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Multidimentional Iterative Filtering: a new approach for investigating plasma turbulence in Hall-MHD and Hybrid-PIC simulations.

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Turbulent space and astrophysical plasmas have a complex dynamics, which involve nonlinear coupling across different temporal and spatial scales. Moreover, there is growing evidence that impulsive events, such as magnetic reconnection instabilities taking place in current sheets, bring to a spatially localized enhancement of energy dissipation, thus speeding up the energy transfer at small scales. Indeed, capturing such a diverse dynamics is challenging. In this work, we employ the multidimensional iterative Filtering (MIF) method, a new multiscale technique for the time-frequency analysis of non-stationary non-linear multidimensional signals. Unlike other traditional methods (e.g., based on Fourier or wavelet decomposition), MIF natively performs the analysis without any previous assumption on the functional form of the signal to be identified. Using MIF, we carry out a space-time analysis of Hall-MHD and Hybrid particle-in-cell numerical simulations of decaying turbulence. Preliminary results assess the ability of MIF to detect localized coherent structures and to separate and characterize the contribution from both the wave-like perturbations and coherent structures to the turbulent dynamics.