Mathematical study of a new Navier-Stokes-alpha model with nonlinear filter equation

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Abstract:
This talk is devoted to the mathematical study of a new Navier-Stokes-alpha model with a nonlinear filter equation. For a given indicator function, this filter equation was first considered by W. Layton, G. Rebholz, and C. Trenchea to select eddies for damping based on the understanding of how nonlinearity acts in real flow problems. Numerically, this nonlinear filter equation was applied to the nonlinear term in the Navier-Stokes equations to provide a precise analysis of numerical diffusion and error estimates. Mathematically, the resulting alpha-model is described by a doubly nonlinear parabolic-elliptic coupled system. We therefore undertake the first theoretical study of this system by considering periodic boundary conditions in the spatial variable. Specifically, we address the existence and uniqueness of weak Leray-type solutions, their rigorous convergence to weak Leray solutions of the classical Navier-Stokes equations, and their long-time dynamics through the concept of the global attractor and some upper bounds for its fractal dimension. This is a joint work with Manuel Fernando Cortez (EPN).