Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

Turbulent Scalar Flux Modeling for an Inclined Jet in Crossflow: An Analysis of the Error Incurred by Various Modeling Assumptions JULIA LING, Sandia National Lab, KEVIN RYAN, JOHN EATON, Stanford University — In order to use Reynolds-Averaged Navier Stokes (RANS) solvers to determine a passive scalar concentration distribution, it is necessary to model the turbulent scalar fluxes. Various models have been proposed for these turbulent scalar fluxes, each of which relies on a different set of basic assumptions. The gradient diffusion hypothesis assumes that the turbulent scalar fluxes can be modeled as diffusive fluxes with an isotropic diffusivity. A fixed turbulent Schmidt number model relies on the Reynolds analogy between momentum and scalar transport. Higher order algebraic closures, such as the Generalized Gradient Diffusion Hypothesis (GGDH), break away from the isotropic assumption inherent in a fixed turbulent Schmidt number model. The error from each of these modeling assumptions was isolated and evaluated through the analysis of a high-fidelity Large Eddy Simulation (LES) for an inclined jet in crossflow configuration. The LES velocity field and Reynolds stresses were fed into a RANS solver and the scalar distribution was calculated using various turbulent scalar flux models. This methodology removed the compounding effect of errors in the velocity field and Reynolds stresses, enabling the direct evaluation of the isotropic assumption and the Reynolds analogy. It was shown that neither of these assumptions were appropriate for this flow. However, it was also demonstrated that the largest source of error in the scalar flux modeling was due to poorly tuned model coefficients, not to any particular modeling assumption.

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Date submitted: 23 Jul 2014 Electronic form version 1.4