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Adjoint Sensitivity Analysis for Scale-Resolving Turbulent Flow Solvers PATRICK BLONIGAN, ANIRBAN GARAI, LASLO DIOSADY, SCOTT MURMAN, NASA Ames Research Center — Adjoint-based sensitivity analysis methods are powerful design tools for engineers who use computational fluid dynamics. In recent years, these engineers have started to use scale-resolving simulations like large-eddy simulations (LES) and direct numerical simulations (DNS), which resolve more scales in complex flows with unsteady separation and jets than the widely-used Reynolds-averaged Navier-Stokes (RANS) methods. However, the conventional adjoint method computes large, unusable sensitivities for scale-resolving simulations, which unlike RANS simulations exhibit the chaotic dynamics inherent in turbulent flows. Sensitivity analysis based on least-squares shadowing (LSS) avoids the issues encountered by conventional adjoint methods, but has a high computational cost even for relatively small simulations [1]. The following talk discusses a more computationally efficient formulation of LSS, "non-intrusive" LSS, and its application to turbulent flows simulated with a discontinuous-Galkerin spectral-element-method LES/DNS solver. Results are presented for the minimal flow unit, a turbulent channel flow with a limited streamwise and spanwise domain.
[1] Q. Wang, R. Hui, and P. Blonigan. Least squares shadowing sensitivity analysis of chaotic limit cycle oscillation

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