The Johns Hopkins Turbulence Databases (*JHTDB*)

FORCED ISOTROPIC TURBULENCE DATA SET ON 4096^3 grid

Data provenance: P.K. Yeung[1] & M.P. Clay[1]
FileDB and Web Services:
S. Hamilton[2], R. Ravoori[2], G. Lemson[2], R. Burns[2] & C. Meneveau[2]
[1]Georgia Institute of Technology, Atlanta, GA 30332
[2]Johns Hopkins University, Baltimore, MD 21218

The data is from a direct numerical simulation of forced isotropic turbulence on a 4096^3 periodic grid, using a pseudo-spectral parallel code. The simulations are documented in Ref. 1. Time integration uses second-order Runge-Kutta. The simulation is de-aliased using phase-shifting and truncation. Energy is injected by keeping the energy density in the lowest wavenumber modes prescribed following the approach of Donzis & Yeung[2]. After the simulation has reached a statistical stationary state, a frame of data, which includes the 3 components of the velocity vector are generated and written in files that can be accessed directly by the database (FileDB system). This dataset does not include pressure.

Simulation parameters and resulting statistics for snapshot 1:

Domain: $2\pi \times 2\pi \times 2\pi$ (i.e. range of x_1 , x_2 and x_3 is $[0,2\pi]$)
Grid: 4096^3
Viscosity $\nu = 1.732 \times 10^{-4}$.
Number of snapshots available: 1
RMS velocities u_1', u_2', u_3' = 2.6050, 2.3731, 2.4028
$u'=(2k/3)^{1/2}$=1.56853
Reynolds number $\mathrm{Re}_\lambda = 610.57$
Dissipation $\varepsilon = 1.4144$
Longitudinal integral scale (averaged over 3 directions) $L_l = 1.3916$
Kolmogorov scale $\eta = 1.3844 \times 10^{-3}$
$k_{max}\ \eta = 2.67$
$<\varepsilon>L_l/u'^3 = 0.51$

Notes: 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. Yeung, P.K., D.A. Donzis, and K.R. Sreenivasan. (2012) "Dissipation, enstrophy and pressure statistics in turbulence simulations at high Reynolds numbers." Journal of Fluid Mechanics **700**, 5-15.
2. Donzis, D.A., and P.K. Yeung (2010). "Resolution effects and scaling in numerical simulations of passive scalar mixing in turbulence." Physica D: Nonlinear Phenomena **239**, 1278-1287.