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Fractional-Order LES Subgrid-Scale Modeling: Theory and Numerics[1] MEHDI SAMIEE, ALI AKHAVAN-SAFAEI, MOHSEN ZAYERNOURI, Michigan State University — Filtering the Navier-Stokes equations in the large-eddy simulation of turbulent flows inherently introduces nonlocal features in the subgrid scale fluid motion. Such long-range effects become even more pronounced when the filter- width enlarges. That urges the development of new nonlocal closure models, which respect the corresponding non-Gaussian statistics of the subgrid stochastic motions. Starting from the filtered Boltzmann equation, we model the corresponding equilibrium distribution function with a *Lévy* stable distribution, which leads to the proposed fractional-order modeling of subgrid-scale stresses. We approximate the filtered equilibrium distribution function with a power-law term, and we derive the corresponding filtered Navier-Stokes equations. Subsequently in our functional modeling, the divergence of subgrid-scale stresses emerges as a single-parameter fractional Laplacian, $(-\Delta)^{\alpha}(\cdot)$, $\alpha \in (0, 1]$, of the filtered velocity field. Finally, the introduced model undergoes *a priori* evaluations based on the direct numerical simulation database of forced and decaying homogeneous isotropic turbulent flows at high and moderate Reynolds numbers, respectively.

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