

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

SAND2016-5778C

Daniel C. Bowman¹ Jonathan M. Lees²

¹Sandia National Laboratories

²Department of Geological Sciences, UNC Chapel Hill

June 22, 2016



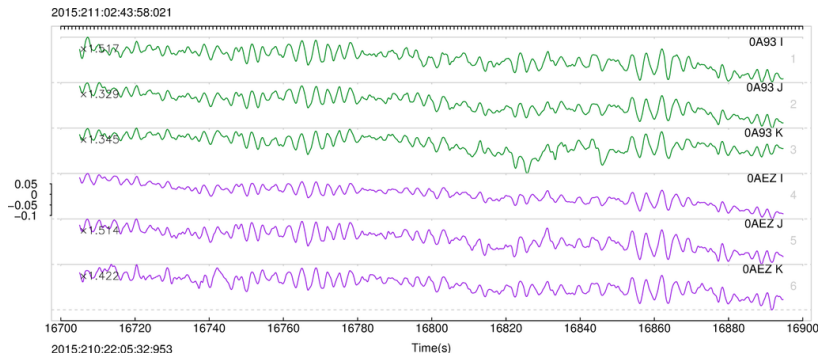
Acoustic Waves in the Atmosphere

The infrasound band: between 0.004 and 20 Hz

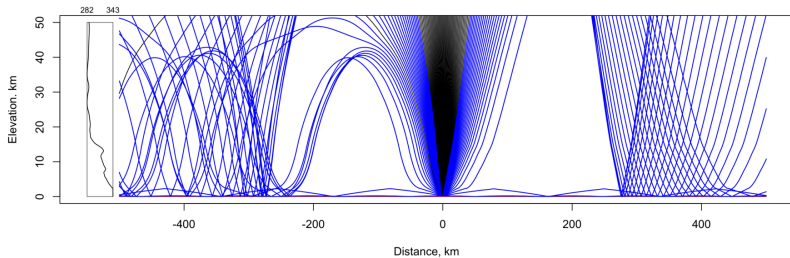
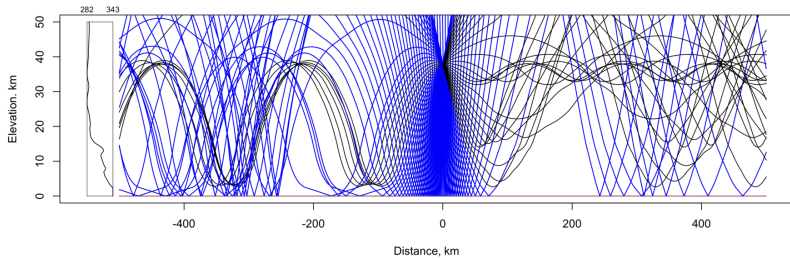
Sources include:

Volcanoes
Severe storms
Ocean waves

Nuclear and chemical explosions
Wind turbines
Industrial exhausts



Propagation



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.)

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:

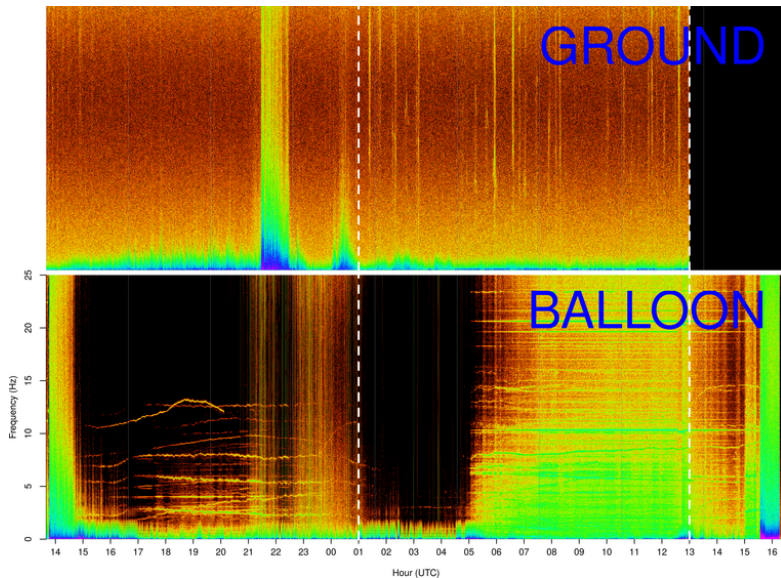
- ▶ Samples mid/upper stratosphere
- ▶ Distance from noise sources
- ▶ Very low differential wind



Image Credit: Mary Lide Parker, UNC Research Communications



Infrasound in the Stratosphere

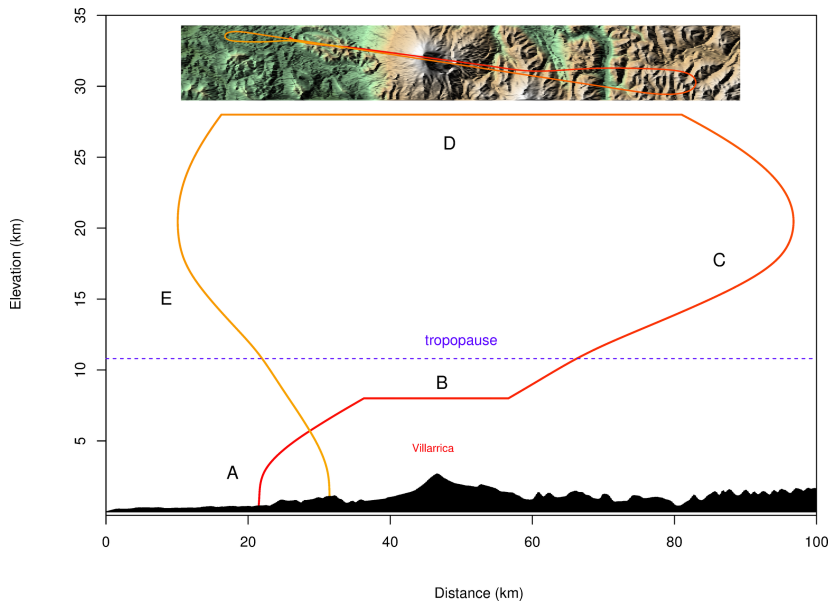


Fourier spectrogram: 15 second window, 14.5 second overlap

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?**

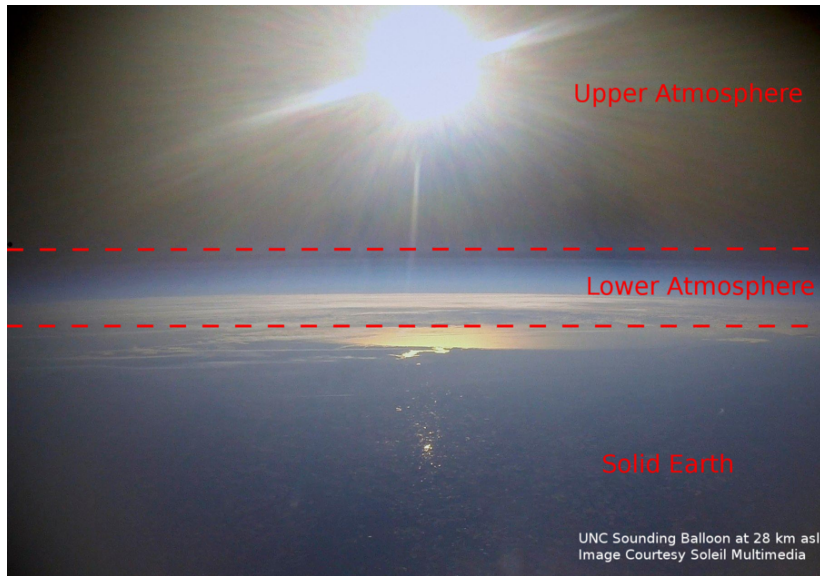
Field Deployments



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



Acknowledgments

National Science Foundation

UNC Martin Fund

High Altitude Student Platform

Columbia Scientific Ballooning Facility

National Aeronautics and Space Administration

Naval Research Laboratory

UNC Office of Research Communication