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Computational study of flow noise from small gaps in turbulent boundary layers[1] JIN HAO, MINSUK JI, MENG WANG, University of Notre Dame — The noise induced by small gaps underneath low-Mach-number turbulent boundary layers is studied using large-eddy simulation and Lighthill's equation. The latter is solved by employing an acoustically compact Green's function for the gap and by a boundary-element method. The gap leading-edge height is 13% of the boundary-layer thickness, and the gap width and trailing-edge height are varied to investigate their effect on sound generation. The radiated acoustic field is dominated by the forward-facing step in the gap and resembles forward-step noise for wide gaps and/or asymmetric gaps with the trailing edge higher than the leading edge. For narrow and symmetric gaps, destructive interference of the sound from leading and trailing edges causes a significant decline in the low-frequency spectral content and thereby creates a broad spectral peak in the mid-frequency range. The effect of acoustic noncompactness of gaps is investigated by comparing solutions based on a compact Green's function and those from a boundary-element calculation. Excellent agreement is observed at low frequencies and away from the wall-normal direction. At higher frequencies, the sound field deviates from that of a compact streamwise dipole. The elevated level of surface pressure fluctuations induced by gaps and their recovery to equilibrium conditions are also examined.

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