Atmospheric Noise with Horizontal Antennas

Carl Luetzelschwab K9LA October 2017

The International Telecommunication Union document "Radio noise" (Recommendation ITU-R P.372-13) gives a wealth of information about the different types of noise that can affect radio communications. These types of noise include:

1) atmospheric noise due to lightning discharges
2) man-made noise from electrical machinery, electronics, power transmission lines and internal combustion engine ignition systems
3) extra-terrestrial sources

This document is available at https://www.itu.int/rec/R-REC-P.372/en.

The atmospheric noise makes up the bulk of the document due to many figures. For the four seasons (Winter = December/January/February, Spring = March/April/May, Summer = June/July/August, Fall = September/October/November), worldwide contours of atmospheric noise are depicted for four-hour blocks of local time beginning with 0000-0400. The receiving antenna for all the measurements is a vertical monopole.

The noise contours are noise figures in dB, and the values are medians at 1 MHz in a 1 Hz bandwidth. Additionally, curves of the variation of noise with frequency and curves of noise variability about the median (upper decile, lower decile and standard deviations) are given.

Figure 1 (which is on the second to the last page of this article) shows the worldwide map for the Winter season in the 0000-0400 local time block. In North America, 0000-0400 local time is at night. Let's go through an example to calculate the expected noise in dBm on 80-Meters in a CW bandwidth (500 Hz).

We'll pick an East Coast station location in the W2 call area. We see that the contour line on Figure 1 (which is Figure 15a in the ITU document) is 70 at our selected location. This is the median noise figure, and is added to the kTB value of -174 dBm/Hz., giving -104 dBm/Hz at 1 MHz. Using the variation with frequency curves on Figure 2 (which is on the last page of this article and is Figure 15b in the ITU document), we see that the noise figure at 3.5 MHz decreases to 56 dB. Thus the noise on 80-Meters is -174 + 56 dBm/Hz = -118 dBm/Hz.

The last calculation we need to do is adjust for the CW bandwidth. Taking the $\log_{10}$ of 500 Hz/1 Hz and multiplying by 10 gives 27 dB. This is added to the -118 dBm/Hz to give -91 dBm in 500 Hz. This would be about S5 on my TenTec OMNI-VI if I was using an 80-Meter vertical monopole for receiving (and assuming my man-made noise is low enough to hear the atmospheric noise). This is also a good example of why low band DXers use receive antennas that exhibit directivity in order to pick up less noise from all around the compass.

We could even go deeper and calculate the distribution of the noise about the median (median implies 50% probability) using Figure 2 (Figure 15c in the ITU document). I'll leave that as an exercise for the reader!

All of this ITU data is great if you're using a vertical monopole for receiving. What about using a horizontal dipole? Will the atmospheric noise be lower or higher or about the same? The only data that I'm aware of for horizontal antennas is a report that measured atmospheric noise in Thailand at 2.3 MHz, 5 MHz and 10 MHz using a trapped dipole at 23 feet high. The title of this document is "HF Atmospheric Noise on Horizontal Dipole Antennas in Thailand" by George H. Hagn, Rangsit Chindahporn and John M. Yarborough. Google the title and you should find this document on the web. Going through their data and plotting it along with the appropriate nighttime ITU data results in Figure 3.

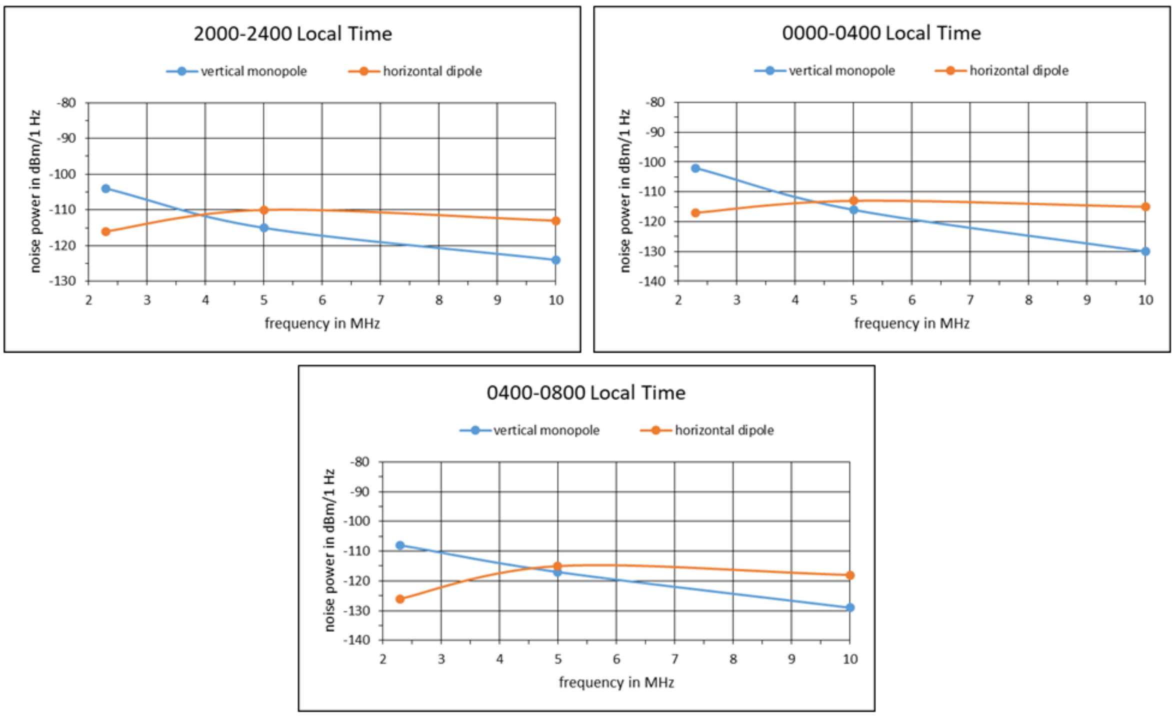

Figure 3

These are interesting results. Below 4.0-4.5 MHz, the vertical is noisier than the dipole (as I expected) by up to 15 dB at 2.3 MHz. That would likely translate to maybe 20 dB at 1.8 MHz.

But above 4.0-4.5 MHz, the vertical is quieter than the dipole. I have to admit I did not expect this. I've always thought that a horizontal antenna would be quieter than a vertical on the low bands – 160-Meters, 80-Meters and 40-Meters. This data is contradictory to my perception. This trend was recognized by the authors and was one of their major conclusions.

We have to realize that the horizontal dipole data was only taken in Thailand. The vertical monopole data was taken at many worldwide stations, so it is a much better representation of worldwide noise data. Does this contribute to the unusual trend? I don't know.

Regardless of the 40-Meters results, this gives a hint of why the Horizontal Waller Flag is emerging as a great 160-Meter and 80-Meter receive antenna.

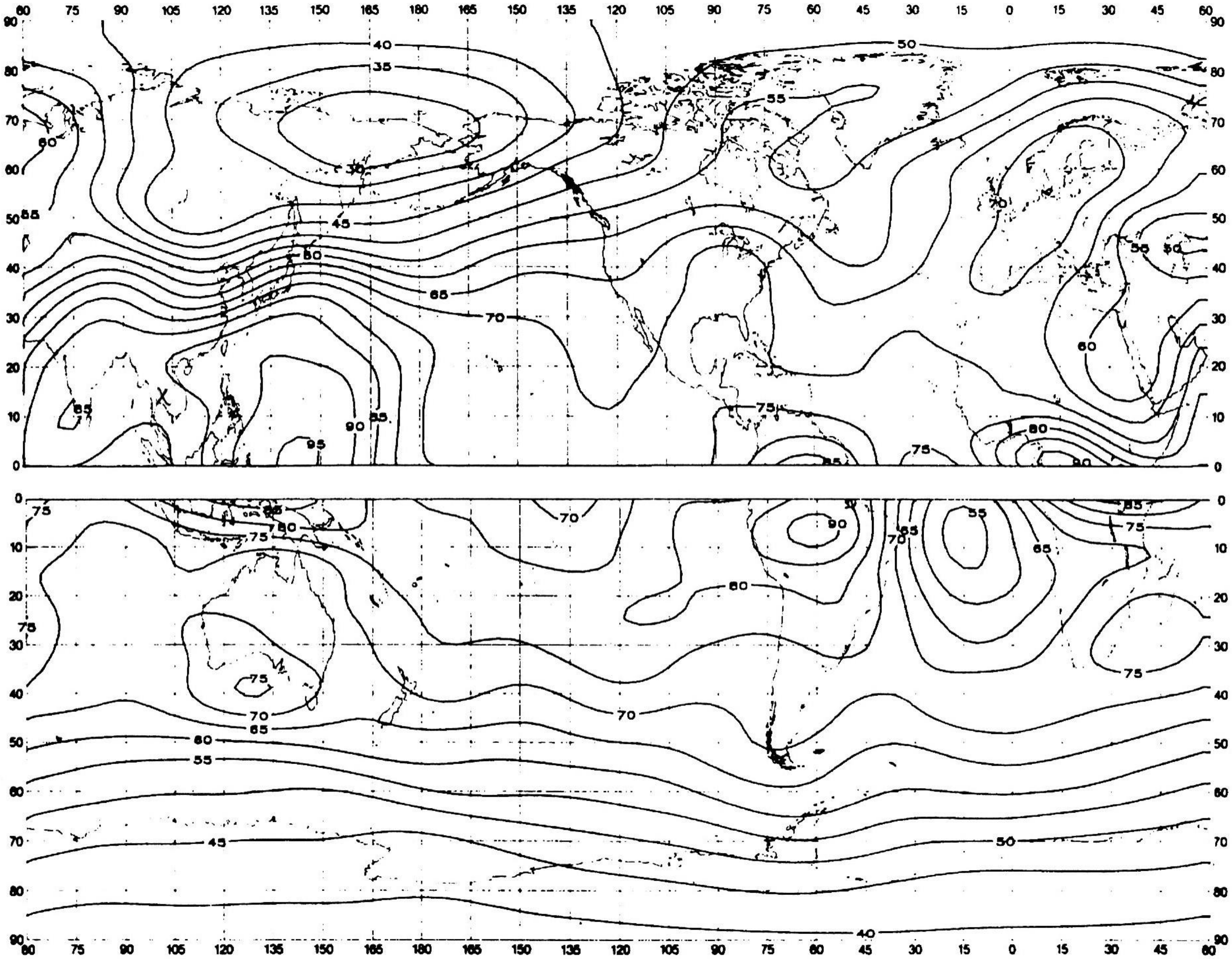

FIGURE 15a – *Expected values of atmospheric radio noise, F_{am} (dB above kT_0b at 1 MHz) (Winter; 0000-0400 LT)*

Figure 1

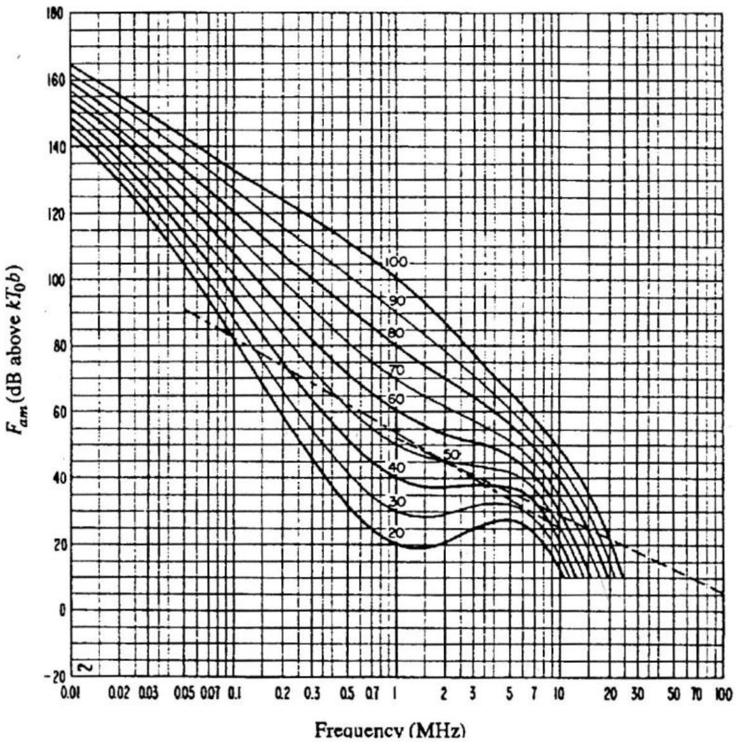

FIGURE 15b – *Variation of radio noise with frequency*
(Winter; 0000-0400 LT)

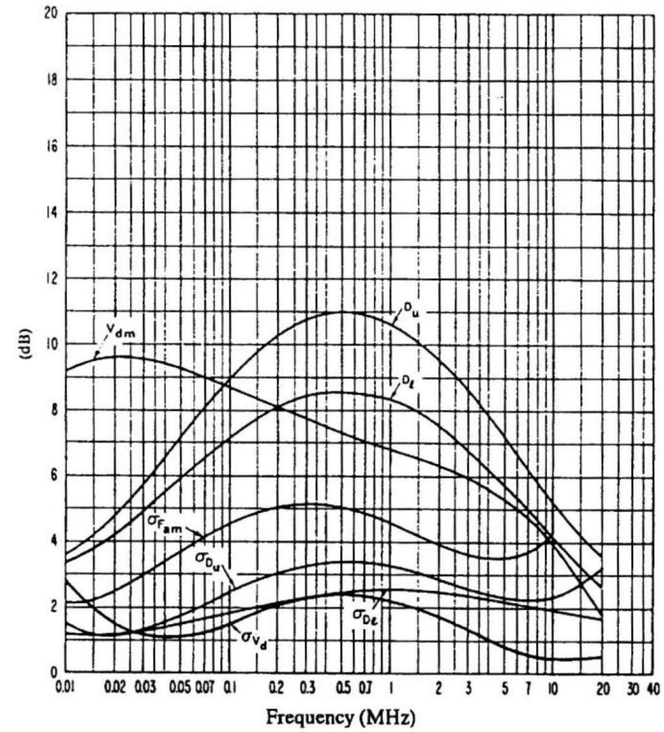

FIGURE 15c – *Data on noise variability and character*
(Winter; 0000-0400 LT)

——— Expected values of atmospheric noise

–·–·– Expected values of man-made noise at a quiet receiving location

- - - - Expected values of galactic noise

$\sigma_{F_{am}}$: Standard deviation of values of F_{am}

D_u : Ratio of upper decile to median value, F_{am}

σ_{D_u} : Standard deviation of values of D_u

D_l : Ratio of median value, F_{am}, to lower decile

σ_{D_l} : Standard deviation of values of D_l

V_{dm} : Expected value of median deviation of average voltage. The values shown are for a bandwidth of 200 Hz

σ_{V_d} : Standard deviation of V_d

0372-15b

Figure 2