ON THE INTERACTION BETWEEN DYNAMIC MODEL DISSIPATION AND NUMERICAL DISSIPATION DUE TO SUPG STABILIZATION

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In reference [1], the origins of stabilized methods are brought to light, being interpreted as subgrid scale numerical models which account for the **numerical** (mathematical) effect of small scales, unresolvable by the discretization, on the resolvable large scales.

In large-eddy simulation (LES) of turbulent flows, a spatial filter is applied to the Navier-Stokes equations with the purpose of filtering out small scales and thereby allowing coarser discretizations to solve for the large (resolved) scales governed by the filtered equations. The filtering operation splits a field into resolved and subgrid scale components, and furthermore, in the case of the filtered Navier-Stokes equations, this operation generates an unknown subgrid scale stress tensor reflecting the **physical** effect of the subgrid scales on the resolved scales. The unknown subgrid scale stress must be modeled to provide closure.

In this talk, we investigate the roles of physical and numerical subgrid scale modeling. The subgrid scales are represented by a physical LES model, namely the popular dynamic Smagorinsky model (or simply dynamic model), as well as by a numerical model in the form of the well-known streamline upwind/Petrov-Galerkin (SUPG) stabilization for finite element discretizations of advection-diffusion systems. The latter is not a physical model, as its purpose is to provide sufficient algorithmic dissipation for a stable, consistent, and convergent numerical method. Here we study the interaction between the physical and numerical models by analyzing energy dissipation associated to the two. Based on this study, a modification to the dynamic model is made as a way to discount the numerical method's algorithmic dissipation from the total subgrid scale dissipation. The modified dynamic model is shown to be successful in simulations of turbulent channel flow.

References

[1] T. J. R. Hughes, "Multiscale phenomena: Green's functions, the Dirichlet-to-Neumann formulation, subgrid scale models, bubbles and the origins of stabilized methods," v. 127, p. 387-401, 1995.