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-Dimensional Finite-Difference Time-Domain Simulation of Explosion Infrasound in Rough Topography

We investigate the impact of rough surface topography on atmospheric infrasound propagation by means of full 3D numerical simulations. The geometry of the reflecting surface and/or structures near the acoustic source strongly influences the development of acoustic waves, thereby affecting the sound radiation patterns in the far field. The linearized Euler equations, describing acoustic overpressures in the presence of background flows, are solved by Finite-Difference Time-Domain (FDTD) method. The FDTD method has advantages to account for complex wave phenomena such as reflection, diffraction, and scattering by arbitrary objects, which may not be properly handled by acoustic rays. Parallel algorithms are implemented to distribute large workload across CPU/GPU clusters. Surface topography, sound speed variation, and wind profiles are taken into consideration for realistic atmospheric propagation. We characterize sound propagation patterns in a series of numerical simulations with different surface topographies and investigate the topographic propagation effects in combination with atmospheric sound speed and wind gradients. Finally, the result of numerical modeling is compared to the acoustic overpressures observed from chemical explosion experiments for verification. By understanding sound propagation in realistic emplacement conditions and atmospheric properties, we expect to improve acoustic source characterization substantially (e.g., yield and explosion mechanisms).

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