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Determining flow and simulation dependent properties of turbulent flows based on an analysis of the Lyapunov exponent. JEFFREY LABAHN, GABRIEL NASTAC, Stanford University, LUCA MAGRI, University of Cambridge, MATTHIAS IHME, Stanford University — The Lyapunov exponent represents the rate of separation of a chaotic solution and can produce insight on flow and simulation dependent properties of turbulent flows. In the current study, an analysis of the Lyapunov exponent is used to investigate its ability to determine the dynamic content and predictability of large-eddy simulation. By comparing inert and reacting flows, it is shown that combustion increases the predictability of the turbulent simulation as a result of the dilatation and increased viscosity by heat release. The predictability time is found to scale with the integral time scale both in the reacting and inert jet flows. It is demonstrated that the global Lyapunov exponent can be utilized as a metric to determine the spatial extent of the computational domain required to capture the dynamic nature of the flow. In addition, an analysis of the local Lyapunov exponent demonstrates that this metric can also determine flow-dependent properties, such as regions of high turbulence and regions that are sensitive to small perturbations within the flow field.

Jeffrey Labahn
Stanford University

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