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To: EDGES Group

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Subject: Estimate of meteor scatter rates and filter thresholds

The statistics of "Forward meteor Scatter" which reflects the signals form the FM and TV transmitters is studied by Yrjota and Jenniskens in Astron Astrophys 330, 739-752 (1993). Figure 2 of this article shows the dependence of the daily count of reflections on the sensitivity of the receiver. For the underdense events the dependence is fit by

$$N = P^{\epsilon}$$

Where the best fit value of ∈ is -0.66, N is the number of events per hour and P is the power in an event.

Table 1 gives the results from EDGES-3 data taken in Oregon as described in memo #310. The table gives the integration time for the sky data in a single 3-position cycle, the time span of the data set and the minimum and maximum power in the FM band (88-108 MHz) within a single 3-position switch cycle. This power is calculated from difference of the power from the EDGES frequency closest to the center of each FM channel located at odd multiples of 100 kHz and EDGES channels between the FM channels closest to the even multiples of 100 kHz. An average is taken over the FM Band. Some of the minimum power could be from sources other than the meteors but is probably very small because if the source is constant in time it should be the same in the 2 and 8 second integrations.

A factor of 4 increase in integration would pick a population of bursts with 4 to the power of 0.66 equals 2.5 times the power if the burst rate is larger than about 1 per second or 3600 per hour and the bursts are shorter than 2 seconds. Also shown in Table 1 are the number of integrations that are below a threshold that is taken in each case to be about twice, four times the minimum and a threshold above the maximum which gives the total number of integrations in the 2 and 8 second data sets.

					Data accepted vs threshold		
Integration	Span	Min pwr	Max pwr	23 K	40 K	80 K	8000 K
2 s	1 hr	23 K	9,750 k	1	49	193	495
Integration	Span	Min pwr	Max pwr	39 K	100 K	200 K	50,000 K
8s	13 hr	38.4 K	48,089 K	1	452	1234	1939

Table 1 FM strength in EDGES-3 data from Oregon made with 2 and 8 seconds integrations.

Another check of the dependence of the number of bursts on their power is to compare the ratio of the max to minimum power to the power of 0.66 to the number of integrations.

The power ratio for the 2 s and 8 second integrations are 424 and 1252 respectively which are 54 and 111 while the number of integrations are 495 and 1939 or ratios of 9 and 17. In this case a slope in the dependence of P to N of one would be closer.

In order to access the viability of the Oregon site Figures 1 and 2 show the spectra from the 2 and 4 second data sets as a function of the threshold which is set in order to determine which 3-position switched data blocks can be used without a bias in the average spectrum after individual frequency channels have been excised as shown in Figures 3 and 4. In Figures 3 and 4 a SNR threshold of 2.5 is applied to the individual spectral channels.

While there is not enough 2 second data to be sure it looks like a threshold of 100 or lower is needed to remove the bias in the FM band and to ensure no contribution from the 26-82 MHz digital TV channel seen in Figure 4. For comparison the maximum FM power in the MRO data from day 2018_159 is 965 K which about 50 times weaker than what is seen in Oregon. This is in approximate agreement with there being 50 times more FM stations with 2000 km of Oregon compared with the number within 2000 km of the MRO.

If data can be taken continuously during a 1 week deployment in Oregon it may still be possible to get enough data to verify that a signature is in reasonable agreement with the Nature paper and could be verified using only 5% of the data. However it may still require even lower acceptance to be able to obtain unbiased data in the FM band.

The LWA detects about 10,000 events per hour or about 3 events per second. While the actual rate is dependent on the sensitivity the rate of 3 events per second is consistent with the assumptions made to compare the 2 and 8 second data sets.

Figure 5 shows the 8 s data with FM excision threshold of 100 expanded in frequency and without frequency smoothing and with any exclusion of the 6 kHz resolution frequency channels. Figure 6 shows that after assigning zero weight to 6 kHz channels more than 4 sigma above the average best fit with 27 term Fourier series there are a few 6 kHz channels remaining in the FM band without an obvious bias at the 1 K level. This provides some indication that with shorter integrations to set the FM excision threshold it may be possible to obtain some data in the FM band without introducing a bias.

Reference:

Helmboldt, J.F., S.W. Ellingson, J.M. Hartman, T.J.W. Lazio, G.B. Taylor, T.L. Wilson, and C.N. Wolfe, “All-sky imaging of meteor trails at 55.25 MHz with the first station of the Long Wavelength Array.” Radio Science 49, no. 3 (2014): 157-180.

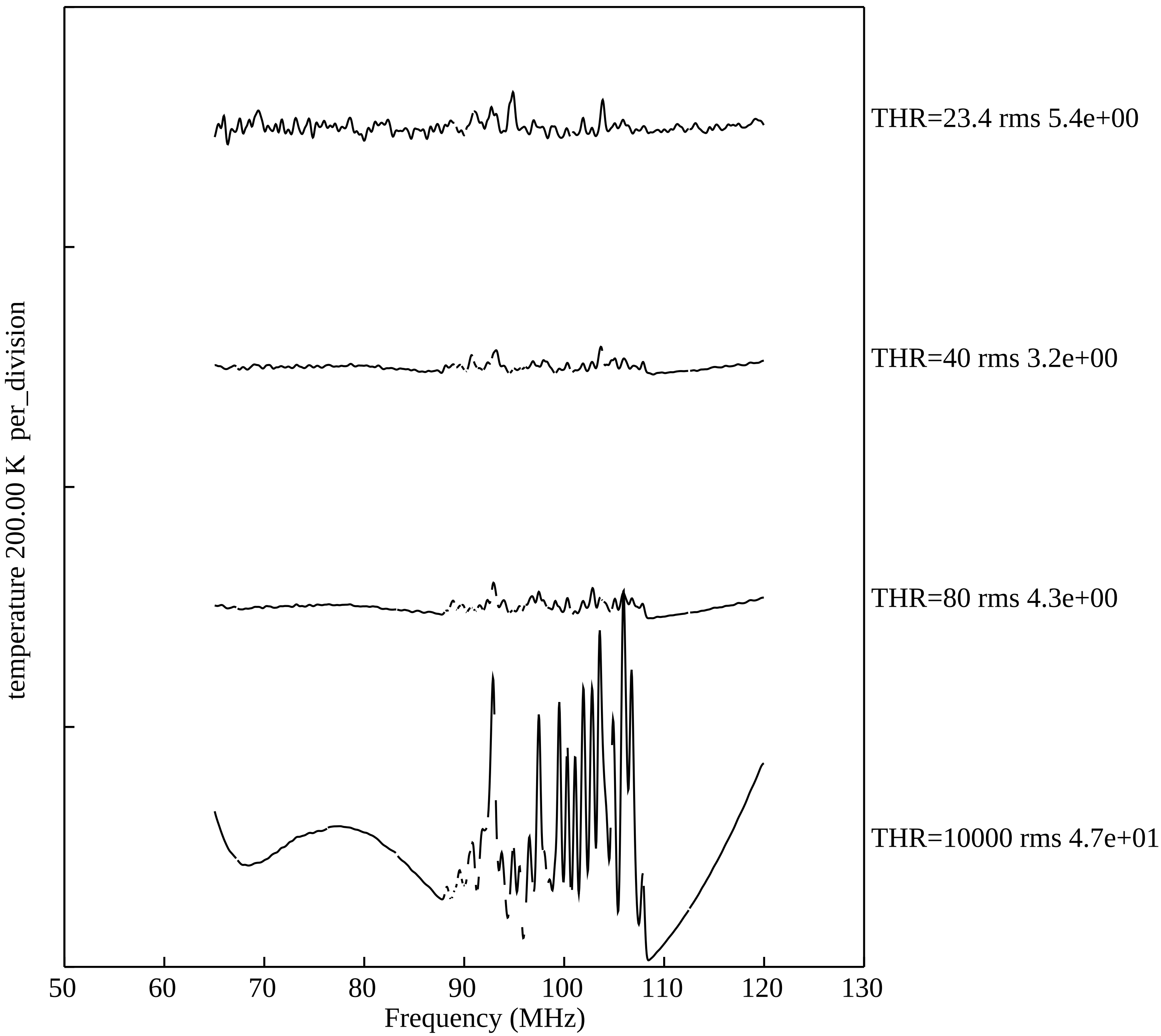

Figure 1. Average of 2s data blocks after setting the different thresholds.

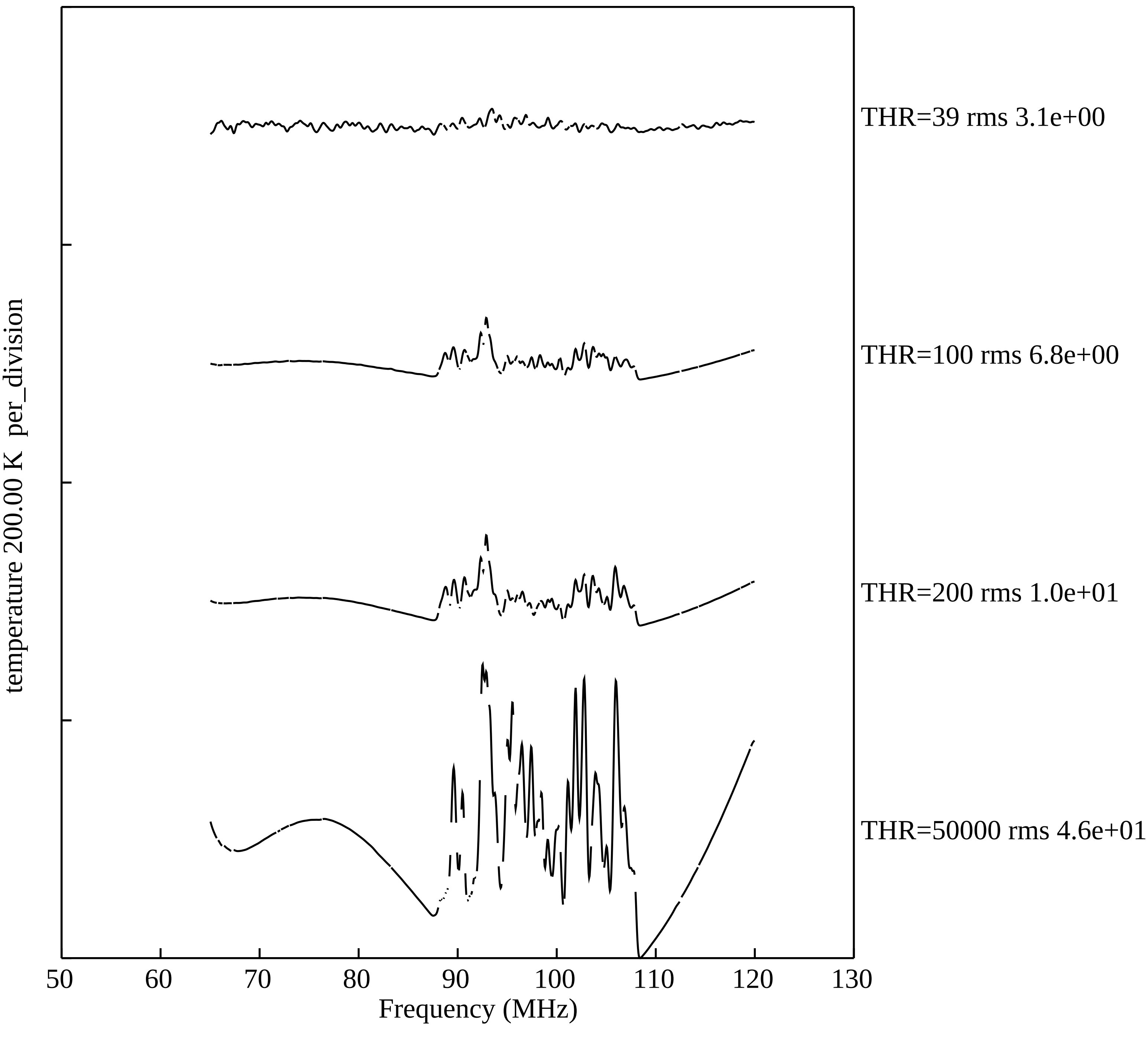

Figure 2. Average of 8s data blocks.

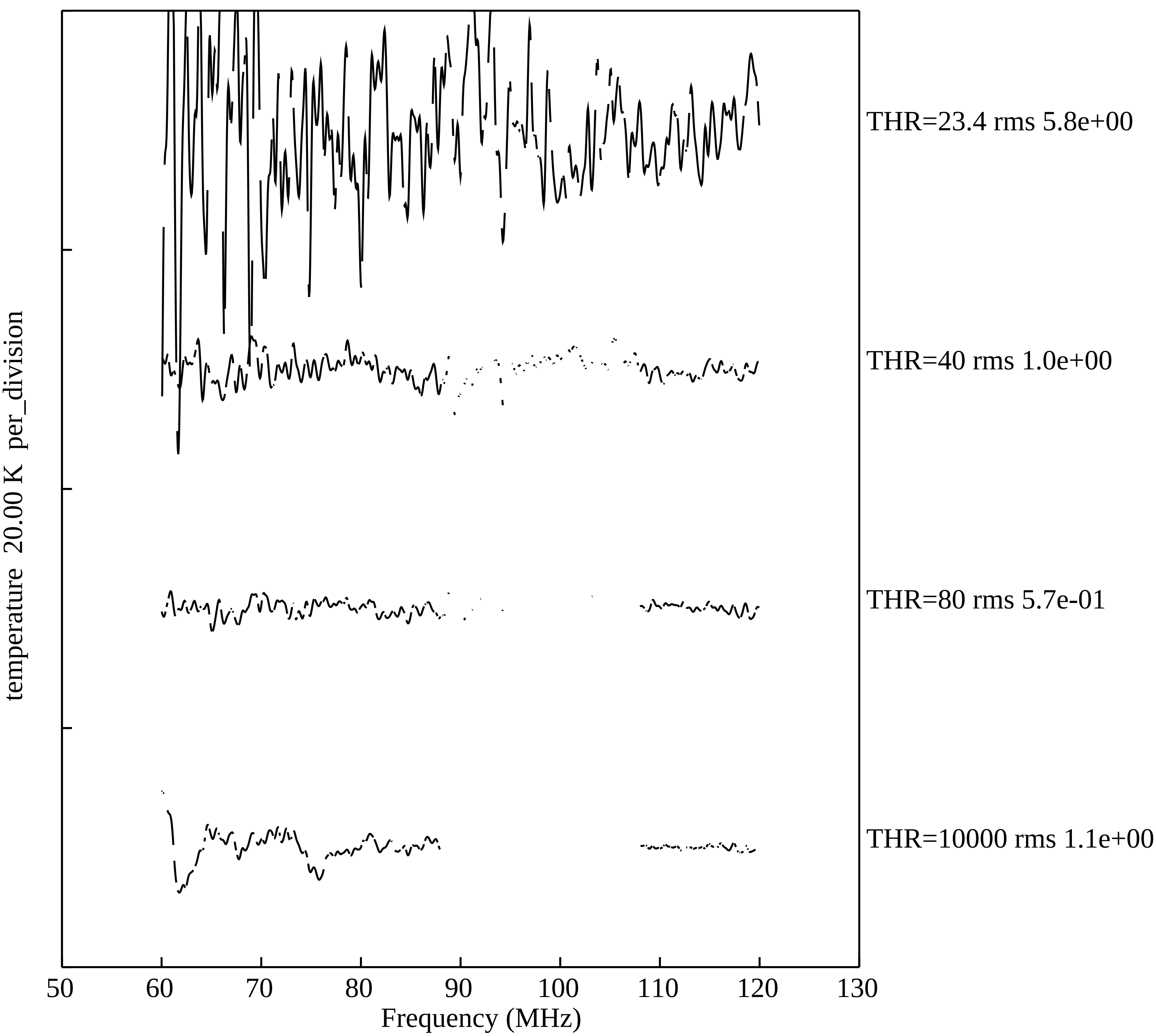

Figure 3. Average of 2 s data blocks with spectral channel deletions.

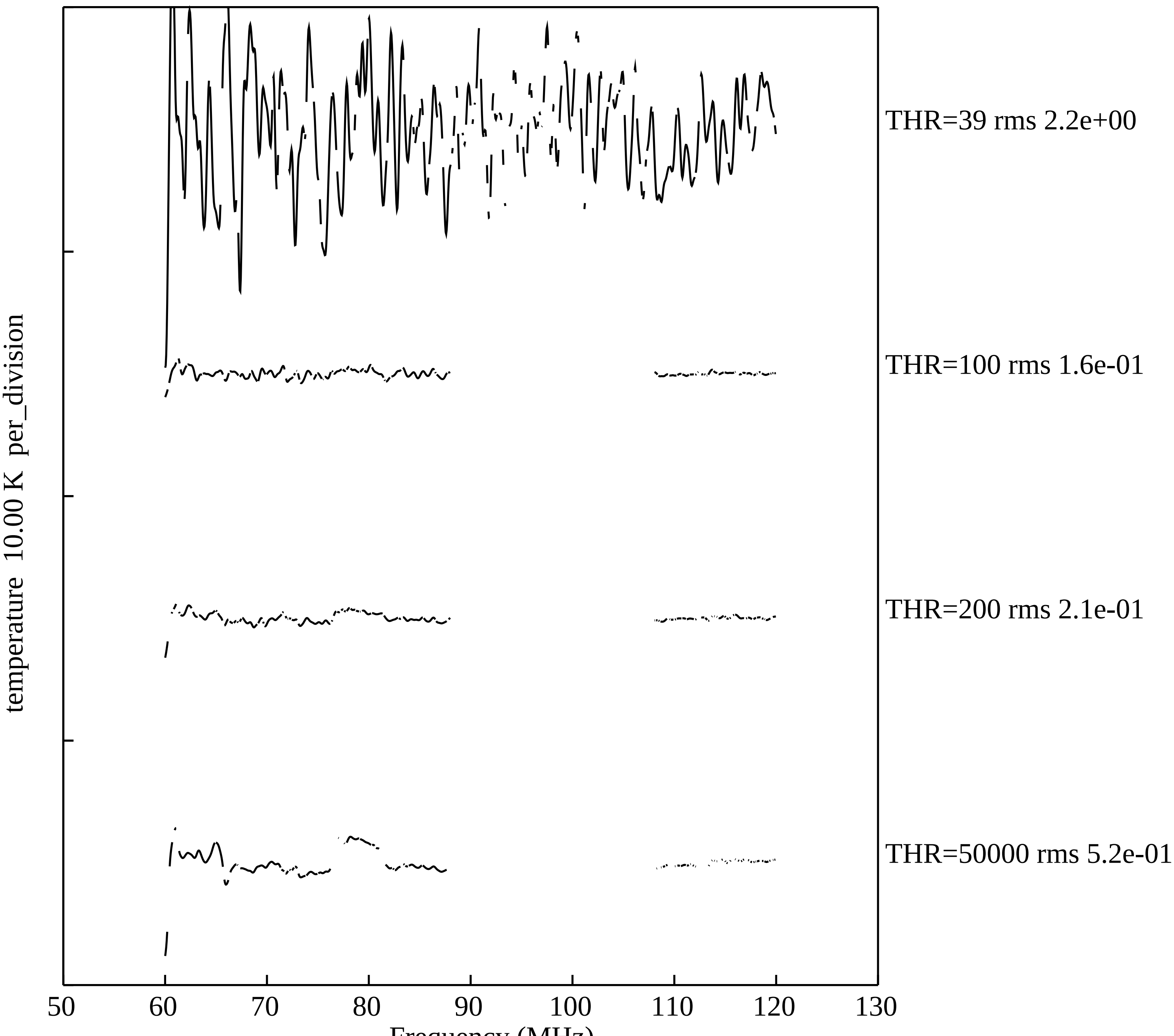

Figure 4. Average of 8 s data with spectral channel deletions.

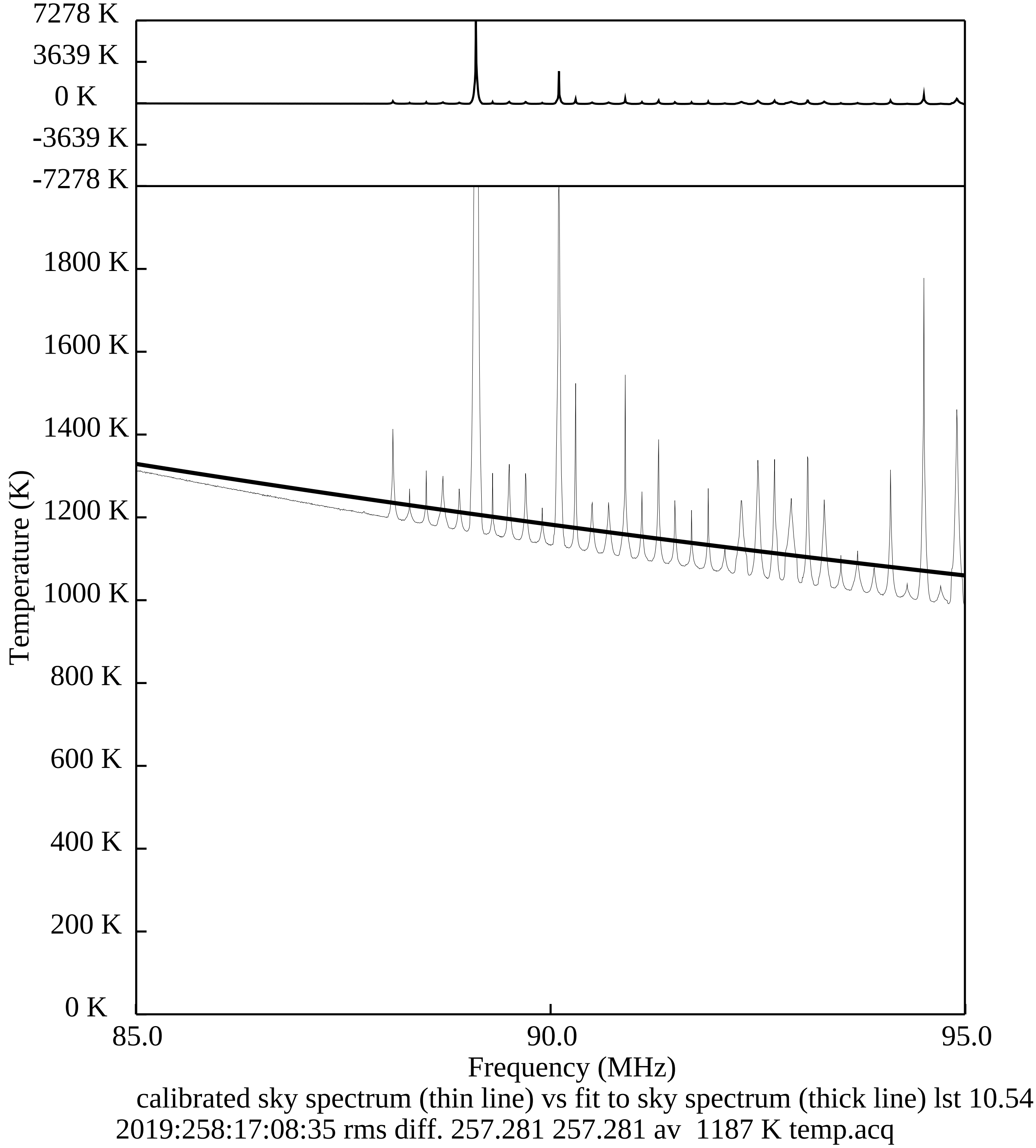

Figure 5. FM with only 3-position switch cycle exclusion without smoothing.

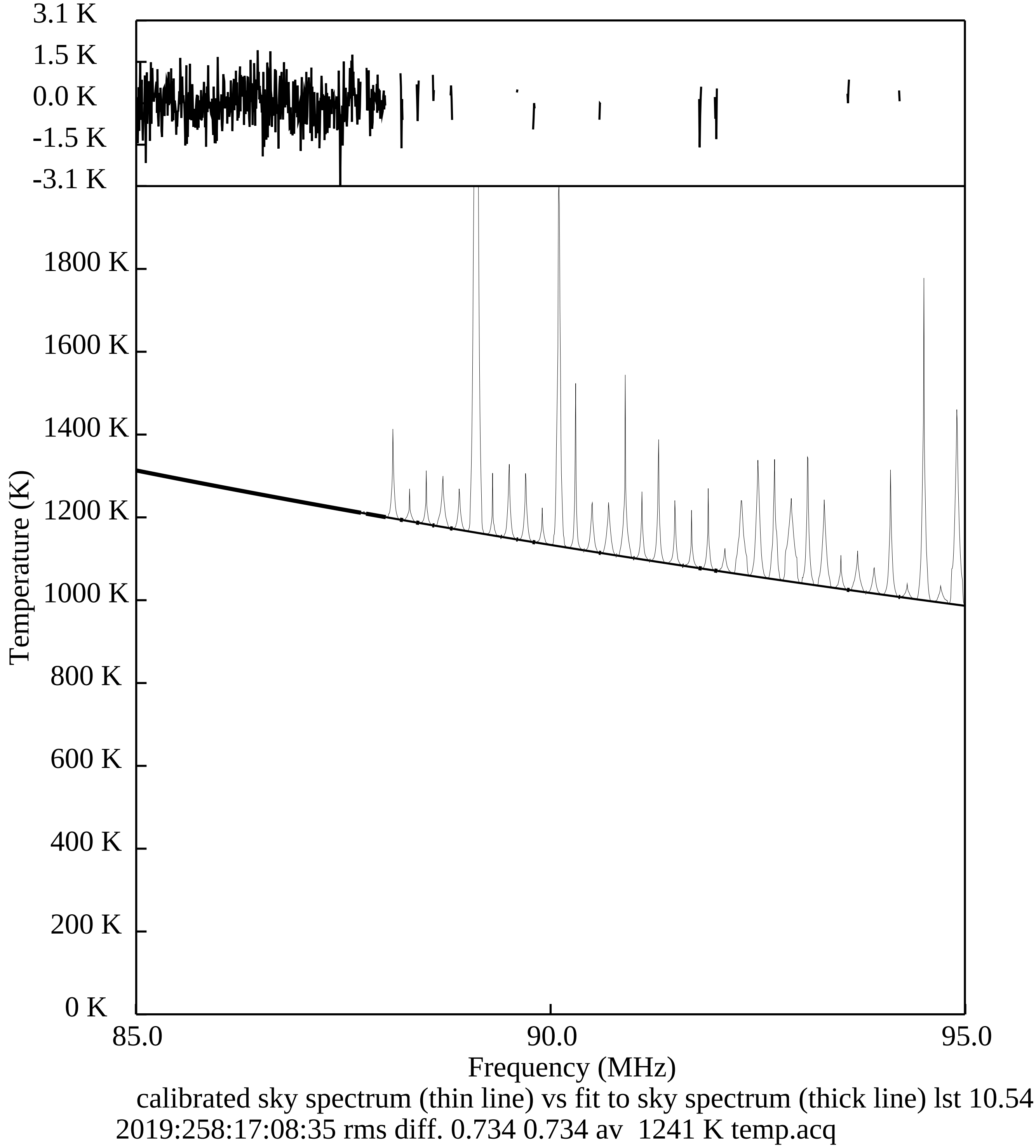

Figure 6. FM with frequency channel exclusion.