Abstract Submitted
for the DFD07 Meeting of
The American Physical Society

Turbulence modeling based on a collisional Boltzmann equation
PRAKASH VEDULA, University of Oklahoma, RODNEY O. FOX, Iowa State University — Statistical descriptions of turbulent eddy motions by analogy with Boltzmann kinetic theory are well known in the literature, where relaxation models, such as the Bhatnagar-Gross-Krook (BGK) model, are used to account for the effects of eddy collisions. We propose to seek improvements to such approaches, through the use of a more detailed description of eddy collisions, via the Boltzmann collision operator, instead of currently used relaxation models. The resulting nonlinear, integro-differential, collisional Boltzmann equation for the evolution of the velocity distribution function is solved using a quadrature-based moment method, where the collision term can be analytically evaluated using multinomial expansions. This approach has the advantage of being able to describe distributions that are far from equilibrium, as it lacks a priori assumptions regarding equilibrium distributions. It can be also shown that the rate of dissipation of turbulent kinetic energy depends on an effective coefficient of restitution, which quantifies the degree of inelasticity of eddy collisions. Results based on return to isotropy of Reynolds stresses for homogeneous anisotropic turbulence, derived from the collisional Boltzmann equation, appear to be promising.

Prakash Vedula
University of Oklahoma

Date submitted: 03 Aug 2007 Electronic form version 1.4