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A VoF method for DNS of droplet-laden incompressible turbulence

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Abstract: We investigated the continuum surface force (CSF) model to include the surface tension within a projection method combined with a split-advection, mass-conserving, wisps-free volume of fluid (VoF) method that we recently developed to perform DNS of fully-resolved droplet-laden incompressible turbulence. The interface curvature is computed accurately using a variable-stencil height-function technique. We tested different implementations of the surface tension and pressure gradient terms within a projection method, and analyzed their stability and the magnitude of the spurious currents for a static drop in both two and three dimensions. We have modified the sequence of the advection sweeps, and show that, in the case of non-zero Weber number, the algorithm is stable, and the spurious currents maximum magnitude is about 1% of the droplet velocity. Finally, we present DNS results of fully-resolved droplet-laden incompressible isotropic turbulence at $Re_\lambda = 75$ using a computational mesh of 1024^3 grid points and 7000 droplets of Weber number $\mathrm{We} = 0.5$, and initial droplet diameter equal to the Taylor lenght-scale of turbulence.

Keywords: droplet-laden flow, isotropic turbulence, volume of fluid method, continuum surface force.