LARGE-EDDY SIMULATION OF TURBULENT FLOWS

1.) 3D Spectra

Using the isotropic turbulence direct numerical simulation (DNS) data *iso_vel128.mat* (located on Canvas or at http://gibbs.science/les/homework/iso_vel128.mat) from Lu et al. (2008) calculate the 3D energy spectrum function $E(k)$ where $k = \sqrt{k_1^2 + k_2^2 + k_3^2}$. Make a log-log plot of $E(k)$ vs. k. On the plot indicate the isotropic scaling range, the production range, and the dissipation range.

2.) 3D Filtering: Real Space

Using the data from problem #1 develop a program(s) that applies a 3D filter to the data in real space at two different scales (of your choice) using:

  (a) a 3D spatial box filter

  (b) a 3D Guassian filter

Present your results by plotting the 3D energy spectrum for each filter type at both filter scales along with the original (unfiltered) energy spectrum from problem #1. Make a separate plot for each filter type.

3.) 3D Filtering: Fourier Space

Using the data from problem #1 develop a program(s) that applies a 3D filter to the data in Fourier space at two different scales (of your choice) using:

  (a) a spatial box filter

  (b) a Guassian filter

  (c) a spectral cutoff filter

Present your results by plotting the 3D energy spectrum for each filter type at both filter scales along with the original (unfiltered) energy spectrum from problem #1. Make a separate plot for each filter type. For the spatial box filter and the Gaussian filter, compare the execution time for your programs from problems #2 and #3.