Logarithmic discretization and systematic derivation of shell models for turbulence

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A detailed systematic derivation of a logarithmically discretized model for two dimensional turbulence and extension into three dimensions is given, starting from the basic fluid equations and proceeding with a particular form of discretization of the wave-number space. We show that it is possible to keep all or a subset of the interactions, either local or disparate scale, and recover various limiting forms of shell models used in plasma and geophysical turbulence studies. The method makes no use of the conservation laws even though it respects the underlying conservation properties of the fluid equations. It gives a family of models ranging from shell models with non-local interactions to anisotropic shell models depending on the way the shells are constructed. Numerical integration of the model shows that energy and enstrophy equipartition seems to dominate over the double cascade for two dimensions, which is unfortunaltely a common problem of two dimensional shell models.