Static Research Network

Baseline Characterisation of 4.2–4.8 kHz Ambient Noise in Distributed Monitoring Arrays

Distribution: Public Archive, Site Coordinators

Date

November 3, 2023

SRN Field Report FR-0182

Classification

Public Research Summary

Authors

Dr. James Chen (Site 3-A)

Dr. Sarah Mitchell (Site 7-C)

Dr. Robert Hayes (Site 12-B)

Executive summary

This report presents baseline characterisation data for ambient electromagnetic noise in the 4.2–4.8 kHz frequency range, collected across three geographically distributed monitoring sites over a six-month observation period (May–October 2023). The study establishes reference noise floor measurements, identifies common interference sources, and documents seasonal and diurnal variation patterns.

Data collection employed standard broadband receivers with identical calibration and sampling protocols. Environmental variables including temperature, humidity, atmospheric pressure, and local electromagnetic activity were monitored continuously. Results indicate stable baseline noise characteristics with predictable interference from industrial sources, atmospheric phenomena, and anthropogenic activity.

Findings provide reference data for anomaly detection algorithms and support ongoing signal characterisation efforts. Baseline parameters have been integrated into automated monitoring systems for real-time comparison and deviation alerting.

1. Introduction

The Static Research Network maintains continuous monitoring of electromagnetic signals across multiple frequency ranges. Accurate characterisation of ambient noise conditions is essential for distinguishing signal anomalies from routine environmental interference. This study establishes baseline noise parameters for the 4.2–4.8 kHz range, a frequency band of particular interest for long-term signal stability research.

1.1 Objectives

- Establish reference noise floor measurements across three monitoring sites
- Document common interference sources and their characteristics
- Identify seasonal and diurnal variation patterns
- Provide baseline data for automated anomaly detection systems

1.2 Study Period

May 1, 2023 – October 31, 2023 (184 days continuous monitoring)

2. Methodology

2.1 Monitoring Sites

Site 3-A (Pacific Northwest)

- Location: Rural coastal region
- Primary interference sources: Maritime communications, atmospheric phenomena
- Environmental characteristics: High humidity, moderate temperature variation

Site 7-C (Midwest)

- Location: Agricultural region, minimal urban development
- Primary interference sources: Agricultural equipment, power distribution infrastructure
- Environmental characteristics: Low humidity, high temperature variation

Site 12-B (Southwest)

- Location: Desert environment, isolated facility
- Primary interference sources: Minimal anthropogenic activity
- Environmental characteristics: Very low humidity, extreme temperature variation

2.2 Equipment Configuration

All sites employed identical monitoring configurations:

- Broadband receiver: Model BR-4000 (calibrated to ±0.1 dB)
- Sampling rate: 100 kHz
- Data storage: Continuous archival with 1-second resolution
- Calibration: Automated verification every 24 hours

2.3 Environmental Monitoring

Continuous environmental data collection:

- Temperature (±0.5°C accuracy)
- Humidity (±2% accuracy)
- Atmospheric pressure (±0.1 hPa accuracy)
- Local electromagnetic field strength (DC to 30 MHz)

3. Results

3.1 Baseline Noise Floor

Mean noise floor measurements (May–October 2023):

Site 3-A: -87.3 dBm (±2.1 dB standard deviation)

Site 7-C: -89.1 dBm (±1.8 dB standard deviation)

Site 12-B: -91.7 dBm (±1.3 dB standard deviation)

Site 12-B demonstrates the lowest noise floor, consistent with its isolated desert location and minimal anthropogenic interference.

3.2 Interference Source Characterisation

Industrial Sources:

- Power distribution harmonics: Observed at all sites, primarily during peak usage hours
- Agricultural equipment: Significant at Site 7-C during planting and harvest seasons
- Maritime communications: Periodic at Site 3-A, correlated with coastal shipping activity

Atmospheric Phenomena:

- Lightning discharges: Broadband impulse interference, observed at all sites
- Ionospheric propagation: Enhanced during solar activity periods
- Precipitation static: Significant at Site 3-A during storm events

Anthropogenic Activity:

- Minimal at Site 12-B (remote location)
- Moderate at Site 7-C (rural agricultural setting)
- Moderate at Site 3-A (coastal maritime activity)

3.3 Temporal Variation

Diurnal Patterns:

All sites exhibited diurnal noise variation correlated with:

- Human activity cycles (industrial/agricultural operations)
- Temperature-dependent atmospheric propagation
- Local power consumption patterns

Peak noise levels typically occurred between 14:00–18:00 local time. Minimum noise levels occurred between 02:00–05:00 local time.

Seasonal Patterns:

- Site 3-A: Higher noise during winter storm season (November–March)
- Site 7-C: Agricultural activity peaks during spring planting and fall harvest
- Site 12-B: Minimal seasonal variation due to isolated location

3.4 Environmental Correlation

Statistical analysis revealed moderate correlation between noise levels and:

- Temperature: $r = 0.34$ ($p < 0.01$)
- Humidity: $r = 0.28$ ($p < 0.01$)

- Atmospheric pressure: $r = -0.19$ ($p < 0.05$)

Correlations are consistent with known atmospheric propagation effects and equipment thermal sensitivity characteristics.

4. Integration with Monitoring Systems

Baseline parameters established by this study have been integrated into automated monitoring systems at all SRN facilities. Real-time comparison algorithms use baseline data to identify statistically significant deviations warranting further analysis.

Deviation Thresholds:

- Level 1 Alert: Noise exceeds baseline by >3 standard deviations
- Level 2 Alert: Noise exceeds baseline by >5 standard deviations
- Level 3 Alert: Sustained deviation >10 minutes duration

These thresholds balance sensitivity for anomaly detection against false alarm rates from routine environmental variation.

5. Conclusions

Six-month baseline characterisation across three geographically distributed sites has established reference noise parameters for the 4.2–4.8 kHz frequency range. Results demonstrate stable baseline conditions with predictable interference patterns and environmental correlations.

Baseline data supports ongoing signal characterisation research and provides foundation for automated anomaly detection. Continued monitoring will refine seasonal variation models and improve detection algorithm performance.

6. Recommendations

1. Continue annual baseline updates to account for long-term environmental changes
2. Expand baseline characterisation to additional frequency ranges
3. Implement cross-site correlation analysis for multi-site anomaly detection
4. Develop adaptive thresholds based on real-time environmental conditions

Acknowledgments:

Technical support provided by Site Operations teams. Environmental monitoring equipment provided by Atmospheric Sciences Division.

Distribution:

- Public Research Archive
- Site Coordinators (All facilities)
- Technical Operations