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Evaluating the Influence of Atmospheric Fluctuations on Infrasound Propagation at Volcán Villarrica

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Abstract

Infrasound is long wavelength (~102 m), low frequency sound produced by powerful geophysical phenomena including avalanches, earthquakes, and volcanoes. The continuous and powerful (~101 Db) infrasound produced by open vent Volcán Villarrica in Southern Chile is here used to analyze sound propagation across varying atmospheric conditions. In January, 2020, we deployed 19 sensors in a radial array leading away from the summit crater in order to quantify the impact of the fluctuating atmosphere on the recorded infrasound signal. This data will inform volcanologists about optimal monitoring site selection methods, and will determine changes in signal amplitude and correlation for a ~10 km signal propagation path.

Evaluating the influence of atmospheric fluctuations on infrasound propagation at Volcán Villarrica

PRESENTER:

Scott J.Gauvain

BACKGROUND:

Infrasound is long wavelength (~10^2 m), low frequency sound produced by open vent volcanoes. We here use continuous ~1 Hz frequency infrasound produced by Volcan Villarrica to assess atmospheric influence on signal recorded for 19 stations. (Figure 1).

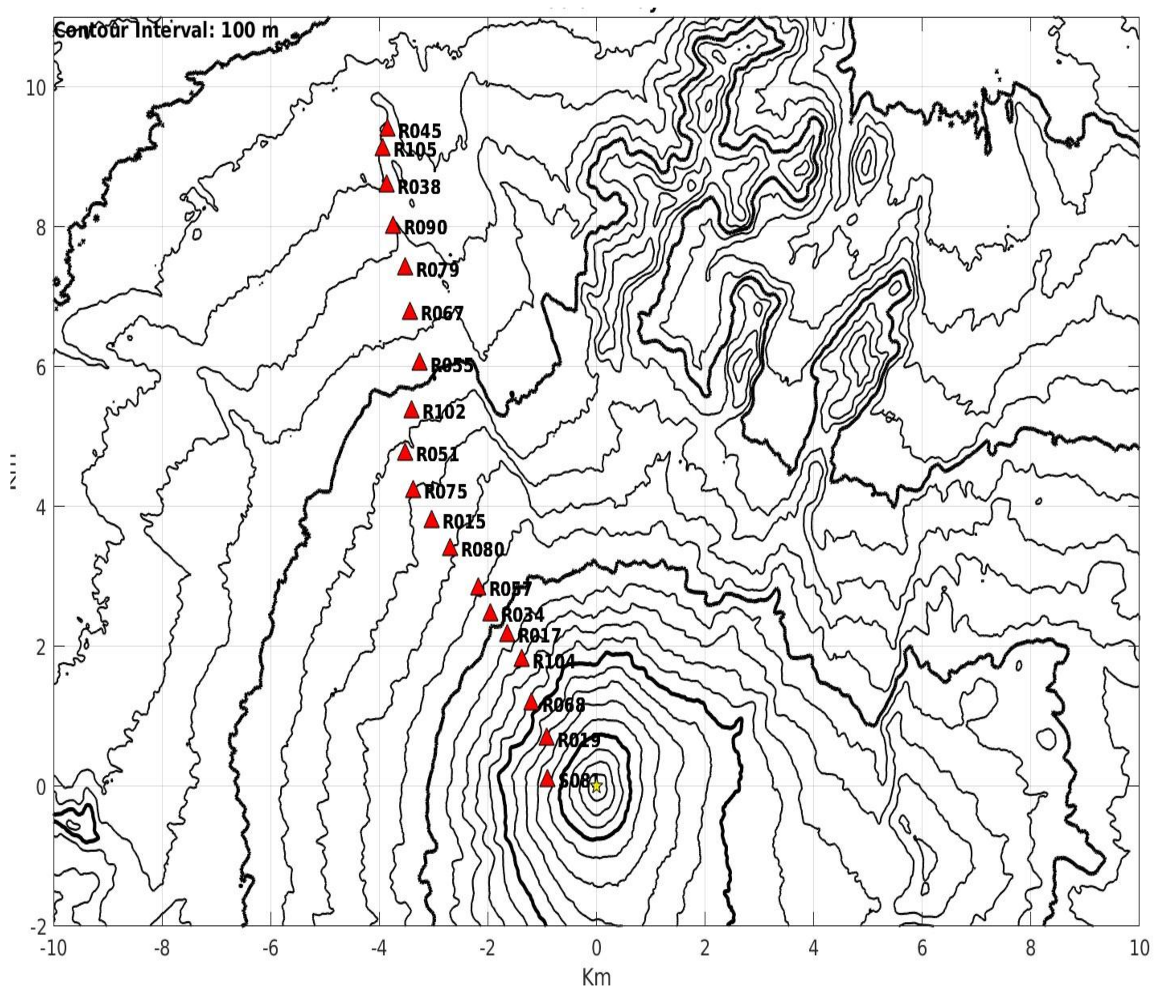

Figure 1: A contour map displays the 19 station array layout. Stations are represented by red triangles, and the volcanic vent by a gold star.

METHODS:

1. Installed microphones in array moving away from the summit crater (Figure 1).
2. Recorded continuous, intense infrasound and measured amplitude decay with distance (Figure 2).
3. Compared data to fast and slow sound speed models (Figure 4).
4. Quantified signal similarity using cross correlation analysis (Figure 3)

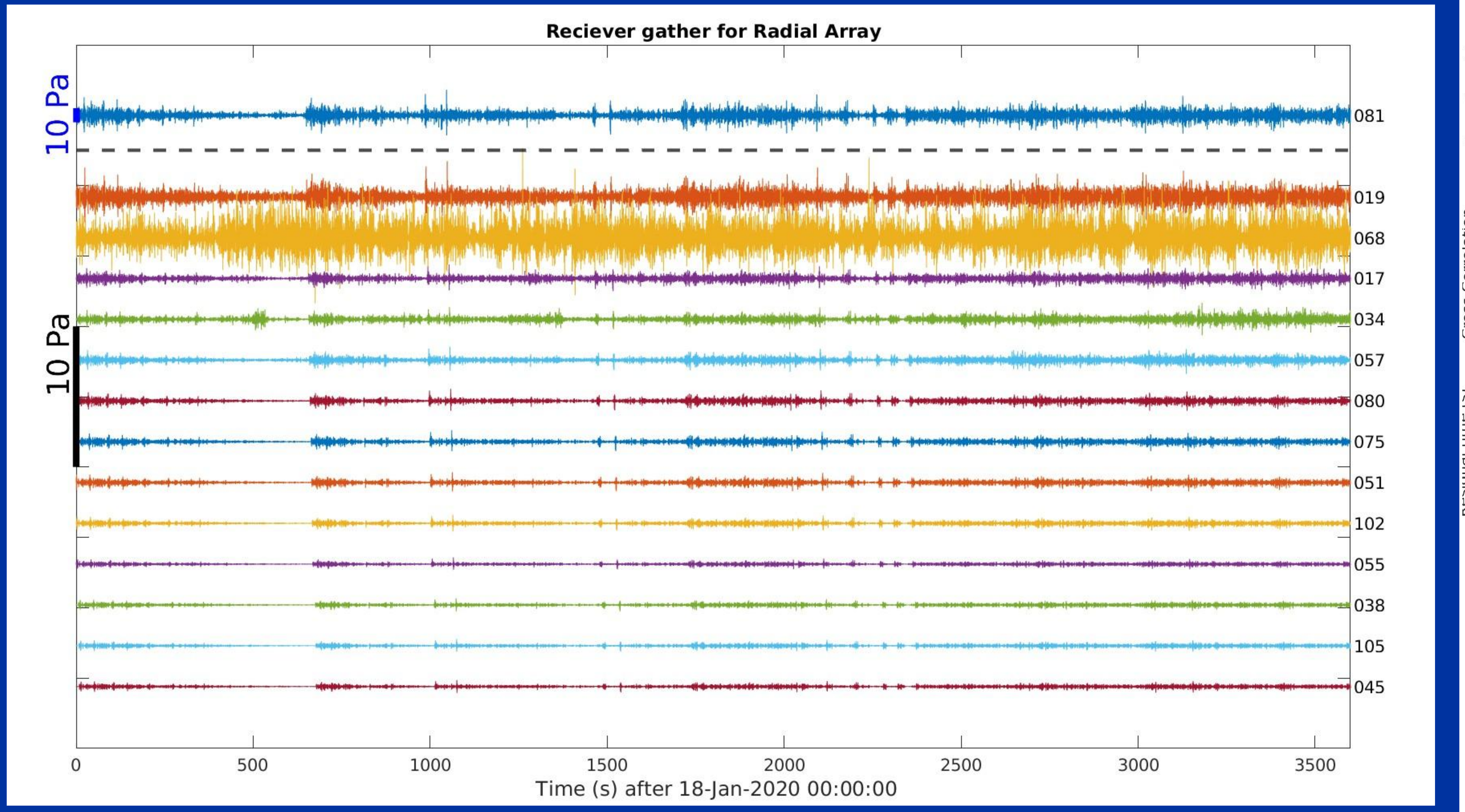

Figure 2: An hour of data displays amplitude (Pascal pressure) fall-off with increased distance from the infrasound source. Larger amplitudes are recorded closest to Villarrica's vent. Station 068 deviates from expectations, recording amplitudes similar to those recorded closer to the vent.

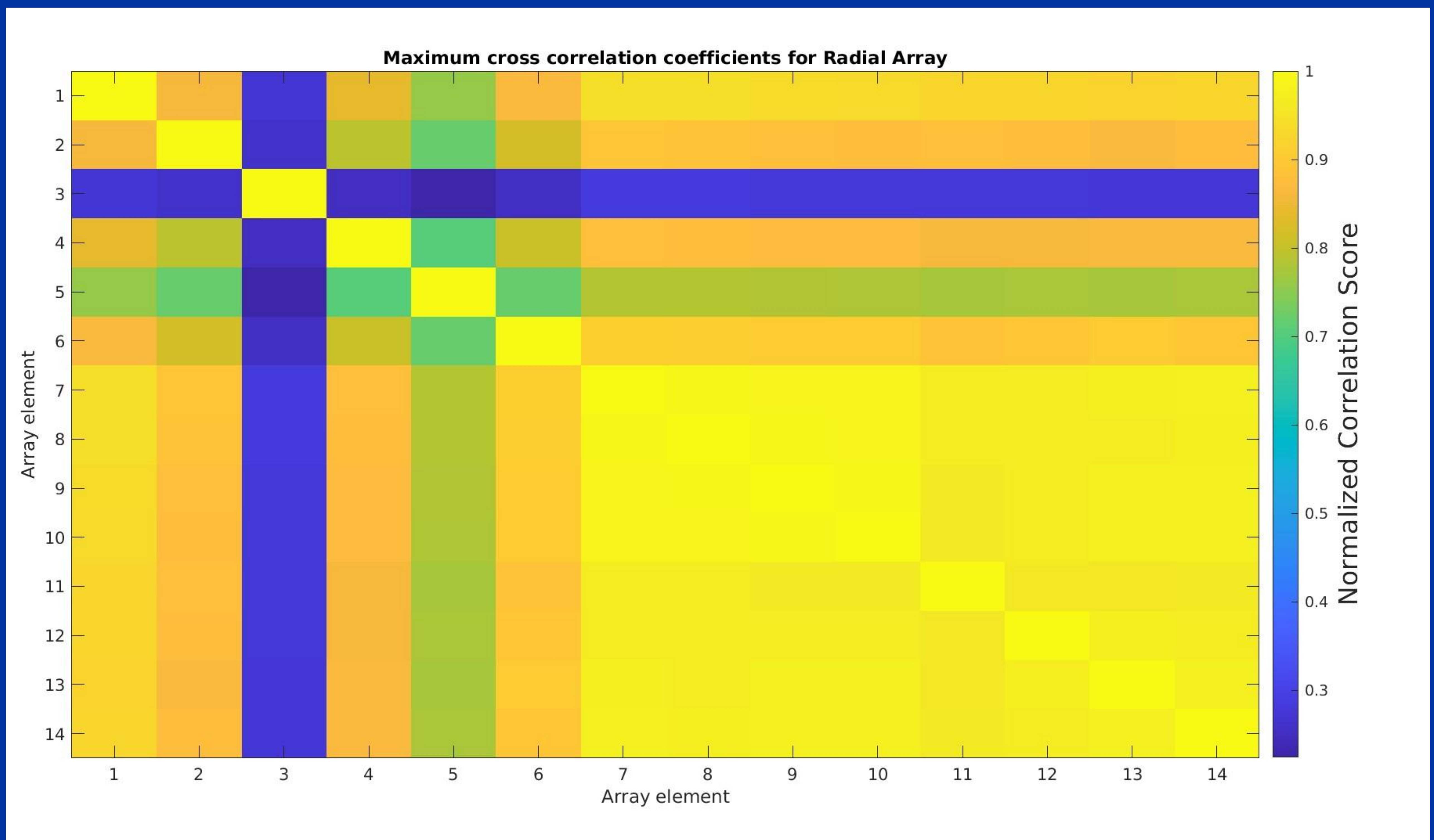

Figure 3: A correlation matrix assessing each station's similarity to one another, with scalebar indicating the correlation score. A score of 1 indicates perfectly correlated signal between array elements. For example, comparing element 1 with itself will result in a score of 1 shown in the northwest corner.

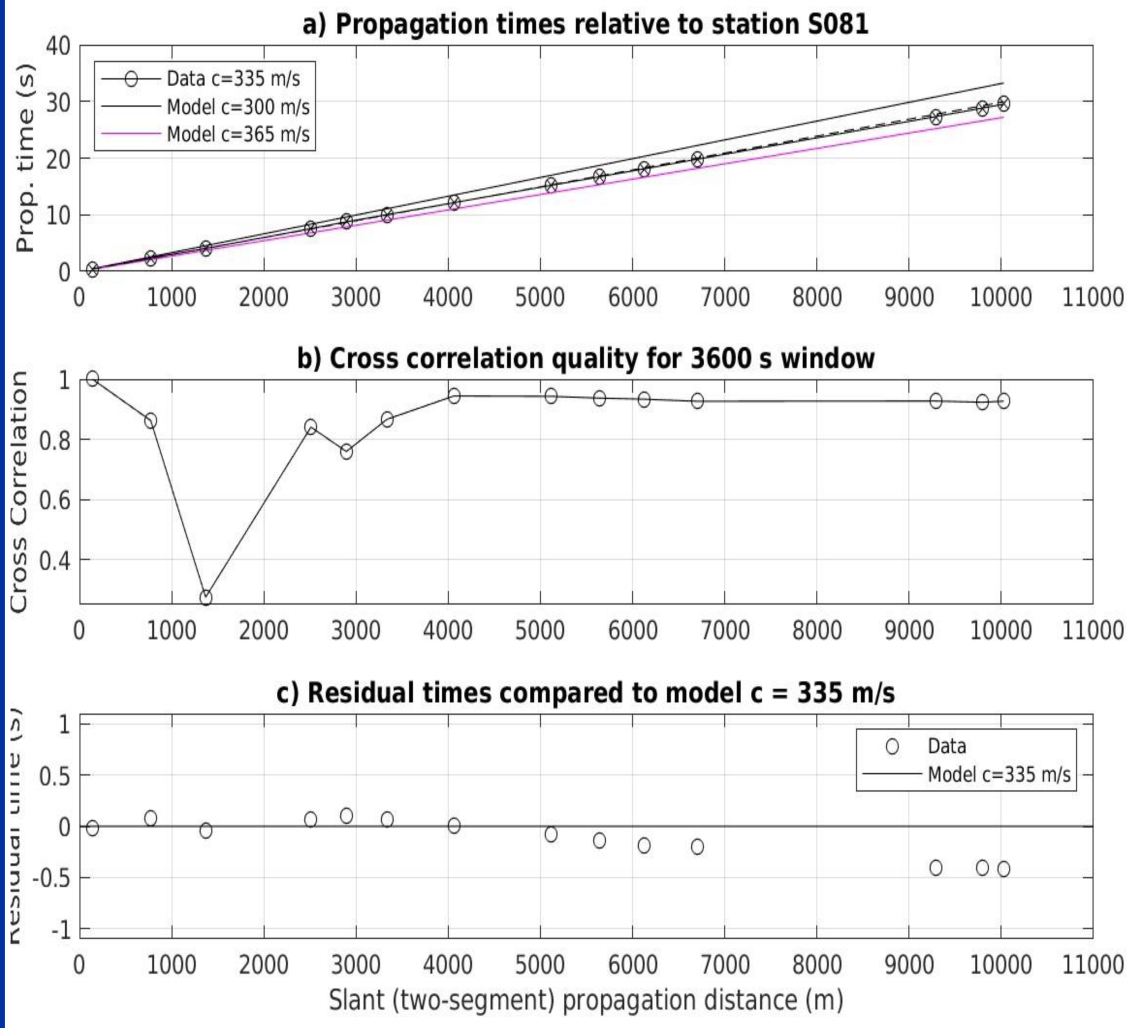

Figure 4: a). Signal propagation times compared to slow and fast sound speed models. b). Cross correlation qualities compared with station 081 closest to the summit. c). Residual times, or differences between data and c=335 m/s sound speed model.

CONCLUSIONS:

Station 068 was installed in an area identified as a 'shadow zone'. Signal correlation is extremely low, and amplitudes do not decay as expected (Figure 2; Figure 3). We propose 068 was heavily influenced by atmospheric turbulence, as a result of the installation site having low surface roughness, high elevation, and no vegetation cover. Correlation scores increase moving away from the crater, suggesting that when array processing, distant stations may be effective as proximal ones.

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