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Machine Learning Models for Detection of Regions of High Model Form Uncertainty in RANS JULIA LING, JEREMY TEMPLETON, Sandia National Laboratories — Reynolds Averaged Navier Stokes (RANS) models are widely used because of their computational efficiency and ease-of-implementation. However, because they rely on inexact turbulence closures, they suffer from significant model form uncertainty in many flows. Many RANS models make use of the Boussinesq hypothesis, which assumes a non-negative, scalar eddy viscosity that provides a linear relation between the Reynolds stresses and the mean strain rate. In many flows of engineering relevance, this eddy viscosity assumption is violated, leading to inaccuracies in the RANS predictions. For example, in near wall regions, the Boussinesq hypothesis fails to capture the correct Reynolds stress anisotropy. In regions of flow curvature, the linear relation between Reynolds stresses and mean strain rate may be inaccurate. This model form uncertainty cannot be quantified by simply varying the model parameters, as it is rooted in the model structure itself. Machine learning models were developed to detect regions of high model form uncertainty. These machine learning models consisted of binary classifiers that predicted, on a point-by-point basis, whether or not key RANS assumptions were violated. These classifiers were trained and evaluated for their sensitivity, specificity, and generalizability on a database of canonical flows.

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