THE UNSTRUCTURED SPECTRAL ELEMENT METHOD CODE: USEME

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We will discuss the current state of our high-order, discontinuous Galerkin solver which solves a range of partial differential equations on unstructured meshes in two and three dimensions. The USEMe suite of tools includes specialized implementations of solvers for a wide range of PDEs including electromagnetics in variable media; compressible Navier-Stokes; the shallow water equations on a sphere; resistive, reduced Magnetohydrodynamics; incompressible Navier-Stokes; free-surface fluid flows; various elliptic equation solvers. These solvers are equipped to handle unstructured finite element grids and allow up to 13th order polynomial representation of fields in each element.

The purely hyperbolic PDE solvers have been equipped with high-order radiation boundary conditions based on a reformulation of the Bayliss-Turkel boundary conditions [1], as well as more traditional perfectly matched layer absorbing layers. These solvers are also capable of high-order convergence in the presence of discontinuous materials due to the construction of the discontinuous Galerkin method. We will present experimental results demonstrating solution accuracy as a function of material property, scheme order, boundary condition order and simulation time. The solvers are efficiently implemented and run in parallel using the MPI libraries.

We will also demonstrate the latest advances in the creation of a user friendly simulation environment for USEMe. We will show how the discontinuous Galerkin formulation has been interfaced to a new PDE wizard, enabling USEMe users to specify and solve their own PDEs in an intuitive way. In addition we will outline the scope of the new Microsoft Windows version of the code, which encompasses an integrated environment featuring a suite of methods for basic domain design, mesh generation, simulation, h-adaptivity, solution rendering as well as the new PDE wizard.

References

[1] A. Bayliss and E. Turkel, *Radiation boundary conditions for wave-like equations*, Comm. Pure and Appl. Math., 33:707-725, 1980.