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

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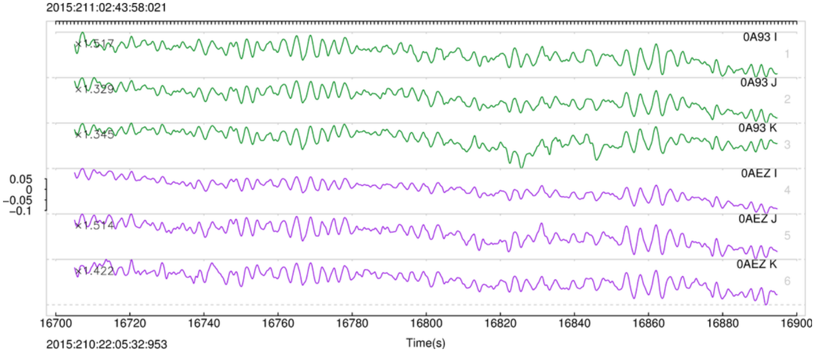
Acoustic Waves in the Atmosphere

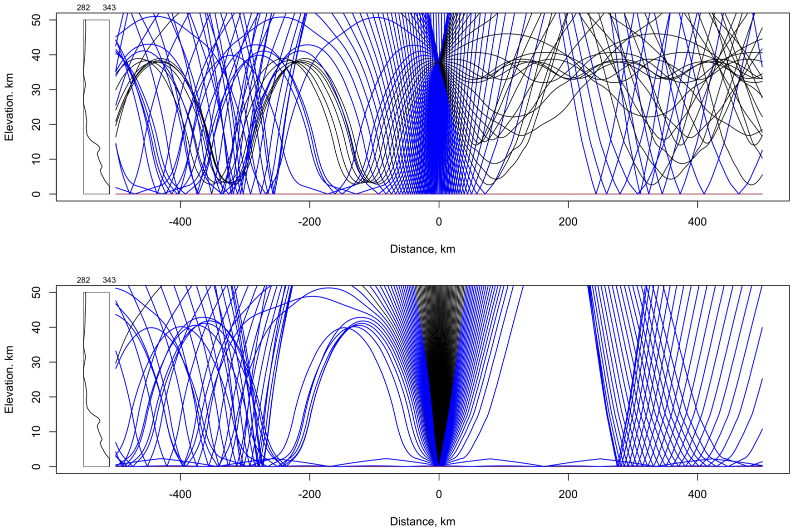
The infrasound band: between 0.004 and 20 Hz

Sources include:

Volcanoes	Nuclear and chemical explosions
Severe storms	Wind turbines
Ocean waves	Industrial exhausts



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)
- $\approx$ 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

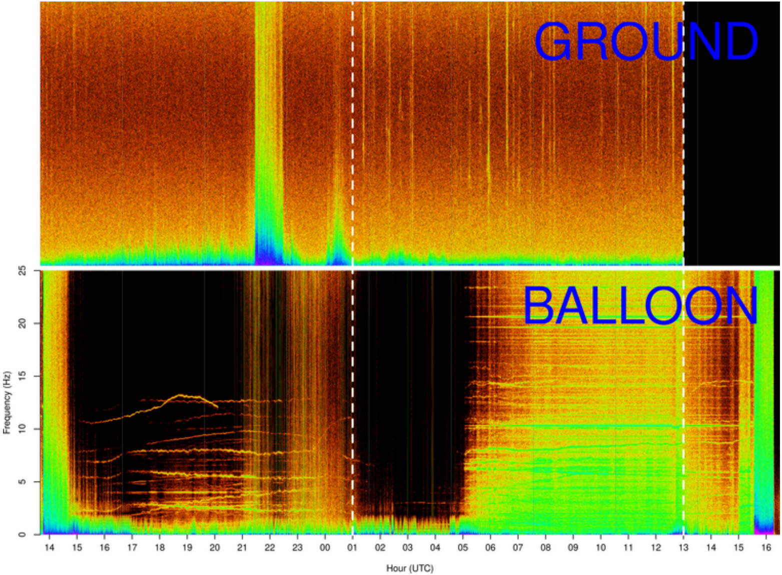
Microphones on Balloons

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



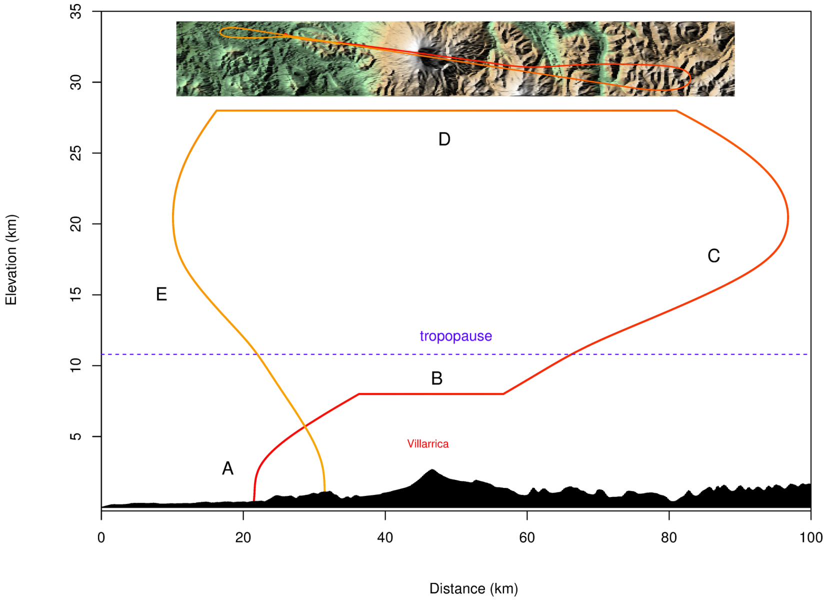
Fourier spectrogram: 15 second window, 14.5 second overlap

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

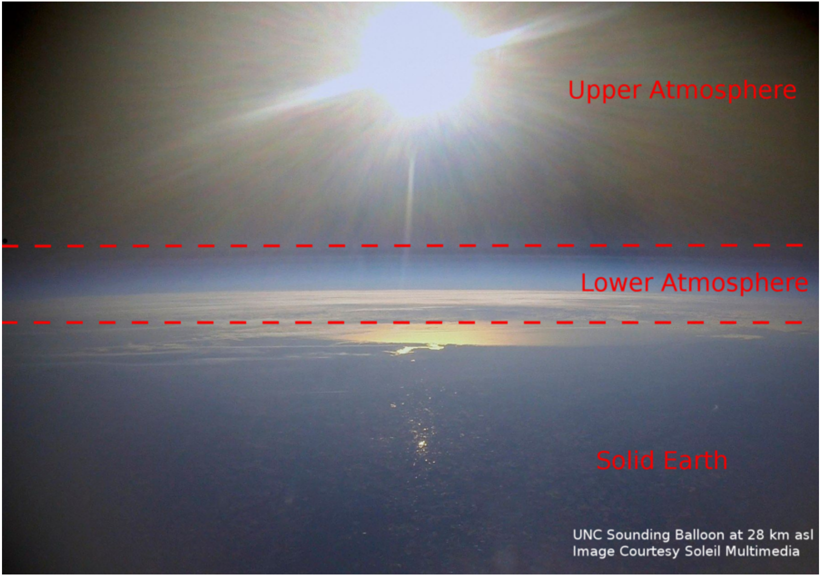


Challenges

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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