

Abstract Submitted
for the DFD12 Meeting of
The American Physical Society

New Methods for Sensitivity Analysis in Chaotic, Turbulent Fluid Flows PATRICK BLONIGAN, QIQI WANG, Massachusetts Institute of Technology — Computational methods for sensitivity analysis are invaluable tools for fluid mechanics research and engineering design. These methods are used in many applications, including aerodynamic shape optimization and adaptive grid refinement. However, traditional sensitivity analysis methods break down when applied to long-time averaged quantities in chaotic fluid flowfields, such as those obtained using high-fidelity turbulence simulations. Also, a number of dynamical properties of chaotic fluid flows, most notably the “Butterfly Effect,” make the formulation of new sensitivity analysis methods difficult. This talk will outline two chaotic sensitivity analysis methods. The first method, the Fokker-Planck adjoint method, forms a probability density function on the strange attractor associated with the system and uses its adjoint to find gradients. The second method, the Least Squares Sensitivity method, finds some “shadow trajectory” in phase space for which perturbations do not grow exponentially. This method is formulated as a quadratic programming problem with linear constraints. This talk is concluded with demonstrations of these new methods on some example problems, including the Lorenz attractor and flow around an airfoil at a high angle of attack.

Patrick Blonigan
Massachusetts Institute of Technology

Date submitted: 03 Aug 2012

Electronic form version 1.4