Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

An efficient algorithm to differentiate statistics in turbulent flows

NISHA CHANDRAMOORTHY, QIQI WANG, MIT — In a chaotic system like a turbulent fluid flow around an airplane wing, the derivatives of state functions such as lift and drag with respect to design or control inputs (for example, the geometry of the airfoil or the freestream Mach number) grow exponentially with time. Yet, the infinite-time average of a state function, equal to its average according to the steady-state distribution over state-space, has a bounded derivative to parameters. Computing this statistical response to infinitesimal changes in parameters is an important technical challenge addressing which enables uncertainty quantification, mesh adaptation, parameter estimation and other gradient-based multidisciplinary design optimization techniques. We present a novel approach, the perturbation space-split sensitivity (S3) algorithm, that is provably convergent to the sensitivity of statistics and computationally efficient. The S3 algorithm is demonstrated on a low Reynolds number flow over a vertical block.

Nisha Chandramoorthy
MIT

Date submitted: 01 Aug 2019 Electronic form version 1.4