SPECTRAL CHARACTERISTICS OF AURORAL REGION SCINTILLATION USING 100 HZ SAMPLING

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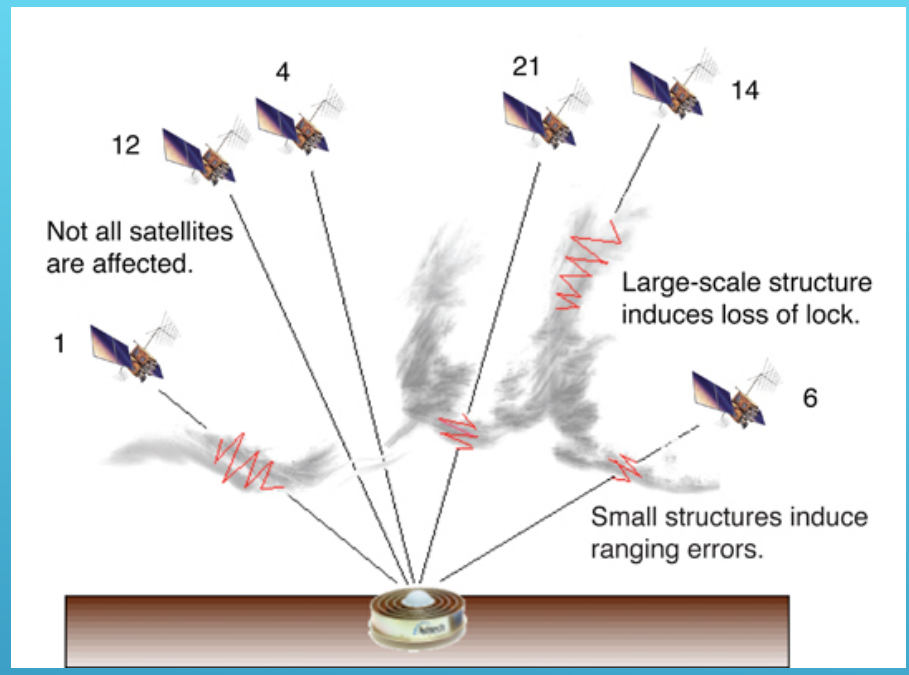
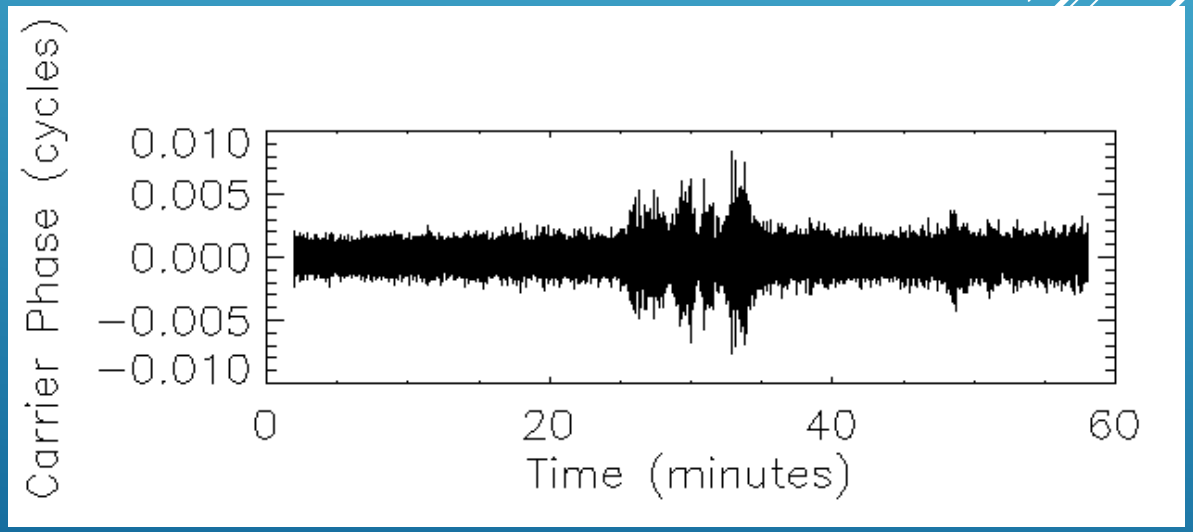
OUTLINE

- Introduction
- Objective
- Data
- Results and Discussion
- Conclusion
- Future Work

INTRODUCTION

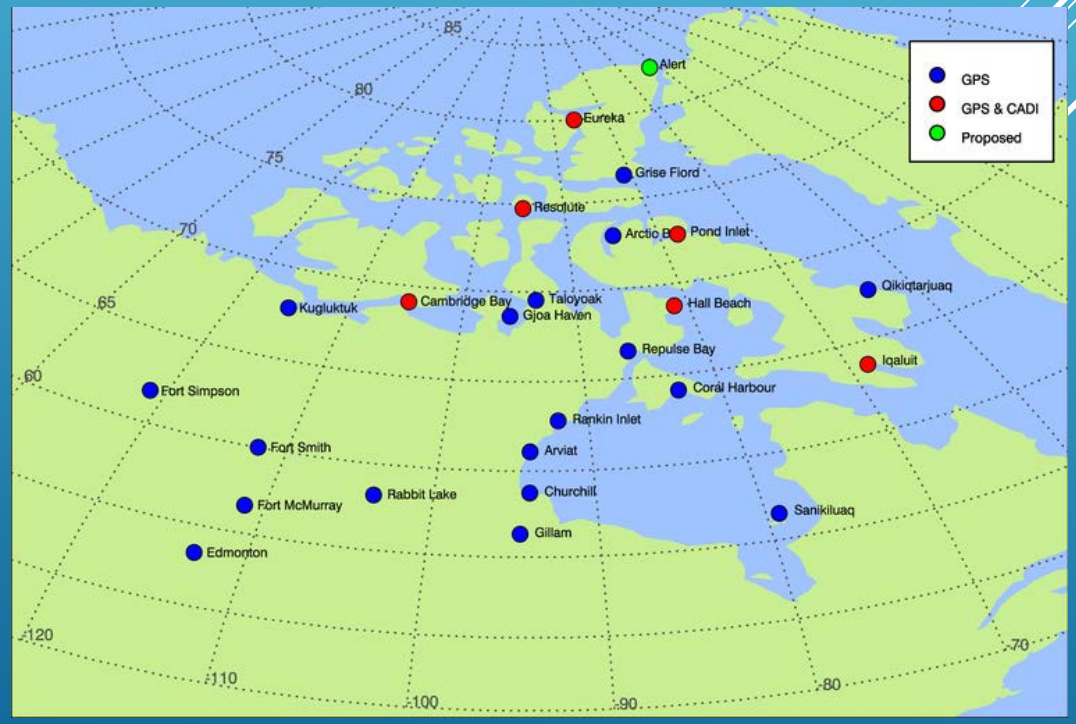
- Trans-ionospheric radio waves effected by refractive, diffractive effects
- Diffractive variations induced by small-scale irregularities
- Observed as rapid variations in amplitude, phase of signal
- Variations (scintillations) used in studying dynamics and morphology of irregularities
- Spectral characteristics





INTRODUCTION

- GPS constellation provide large spatial and temporal coverage of trans-ionospheric radio waves
- Popular tool in ionospheric research, scintillation research
- Introduction of receivers in Canadian High Arctic Ionospheric Network (CHAIN) with 100 Hz sampling
- GPS amplitude and carrier phase
- Twice previous receiver sampling rates

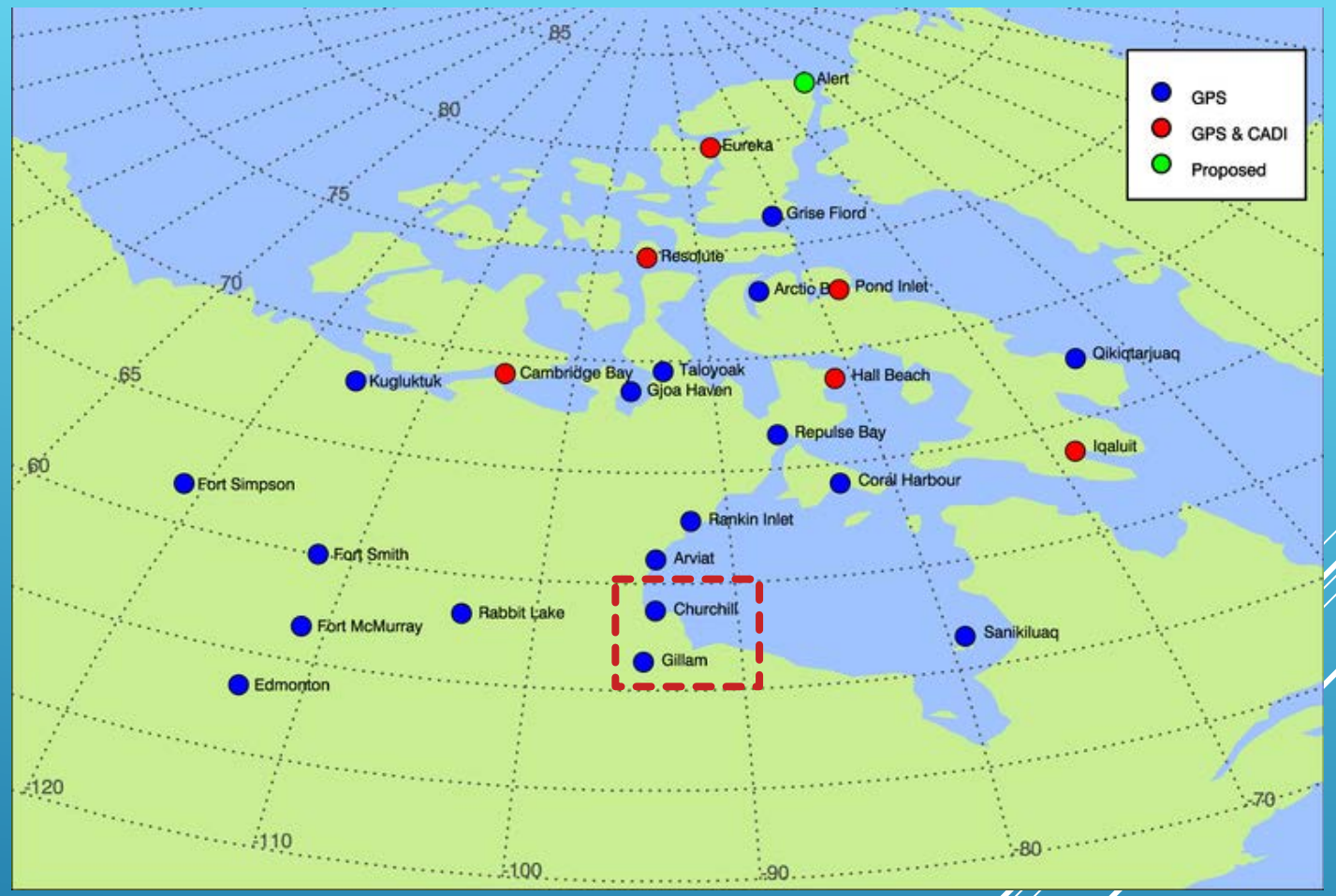


OBJECTIVE

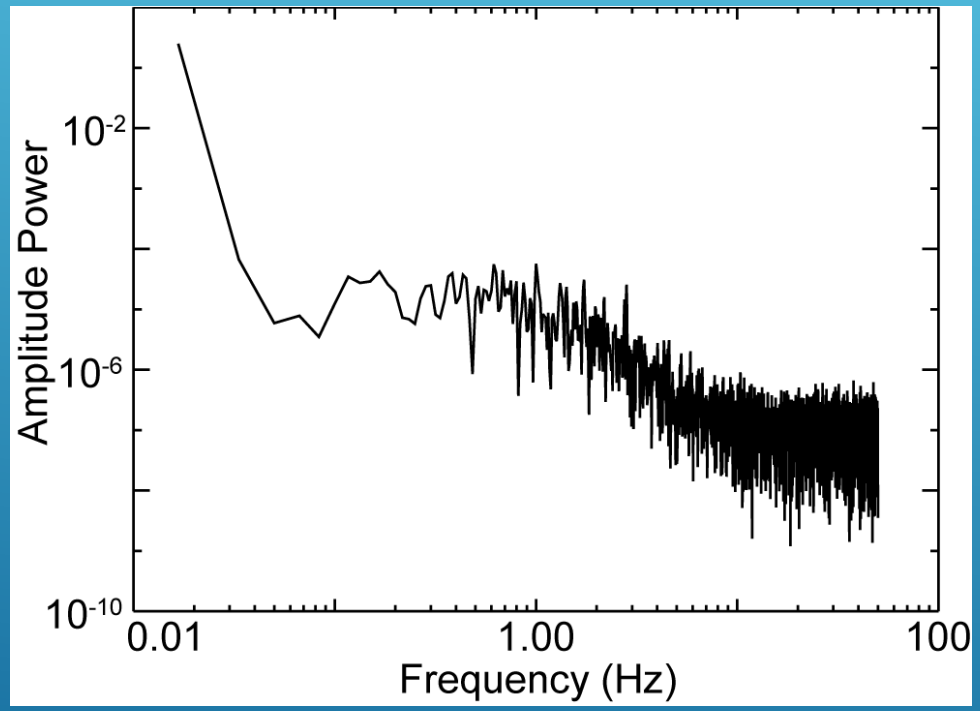
- Are previous sampling rates (max 50 Hz) enough to see entire available picture of scintillation?
- Are scintillation spectral characteristics observed in high frequencies or is region dominated by noise?

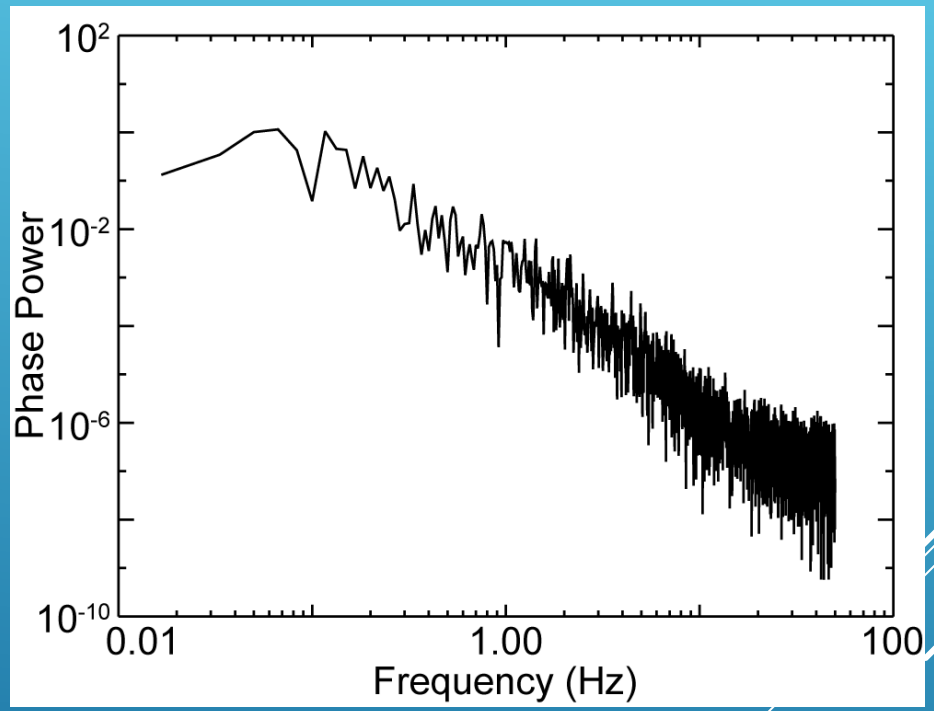
DATA

- Two receivers in CHAIN network
  - Churchill, Gillam
- 100 Hz amplitude and carrier phase
- May 24-31 2013



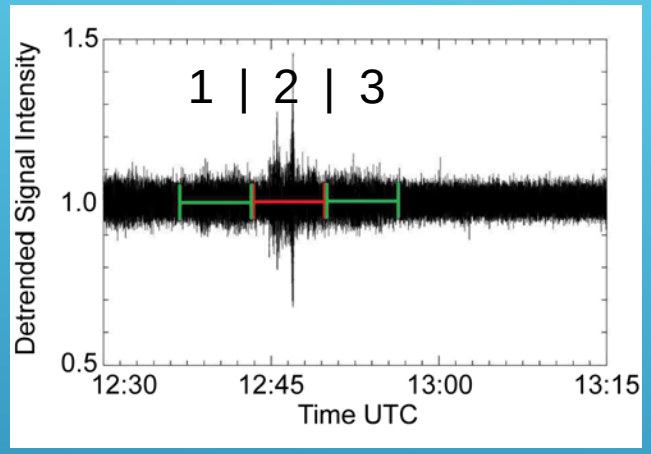
RESULTS AND DISCUSSION

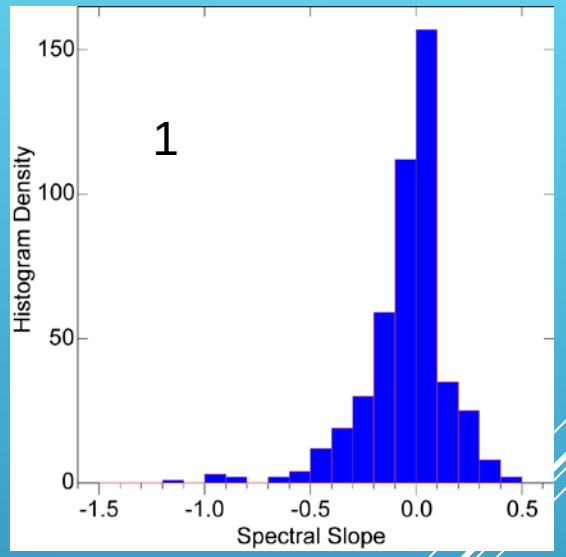


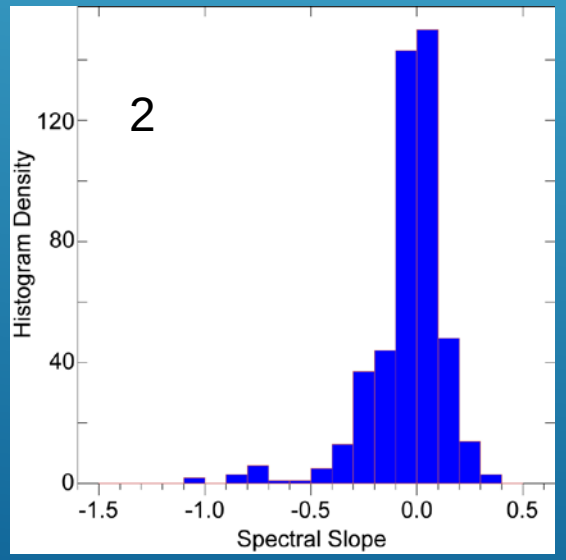


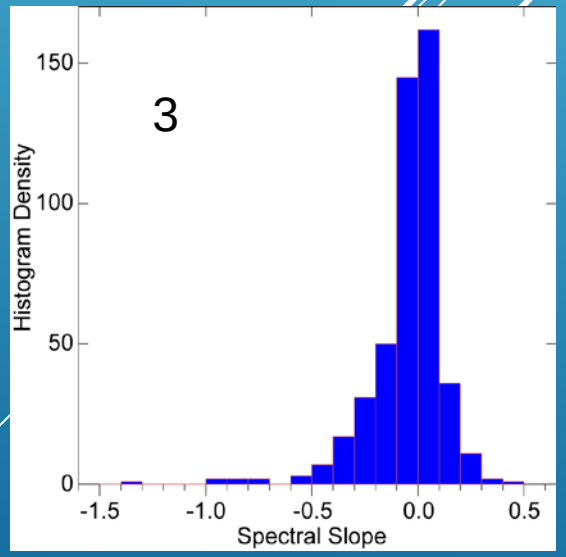
AMPLITUDE

- Examine slope ‘deviation region’ of amplitude spectra
- Four minute window before and after event
- Mean slopes:
  - Before: -0.0489 ± 0.2219
  - During: -0.0353 ± 0.1668
  - After: -0.0475 ± 0.1801
- Suggests no scintillation characteristics
- Expected receiver noise floor = ~5x10^{-7}, agrees with results



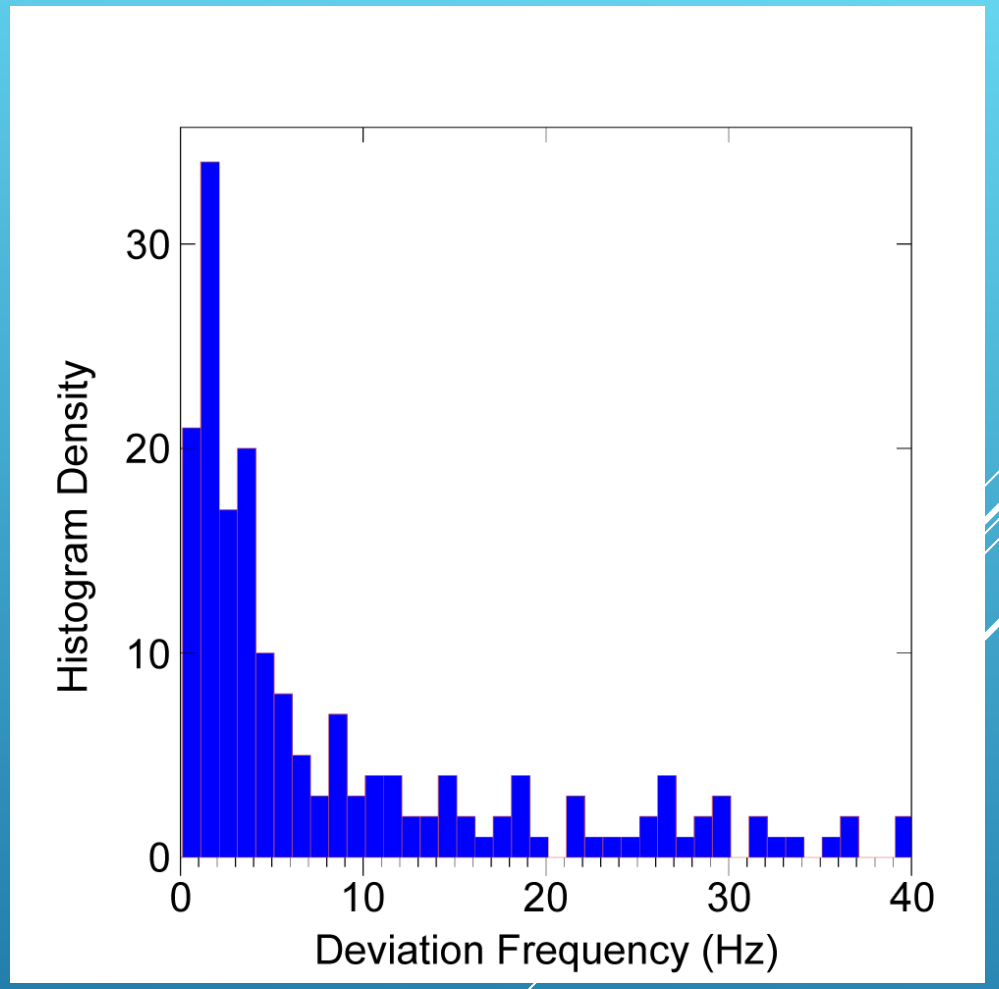






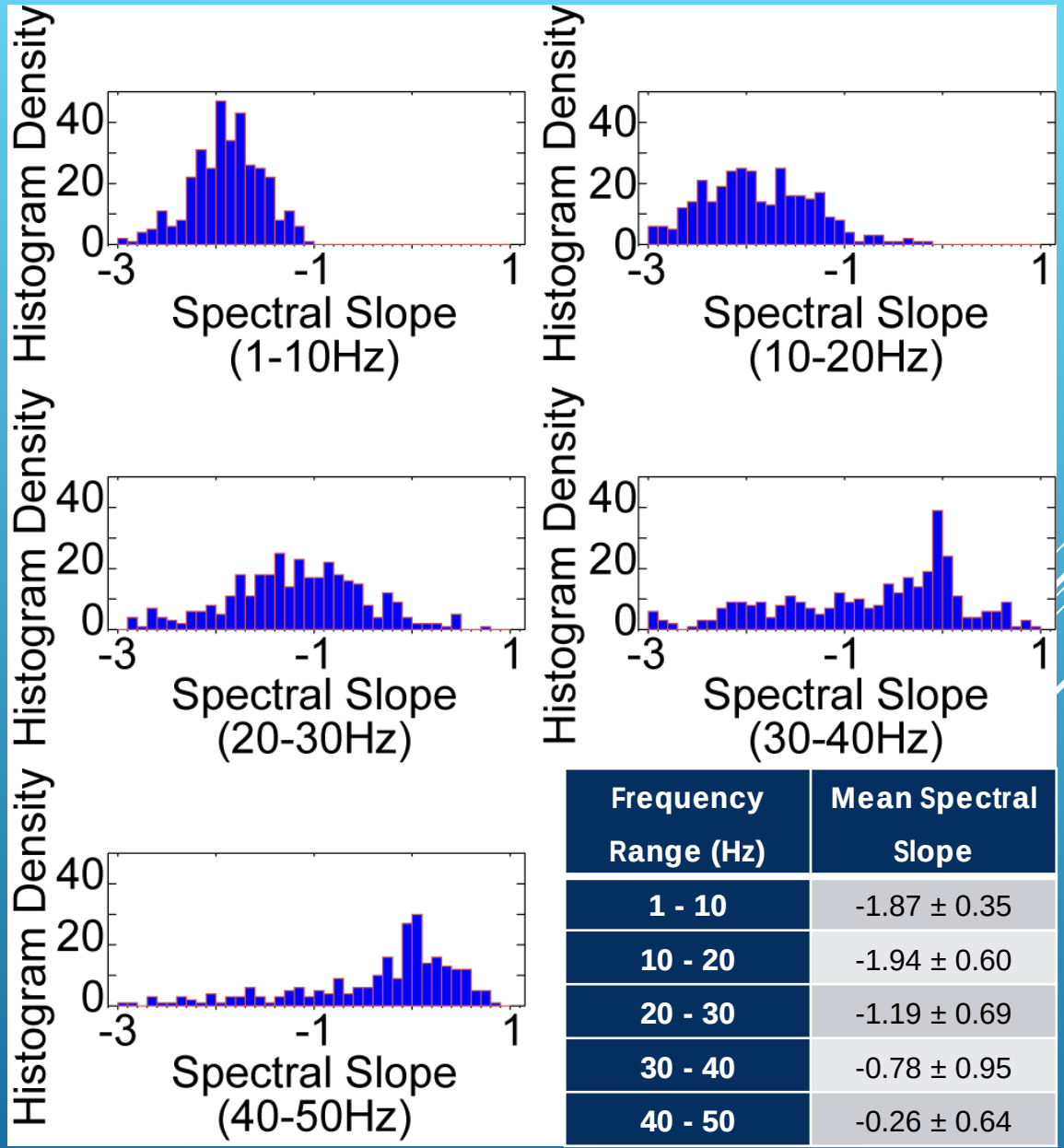
AMPLITUDE

- Distribution of frequencies at which deviation occurs
- May occur at frequencies upwards of 40 Hz
- Mean about 10 Hz
- This suggests 100 Hz sampling is necessary to capture entirety of all events



PHASE

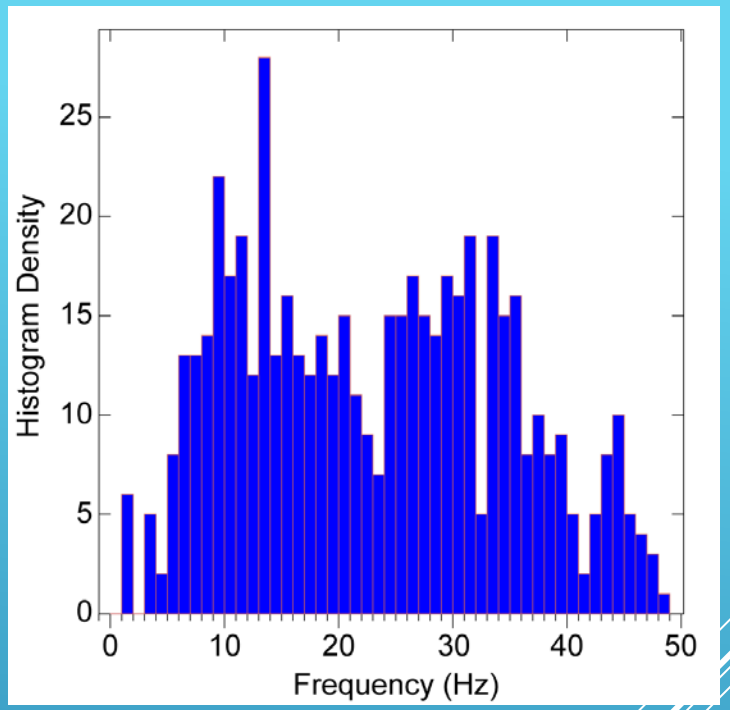
- Further investigate shallowing of slope
- Distributions of spectral slope in frequency windows
- Trend towards shallower slope with increased frequency

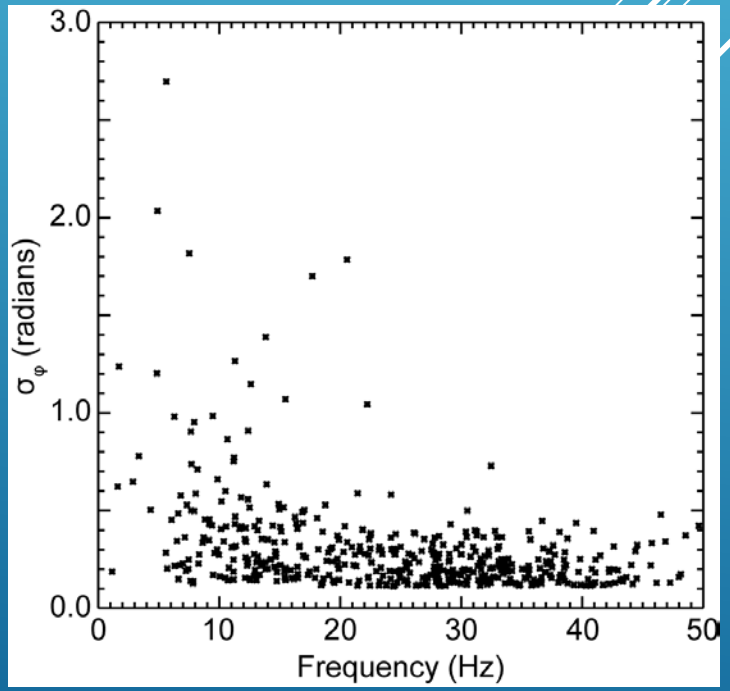


Frequency Range (Hz)	Mean Spectral Slope
1 - 10	-1.87 ± 0.35
10 - 20	-1.94 ± 0.60
20 - 30	-1.19 ± 0.69
30 - 40	-0.78 ± 0.95
40 - 50	-0.26 ± 0.64

PHASE

- Frequency when shallowing begins varies significantly
- About 50% shallow below 25Hz
- If shallowing is noise, expect larger magnitude scintillation to have high frequency shallowing
- Opposite is observed
- Suggests shallowing is not noise floor
- Expected receiver noise floor ~8.3×10^{-8}, typically lower than shallowing





CONCLUSION

- Using 100 Hz sampling, examining high frequency components of GPS amplitude and phase scintillation
- Amplitude scintillation shows clear noise floor in higher frequencies
- Majority of event noise floors start below 25 Hz
- Noise floor can begin at frequencies greater than 25Hz, suggesting need for 100 Hz sampling to obtain full picture

CONCLUSION

- Phase spectra present shallowing of spectral slope in higher frequencies
- Based on hardware noise floor and comparison of shallowing frequency and magnitude of scintillation, shallowing does not appear to be noise
- If shallowing is caused by noise, half of the events shallow after 25 Hz, indicating a need for 100 Hz (or higher) sampling for phase scintillation

FUTURE WORK

- Further investigate shallowing of phase spectral slope
- Attempt to relate shallowing to geophysical phenomenon
- Further investigate amplitude scintillation events where noise is introduced after 25 Hz
  - Is anything new contained within this range?