MODELLING ATMOSPHERIC FLOWS WITH ADAPTIVE MOVING MESHES

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ABSTRACT

To better accommodate the highly disparate length scales encountered in geophysical flows, we have extended EULAG with a solution-adaptive moving mesh capability [1]. The development builds on [2], where the authors set forth a time-dependent curvilinear coordinate formulation of the governing PDEs to enable dynamic mesh adaptivity in EULAG. Here, the anelastic flux-form dynamical core of EULAG is augmented with so-called moving mesh partial differential equations (MMPDEs) [3] – derived from optimisation of a mesh mapping functional involving various adaptation properties (e.g. mesh density, smoothness, alignment) – which govern the distribution of the mesh points dynamically. Special attention is given to the *compatibility* of the flux-form MPDATA [4] advective transport with mass continuity, which is essential for the monotonicity of the solution. An enhancement to MPDATA is provided that achieves full compatibility with mass continuity under arbitrary moving meshes. To satisfy the geometric conservation law (GCL), required for compatibility, we have devised a diagnostic solution approach that treats the GCL conceptually as an elliptic problem.

The benefits of the developed solution-adaptive moving mesh solver are demonstrated for passive scalar advection in a prescribed deformational flow, and the life cycle of a large-scale atmospheric baroclinic wave instability showing coexisting fine-scale phenomena of fronts and internal gravity waves. For the latter problem, we compare the results for a number of different physically motivated mesh refinement criteria.

REFERENCES

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