Vortex Method Simulation of Turbulent Flows

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Abstract: Gridfree vortex methods represent a natural approach to the simulation of turbulent flows: they model vortical flow structures as vortices; they are minimally affected by numerical diffusion; they resolve sharp flow features without smoothing; and, by being gridfree, they are readily applied to geometries found in industrial applications. Moreover, with the development of techniques such as the Fast Multipole Method, simulations with large numbers of vortex elements are possible. While vortex methods cannot be realistically applied in the context of direct numerical simulations of turbulence, they do have sufficient resolution to provide credible modeling as a large eddy simulation (LES). How best to achieve this end is not self-evident. This talk considers the attributes of a particular vortex method for carrying out LES of turbulent flow that is being developed for application in industry by VorCat, Inc. VorCat makes use of freely convecting and stretching vortex tubes together with a thin unstructured sheet mesh in the vicinity of solid walls. Such elements enhance the efficiency and accuracy of the simulations while remaining closely aligned with the physics of turbulence. VorCat has been applied to a range of complex flows with the goal of establishing the level of its performance in diverse situations. Preliminary results from several calculations will be presented here. These include a zero-pressure gradient spatially developing turbulent boundary layer, the flow past a sphere, and mixing layer and jet flows, among others.