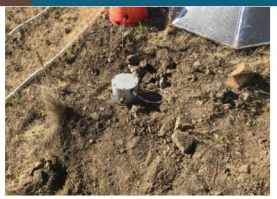
SAND2019-13056PE

Comparison of Infrasound Wind Noise Reduction Systems for Use in Temporary Deployments




Infrasound Technology Workshop
November 2019

PRESENTED BY

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RESEARCH COLLABORATION WITH

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SAND 2019-XXXX

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OUTLINE

1. Background
2. Noise Reduction Methods for Permanent Stations
3. Experiment Setup
4. Methods
5. Results and Discussion
6. Conclusions
7. Future Implementation

BACKGROUND

Turbulence within the atmosphere (wind) generates noise within frequency band of interest.

Infrasound sensors measure pressure fluctuations,

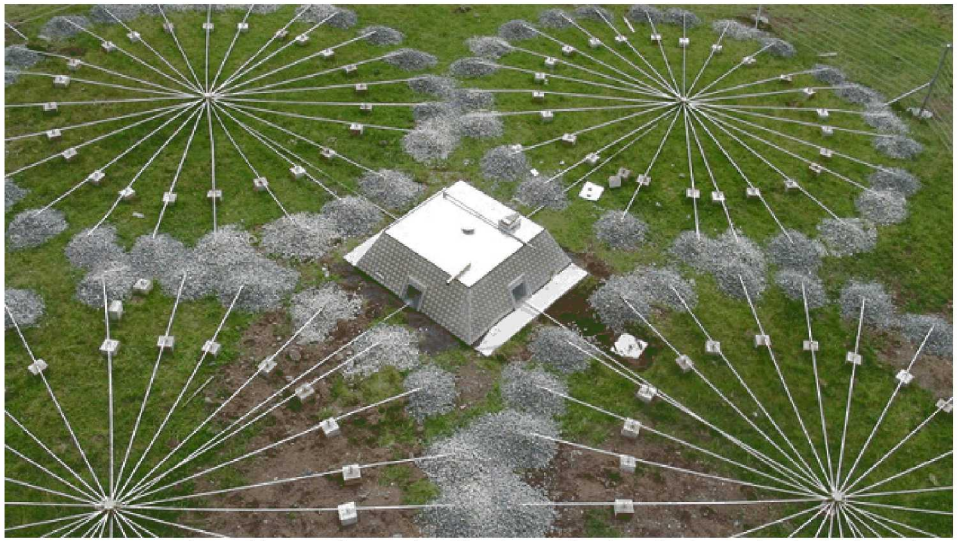
- Pressure fluctuations scale with the ambient density and velocity fluctuations of ground winds:

$$\delta p \sim \rho v \delta v$$

Reducing the wind velocity reduces its impact on the signals recorded at the sensor.

- Extensive studies done for permanent deployments
- Anecdotal evidence for temporary deployments

IMS WIND NOISE REDUCTION SYSTEMS



https://www.ctbto.org/verification-regime/monitoring-technologies-how-they-work/infrasound-monitoring/

https://www.ctbto.org/verification-regime/featured-stations/types/infrasound/is55-windless-bightantarctica-united-states/

Modified from https://www.ctbto.org/verification-regime/monitoring-technologies-how-they-work/infrasound-monitoring/

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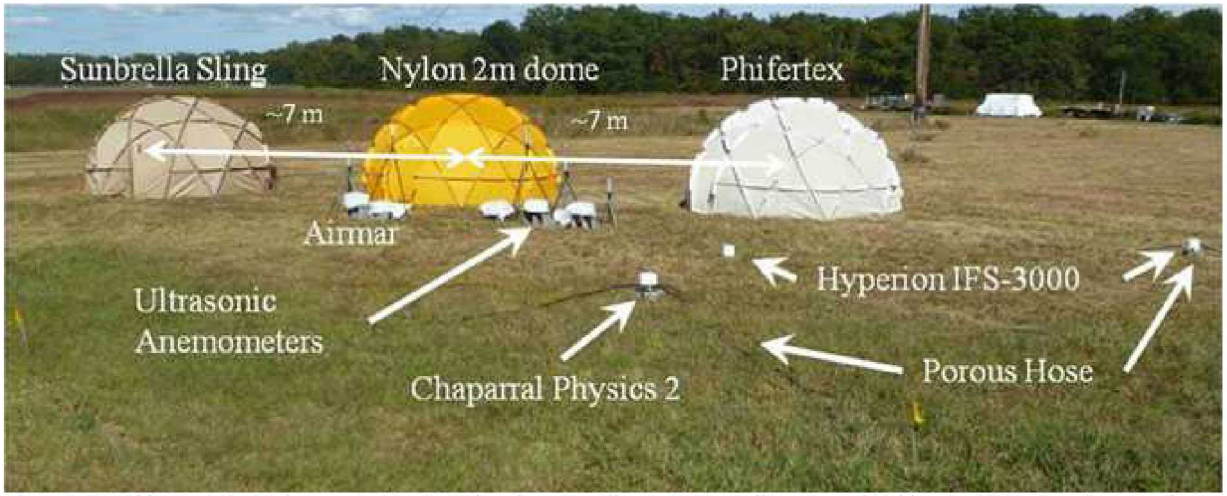
OTHER SYSTEMS FOR WIND NOISE REDUCTION



Raspet, R., Abbott, J.P., Webster, J., Yu, J., Talmadge, C., Alberts II, K., Collier, S. and Noble, J., 2019. New Systems for Wind Noise Reduction for Infrasonic Measurements. In *Infrasound Monitoring for Atmospheric Studies* (pp. 91-124). Springer, Cham.

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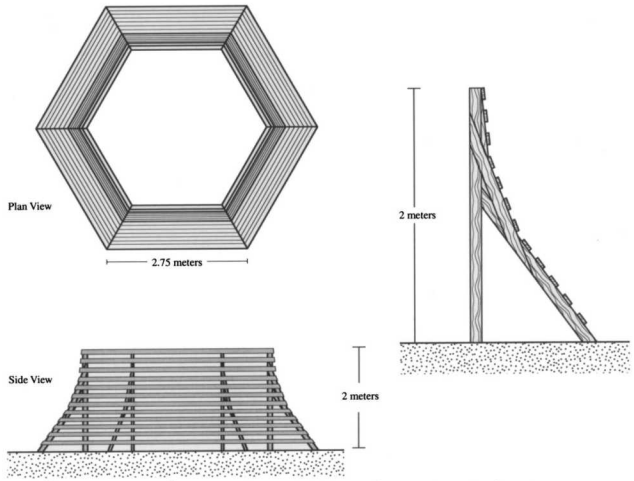
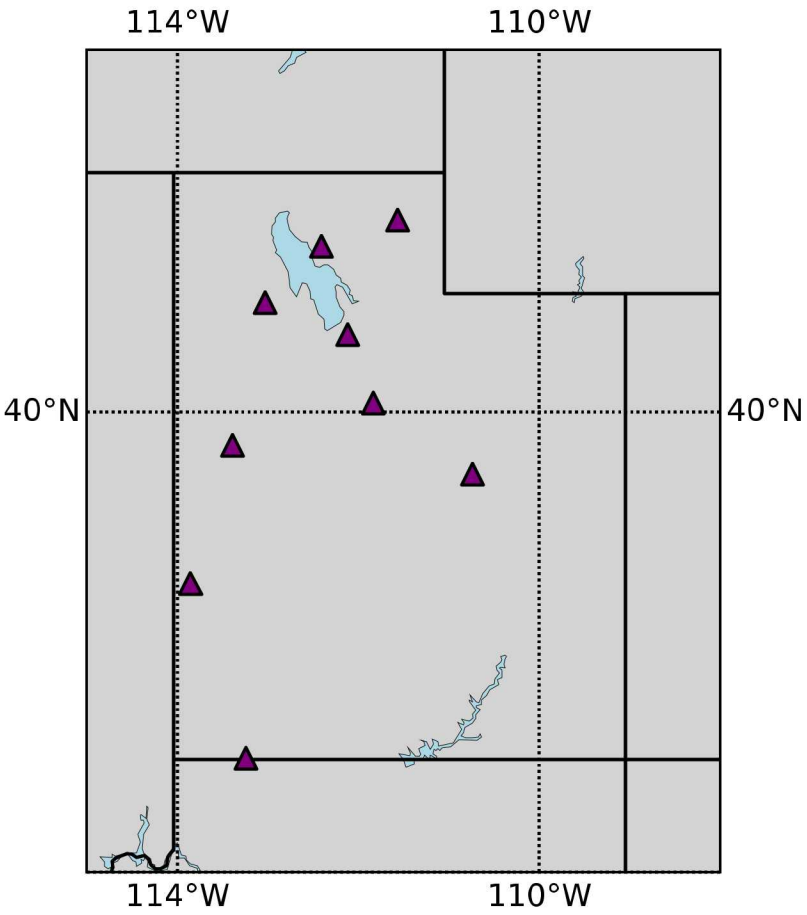


Hedlin, M.A. and Raspet, R., 2003. Infrasonic wind-noise reduction by barriers and spatial filters. The Journal of the Acoustical Society of America, 114(3), pp.1379-1386.

MOTIVATION



Need to replace/augment the infrasound arrays in Utah for a temporary (5 year) deployment.

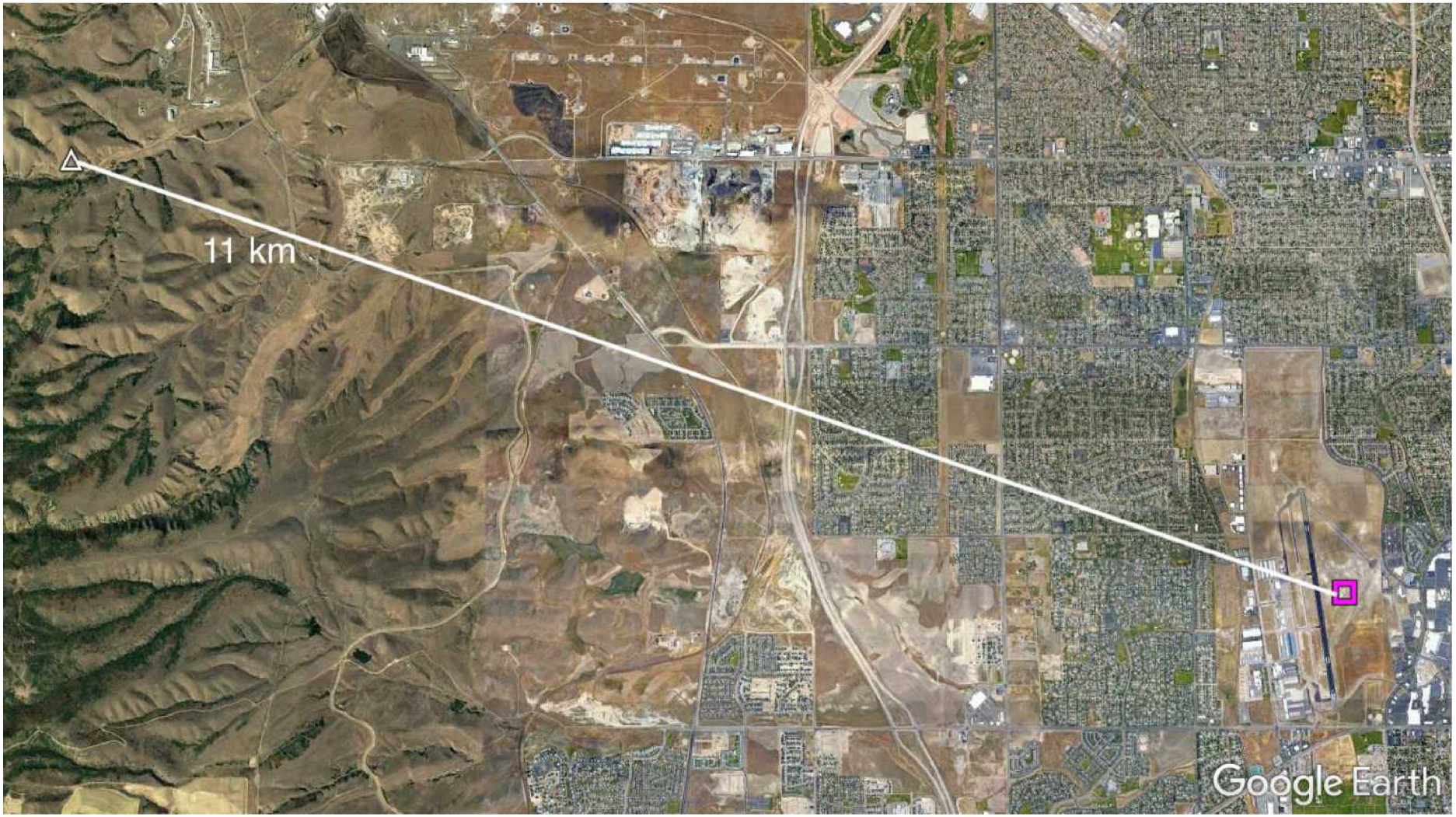
What is the best wind noise reduction system to use overall?

How do smaller footprint systems compare?

EXPERIMENT SETUP

1. Reference
2. Hyperion HF shroud
3. Hyperion HF shroud
4. Hyperion HF shroud + metal mesh dome
5. Hyperion HF shroud + bucket
6. Hyperion Four Port Garden Hose shroud + 4 Miracle-Gro Soaker System hoses

EXPERIMENT SETUP



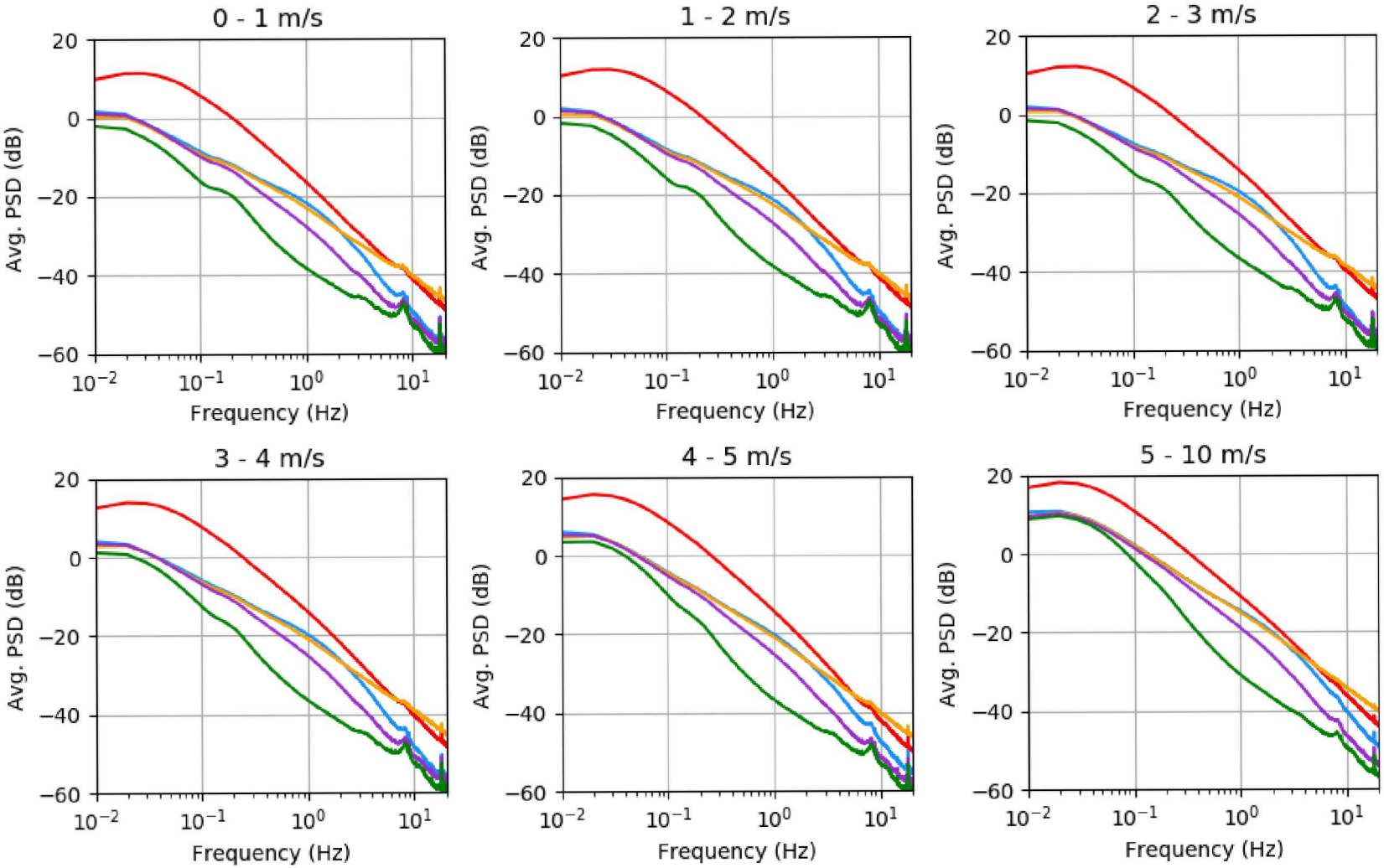
METHODS

1. Wind speed intervals: 1 m/s increments up to 5m/s and 5-10 m/s
2. PSDs calculated for 20 s time window
   - Hann window with 50% overlap
3. Average PSD taken for each wind speed interval
4. Noise reduction calculated from reference

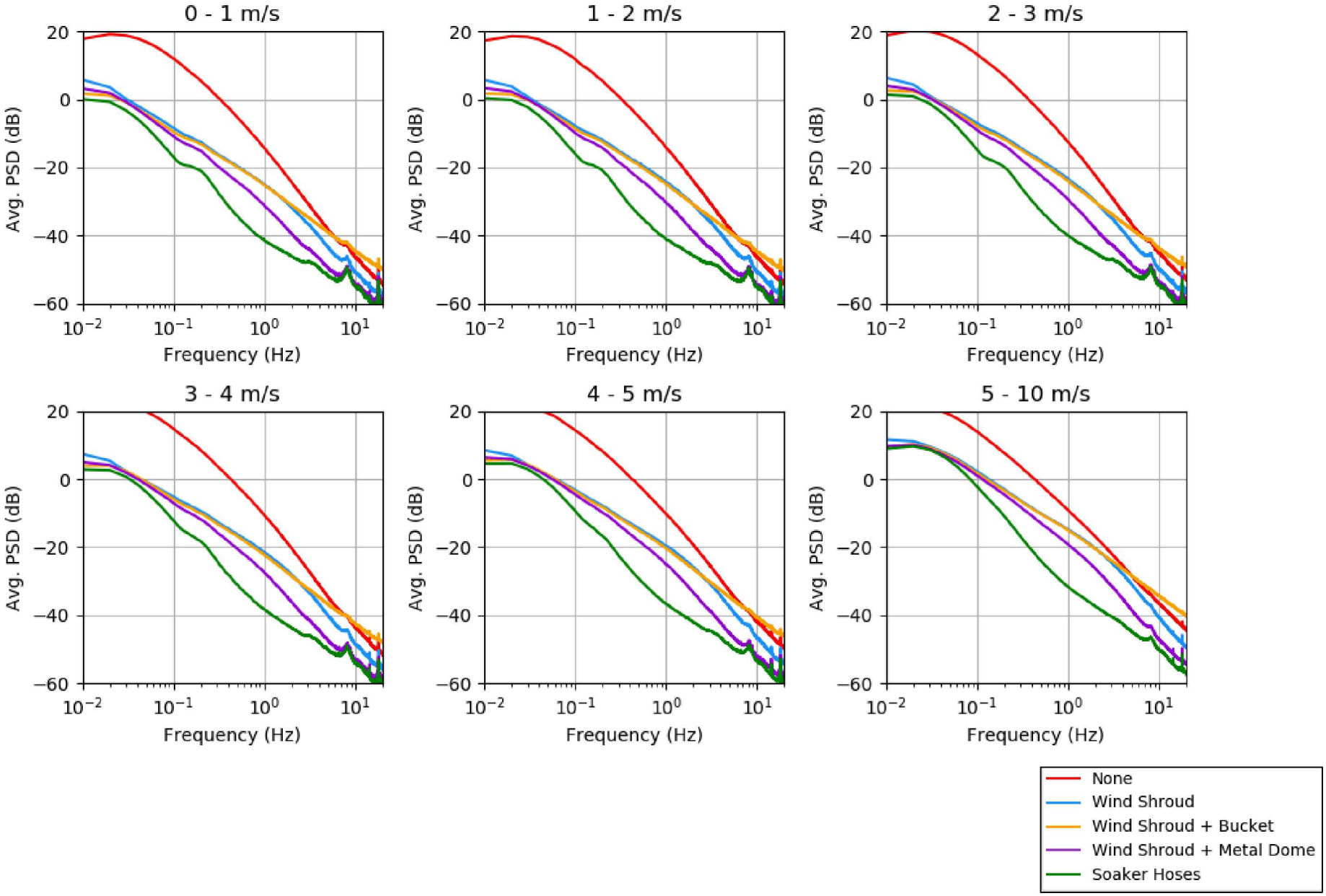
BEAUFORT SCALE

Force		Anemometer reading mph	kmh	m/s	knts	Description		Effect on kite
0		0-1	<1	<0.3	0-1	Calm; smoke rises vertically.	Calm	Launch frustratio
1		1-3	1-5	0.3-1.5	1-3	Direction of wind shown by smoke drift, but not by wind vane.	Light air	Very large lightweight deltas, Rokkaku etc, may fly on a light
2		4-7	6-11	1.5-3.3	4-6	Wind felt on face; leaves rustle; ordinary vanes moved.	Light Breeze	Sutton ff30 lofts 650g at 3.5mph
3		8-12	12-19	3.3-5.5	7-10	Leaves and small twigs in constant motion; wind extends light flag.	Gentle Breeze	Drogue needed on Flowform kites
4		13-18	20-28	5.5-8.0	11-16	Raises dust and loose paper; small branches are moved.	Moderate Breeze	
5		19-24	29-38	8.0-10.8	17-21	Small trees in leaf begin to sway; crested wavelets form on inland waters.	Fresh Breeze	Reduce kite size increase line weight & drogue size
6		25-31	39-49	10.8-13.9	22-27	Large branches in motion; whistling heard in telegraph.	Strong Breeze	

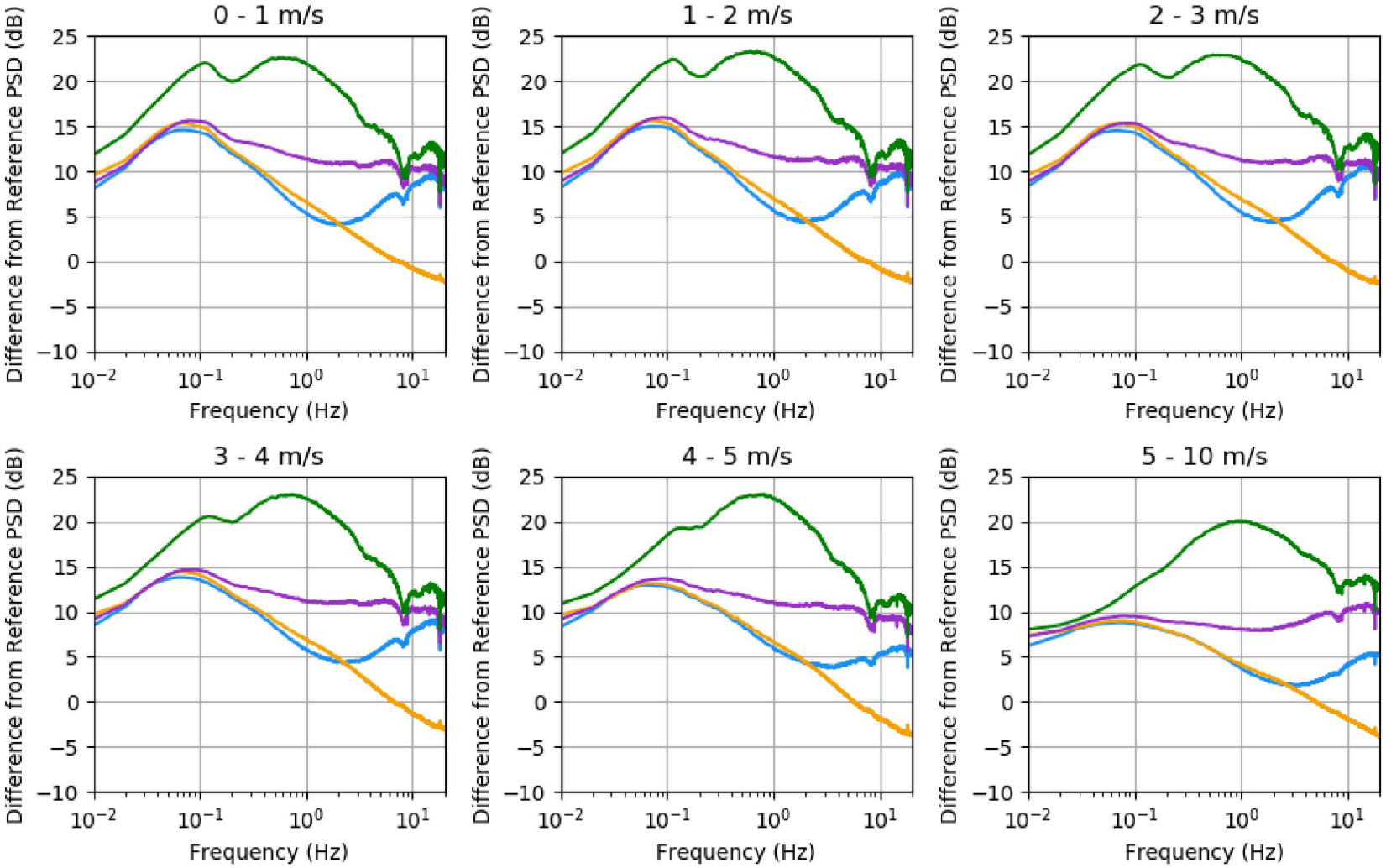
RESULTS


0 - 1 m/s
1 - 2 m/s
2 - 3 m/s
3 - 4 m/s
4 - 5 m/s
5 - 10 m/s
Avg. PSD (dB)
Frequency (Hz)
None
Wind Shroud
Wind Shroud + Bucket
Wind Shroud + Metal Dome
Soaker Hoses

RESULTS – NIGHT ONLY



RESULTS


0 - 1 m/s
1 - 2 m/s
2 - 3 m/s
3 - 4 m/s
4 - 5 m/s
5 - 10 m/s
Difference from Reference PSD (dB)
Frequency (Hz)
Wind Shroud
Wind Shroud + Bucket
Wind Shroud + Metal Dome
Soaker Hoses

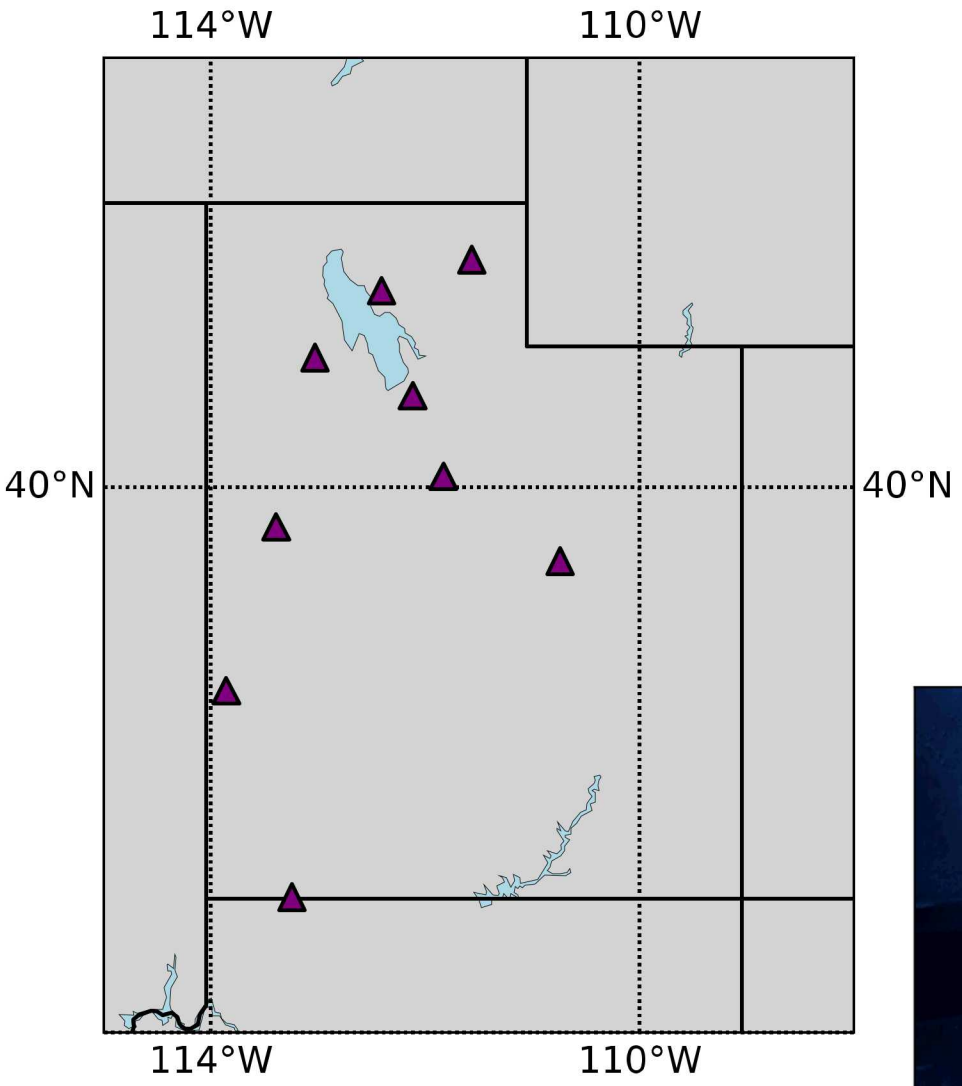
CONCLUSIONS

Final Standing:

1. Hyperion Four Port Garden Hose shroud + 4 Miracle-Gro Soaker System hoses
2. Hyperion HF shroud + metal mesh dome
3. Hyperion HF shroud
4. Hyperion HF shroud + bucket (not recommended)

Station Characteristics	Wind Noise Reduction System Recommended
Low-lying vegetation, ≥ 30 m space	Hyperion Four Port Garden Hose shroud + 4 Miracle-Gro Soaker System hoses
Low-lying vegetation, ≤ 30 m space	Hyperion HF shroud + metal mesh dome
Dense vegetation, ≥ 30 m space	Hyperion Four Port Garden Hose shroud + 4 Miracle-Gro Soaker System hoses OR Hyperion HF shroud + metal mesh dome
Dense vegetation, ≤ 30 m space	Hyperion HF shroud + metal mesh dome
On top of a steep slope	Hyperion Four Port Garden Hose shroud + 4 Miracle-Gro Soaker System hoses
Expecting high SNR signals	Hyperion HF shroud or anything better

FUTURE WORK



Sources of infrasound:

1. Earthquakes
2. Mining explosions
3. Mine collapse
4. Aircraft