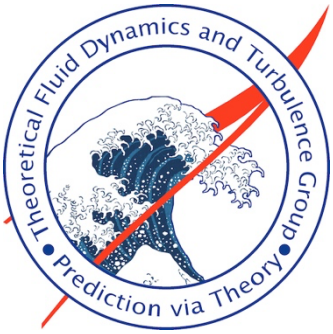
Split-Step Simulations of Sonic Boom Propagation Beyond the Lateral Cutoff in a Turbulent Atmosphere



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Recent flight tests during the Quiet Supersonic Flights 2018 (QSF18) study reported sonic booms heard outside of the primary carpet region. In the absence of turbulence, the lateral cutoff region separates the primary sonic boom carpet from the shadow zone, where the sonic boom signal experiences significant attenuation. However, when turbulence is present in the atmospheric boundary layer (ABL), additional scattering of the sonic boom to the shadow zone region occurs. A method is presented for simulating sonic boom propagation in a turbulent atmospheric boundary layer beyond the lateral cutoff region into the shadow zone. A split-step method is used to integrate a partially one-way equation for the acoustic pressure. Inhomogeneous turbulence, representative of the ABL, is generated in the computational domain with a Fourier synthesis approach. Distributions of several loudness metrics in the shadow zone region for a sonic boom N-wave and a shaped boom are examined. Increasing both turbulence root-mean-square velocity and integral length scale are found to increase the average loudness of booms in the shadow zone. (This research is supported by the Commercial Supersonic Technology Project of the National Aeronautics and Space Administration under Grant No. 80NSSC19K1685.)