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Abstract for an Invited Paper
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Spatial transport and spectral dynamics of turbulence spectra[1]

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The basic physical processes that lead to nonlinear evolution of the probability distribution function of turbulence in space as well as in scale space, will be discussed. It will be argued that the primary means by which the turbulence evolves from regions where it is excited into regions where it is dissipated is via nonlinear mode-coupling processes. Those same processes leads to the evolution in the usual Kolmogorov picture, in which the turbulence evolves by cascading from the scales at which it is excited, towards scales where it is dissipated. It will be shown that these two processes of spreading and cascade are inherently linked. Different models that aim to describe different aspects of this generic, ubiqiutous phenomenon will be introduced. Basic implications of such models and underlying assumptions will be discussed. The simple “ballistic front” solution, which is a common solution of these models, will be discussed. Also, the analogy to the evolution of the particle distribution function (ala’ Boltzmann’s equation) will be discussed and it will be shown that the nonlinear bi-evolution of the spectrum based on a Markovian closure approximation of two-scale dynamics, conserves energy, and satisfies a simple Boltzmann’s H-theorem. In addition, it will be pointed out that spatial evolution of turbulence results in self-consistent evolution of the background gradient profiles that drives the turbulence in the first place. It will be argued that for simple models of drift-wave turbulence, this evolution can be described simply by the evolution of mean potential vorticity (PV) under the action of the Reynolds stresses generated by the fluctuations. Thus, we will argue that PV homogenization and spreading are two processes that needs to be considered together.

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