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Title: Numerical mathematics for computation of local and nonlocal nonlinear transport models in fluid mechanics

Abstract: Local and nonlocal nonlinear hyperbolic-transport models are relevant on the mathematical foundations of modeling in fluid mechanics anchored on the basic and applied sciences. For instance, such models appear in a close connection with several dynamics and models in fluids (e.g., the surface quasi-geostrophic equation, vortex sheet and formation of vortex streets) and also in porous media flow and related equilibrium and nonequilibrium problems (e.g., nonlinear transport of fluids in porous medium as well as in shallow water equations with variable topography and discontinuous initial data). In this work, we will discuss how new insights on the improved concepts no-flow curves and no-flow surfaces in a Lagragian-Eulereian formulation via numerical analysis linked to nocal and nonlocal nonlinear hyperbolic-transport models are key ingredients to address their inherent properties: nonlinearity, wave-breaking phenomena (shocks) and unique weak-entropy solution for local and nonlocal models. Indeed, we also undertake a numerical-analytical study of an initial value problem associated with 1D doubly (nonlocal) fractional conservation and its interplay between the Hilbert transform and the Riesz potential. We will also present advances in the design of a new class of semi-discrete positive Lagrangian-Eulerian schemes for solving multidimensional systems of (local) hyperbolic-transport problems supported by rigorous analysis.