Abstract Submitted
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A High-Spatial-Resolution Three-Dimensional Three-Component Velocimetry Method Based on Divergence-Free Polynomials[1] KEISHI KUMASHIRO, University of Toronto, ADAM STEINBERG, Georgia Institute of Technology, MASAYUKI YANO, University of Toronto — We present a physics-constrained method of inferring three-dimensional three-component (3D3C) velocity fields in constant-density flows from reconstructed 3D Mie-scattering fields of tracer particles. The proposed method is based on the representation of the estimated velocity field as a linear combination of divergence-free polynomial basis functions; the piecewise constant representation of the estimated velocity field that is inherent to tomographic particle image velocimetry (T-PIV) is replaced by a smooth representation that automatically satisfies conservation of mass. The appropriate linear combination is determined using a non-regularized motion estimation framework that is influenced by optical flow estimation. We provide a detailed evaluation of the proposed method in terms of accuracy and spatial resolution, treating 3D constant-density DNS data as the ground truth. We show that the proposed method (a) yields significant improvements in accuracy and spatial resolution compared to an idealized implementation of T-PIV and (b) achieves comparable accuracy and spatial resolution to an idealized estimate that corresponds to the theoretical one-vector-per-particle limit.

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