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Effects of step non-compactness and free-stream convection on step noise[1] JIN HAO, AHMED ELTAWEEL, MENG WANG, University of Notre Dame — The effects of acoustic non-compactness of steps and free-stream convection on sound generation in a turbulent boundary layer over small steps are investigated in the Lighthill framework by comparing solutions obtained using a boundary-element method with those based on a compact-step Green's function. When the ratio of acoustic wavelength to the step height, λ/h, is large, good agreement between the two is found in terms of sound spectra and directivity. Discrepancies become significant with decreasing λ/h. For mildly non-compact step heights, the sound directivity for forward steps exhibits asymmetry, with the upstream side maintaining an approximate dipole lobe while the rest significantly distorted. Dips in sound spectra and multiple lobes in directivity are observed along with significantly enhanced sound power when λ/h is sufficiently small, indicating that edge-scattering becomes the dominant source mechanism. The effect of convection on the far-field sound is found to be significant at free-stream Mach number of 0.1 or higher. These results indicate that both step non-compactness and convection effects must be taken into consideration when performing wind-tunnel experiments for hydroacoustic applications.

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