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Infrasound Source Modeling and Data Inversion using Coupled Seismo-Acoustic Simulations

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Buried explosions are known to produce infrasonic signals in the atmosphere. The phenomena responsible for the generation of the infrasound include seismic-to-acoustic coupling at the Earth's free surface, surface waves, and spall. In a previous study, we inverted infrasonic data collected as part of the Source Physics Experiment and determined that the majority of the infrasound energy was generated by the spall. This determination was made by inverting the observed infrasound where the source model was characterized by a spall term as well as a buried isotropic explosion. The inversion suggests that the spall term explained about 99% of the observed data. However, the forward model was acoustic throughout, meaning that the elastic energy produced by the buried isotropic source was not correctly simulated, nor was the seismic-to-acoustic coupling at the Earth's surface. In this study, we investigate the degree to which this acoustic approximation influenced our initial conclusions. Specifically, we use a Sandia-developed finite difference code that contains both elastic and acoustic model regimes to produce axially symmetric models with source parameters similar to our previous work. Because the code properly simulates elastic and acoustic waves, we can generate more realistic Green's functions for the linear inversion of the data. We discuss 1) the effects that the more realistic Green's functions have on the inversion of the data, 2) the accuracy of our initial conclusions based on the purely acoustic model, and 3) whether low-cost, purely acoustic models are adequate for linear source inversions with observed infrasound data. Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.