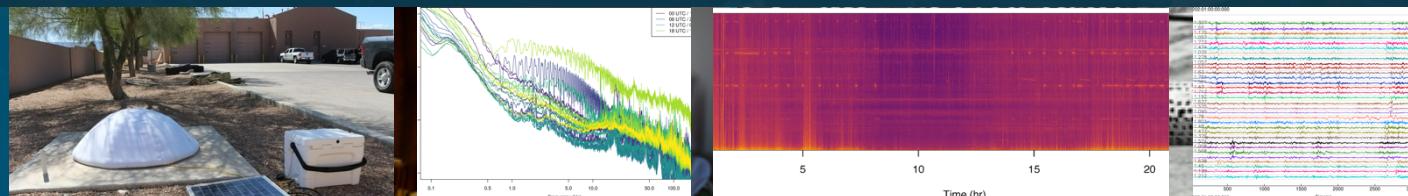




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Characterizing atmospheric state and human activity with urban infrasound sensors



Presented by Daniel C. Bowman

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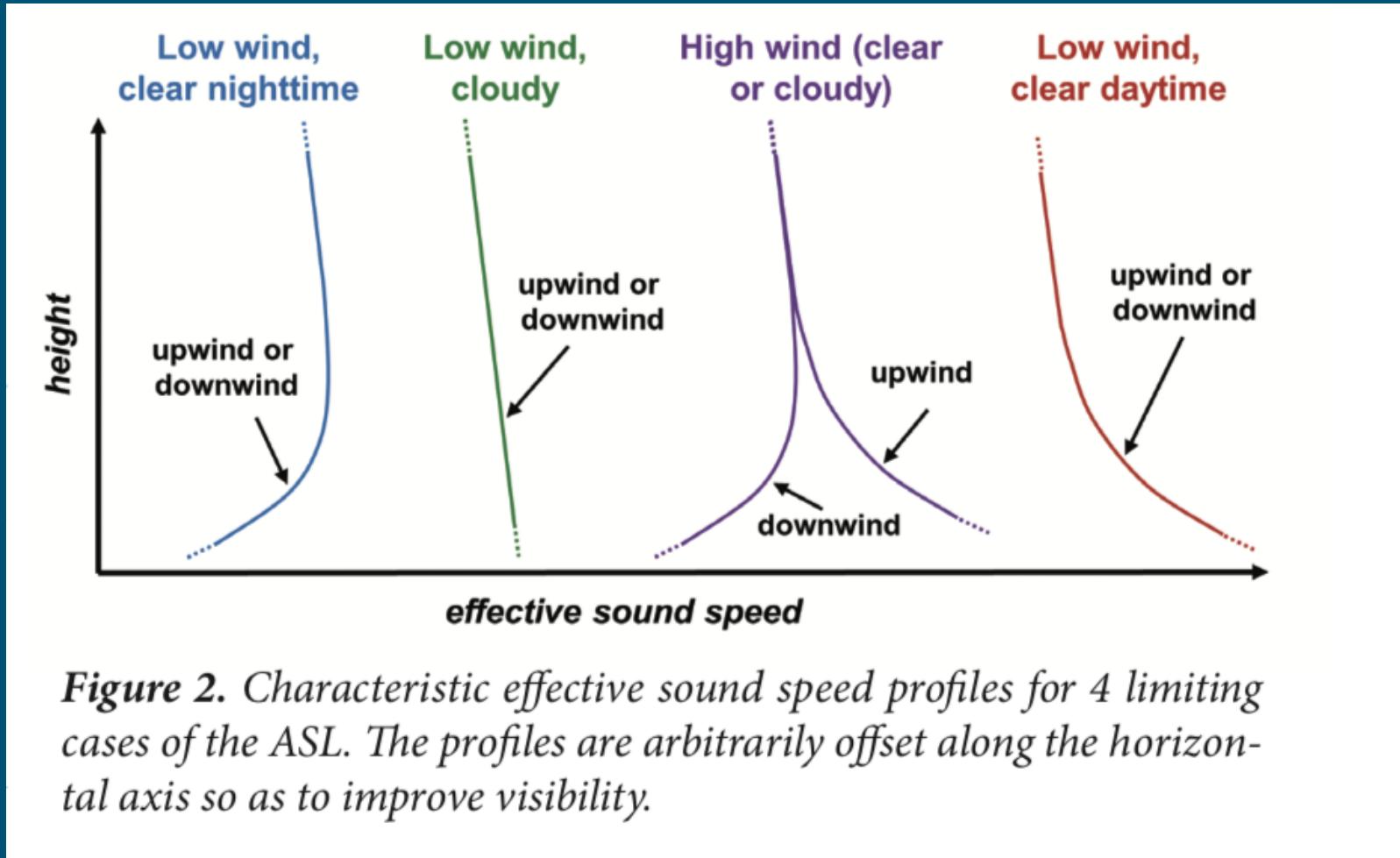


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Motivation

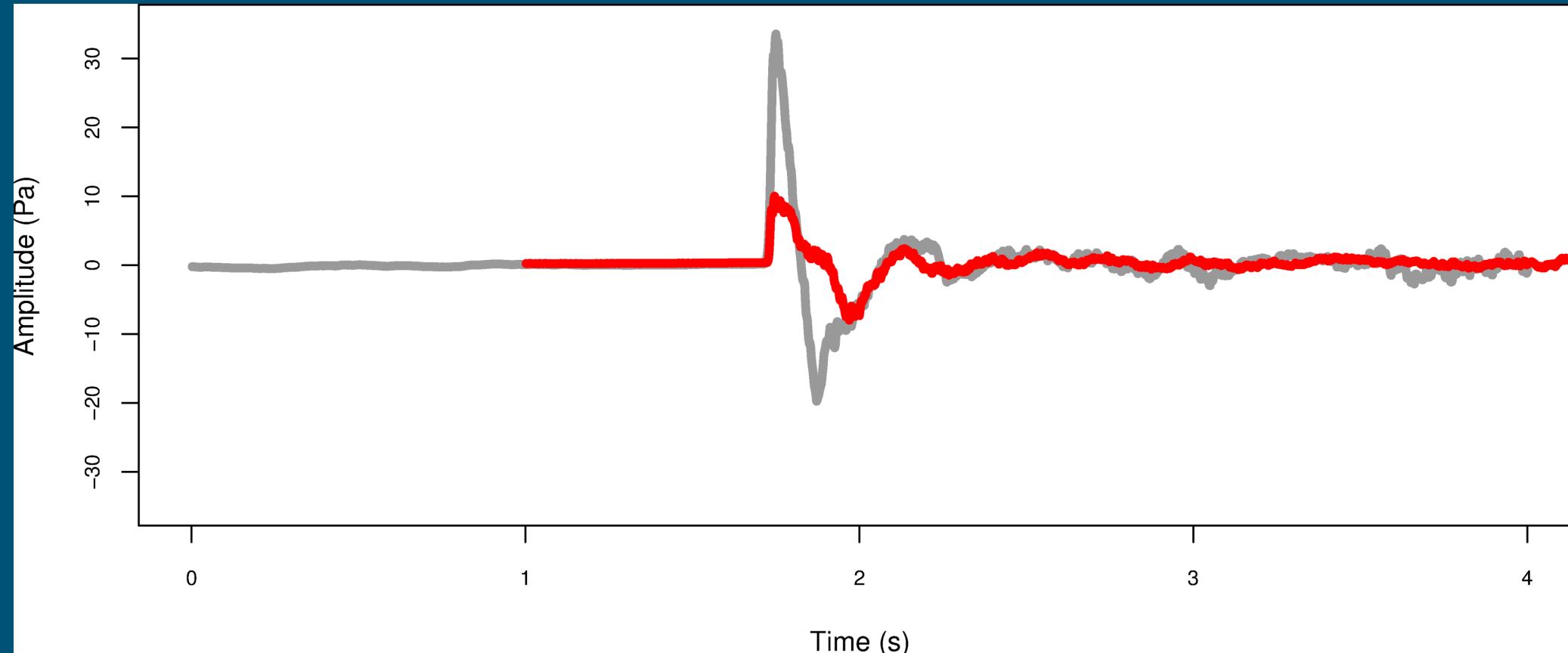


Infrasound is a powerful tool for yield estimation – but its characteristics also depend on atmospheric state.



The atmosphere is dynamic

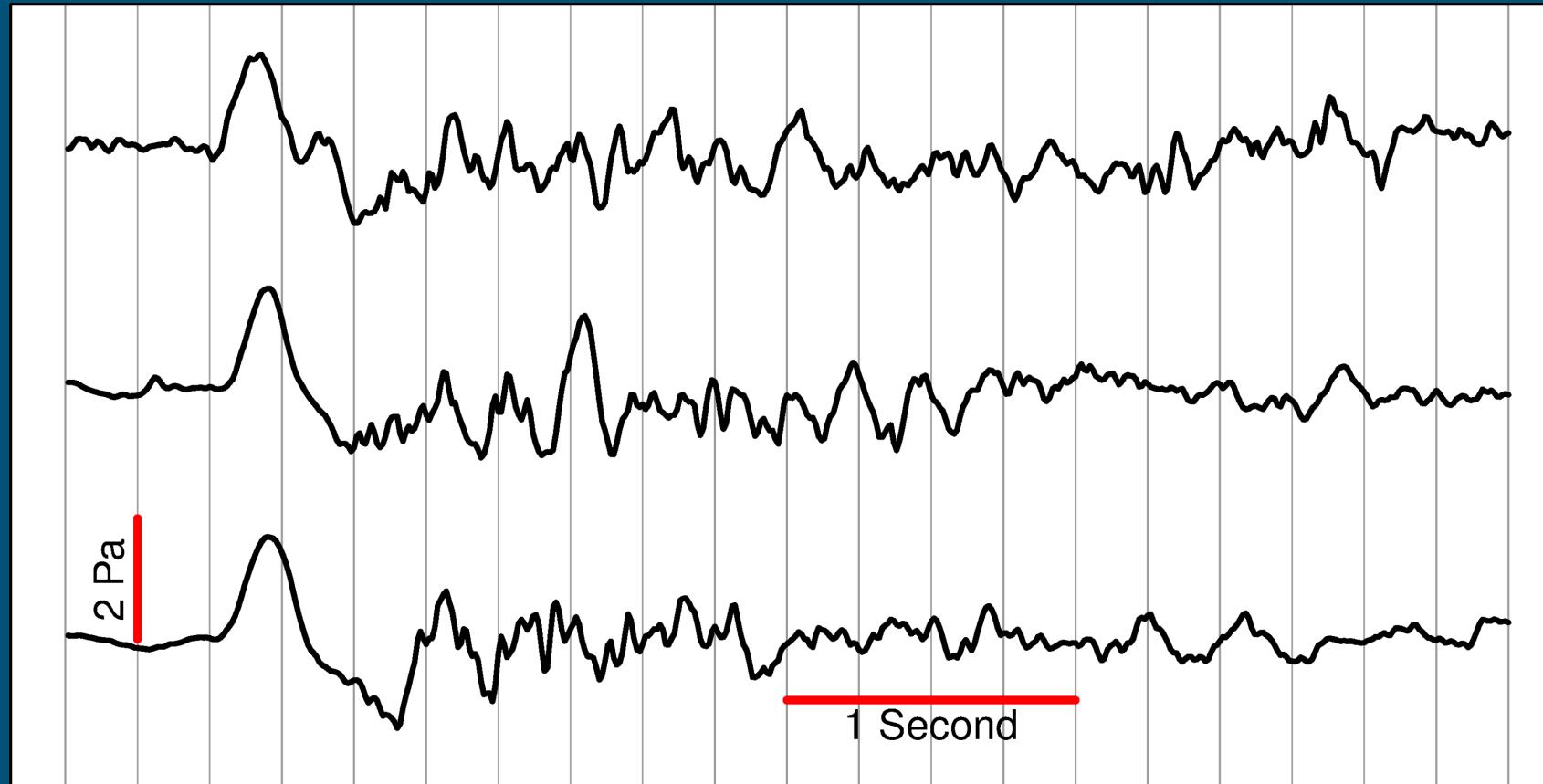
The same sized explosion, at the same place, recorded on the same sensor, 90 minutes apart. This is close to the maximum time resolution of operational weather models.



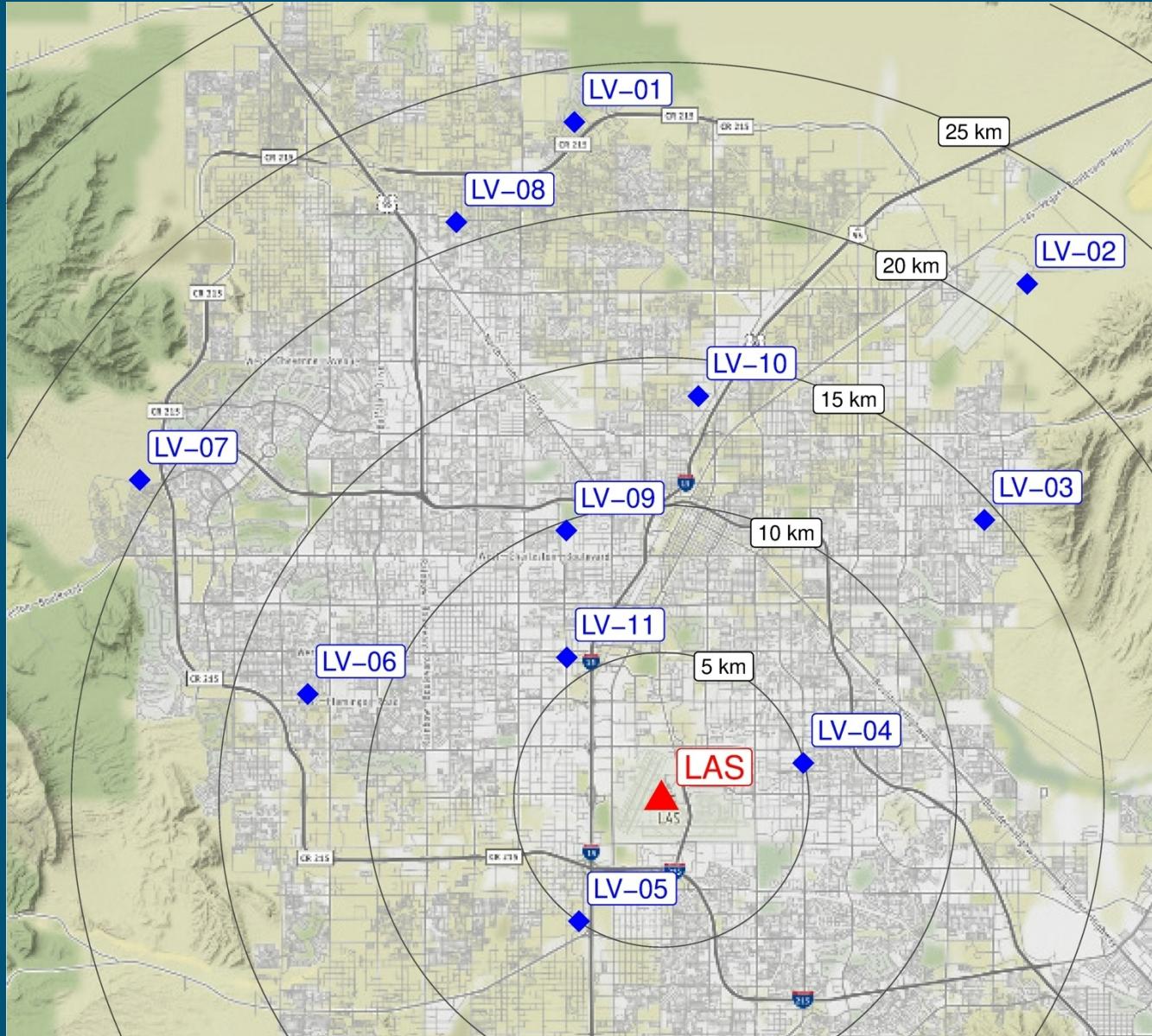
More evidence of the dynamic atmosphere



Closely spaced explosions detonated 90 seconds apart show significant variability, especially in the coda. Operational models will never predict this deterministically.



Collect infrasound and meteorological data in Las Vegas



- Install multiple infrasound sites
- Capture atmospheric data
- Keep network up for at least a year
- Characterize the ambient acoustic environment
- Identify specific regimes (e. g. temperature inversions)
- Use cluster analysis to classify atmospheric states

Station examples





Lost Vegas: COVID-19 Shutdown Clears the Strip

A photographic look at the now-empty spaces along the city's iconic boulevard.

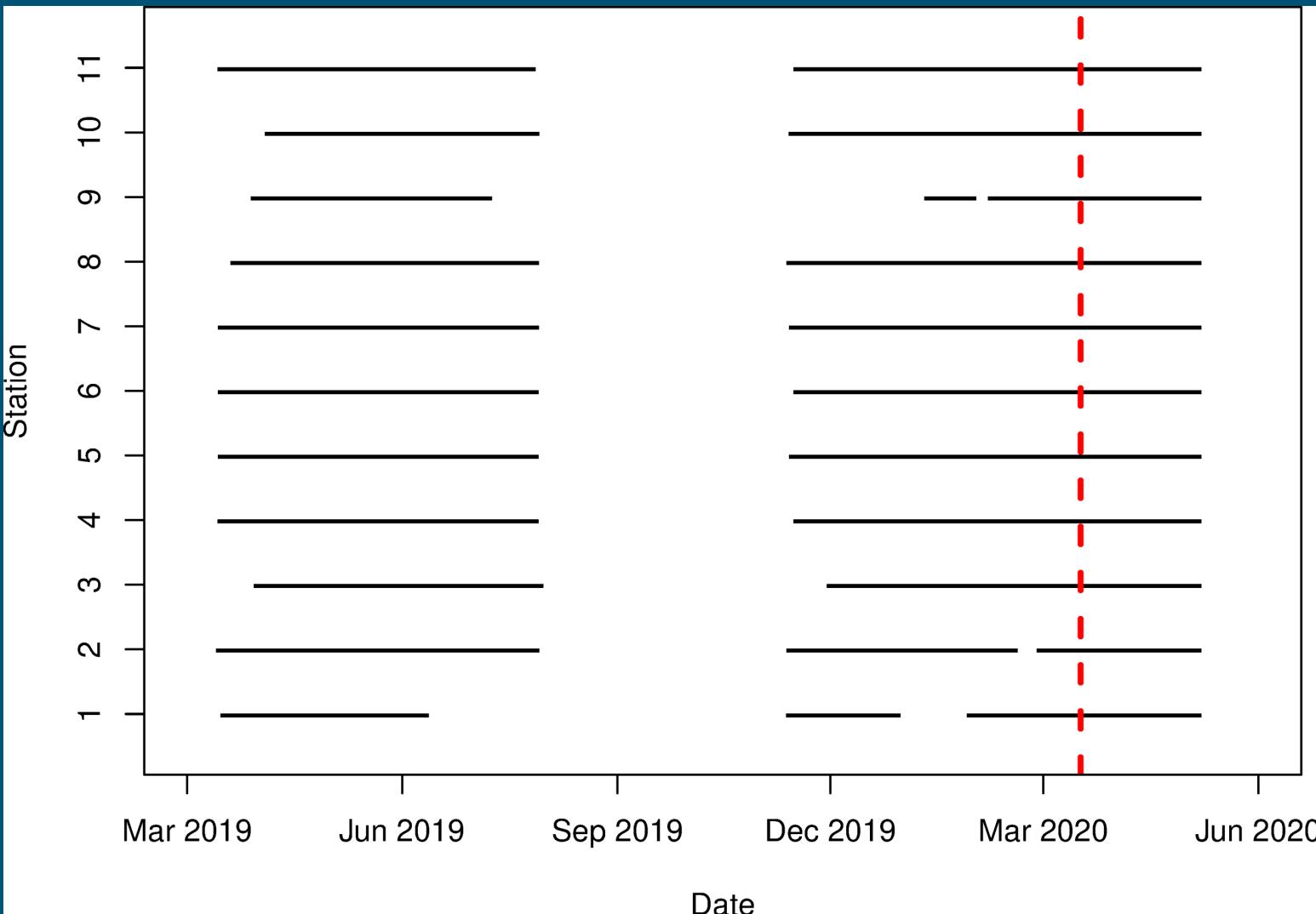
City Libraries Photographs of the Response to the COVID-19 Pandemic in Las Vegas, Nevada, PH-00428.

To slow the march of the COVID-19 infection, Nevada Governor Steve Sisolak closed all casinos, bars, and dine-in restaurants in the State on March 17th. What followed can only be described as historic as the Las Vegas Strip was transformed into a landscape void of the usual throngs of tourists, sightseers, hucksters, and the likes.

Left in the wake of closure is the free-market super-scape painted with a post-apocalyptic brush.

March
20
2020

COVID-19: Station coverage



The Las Vegas Infrasound Array was in position to record what happens when a city is “turned off”.

We pivoted to research how urban infrasound changes as human patterns of life are disrupted.

Bird *et al.* (2021). Monitoring changes in human activity during the COVID-19 shutdown in Las Vegas, Nevada using infrasound microbarometers. *The Journal of the Acoustical Society of America* **149** (3), 1796-1802.

Pandemic-induced shifts in the sound environment

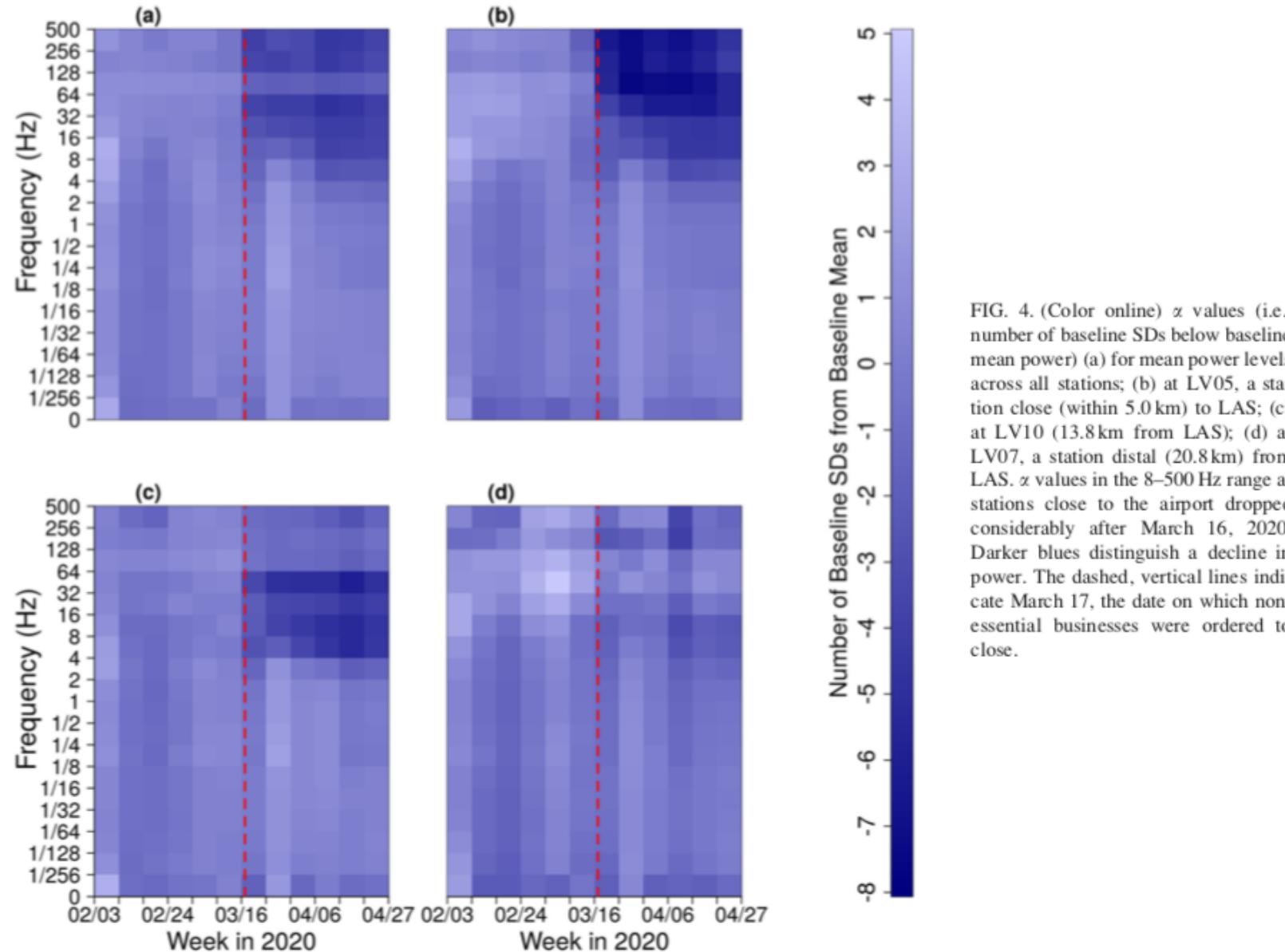
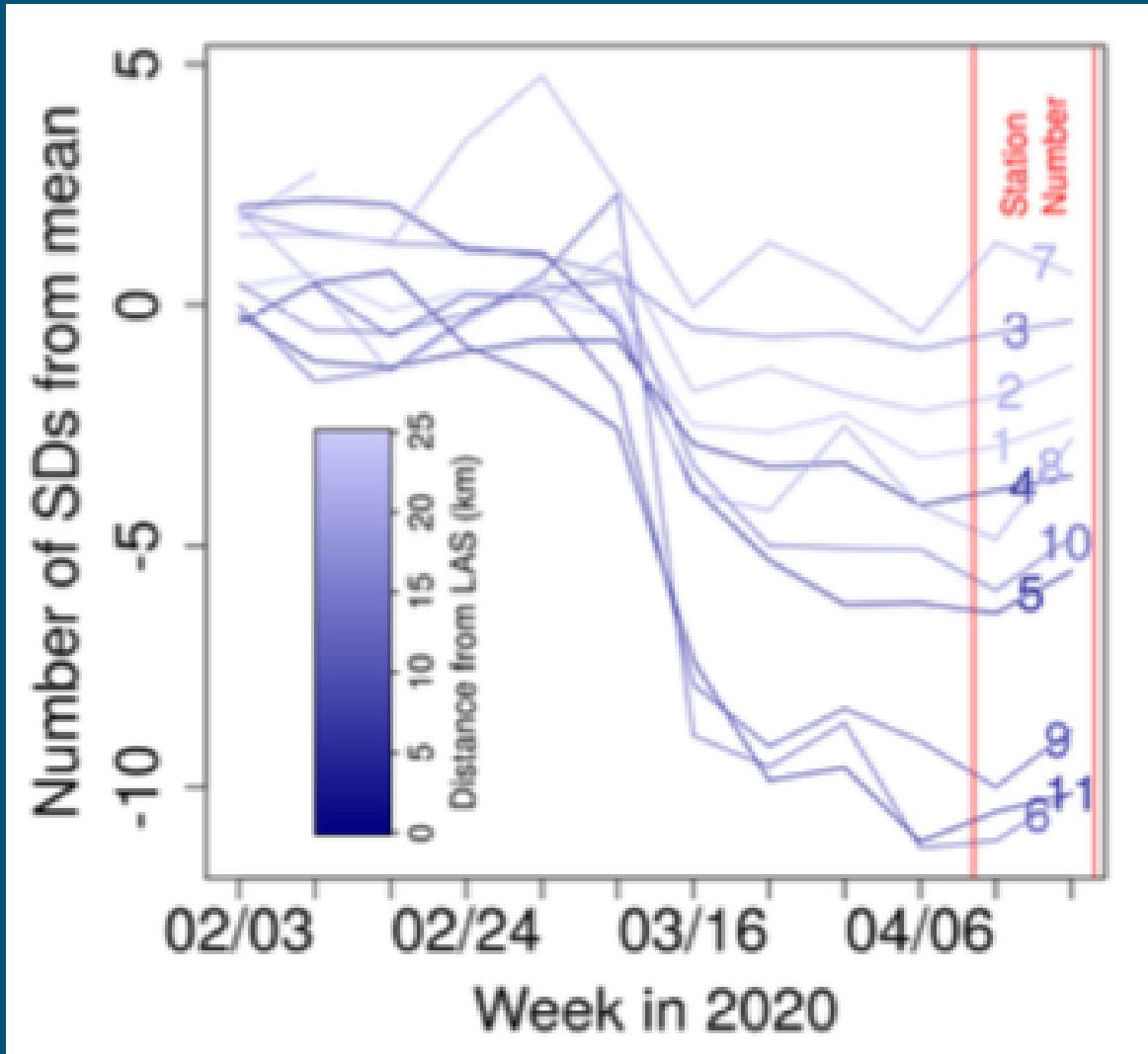


FIG. 4. (Color online) α values (i.e., number of baseline SDs below baseline mean power) (a) for mean power levels across all stations; (b) at LV05, a station close (within 5.0 km) to LAS; (c) at LV10 (13.8 km from LAS); (d) at LV07, a station distal (20.8 km) from LAS. α values in the 8–500 Hz range at stations close to the airport dropped considerably after March 16, 2020. Darker blues distinguish a decline in power. The dashed, vertical lines indicate March 17, the date on which non-essential businesses were ordered to close.

Compared 2020 sounds with 2019 sounds on the same date, shifted to accommodate weekend/weekday

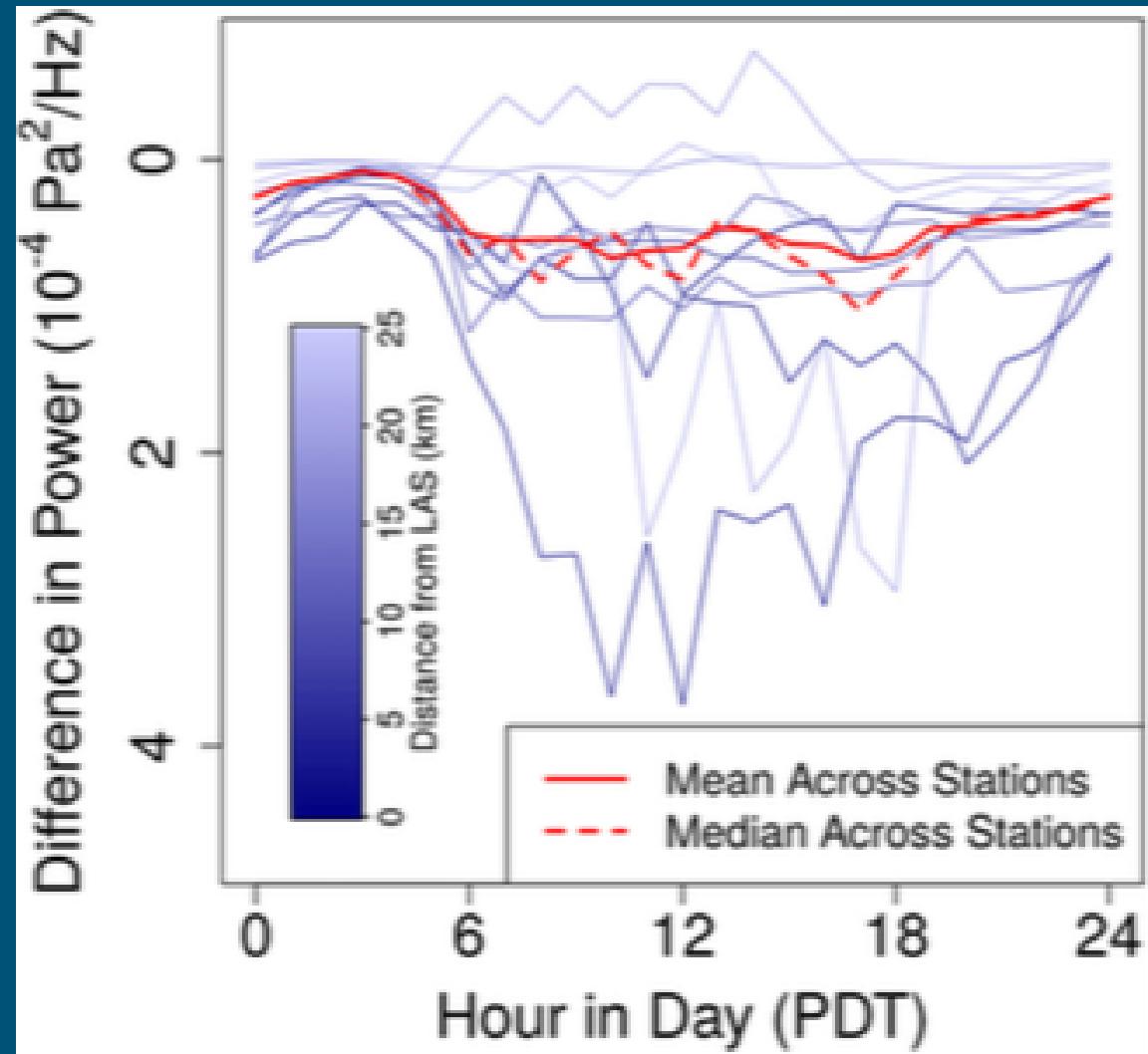
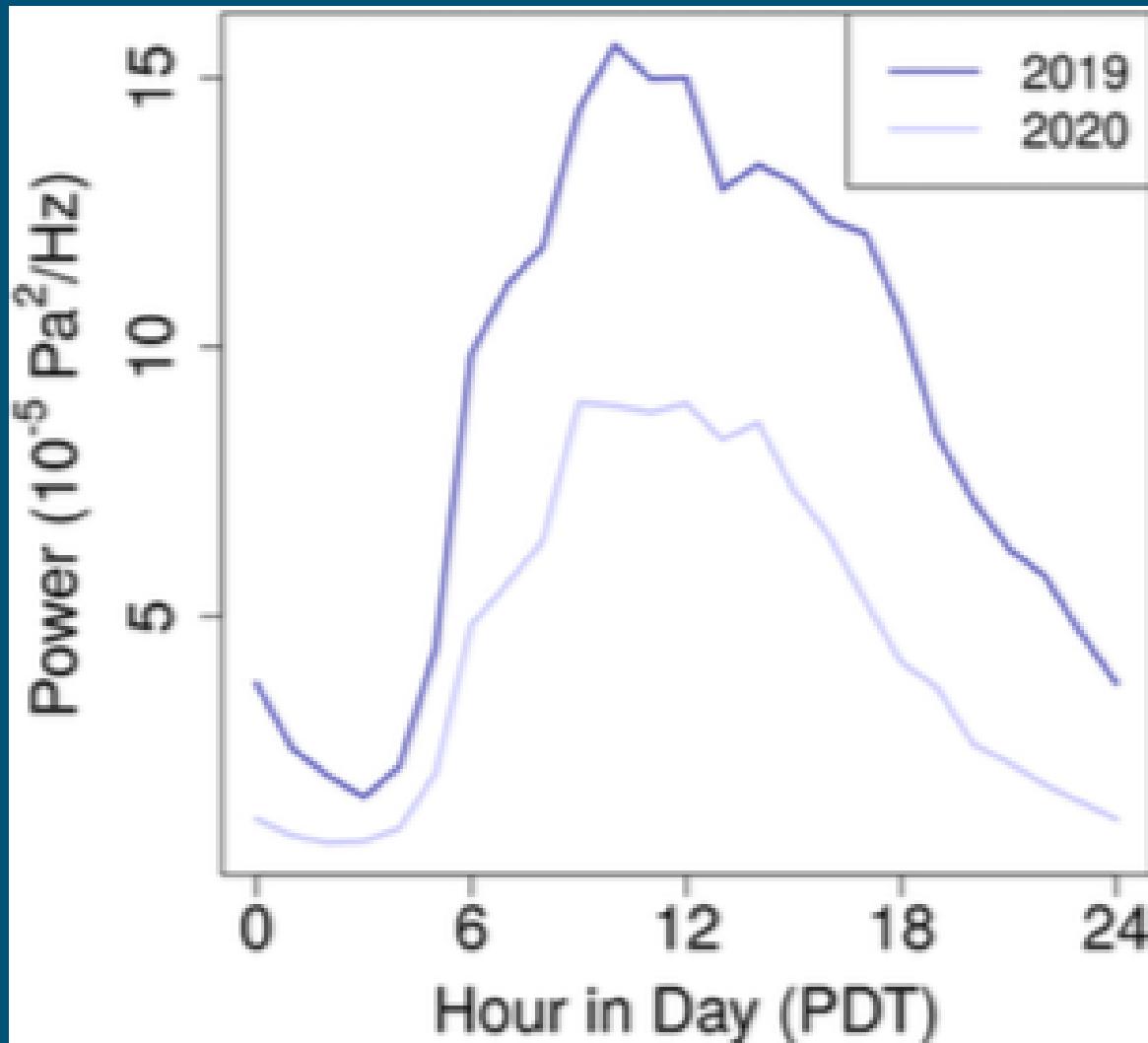
- Sound above about 8 Hz decreased after the shutdown
- The shift was not consistent across the city

How different parts of the city responded



In general, areas near the city center experienced larger drops in acoustic power relative to 2019.

Shifts in acoustic patterns vs. time of day



Next Steps for the Las Vegas Infrasound Array Data



We are presently assessing funding sources to do the following:

1. **Investigate patterns in post-COVID recovery** using data recorded in 2021
2. **Characterize urban infrasound patterns in general** now that life is returning to 'normal'
3. **Associate atmospheric state with infrasound regimes** as originally planned
4. **Install arrays to localize specific infrasound sources** to better understand where signals originate

This network is a unique resource for forensic acoustics algorithm development in an urban environment.

Acknowledgments



Melissa Wright and Doug Seastrand (Mission Support and Test Services) installed and operated the network. Fransiska Dannemann Dugick assisted with data analysis and paper writing. Jonathan Lees served as academic advisor to Eli Bird.

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