For use: These simulations are provided free to use with proper reference.

Please reference Portillo et al. (2018): https://ui.adsabs.harvard.edu/abs/2018ApJ...862..119P/abstract

If you have questions, please email: Dr. Stephen Portillo at sportill@uw.edu

Portillo et al. (2018) calculated the 3PCF of Cho-Godunov MHD turbulent boxes using the Fourier transform approach presented in Slepian & Eisenstein (2016). The 3PCF is the excess product of density in triples of grid cells at the corners of triangles of certain shapes and includes phase information that is missed in the power-spectrum. For a density field $\delta(\boldsymbol{x})$, the 3PCF can be written as a function of two triangle side lengths r_1 and r_2 and the cosine of the angle between them, $\hat{r}_1 \cdot \hat{r}_2$,

$$\zeta(r_1, r_2, \hat{r}_1 \cdot \hat{r}_2) = \langle \delta(\boldsymbol{x})\delta(\boldsymbol{x} + \boldsymbol{r_1})\delta(\boldsymbol{x} + \boldsymbol{r_2})\rangle$$

where the angle brackets average over all triangles of this shape: that is, all positions $\boldsymbol{x}$ in the field, all vectors $\boldsymbol{r_1}$ with length r_1, and all vectors $\boldsymbol{r_2}$ with length r_1 that form an angle $\arccos(\hat{r}_1 \cdot \hat{r}_2)$ with $\boldsymbol{r_1}$. Slepian & Eisenstein (2016) presents a fast method to calculate the 3PCF in the Legendre basis where the angle dependence is written in terms of the Legendre polynomials:

$$\zeta(r_1, r_2, \hat{r}_1 \cdot \hat{r}_2) = \sum_{\ell} \zeta_\ell(r_1, r_2) P_\ell(\hat{r}_1 \cdot \hat{r}_2)$$

and the radial dependence is found in bins described by a binning function Φ:

$$\bar{\zeta}_\ell(r_1, r_2) = \int_{r \in \Phi(r_1)} r^2 dr \int_{r' \in \Phi(r_2)} {r'}^2 dr' \, \zeta_\ell(r, r')$$

We provide 3PCFs calculated up to $\ell_{\max} = 5$ for n_b radial bins of a constant width of 4 simulation voxels, so that the last bin probes scales up to 128 voxels, half the simulation box size. There is a 3PCF file for each Cho-Godunov simulation, with the density field $\delta(\boldsymbol{x})$ being the log density, normalized to have zero mean and unit variance. Each file is an $(\ell_{\max} + 1) \times n_b \times n_b$ numpy array representing $\bar{\zeta}_\ell(r_1, r_2)$ with ℓ running from 0 to $\ell_{\max}$ over the first index, and the radial bins running over the other indices.

We note that it can be useful to scale $\bar{\zeta}$ by the product of the number of voxels in both radial bins, which scales as $r_1 r_2$, so we include the file `bin_bounds_and_pixel_number_256.128.32.npy`. This file is a 2×33 numpy array. The first row has the 33 radial bin boundaries, in units of voxels. The second row has the number of voxels in each of the 32 radial bins.

See Portillo et al. (2018) for more details.