

Capturing acoustic energy input into the upper atmosphere using free flying sensor arrays

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Acoustic Waves in the Atmosphere

The infrasound band: between 0.004 and 20 Hz
Sources include:

Volcanoes

Severe storms

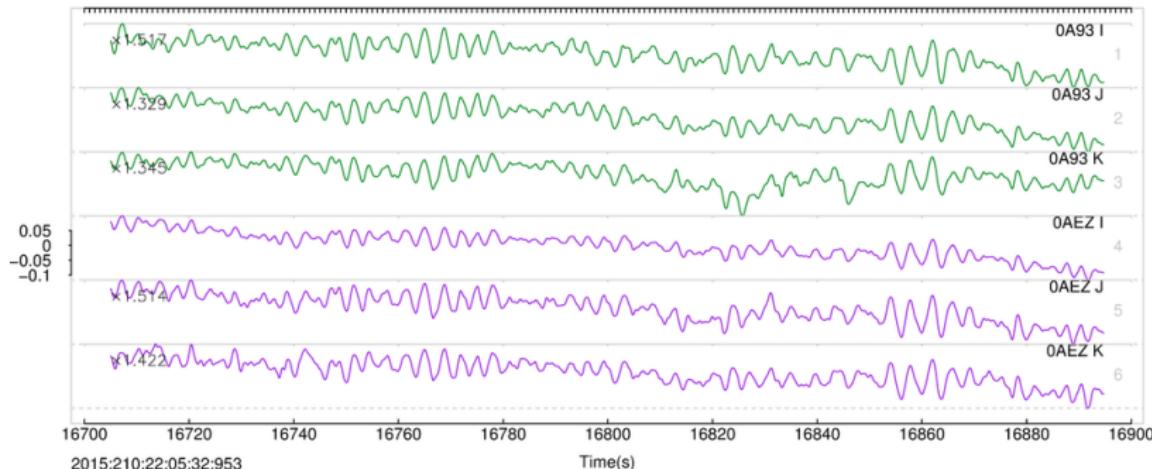
Ocean waves

Nuclear and chemical explosions

Wind turbines

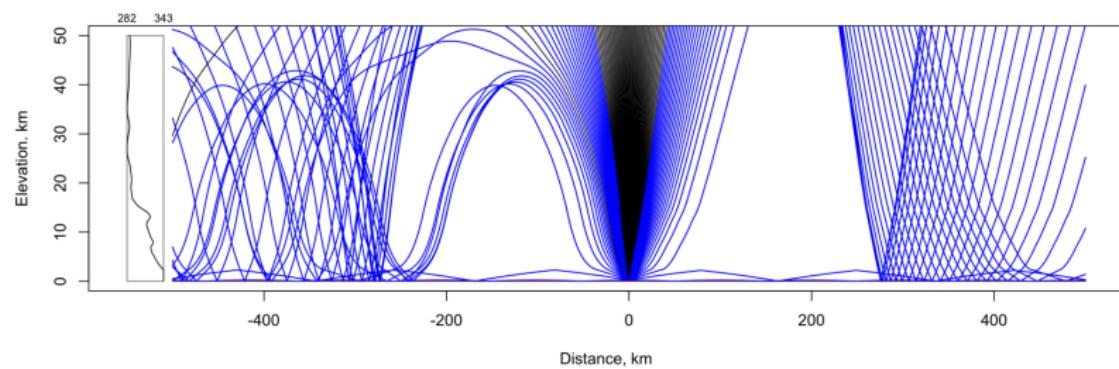
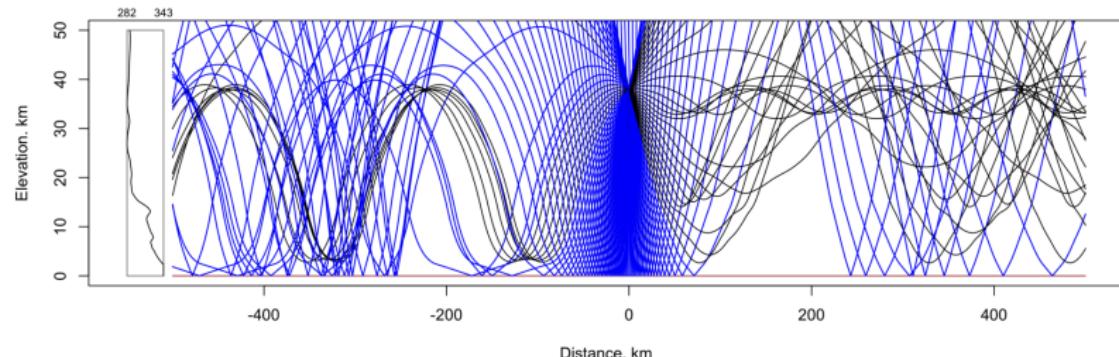
Industrial exhausts

2015:211:02:43:58:021



2015:210:22:05:32:953

Propagation



Energy Transfer

Acoustic wave dissipation heats the upper atmosphere:

- ▶ 30 K/day heating from microbarom (Rind, 1977)
- ▶ 0.03 K from explosions (Drobzheva and Krasnov, 2006)
- ▶ ≈ 13 K/day from thunderstorms (Krasnov et al., 2007)
- ▶ Intentional heating is unfeasible (ibid.)

Limitations

Acoustic instruments are confined to the Earth's surface.

Consequences:

- ① Up going wave population has not been measured
- ② Some acoustic signals may never reach the Earth's surface
- ③ Pervasive wind noise

Microphones on Balloons

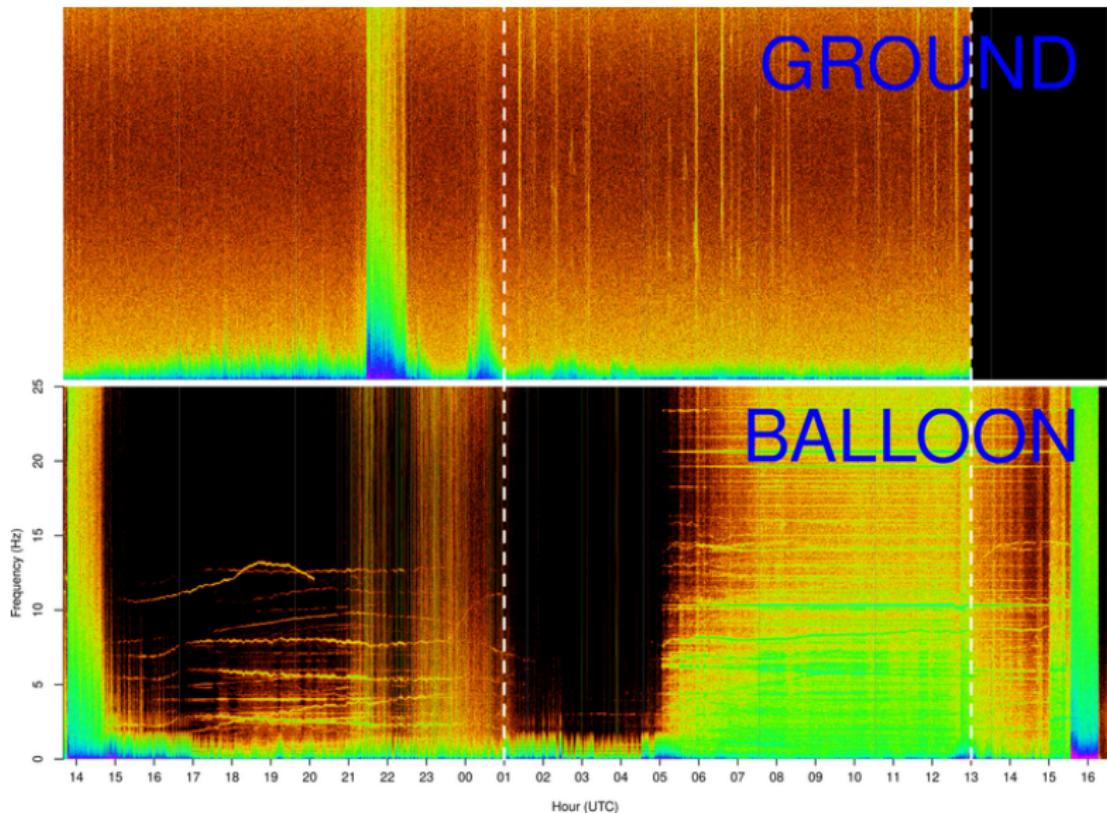
Quasi-Lagrangian high altitude flight system:

- ▶ Samples mid/upper stratosphere
- ▶ Distance from noise sources
- ▶ Very low differential wind



Image Credit: Mary Lide Parker, UNC Research Communications

Infrasound in the Stratosphere



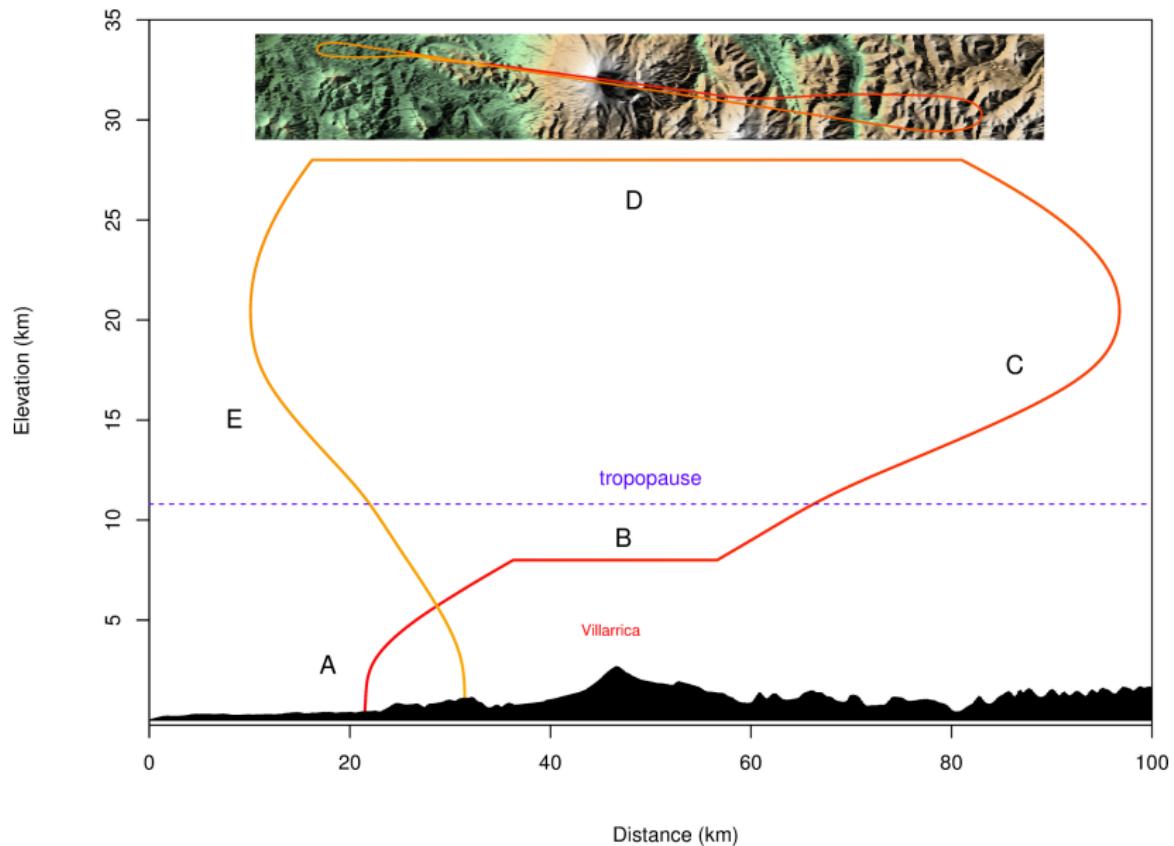
Fourier spectrogram: 15 second window, 14.5 second overlap

CEDAR Acoustic Heating: Objectives

Answer three key questions:

- ① What is the acoustic wave field at the MLT boundary?
- ② How does it vary over time?
- ③ **How much heat does it contribute to the upper atmosphere?**

Field Deployments

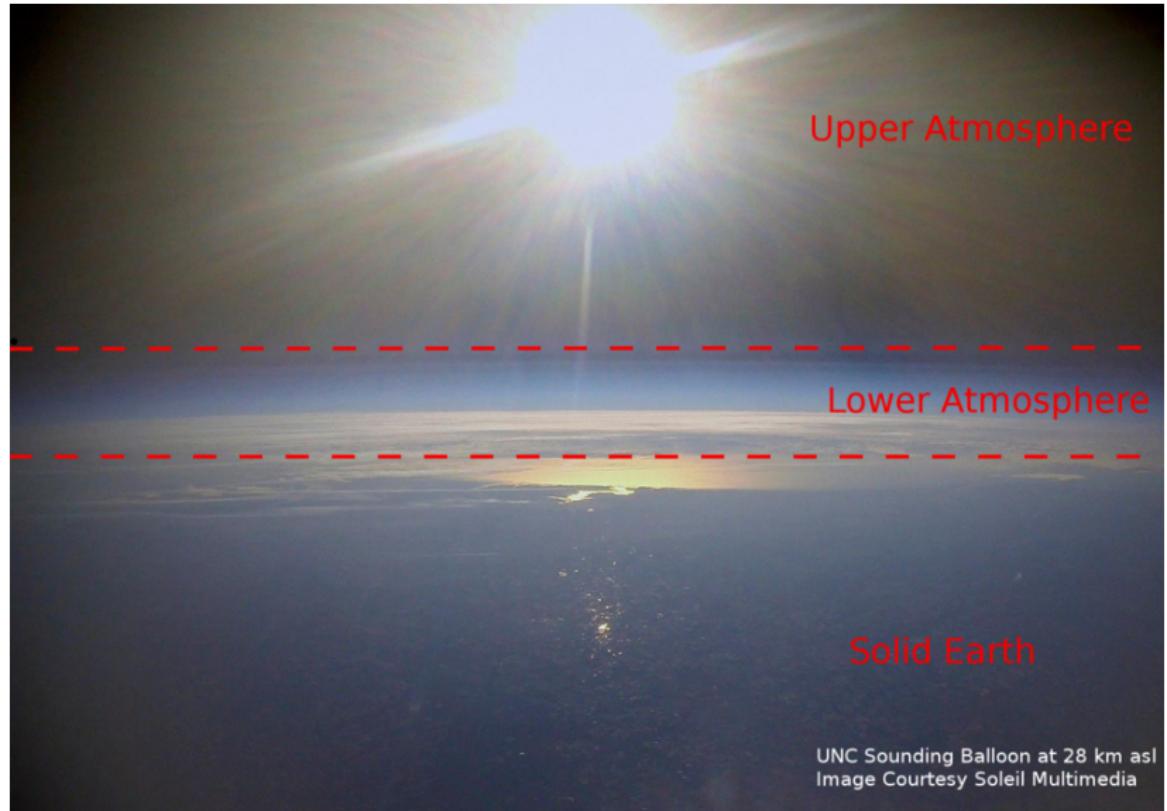


Challenges

Airborne geoacoustic networks \neq ground geoacoustic networks

- ▶ Increased detection range versus poor station keeping
- ▶ Low wind noise but pressure amplitude drop with altitude
- ▶ 3D network with poorly characterized noise sources

Conclusions



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High Altitude Student Platform

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