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Developing flexible but efficient software for dynamical systems analysis of fluid flow[1] SIAVASH AMELI, YOGIN DESAI[2], SHAWN SHADDEN, Illinois Institute of Technology — The computation of Lagrangian coherent structures (LCS) has become a standard tool for the analysis of advective transport in unsteady flow applications. LCS identification is typically accomplished by computation of finite-time (or finite-size) Lyapunov exponent fields (FTLE), or similar measures based on the Cauchy Green deformation tensor. Sampling of such fields over the fluid domain requires the advection of large numbers of tracers, which can be computationally intensive, but presents a large degree of data parallelism. There is compelling need for software that provides a flexible interface for LCS computation from fluid flow data, while leveraging advances in parallel architectures for data processing. We will describe work on these fronts. Specifically, we discuss the use of the Visualization Toolkit (VTK) libraries as a foundation for object-oriented, polymorphic LCS computation, and how this framework can facilitate integration into powerful flow visualization software such as Paraview. We also discuss the development of CUDA-c and OpenCL GPU kernels, and multicore CPU implementation, for efficient parallel computation of the flow map. We demonstrate results of these implementations on large-scale computations involving millions of tracers on large unstructured grids.

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