Mode reduction schemes and subgrid models for homogeneous turbulence

John C. Bowman
Department of Mathematical and Statistical Sciences
University of Alberta
Edmonton, Alberta, T6G 2G

Abstract

The need to represent unresolved degrees of freedom in turbulence simulations is well appreciated by the geophysical fluid dynamics community.

In the technique of spectral reduction, one attempts to represent collections of Fourier modes by nonuniformly spaced modes with enhanced coupling coefficients. This decimation scheme exploits the continuity of moments of the underlying probability distribution function of the velocity field. While the reduced model can be designed to respect conservation laws and a Liouville theorem, difficulties arise in reproducing known equipartition solutions of the truncated inviscid dynamics. We illustrate the technique by applying it to the GOY shell model and show how it could be used to derive reliable dynamic subgrid models.

We also mention alternative ideas, such as multigrid-like schemes that enforce short-range periodicity at the small scales, nonuniform basis functions, and subgrid models that rely on Kolmogorov's notion of a self-similar local energy flux to the high wavenumbers.