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Topographic Effects of Infrasound Wave Propagation

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Abstract

Infrasound is acoustic energy with low frequencies often below the threshold of human hearing (< 20 Hz). Continuous infrasound is produced by Volcán Villarrica (Southern Chile) and may be recorded with specialized microphones. In January, 2020 our team deployed 18 infrasound sensors oriented in a linear fashion from the volcanic crater out to 10 km at roughly 400 meter intervals. The objective was to measure the power output and expected signal arrival times as atmospheric conditions fluctuate. I will use the recorded data from this continuous and powerful producer of infrasound to invert for atmospheric conditions, which will influence arrival times. Understanding the structure of the atmosphere is possible with infrasound monitoring, and can be useful in climate and volcanic plume dispersion models. These results will also help inform volcanologists about optimal distances where infrasound sensors should be installed in the field, and how to avoid 'shadow zones', where there will be a complete absence of infrasound. I will be modeling the influence of a changing atmosphere using finite difference time domain wave propagation simulations.

This student presentation is available at ScholarWorks: https://scholarworks.boisestate.edu/under_showcase_2020/65

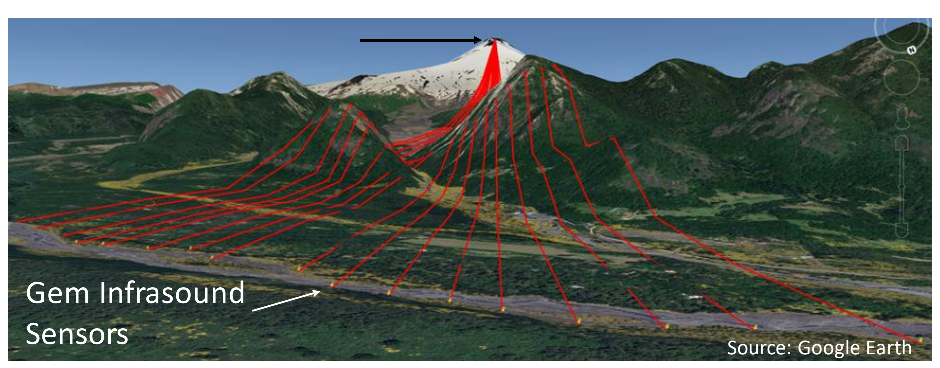
Topographic effects of infrasound wave propagation

PRESENTER:
Jerry Mock

BACKGROUND: Infrasound is long wavelength sound, inaudible to humans, which is widely used in volcano monitoring. Infrasound radiation is directly correlated with physical processes occurring at a volcanic vent and may be used to determine volcanic activity levels. Volcán Villarrica, Chile, has an open vent and active lava lake, which is an excellent source of powerful and continuous infrasound. One of the research goals of our January 2020 expedition to Villarrica was to determine the influence of intervening topography on the amplitude and spectral content of infrasound data recorded far from the vent (~12 km).

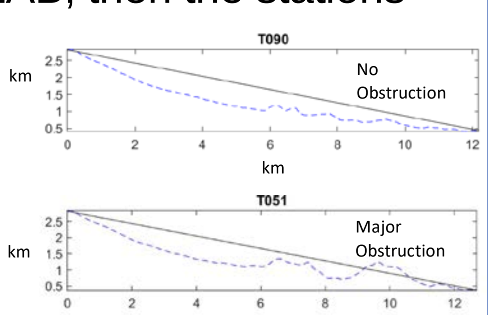
METHODS

1.Infrasound data was collected from Volcán Villarrica in Chile by setting up a linear Gem sensor array, with the line normal and equidistant to the source (Volcán Villarrica).



2. The topographic data was mapped using Google Earth and MATLAB, then the stations were split into 3 groups.

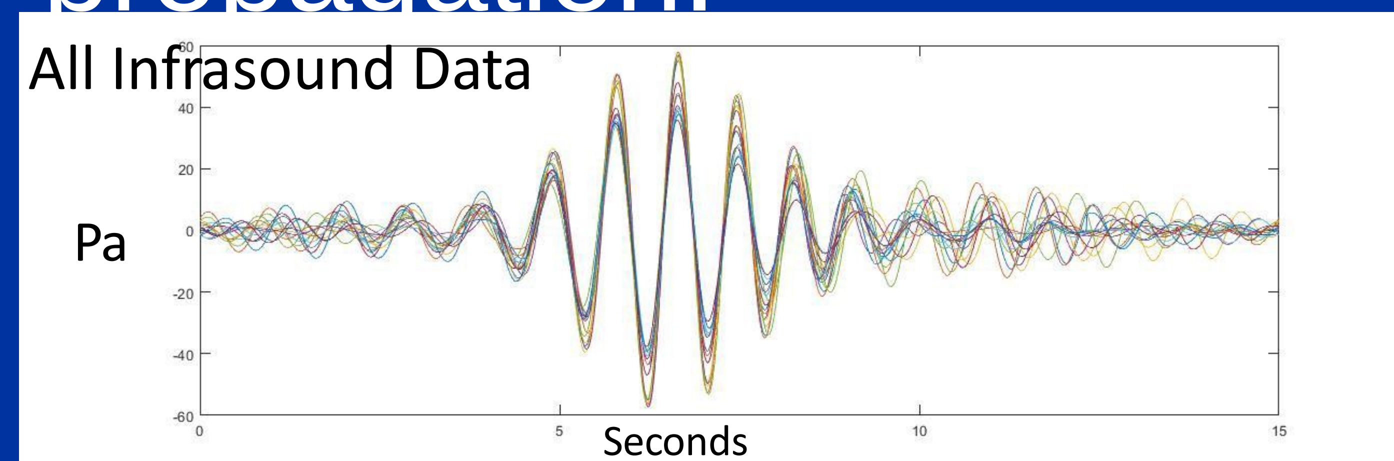
- No obstruction
- Partial Obstruction
- Major Obstruction



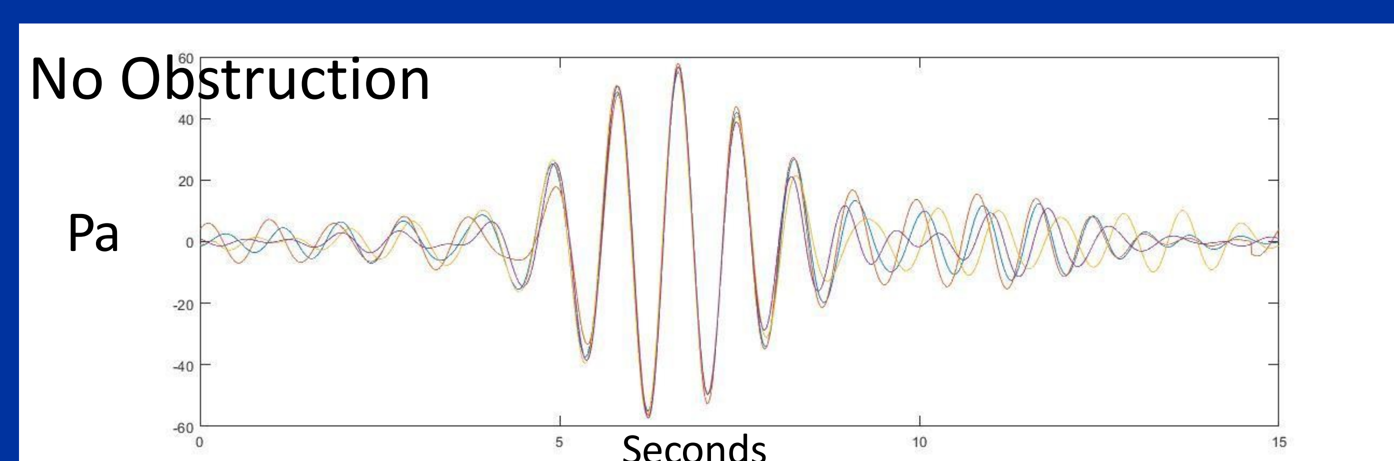
3. The infrasound data was processed in MATLAB to alleviate the noise using high and low pass digital filters and aligned peak to peak for comparison, removing distance as a noise factor.

4. The waveforms of three groups were graphed in MATLAB and compared.

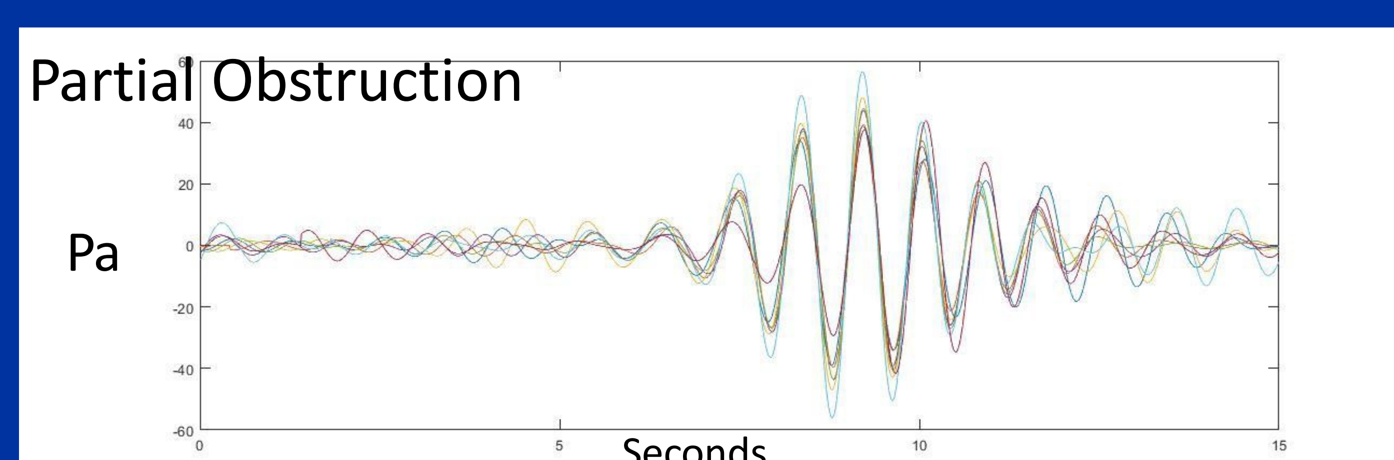
Initial Findings: Intervening topography **does impact** infrasonic wave propagation.



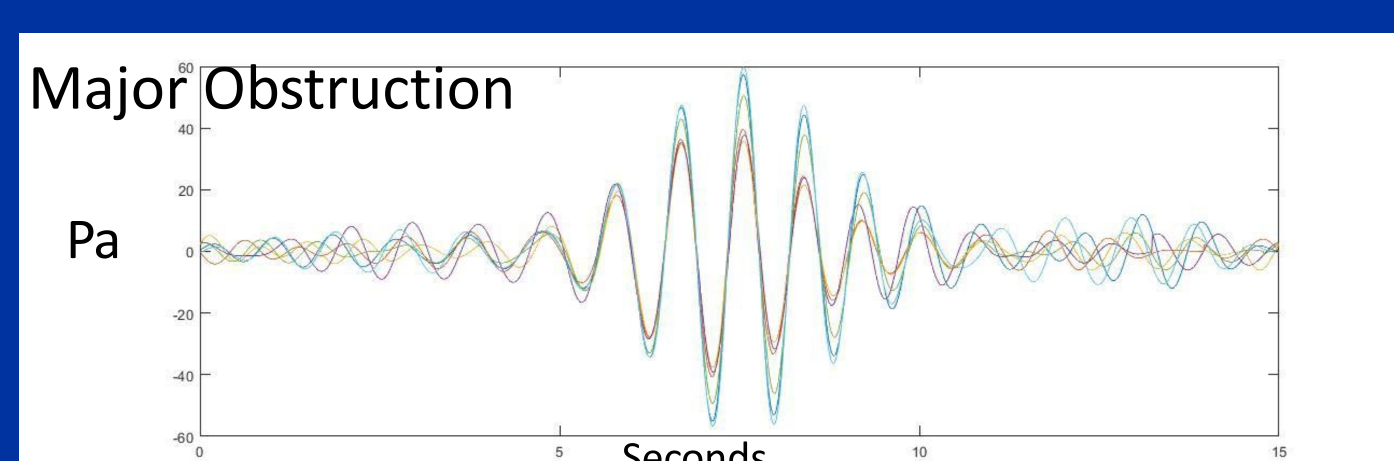
One explosion captured by the Gem infrasound sensor array



With no topographic obstruction, all the data match well in amplitude and wavelength



With partial obstruction, the data are much more erratic in amplitude and inconsistent in wavelength



With major obstruction, the data are much more erratic in amplitude, though consistent in wavelength

EQUIPMENT

The Gem infrasound sensors are the product of years of effort by Dr. Jacob Anderson here at Boise State University. The Gems used on the January 2020 expedition to Villarrica were manufactured by every one of the authors in one capacity or another.

CONCLUSIONS

Initial findings show that topographic interference does impact infrasound wave propagation by direct visual comparison of the data.

Ongoing research will consist of running propagation models from the source and doing quantitative analysis on a supercomputer as well as doing comparison with the infrasound signal direct from the crater rim as a standard. Geophysicist Dr. Keehoon Kim has provided the code for propagation modeling that will be used in 2D and 3D comparisons.

Topographic interference research will inform on the placement of future monitoring stations and improve on the current infrasound model.

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