A computational study of stratified flow past a sphere

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A study is reported that examines simulations of stratified three-dimensional flow past a sphere and a hemisphere for a range of stable stratifications, and both laminar and turbulent boundary layer flows. The numerical results show changes in the flow pattern with Froude number to be in good agreement with theory as well as earlier numerical and experimental results [1]. Quantitative comparisons include investigation into a relation between the drag coefficient and Froude number at various flow regimes. The details of flow patterns and pressure distributions are closely examined together with their influence on a drag coefficient. Extensions to weekly and strongly (stably) stratified orographic flows are reported, to link the results of the study to diverse aspects of highly nonlinear atmospheric flows past complex terrain.

The results are obtained with a recently developed general unstructured/hybrid mesh framework suitable for the investigation of all-scale flow models. The framework uses the finite volume discretisation in space with a flexible edge-based data structure admitting unstructured meshes with arbitrarily shaped cells. A three-dimensional semi-implicit unstructured-mesh model [2] integrates non-hydrostatic anelastic equations, suitable for simulation of small-to-mesoscale atmospheric flows. It builds on the non-oscillatory forward-in-time Multidimensional Positive Definite Advection Transport Algorithm (MPDATA) approach [3], non-symmetric Krylov-subspace elliptic solvers and a class of non-oscillatory forward-in-time algorithms.

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