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Jet crackle: skewness transport budget and a mechanistic source model DAVID BUCHTA, JONATHAN FREUND, University of Illinois at Urbana-Champaign — The sound from high-speed (supersonic) jets, such as on military aircraft, is distinctly different than that from lower-speed jets, such as on commercial airliners. Atop the already loud noise, a higher speed adds an intense, fricative, and intermittent character. The observed pressure wave patterns have strong peaks which are followed by relatively long shallows; notably, their pressure skewness is $S_k \geq 0.4$. Direct numerical simulation of free-shear-flow turbulence show that these skewed pressure waves occur immediately adjacent to the turbulence source for $M \geq 2.5$. Additionally, the near-field waves are seen to intersect and nonlinearly merge with other waves. Statistical analysis of terms in a pressure skewness transport equation show that starting just beyond δ_{99} the nonlinear wave mechanics that add to S_k are balanced by damping molecular effects, consistent with this aspect of the sound arising in the source region. A gas dynamics description is developed that neglects rotational turbulence dynamics and yet reproduces the key crackle features. At its core, this mechanism shows simply that nonlinear compressive effects lead directly to stronger compressions than expansions and thus $S_k > 0$.

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