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Reduced-order models for jet noise

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The research reported here leads to a simple prediction methodology based on a reduced-order model for jet noise. The approach is a hybrid one made up of three components. Each component uses modelling and numerical techniques optimised to suit a particular purpose. The propagation of noise to the far field is captured via a new method for solution of the adjoint linearised Euler equations, describing how sound emitted by the jet is modified by propagation through the time-averaged but spatially varying jet flowfield. The directivity of the quadrupole sources is more general than is usually assumed and their statistical properties are modelled based on a RANS solution for the jet: the cross-correlation of the turbulent quadrupoles is modelled as Gaussian with length and time parameters proportional to the local length and timescales from the RANS solution, The constants of proportionality are determined through comparison with correlations from LES and from experimental data. Hence the source model is determined entirely from near field data and the far-field sound is then predicted with no empirical constants. Comparison between this predicted noise and experimental data is very good, across a wide spectral range and even at angles close to the jet axis.