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Soundproof simulations of stratospheric gravity waves on unstructured meshes

P. Smolarkiewicz (1) and J. Szmelter (2)

(1) NCAR, Boulder, Colorado, USA (smolar@ucar.edu), (2) Loughborough University, Leicestershire , UK (j.szmelter@lboro.ac.uk)

An edge-based unstructured-mesh semi-implicit model is presented that integrates nonhydrostatic soundproof equations, inclusive of anelastic and pseudo-incompressible systems of partial differential equations. The model numerics employ nonoscillatory forward-in-time MPDATA methods [Smolarkiewicz, 2006, Int. J. Numer. Meth. Fl., 50, 1123-1144] using finite-volume spatial discretization and unstructured meshes with arbitrarily shaped cells. Implicit treatment of gravity waves benefits both accuracy and stability of the model. The unstructured-mesh solutions are compared to equivalent structured-grid results for intricate, multiscale internal-wave phenomenon of a non-Boussinesq amplification and breaking of deep stratospheric gravity waves. The departures of the anelastic and pseudo-incompressible results are quantified in reference to a recent asymptotic theory [Achatz et al., 2010, J. Fluid Mech., 663, 120-147].