Large Eddy Simulation on Unstructured Grids

For over 10 years now, through the US Department of Energy's Academic Alliance Program, Stanford University has had regular access to the world's largest supercomputers. These machines have allowed high-fidelity computational fluid dynamics (CFD) simulations of complex systems in real engineering configurations using the Large Eddy Simulation methodology on unstructured grids. In this talk I will describe several of these simulations in detail, from realistic jet engine calculations where variable density methods are appropriate, through multi-material jets in supersonic crossflow, where shocks and contact discontinuities complicate the simulation of turbulence considerably. These results were accompanied by many developments and hard lessons in numerical analysis and methods that will also be described. In particular, the concept of Summation-By-Parts operators has been important in guiding the development of finite volume methods appropriate for Large Eddy Simulation because of their stability and inherently low dissipation.

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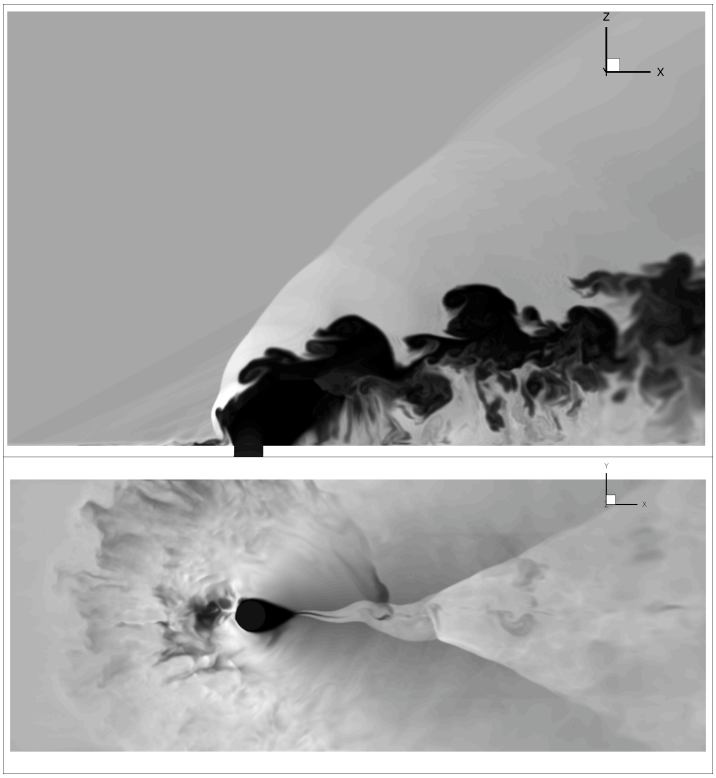

Figure 1: Temperature from sonic transverse hydrogen jet in supersonic crossflow: top) mid-plane; bottom) plane near bottom wall showing large regions of complex separation upstream of the jet.