An Unstructured Adaptive Mesh Model for Stratified Turbulence in Atmospheric Flows

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ABSTRACT

The development is summarized of an unstructured (and hybrid) mesh model for atmospheric inertia-gravity waves. It employs an edge-based finite volume non-oscillatory forward-in-time (NFT) approach. The edge-based data structure allows integration of the generic physical form of the governing PDE over arbitrarily-shaped cells. This flexible meshing can be used for optimal point distribution and adaptivity. The unstructured-mesh development follows proven structured-grid methodologies of EULAG, an established model for meteorological research. Reference [Smolarkiewicz and Szmelter, *J. Comput. Phys,* **206 (**2005) 624-649] documents the generalisation to unstructured meshes of the multidimensional positive definite advection transport algorithm (MPDATA), including its monotonic and infinite-gauge options that form a key element of the EULAG's numerics.

Global modelling will be illustrated with examples involving irregular meshes and stratified rotating hydrostatic flows. Local area modelling with unstructured meshes and non-hydrostatic soundproof equations will be illustrated with simulations of canonical 2D and 3D orographic flows in weakly and strongly stratified regimes as well as with a non-Boussinesq amplification and breakdown of deep stratospheric gravity waves. Numerical developments leading to static mesh adaptivity will be described. They include error estimation based on MPDATA and mesh manipulation techniques.