Abstract Submitted
for the DFD15 Meeting of
The American Physical Society

Model-Form Uncertainty Quantification in RANS Simulation of Wing-Body Junction Flow JINLONG WU, JIANXUN WANG, HENG XIAO, Virginia Tech — Junction flow, known as one of the remaining challenges for computational aerodynamics, occurs when a boundary layer encounters an obstacle mounted on the surface. Previous studies have shown that the RANS models are not capable to provide satisfactory prediction. In this work, a novel open-box, physics-informed Bayesian framework is used to quantify the model-form uncertainties in RANS simulation of junction flow. The first objective is to correct the bias in RANS prediction, by utilizing several observation data. The second one is to quantify the model-form uncertainties, which can enable risk-informed decision-making. To begin with a standard RANS simulation, which is performed on a 3:2 elliptic nose and NACA0020 tail cylinder, uncertainties with empirical prior knowledge and physical constraints are directly injected into the Reynolds stresses term, and the unbiased knowledge from observation data is incorporated by an iterative ensemble Kalman method. Current results show that the bias in the quantities of interest (QoIs) of the RANS prediction, e.g., mean velocity, turbulent kinetic energy, etc, can be significantly corrected by this novel Bayesian framework. The probability density distributions of QoIs show that the model-form uncertainty can be quantified as well.

Jinlong Wu
Virginia Tech

Date submitted: 30 Jul 2015 Electronic form version 1.4