The Johns Hopkins Turbulence Databases (*JHTDB*)

ROTATING STRATIFIED TURBULENCE DATA SET ON 4096^3 grid

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The data is from a direct numerical simulation of rotating stratified turbulence on a 4096^3 periodic grid using a pseudo-spectral parallel code, GHOST. The simulations are documented in Ref. 1. The relative strength of stratification vs. rotation is characterized by the ratio of the Brunt-Väisälä to inertial wave frequency, $N/f = 4.95$. The code solves the Boussinesq equations with a solid body rotation force acting as the only external forcing mechanism. Time integration uses fourth-order Runge-Kutta. The simulation is initialized with large-scale isotropic conditions on a coarser grid. As the simulation progresses resolution is increased, peaking with 4096^3 at maximum dissipation. After the simulation has reached a statistical stationary state, 5 frames of data, which includes the 3 components of the velocity vector and the temperature fluctuations, are generated and written in files that can be accessed directly by the database (FileDB system).

Simulation parameters and resulting statistics for snapshot 1:

Domain: 2π x 2π x 2π (i.e. range of x_1, x_2 and x_3 is $[0,2\pi]$)
Grid: 4096^3
Number of snapshots available: 5
Viscosity $\nu = 4 \times 10^{-5}$
Prandlt number $Pr = \nu/\kappa = 1$
Brunt-Väisälä frequency $N = 13.2$
Inertial wave frequency $f = 2.67$
RMS velocity $U_o = 0.83$
Scale of energy spectrum peak $L_o = 2\pi/k_0 = 2.5$
Integral length scale $L_{int} = 2\pi \int E_V(k)dk \,/\, \int kE_V(k)dk = 2.6$
Froude number $Fr = U_o/L_oN = 0.0242$
Rossby number $Ro = U_o/L_of = 0.12$
Reynolds number $Re = U_oL_o/\nu = 5.4 \times 10^4$
Kinetic Energy Dissipation $\varepsilon_V = 0.0123$
Potential Energy Dissipation $\varepsilon_P = 0.0077$
Kolmogorov scale $\eta = 1.51515 \times 10^{-3}$
$k_{max}\,\eta = 3.1$

Note: The divergence-free condition in the simulation is enforced using spectral representation of the derivatives. JHTDB analysis tools for gradients are based on finite differencing or splines of various orders. Therefore, when evaluating the divergence using these spatially more localized derivative operators, a non-negligible (but for this well-resolved DNS rather small) error in the divergence is obtained, as expected.

References:

1. Rosenberg, D., A. Pouquet, R. Marino, and P.D. Mininni. (2015) "Evidence for Bolgiano-Obukhov scaling in rotating stratified turbulence using high-resolution direct numerical simulations." Physics of Fluids **27**, 055105.