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Numerical modeling of sonic boom propagation from hypersonic aircraft

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A numerical study of sonic boom propagation from hypersonic aircraft is performed including the effects of nonlinearity, atmospheric absorption and dispersion, and atmospheric stratification. A second-order split-step algorithm, which alternates application of nonlinearity in the time domain and complex absorption in the frequency domain, allows for a faster convergence of results with fewer range steps than with conventional first-order algorithms. Nonlinearity is calculated using the potential, the integral of the pressure, as proposed by Burgers and later applied to sonic booms by Hayes et al. This method, an alternative to Landau's law of equal areas, efficiently locates the shock position by selecting the maximum potential in multivalued regions. Definition of atmospheric absorption at high altitudes is important for modeling the propagation of sonic booms from hypersonic aircraft. Some aspects of an extended absorption model by Sutherland and Bass are adopted, therefore, which extend absorption predictions above the 20 km limit of the current ISO and ANSI standards. The study is completed using the meteorological conditions at two locations, Le Havre, France and Edwards Air Force Base, CA, USA, over the course of a year. [Work supported by European Union through ATLLAS AST5-CT-2006-030729, meteorological data provided by ECMWF.]