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Toward Uncertainty Quantification of Turbulence Closure Models
AASHWIN MISHRA, SHARATH GIRIMAJI, Texas A&M University — Predictive turbulence calculations require that the uncertainty in various constituent closures is quantified. We propose that uncertainty quantification must commence at the Reynolds stress closure level, specifically, with the pressure-strain correlation term. The Reynolds stress tensor provides an insufficient basis to describe the internal structure of a turbulent field, expressly its dimensionality. It is demonstrated that this leads to an inherent degree of uncertainty in classical models for turbulent flows. Using Interval Analysis, we quantify the propagation of this epistemic uncertainty for rapid pressure strain correlation models for different regimes of mean flow. It is exhibited that the magnitude of this uncertainty is dependent not just upon the dimensionality of the turbulent field, but to a greater degree upon the nature of the mean flow. In contrast to prior beliefs, we prove that such uncertainty is present (and even greater) in the absence of mean rotation. Finally, we analyze the qualitative and quantitative effects of the non-linear component of pressure on this systemic uncertainty.

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