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Impacts of minute-scale atmospheric variability on acoustic signals from surface explosions

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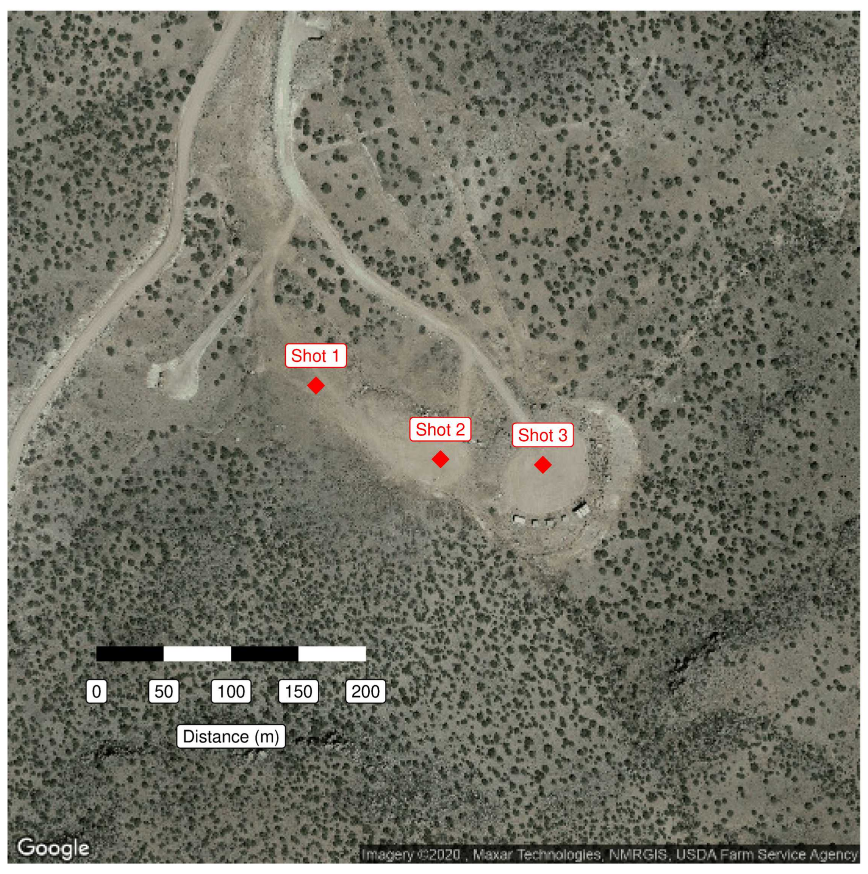
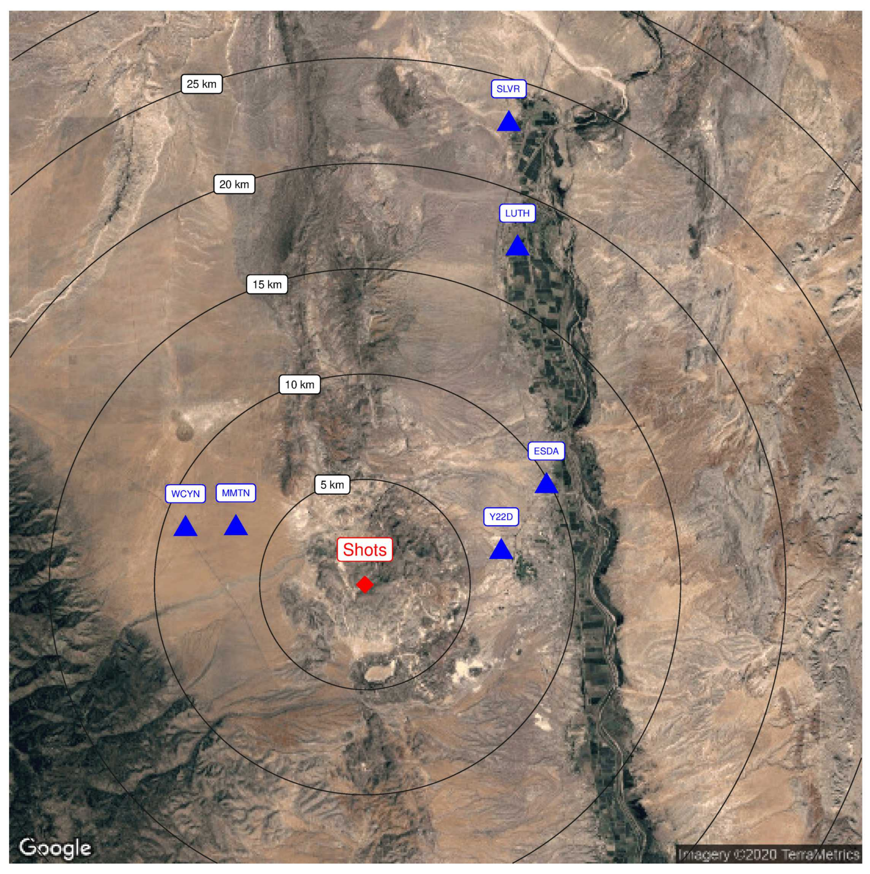
Introduction

The Earth's atmosphere changes over very short time scales, which impacts our ability to accurately model acoustic propagation. Remarkable variations in acoustic amplitude have been observed over an hour and a half, but it is unclear how much fluctuation may occur over the minute range. Here, we show results from the TurboWave experiment, which recorded acoustic signals from **three 1 ton TNT equivalent explosions detonated 90 seconds apart** at the Energetic Materials Research and Testing Center near Socorro, NM. Sound was recorded on a local network extending from 6.5 to 22 km away, and on two arrays located 177 and 259 km to the East. Initial results indicate that **near source topography** and **minute scale atmospheric variability** control the signal properties at local range, particularly impacting the coda. Simulations that examine acoustic propagation across topography in an homogeneous atmosphere recover some but not all of these variations. Fluctuations in acoustic signals returning from the stratosphere are seen at the eastern stations, indicating that the refraction zone is spatially and/or temporally variable over very short scales.

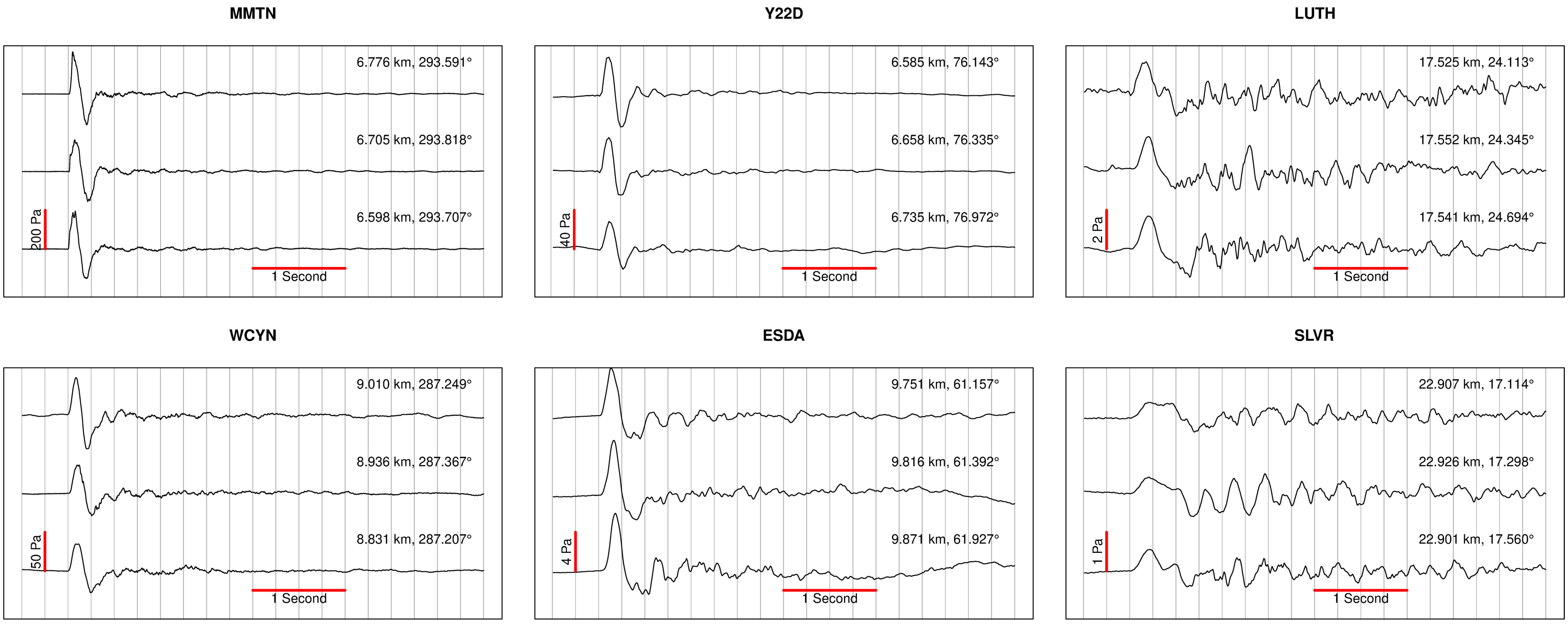
Location of Shots



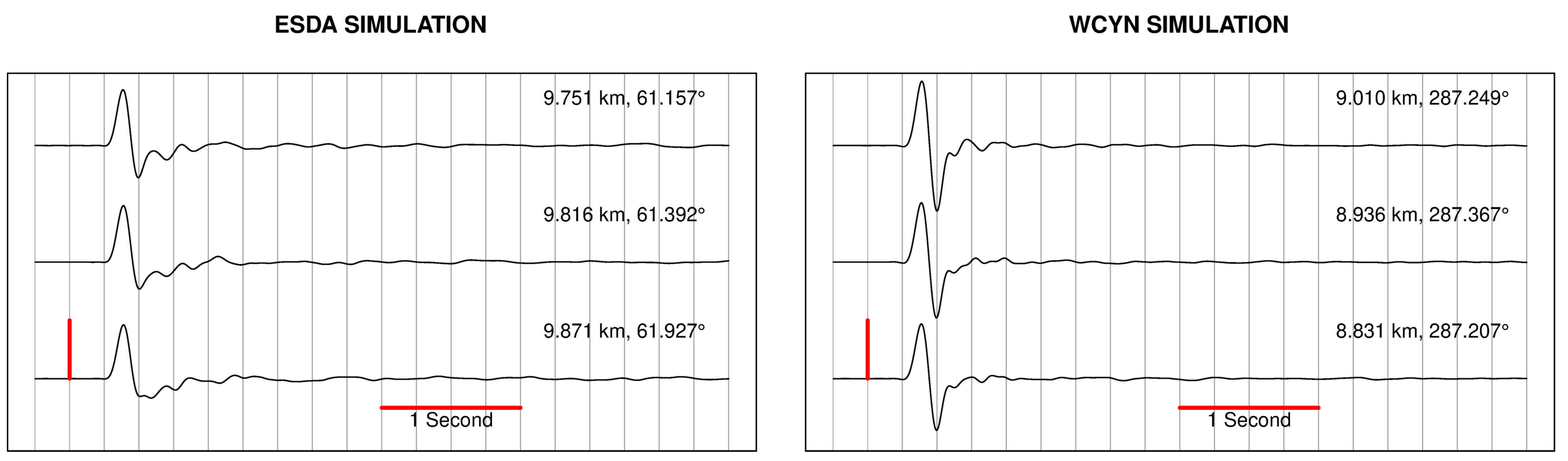
Local Network



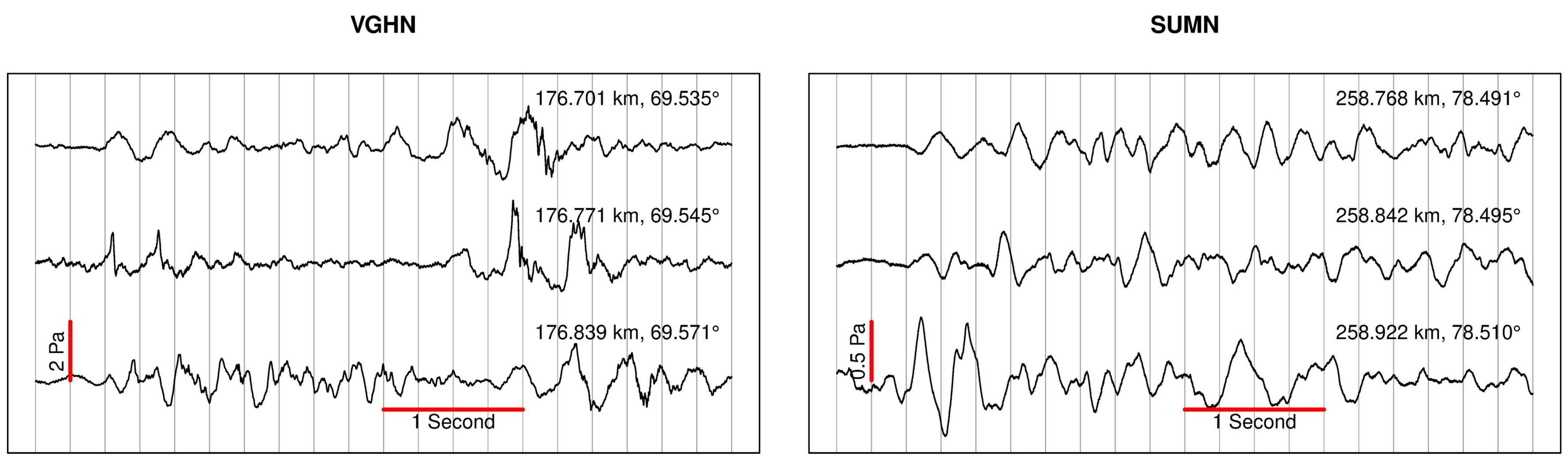
Close Waveforms



Simulations (Homogeneous Atmosphere)



Far Waveforms



Conclusions

Our results indicate that atmospheric structures that persist for tens of seconds to minutes can affect the coda of local events (<25 km) and dramatically impact the waveforms of signals refracted from the stratosphere (>150 km). Since these structures will likely remain forever below the resolution of numerical weather prediction models, **deterministic acoustic waveform modeling will never be possible beyond about ten kilometers** and certainly not at stratospheric ranges. This underscores the need for acoustic signal characterization that relies on features less affected by passage through caustics, such as total energy or frequency content. Simulations under homogeneous atmospheric conditions show that near-source topography does impact the amplitude and waveform of acoustic signals even when the event locations are within one hundred meters of each other. This implies that robust location techniques could be developed when there is a need to precisely determine a point source's position to within several tens of meters.

Acknowledgments

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