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Tethered Aerostat Effects on Nearby Seismometers

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Abstract

This report assesses seismic interference generated by a tethered aerostat. The study was motivated by a planned aerostat deployment within the footprint of the Dry Alluvium Geology seismic network. No evidence was found for seismic interference generated by the aerostat, and thus the effects on the Dry Alluvium Geology sensors will be negligible.

Acknowledgment

The funding sources for the experiment were via the Keck Institute for Space Studies, the JPL R & TD program, and the U. S. Department of Energy. The experiment was carried out by staff from the Jet Propulsion Laboratory, California Institute of Technology, under a contract with NASA.

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1 Motivation

JPL has proposed to deploy a tethered aerostat to record infrasound during the DAG experiment. Concerns were raised during the DAG Diagnostics Review about seismic signals generated by the aerostat. Specifically, seismic SMEs wanted to know if aerostat vibrations could raise the noise levels on nearby seismometers.

Recently JPL deployed their aerostat along with a geophone array to investigate signals from a seismic hammer. This provided an opportunity to investigate whether the aerostat produced noticeable interference on the seismometers.

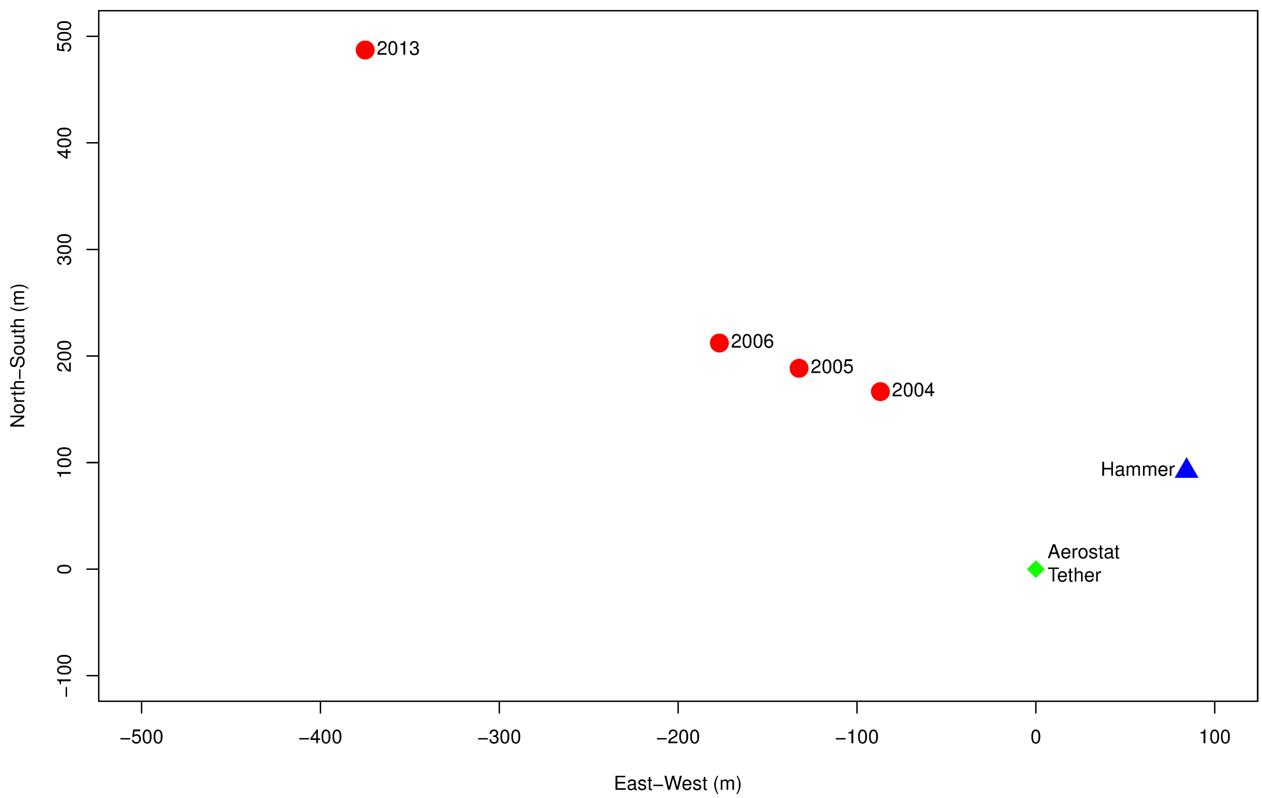

Figure 1. Aerostat tether point and locations of geophones investigated in this report.

2 Experiment

JPL, Caltech and HH Seismic deployed a ground seismoacoustic array consisting of Paroscientific microbarometers, geophones, and broadband seismometers (Figure 1). Additional Paroscientific microbarometers were placed on an aerostat that was attached to a 1000 ft tether. The tether was anchored to a parked pickup truck. A free flying hot air balloon collected additional acoustic data from the air. A seismic hammer generated ground motion and acoustic signals during the test.

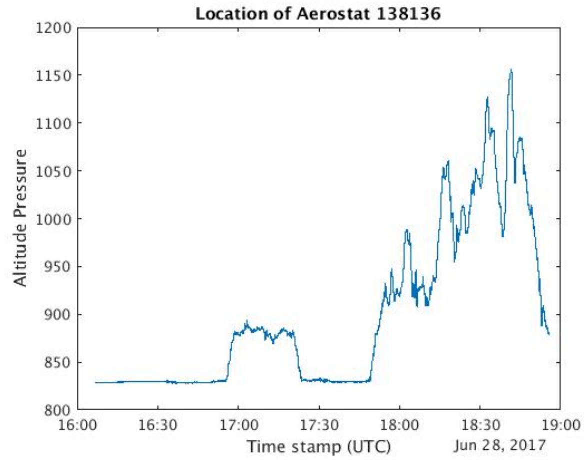

Figure 2. Pressure elevation of the aerostat envelope during the experiment.

3 Data Analysis

The objective is to compare seismic signals before and after the aerostat was deployed. An estimated launch time of 17:49 UTC was determined from pressure records made just below the aerostat envelope (Figure 2). Two sets of instruments were evaluated: three geophones within about 200 m of the aerostat anchor, and one over 400 m away as a control. Welch spectra were produced showing noise levels before and after the aerostat was launched (Figure 3). The data consisted of two ten minute segments of data with a 1 second Welch window. Fourier spectrograms were rendered in order to check for time-varying signals that the spectral analysis may have missed (Figure 4).

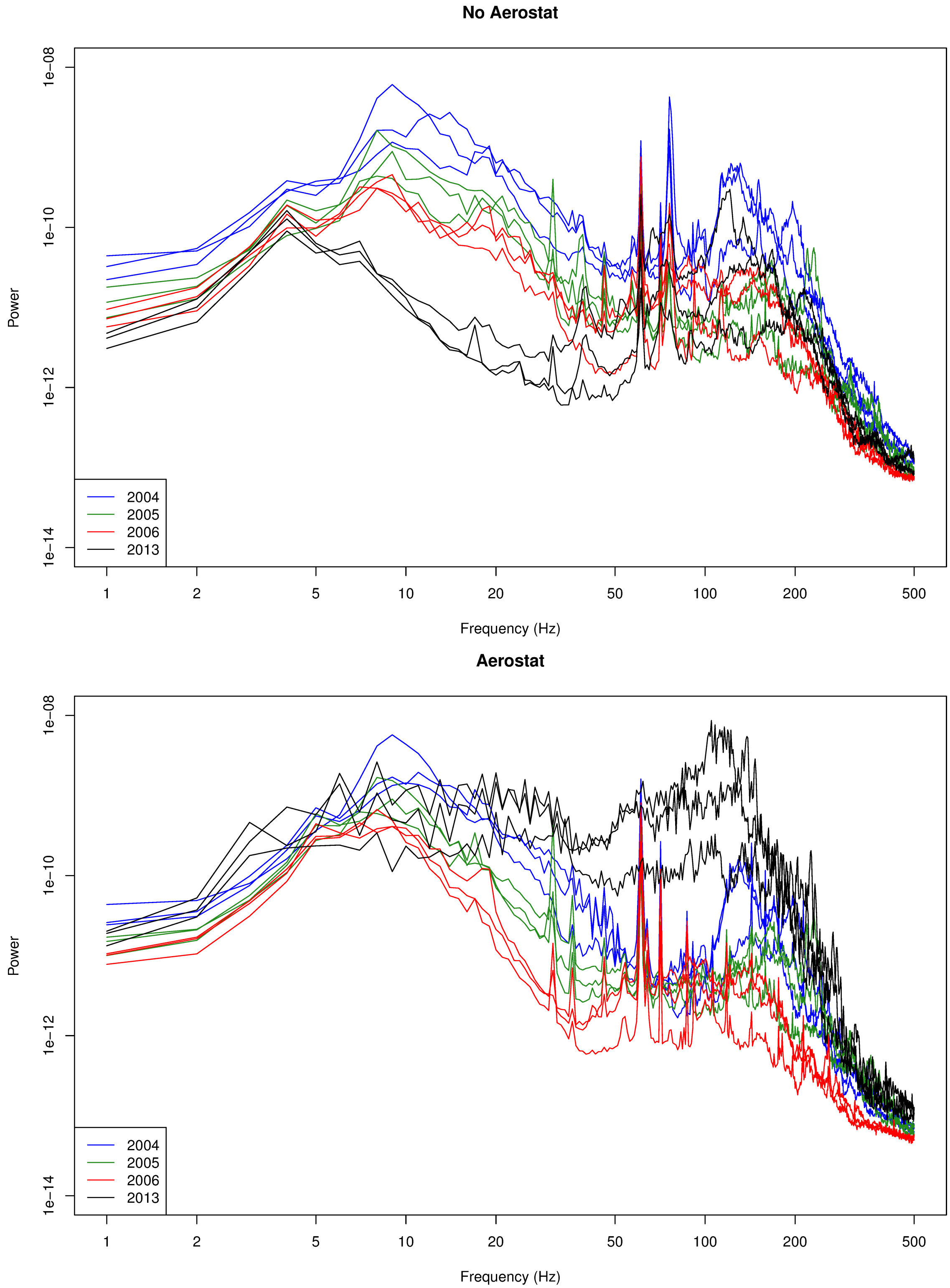

Figure 3. Welch spectra of the geophones shown on Figure 1 before and during the aerostat deployment.

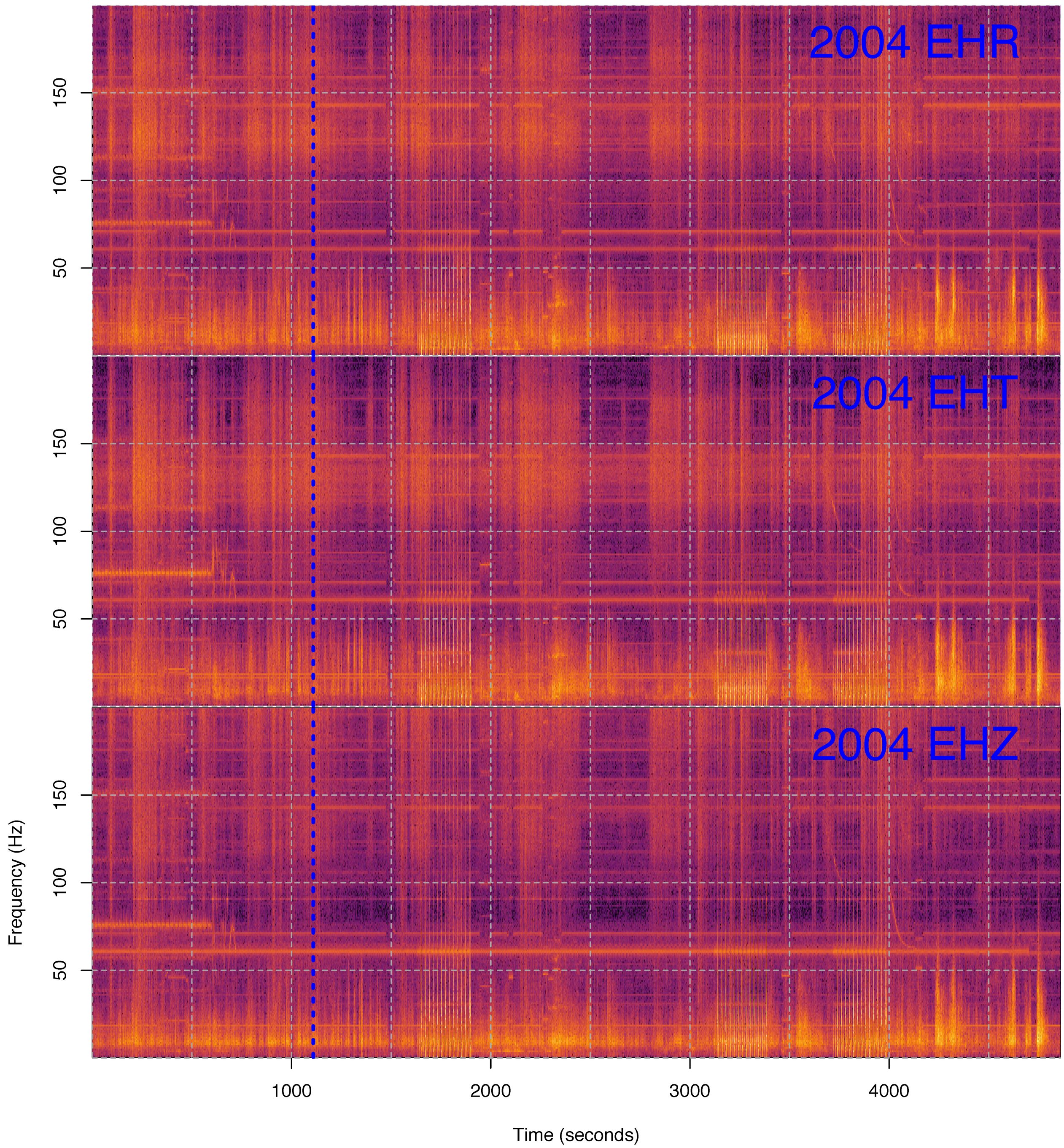

Figure 4. A Fourier spectrogram of Station 2004 (closest to the aerostat tether point). The dashed blue line separates the time before the aerostat was launched (left) and after it was in the air (right).

4 Discussion and Conclusions

There are no obvious aerostat-induced features in the Welch spectrum (Figure 3). Before the aerostat was launched, the three closest stations (2004, 2005, and 2006) were noisier than the faraway station (2013). After the launch, the closer stations are slightly less noisier, but increased activity was visible on the far station. Both sets of spectra show several narrow band signatures in the 20-200 Hz range. All of the dominant narrow band features exist both pre and post launch, indicating that they are probably not due to the motion of the aerostat or its tether.

Spectrograms of the closest sensor do not show any clear changes due to the aerostat launch (Figure 4). Narrow band spectral lines are likely anthropogenic and persist throughout the time window. Broad band stripes from the seismic hammer shots are visible just before 2000 seconds, just after 3000 seconds, and just before 4000 seconds. Aircraft Doppler signatures occur between 3500 and 4500 seconds.

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