frac{\partial}{\partial t} q + \nabla \cdot (\gamma q) = 0 \]
\[ q(t, x) = q(t_0, x) + \int_{t_0}^{t} \nabla \cdot (\gamma q) \, dt \]
where (\( q, t, x \)) are the spherical coordinates.

3. Comparison between ERK and RK4

- Barotropic Instability [2]. Initial condition: perturbation
  of an equilibrium state. Discriminant test case for a Cubed
  Sphere due to a large interpanel gradient.


- Assessing the long time behavior of the HCCS scheme
  using a family of quasi-analytic solutions.

Figure 3: Vorticity at 6 days on the grid 6 x 96 x 96. Top : ERK2 with \( \Delta t = 1 \) hour. Bottom : RK4 with \( \Delta t = 32 \) seconds.

Table 1: Phase error \( \Delta \tau \) for the wave propagation with different schemes on the Cubed-Sphere 6 x 64 x 64.

References

  scheme, submited.
1971.
[5] O. Shamil and N. Baldor, A quantitative test case for global-scale dynamical cores based on analytic