Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

Statistically accurate low-order models for uncertainty quantification in turbulent dynamical systems THEMISTOKLIS SAPSIS, MIT — A framework for low-order predictive statistical modeling and uncertainty quantification in turbulent dynamical systems will be presented. These reduced-order, modified quasilinear Gaussian (ROMQG) algorithms apply to turbulent dynamical systems in which there is significant linear instability or linear non-normal dynamics in the unperturbed system and energy-conserving non-linear interactions that transfer energy from the unstable modes to the stable modes where dissipation occurs, resulting in a statistical steady state; such turbulent dynamical systems are ubiquitous in geophysical and engineering turbulence. The ROMQG method involves constructing a low-order, nonlinear, dynamical system for the mean and covariance statistics in the reduced subspace that has the unperturbed statistics as a stable fixed point and optimally incorporates the indirect effect of non-Gaussian third-order statistics for the unperturbed system in a systematic calibration stage. This calibration procedure is achieved through information involving only the mean and covariance statistics for the unperturbed equilibrium. The performance of the ROMQG algorithm is assessed on two stringent test cases: the 40-mode Lorenz 96 model mimicking midlatitude atmospheric turbulence and two-layer baroclinic models for high-latitude ocean turbulence with over 125,000 degrees of freedom.

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Date submitted: 01 Aug 2014 Electronic form version 1.4