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Conditional statistics for passive-scalar mixing in confined turbulent shear flows JAMES HILL, HUA FENG, MICHAEL OLSEN, RODNEY FOX, Iowa State University — The conditional moment closure is one of the fundamental closure models used for turbulent flows. Although there is a large body of literature on turbulent shear flows, conditional statistics of experimental data are scarce, despite their necessity for understanding turbulent flows and validating numerical models. In the present work, a combined particle image velocimetry (PIV) and planar laser-induced fluorescence (PLIF) system was employed to investigate turbulent mixing in a confined liquid-phase plane-wake flow and in a confined liquid-phase rectangular-jet flow. The Reynolds number based on bulk velocity and hydraulic diameter was 37,500 for the wake flow and 50,000 for the jet flow. The Schmidt number for the passive scalar was approximately 1,250. Velocity components conditioned on the scalar for both the wake and jet flows were evaluated. It was noticed that the β-PDF predicted the experimental data very well for all observed locations. Since the joint velocity-scalar PDF was not jointly Gaussian in these flows, the conditional mean velocity was found to agree with a linear model only when the mixture fraction is close to the local mean mixture fraction. The gradient PDF model was also tested against the experimental data. The model predicted the cross-stream conditional velocity very well, but gave poor predictions for the streamwise conditional velocity. Finally, the scalar fluctuations conditioned on velocity are analyzed using existing models.

James Hill
Iowa State University

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