Numerical simulation of rotating and stratified turbulent flows using truncated Navier-Stokes dynamics

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The truncated Navier-Stokes (TNS) procedure for large eddy simulation is equivalent to performing a sequence of under-resolved direct numerical simulations and a periodic filtering of the small-scale component of the solution. The method has been implemented previously to simulate isotropic turbulence, channel flow, and Rayleigh-Benard convection and recently extended to stratified and rotating flows. We will discuss important restrictions that transformation to a rotating frame imposes on subgrid-scale models and describe results of simulations of decaying homogeneous turbulence with and without a Coriolis term in the limit of vanishing molecular viscosity. For simulations of stratified flows we chose a wake of a towed sphere since for this flow detailed experimental data are available. The horizontally periodic computational domain has a solid wall in the bottom and free surface at the top. The numerical code uses Legendre-polynomial based subdomain spectral method in the vertical and Fourier method in the horizontal directions. Numerical simulations are performed for a wide range of Reynolds numbers (Re=5,000 and 50,000) and Froude numbers (Fr between 4 and 64). We will discuss the development and evolution of the flow and the scaling behavior of its characteristic length scales.

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