Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

Statistical Modeling of Epistemic Uncertainty in RANS Turbulence Models IMAN RAHBARI, VAHID ESFAHANIAN, University of Tehran — RANS turbulence models are widely used in industrial applications thanks to their low computational costs. However, they introduce model-form uncertainty originating from eddy-viscosity hypothesis, assumptions behind transport equations of turbulent properties, free parameters in the models, and wall functions. In contrast, DNS provides detailed and accurate results but in high computational costs making it unaffordable in industrial uses. Therefore, quantification of structural uncertainty in RANS models using DNS data could help engineers to make better decisions from the results of turbulence models. In this study, a new and efficient method for statistical modeling of uncertainties in RANS models is presented, in which deviation of predicted Reynolds stress tensor from results of DNS data is modeled through a Gaussian Random Field. A new covariance kernel is proposed based on eigendecomposition of a sample kernel, hyperparameters are found by minimization of negative log likelihood employing Particle Swarm Optimization algorithm. Thereafter, the random field is sampled using Karhunen-Loeve expansion followed by solving RANS equations to obtain the quantity of interest for each sample as uncertainty propagation. In the present study, fully developed channel flow as well as flow in a converging-diverging channel are considered as test cases.

Iman Rahbari
University of Tehran

Date submitted: 01 Aug 2014 Electronic form version 1.4