Abstract Submitted
for the DFD12 Meeting of
The American Physical Society

Model Invariance as a Basis for Hybrid LES-RANS Techniques
STEPHEN WOODRUFF, Computational AeroSciences Branch, NASA Langley Research Center — Advances in computing power have made hybrid Large-Eddy Simulation (LES) - Reynolds-Averaged Navier-Stokes (RANS) approaches feasible for practical problems where RANS methods alone are unsatisfactory. Hybrid methods have been most successful when RANS and LES regions can be placed so there is little interaction between them. A more effective computation would be one where LES regions are placed exactly where required by the physics. In the present work, model-invariant quantities are defined as combinations of the flow variables which yield physical results throughout the RANS/LES transition (such as the Reynolds stress, constructed from RANS and LES contributions). Model invariance provides a means for interpreting simulation results in RANS/LES transitions; the requirement that model invariance be preserved by the flow equations introduces terms that facilitate RANS/LES transitions and allow more freedom in placing those transitions. Numerical experiments are employed to demonstrate the ability of this approach to eliminate the mismatch seen between the RANS log law and the LES log law when hybrid techniques are applied to shear layers. The insensitivity of the approach to the choice of the RANS/LES blending function and other properties of the approach are also discussed

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Date submitted: 03 Aug 2012 Electronic form version 1.4