Abstract Submitted
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Integrated computation of Lagrangian coherent structures during DNS of unsteady and turbulent flows[1] JUSTIN FINN, SOURABH APTE, Oregon State University — The computation of Lagrangian coherent structures (LCS) typically involves post processing of experimentally or numerically obtained fluid velocity fields to obtain the finite time Lyapunov exponent (FTLE) via a sequence of flow maps (vector fields which describe fluid displacement patterns over a finite time interval, $t_0 \pm T$). However, this procedure can be prohibitively expensive for large-scale complex flows of engineering interest. In this work, an alternative approach involving computation of the FTLE on the fly during direct numerical simulation (DNS) of the 3D Navier-Stokes equations is developed. This incorporation of the FTLE computations into a parallel DNS solver relies on Lagrangian particle tracking to compose forward time flow maps, and an Eulerian treatment of the backward time flow map [Leung, J. Comp. Physics 2011] coupled with a semi-Lagrangian advection scheme. The time T flow maps are accurately constructed from smaller sub-steps [Brunton & Rowley, Chaos 2010], resulting in low CPU and memory requirements for computing evolving FTLE fields. Illustrative examples will be presented to demonstrate the capability of the approach including the evolution of a turbulent vortex ring and turbulent flows in complex porous media.

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