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Large eddy simulations of a Mach 0.9 jet with fully-turbulent nozzle-exit boundary layer[1] GUILLAUME BRES, FRANK HAM, Cascade Technologies Inc., PETER JORDAN, Institut Pprime — From past studies, it is well known that the state of the nozzle-exit boundary layer is a key parameter for the flow development and noise characteristics of a jet. However, because of the computational cost of simulating high Reynolds number wall-driven turbulence, the nozzle boundary layer is typically assumed to be laminar or weakly disturbed in most jet simulations. This approach often leads to enhanced laminar to turbulent shear-layer transition and increased noise due to vortex pairing. In the present work, large eddy simulations of an isothermal Mach 0.9 jet (Re = 1E6) issued from a convergent-straight nozzle are performed using the compressible flow solver "Charles" developed at Cascade Technologies. Localized adaptive mesh refinement, synthetic turbulence and wall modeling are used inside the nozzle to ensure fully turbulent profiles at the nozzle exit. This resulted in significant improvements for the flowfield and sound predictions, compared to the typical approach based on laminar flow assumption in the nozzle. The far-field noise spectra now remarkably match the measurements from the companion experiment conducted at Pprime Institute, within 0.5 dB for most angles and relevant frequencies. As a next step toward better understanding of jet noise, the large transient database collected during the simulation is currently being mined using reduced order modeling and wavepacket analysis.

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