EDGES MEMO #455

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To: EDGES group

From: Alan E.E. Rogers

Subject: The effects solar emissions on the global 21-cm data

The effects thought to be related to the sun were first reported in memo 438 and were thought to be the result of scintillation. It was noted that there was an occasional peak at 65 MHz and it was seen to increase in strength on shorter integration implying that the feature is short lived like in a scintillation. A solar flare on 31 December 2023 was analyzed in memo 439 and some bumps in the solar spectrum at the level of a few thousand Kelvin are seen in the plots in figure 2 of this memo but no connection was made with the peak at 65 MHz.

Memos 450 through 454 have studied the origin of the peak at 65 MHz and concluded that it is related to the increased solar activity as we climb to the peak of the solar cycle and the solution for the global 21-cm data is to avoid using data when the sun's elevation is above -20 degrees elevation at least for data taken since day 200 of 2023.

Figure 1 shows the analysis of the solar burst on 5 August 2024 at 05:23 UT which shows that in one 3-position switch cycle there is a very strong relatively narrow peak a 60 MHz. The peak is about one million deg K which suggests that the emission might be from an electron cyclotron maser as discussed in White et al. 2024.

Figure 2 shows the analysis of a solar burst on 1 September 2023 at 03:24 UT which shows a peak at 60 MHz which is only about ten thousand K which is a factor of a hundred times weaker the burst on 5 August 2024. This is shown for comparison at an earlier time in the solar cycle when the feature at 65 MHz shown in figure 5 of memo 544 was not being detected. Figure 3 shows the waterfall plot of the burst on 1 September 2023. Solar bursts in 2023 were far less frequent than in 2024.

Tests of the use of the data for extracting the best fit of the global 21-cm absorption spectrum with 5-loglog terms removed and a fixed value of tau = 4 were made with data from 2023 day 363 to 2024 day 215 were made with limits of the sun's elevation are given in the table below:

Center frequency MHz	SNR	sig degK	width MHz	rmsin mK	rms degK	Sun limit deg
79.7	43.7	0.63	19.8	105	20	-30
79.3	41.8	0.63	20.3	93	20	-20
78.9	38.3	0.63	20.9	86	20	-15
78.5	30.5	0.64	21.8	79	24	-10
78.1	28.4	0.64	22.5	74	25	-5
77.7	25.0	0.64	23.4	69	27	0

Table 1. Results of a grid search for 21-cm absorption 1 hour blocks of GHA 6-18 hours

Figure 4 shows the results of the first case in table 1 for a grid search for the 21-cm absorption using data from 2023 day 363 to 2024 day 215 in 1 hour blocks of GHA from 6 to 18 hours. 5 loglog terms are removed with tau = 4.

In summary the best result is for limiting the data to the Sun elevation of -30 degrees is shown in Figure 4 but this case is only marginally better than a limit of -20 degrees.

References: White, S.M., Shimojo, M., Iwai, K., Bastian, T.S., Fleishman, G.D., Gary, D.E., Magdalenic, J. and Vourlidas, A., 2024. Electron Cyclotron Maser Emission and the Brightest Solar Radio Bursts. *arXiv preprint arXiv:2405.01755*

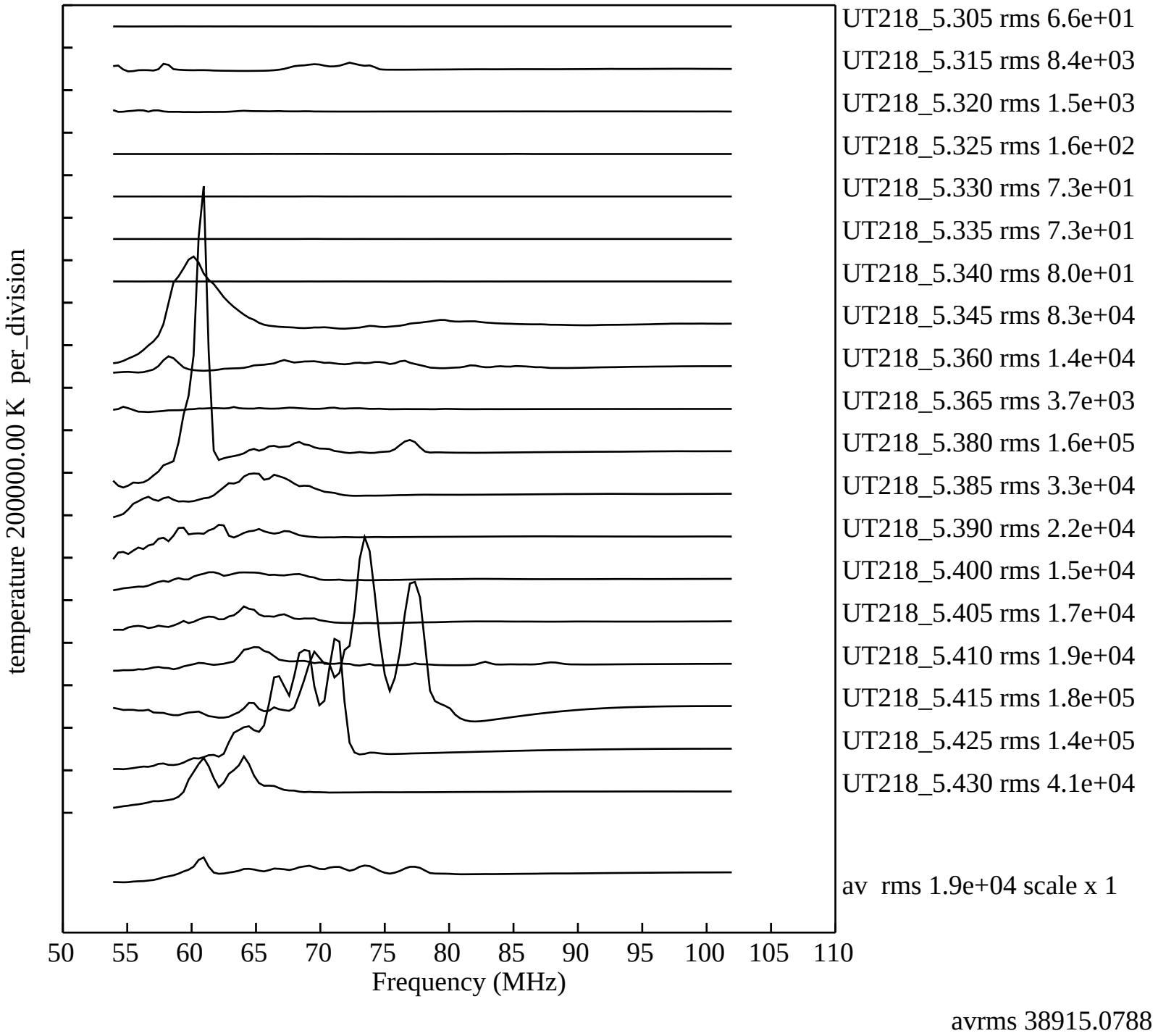

Figure 1. Solar burst spectrum of 5 August 2024 vs each 3-position switch cycle 3-terms removed

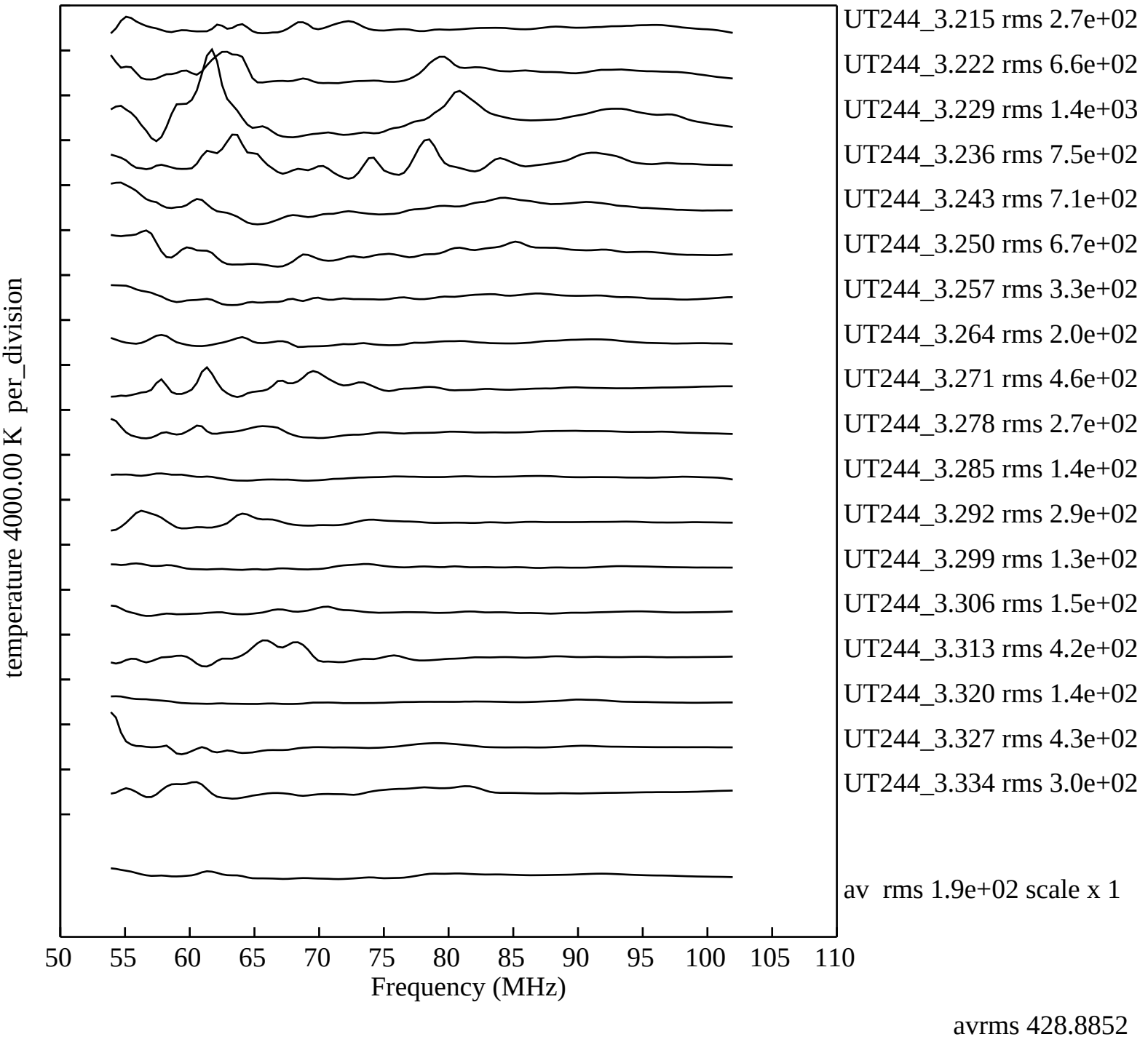

Figure 2. Solar burst spectrum of 1 September 2023 vs each 3-position switch cycle 3-terms removed

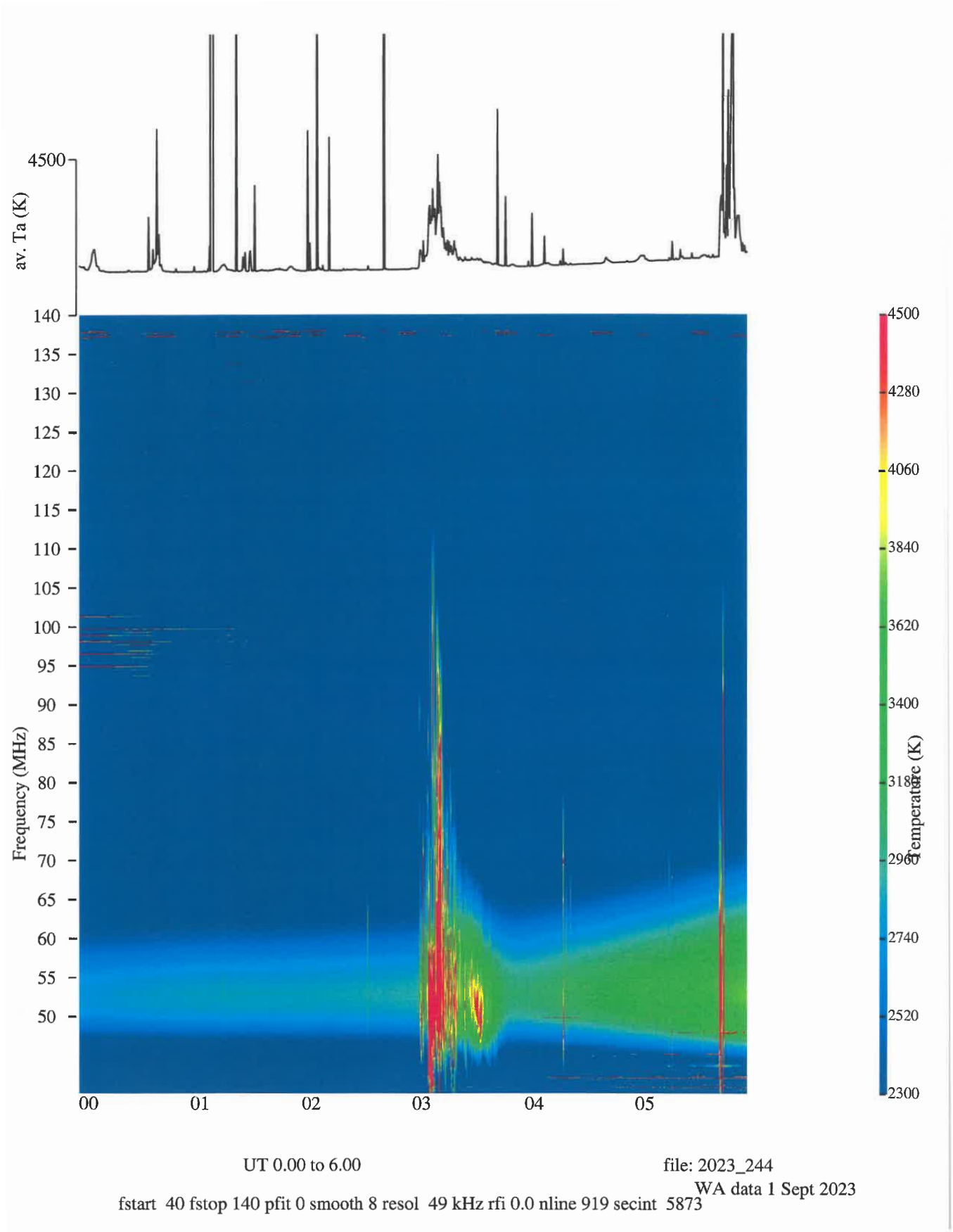

Figure 3. Waterfall plot of Solar burst spectrum of 1 September 2023 from WA

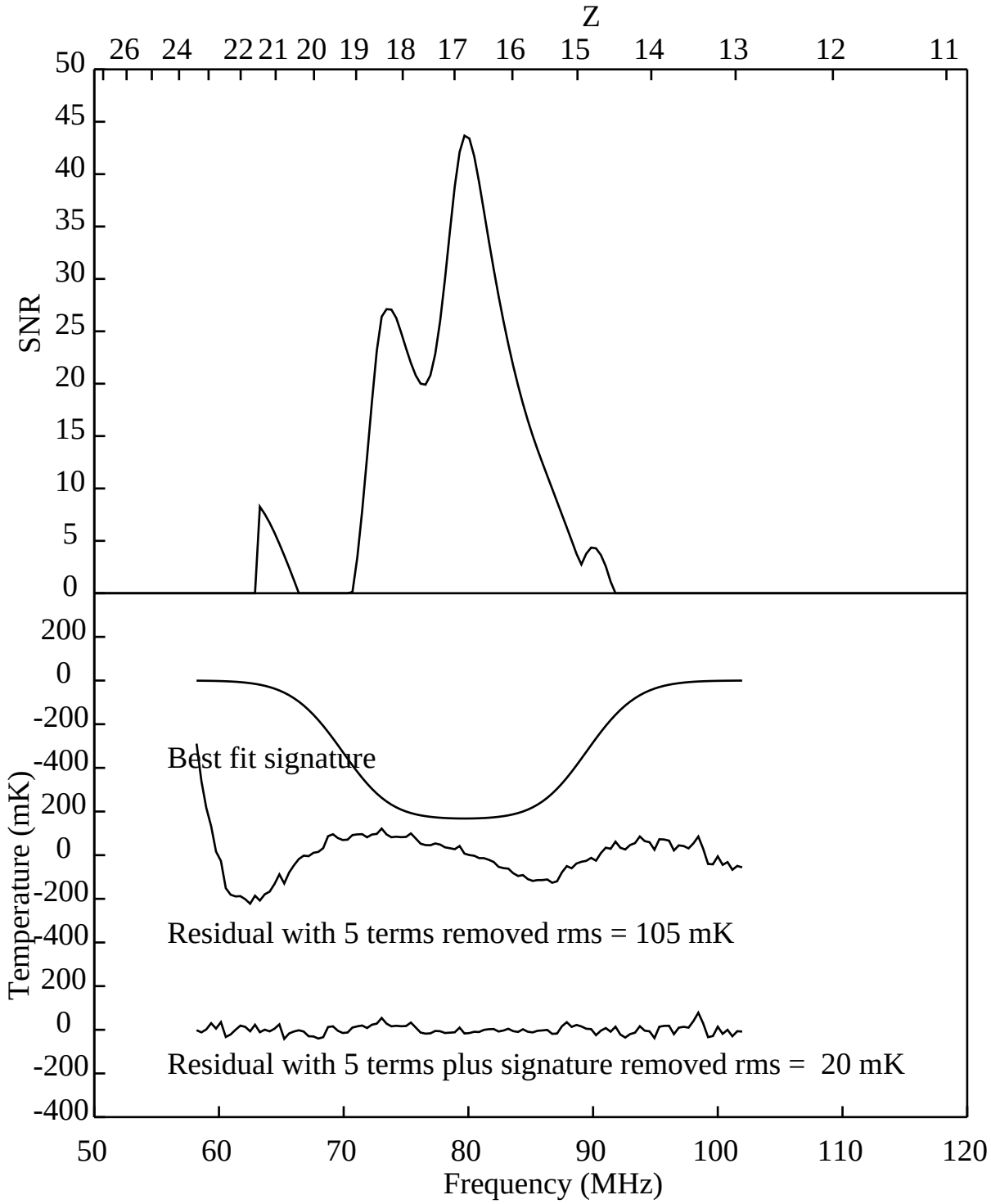

Figure 4. Grid search plots of the first case in table 1 using a sun elevation limit of -30 degrees