Patterns in Received Noise

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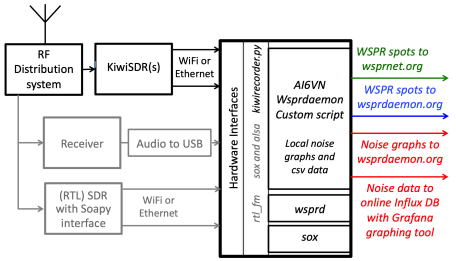
Abstract

There are valid concerns that local noise, often as common mode, is an increasing problem for radio amateurs. By adding two noise measurement algorithms to a robust Weak Signal Propagation Reporter (WSPR) processing and reporting package - wsprdaemon - we now have the capability to record and share noise level measurements from over twenty amateur stations. In this poster we summarise our noise measurement methods and provide examples of patterns in received noise on the HF bands ranging from very quiet rural Northern California, Utah, and Austria to a more typical suburban noise environment. These patterns show clearly where and when the local noise floor becomes a limiting factor. More intriguingly, we have observed coherent fluctuations in the noise over periods of hours at a pair stations 1000 km apart. With ten months of observations every two minutes we can see systematic seasonal variations in the daily noise patterns.

Introduction

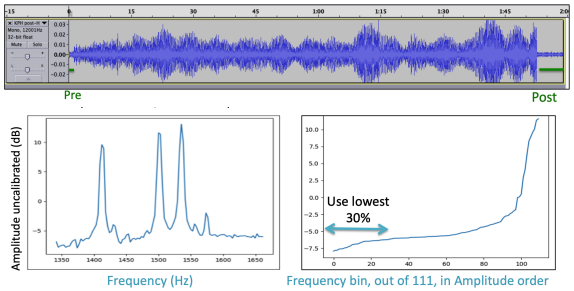
Our project began with two strands of thought. First, there is a widespread opinion that amateurs are experiencing higher noise levels on the LF-HF bands. Second, each day about 1.5 million reports of signal to noise ratio (SNR) are made by radio amateurs using the Weak Signal Propagation Reporter (WSPR) protocol. What might we learn if we were to implement a method of estimating noise level at the same time and on the same frequencies as WSPR spots were being received?

While there have been several initiatives by national amateur radio societies including the UK (1), the Netherlands (2), South Africa (3) and Germany (4), and some preliminary studies by the ARRL, ours is a community-based international effort with open access to real-time data. The block diagram below outlines the current hardware and key software modules. While we have confidence in stable calibration for the KiwiSDR and the analysis software, characterizing the RF distribution system is more challenging, and the antenna even more so. Hence, for now, our focus is on patterns of noise rather than absolute levels.



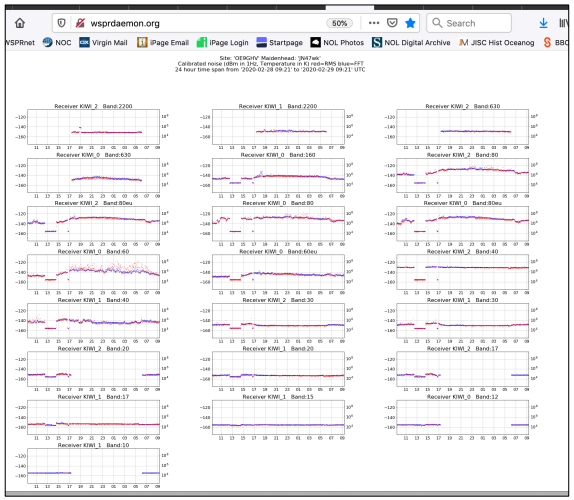
Methods

Our noise measurement approach exploits gaps in time and frequency associated with WSPR transmissions. We make an RMS noise measurement in the quietest 50 ms before of after a WSPR transmission and, as a separate measurement, sum the power in the lowest 30% of FFT amplitudes in a WSPR band and 60 Hz either side, as illustrated below.

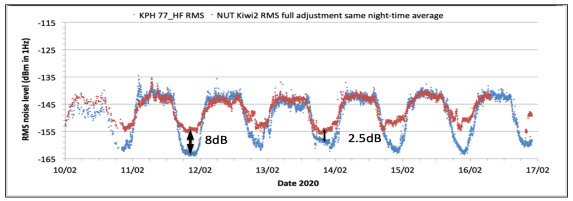


Data and Analysis

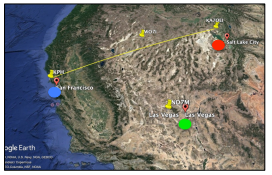
Noise estimates are available in real time at http://wsprdaemon.org , as in the plots below, or via an interactive Grafana site at https://grafana.int8.com/d/3dcOdAmWk

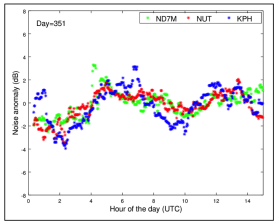


Diurnal patterns of noise provide a useful diagnostic for local noise contamination. In the plot below, where we have matched the average night-time levels, the daytime noise at the Northern Utah SDR site (blue) is some 2.5 to 8 dB higher than at KPH, Point Reyes, California (red). Consequently, only during the night can we search for and study coherent patterns of fluctuations in the noise at these two stations.



Time series of night-time noise level anomalies from KPH (blue), Northern Utah (red) and ND7M, S. Nevada (red) provide a rich data set that we have yet to fully analyze. Fluctuations at several temporal (spatial?) scales are present, with, in this example, a dominant variation at a period of of about seven hours being of similar amplitude and timing at the three sites.





Conclusion

- We have demonstrated an open access, operational approach to gathering noise level data contemporaneously with receiving WSPR spots from some 20 stations.
- Obtaining absolute values for noise level eludes us so far, but in the mean time studies of noise level anomalies are providing useful insights.
- Comparing diurnal noise variations against a site with low local noise, even if 1000km distant, allows us to assess level, timing, and band-specific impact.
- Our data sets are rich in what appear to be regional fluctuations in noise that warrant further study.

References

1 rsgb.org/main/technical/propagation/noise-floor-study/hf-noise-monitoring-campaign/.
2 hf.r-e-f.org/c4_iaru_r1/16_Vienne/VIE16_C4_15_VERON_Provisional%20Results%20of%20Measurement%20Campaign.pdf.
3 rfnoise.amsatsa.org.za/about_us.php.
4 vienna.iaru-r1.org/wp-content/uploads/2019/01/VIE19-C7-002-DARC-ENAMS.pdf..

Acknowledgements

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