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UNSTRUCTURED MESH BASED APPROACH FOR NONHYDROSTATIC FLOWS

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Global atmospheric flow simulations involve semi-implicit integration of the non-hydrostatic compressible Euler equations under gravity on a rotating sphere. The presentation will discuss the developments of a fully unstructured (and hybrid) mesh class of models for non-hydrostatic flows with emphasis on simulating inertia gravity waves. Global and limited area atmospheric models will be presented. The methodology employs an edge-based, finite volume discretisation within the non-oscillatory forward-in-time (NFT) framework based on the unstructured mesh Multidimensional Positive Definite Advection Transport Algorithm (MPDATA) and elliptic (Krylov) solvers [1]. The latter depend on complex non-symmetric elliptic equations. Bespoke operator preconditioning is required due to the large condition number of the underlying sparse linear operator. The scheme allows integration of the generic physical form of the governing PDEs formulated on arbitrary hybrid computational meshes discretising the generalised curvilinear framework of the computational space and uses a co-located arrangement for all the prognostic variables. For global models its application in the hybrid MPI-OpenMP finite volume module (FVM) dynamical core module of the ECMWF's Integrated Forecasting System (IFS) will be summarised [2]. It is based on a non-hydrostatic solver for compressible Euler equations under gravity on a rotating sphere. FVM utilises meshes derived from the octahedral reduced Gaussian grid; where an unstructured mesh finite-volume discretised horizontal mesh is supplemented by a structured vertical coordinate and employs a flexible data structure framework ATLAS developed at ECMWF [3]. For limited area models the approach will be evaluated for a range of soundproof nonhydrostatic flow solvers. Simulations of stratified orographic flows and the associated gravity-wave phenomena in media with uniform and variable dispersive properties will be presented. They verify the developments and demonstrate the efficacy of the implicit large eddy simulation operating on unstructured meshes for study of stratified turbulent flows.

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