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Implied Models Approach for Turbulence Model Form Physics-Based Uncertainty Quantification KERRY S. KLEMMER, MICHAEL E. MUELLER, Princeton University — Model form uncertainty arises from physical assumptions made in constructing models either to reduce the physical complexity or to model physical processes that are not well understood. Understanding these uncertainties is important for both quantifying prediction uncertainty and understanding the source and nature of model errors. Data-based methods for model form uncertainty quantification (UQ) are limited by the availability of data, and, in turbulence, data is often limited by Reynolds number or geometry. In contrast, physics-based UQ seeks to analyze the model form uncertainty by leveraging the physical assumptions inherent in these models so that it can be extrapolated beyond available data. In this work, an "implied models" approach is developed and applied to Reynolds stress modeling. In the approach, a model error transport equation is derived from the fundamental governing equations by taking the difference between the exact Reynolds stress equation and the equation implied by a particular model form. Budgets of the model error transport are analyzed to better understand the sources of error in RANS models, focusing on the relative contributions from the Boussinesq hypothesis and the specific form of the eddy viscosity in canonical turbulent flows.

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