EDGES MEMO #330

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
HAYSTACK OBSERVATORY
WESTFORD, MASSACHUSETTS 01886

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Telephone: 617-715-5571
Fax: 617-715-0590

To: EDGES group

From: Alan E.E. Rogers

Subject: A preliminary analysis of the lowband-2 data with the antenna oriented at azimuth of 42 deg on the low-2 perforated ground plane. The receiver 2 was installed in February as described in memo 326.

The receiver calibration is described in ASU memo 163.

An independent calibration processing was made using the data from spectra and S11 data from Receiver02_2019_12_10_040_to_200_25C and the results are shown in Figure 1.

Figure 2 shows the residuals to a 5-term LinLog fit to the spectra averaged over 12 hours centered at GHA = 12 hrs each day.

Figure 3 shows the residuals to an average of 2 hour data blocks for all days shown in Figure 2 centered at different GHA. In this case the residuals are to 5 physical terms which should result in less structure than seen in Figure 3 . An empirical search was made the cause of what appears to be the result of a poor calibration or error in the antenna S11 measurement in the field.

Figure 4 shows the result of applying a 0.5 dB reduction of the LNA S11. Test of applying a small constant reduction of 0.1 dB in the antenna S11 yielded a much smaller improvement so a possible explanation might be that the LNA's S11 changed between the lab and the field.

The LNA S11 measurement accuracy was checked using the calibration data by comparing the rms residuals of the simulators and the open and shorted cables in a grid search for a minimum. Table 1 shows the S11 offset that minimizes the rms.

open	short	Simulator 2	Simulator 3
-0.7 dB	0.1 dB	-0.1 dB	0.1 dB

Apart from open cable result, which is the outlier. these results do not confirm a -0.5 dB offset and suggest the LNA S11 must have changed between the lab and the field.

A 0.5 dB error in the LNA S11 changes the lab simulator2 and simulator3 rms by only few mK out of 60 mK. It may take simulator based on a noise source and cable to make a better check of the LNA S11 via the simulator cross-checks.

For comparison Figure 5 shows the residuals for an average of 2 hour blocks from all days of the 2017 low1 data in the same range of day numbers. Clearly low1 data shows much less change with GHA.

Despite the poor calibration of the low2 data an absorption consistent can be obtained from data averaged over a GHA range from 6 to 18 hours for all days and is shown in Figure 6. The dependence of the absorption results from the low-2 data from 2020 days 55 to 99 averaged in 2 hour blocks centered at different values of GHA are listed in Table 2. A grid search in center frequency and width was made to find the best fit absorption for a fixed value of flattening parameter tau = 7 using 5-terms of physical parameters to fit the foreground. Results in reasonable agreement with the result in the Nature paper are obtained for GHA centered at 04 hours through 16 hours. The rms in the second to the last column is the rms obtained without fitting an absorption in a 6-th term and the last column is the rms residual to the

best fit. With this data and the limitations of the poor calibration discussed above it was not possible to obtain a reasonable absorption result owing to the high level of noise plus systematics in the foreground fit.

GHA hours	Center MHZ	SNR	Amplitude K	Width MHz	rms mK	rms mK
00	-	-	-	-	354	-
02	-	-	-	-	353	-
04	75.0	15.9	0.68	13.8	194	110
06	78.1	14.3	0.51	17.2	114	69
08	78.1	17.9	0.49	18.0	95	49
10	78.9	21.0	0.56	19.1	89	41
12	78.5	15.5	0.62	18.7	95	53
14	78.9	20.3	0.66	17.8	84	37
16	78.5	15.2	0.68	18.1	98	56
18	-	-	-	-	152	-
20	-	-	-	-	210	-
22	-	-	-	-	337	-

Table 2. The result of grid searches for 21-cm absorption as a function of GHA

A plot of the result for GHA = 8 hours is shown in Figure 7.

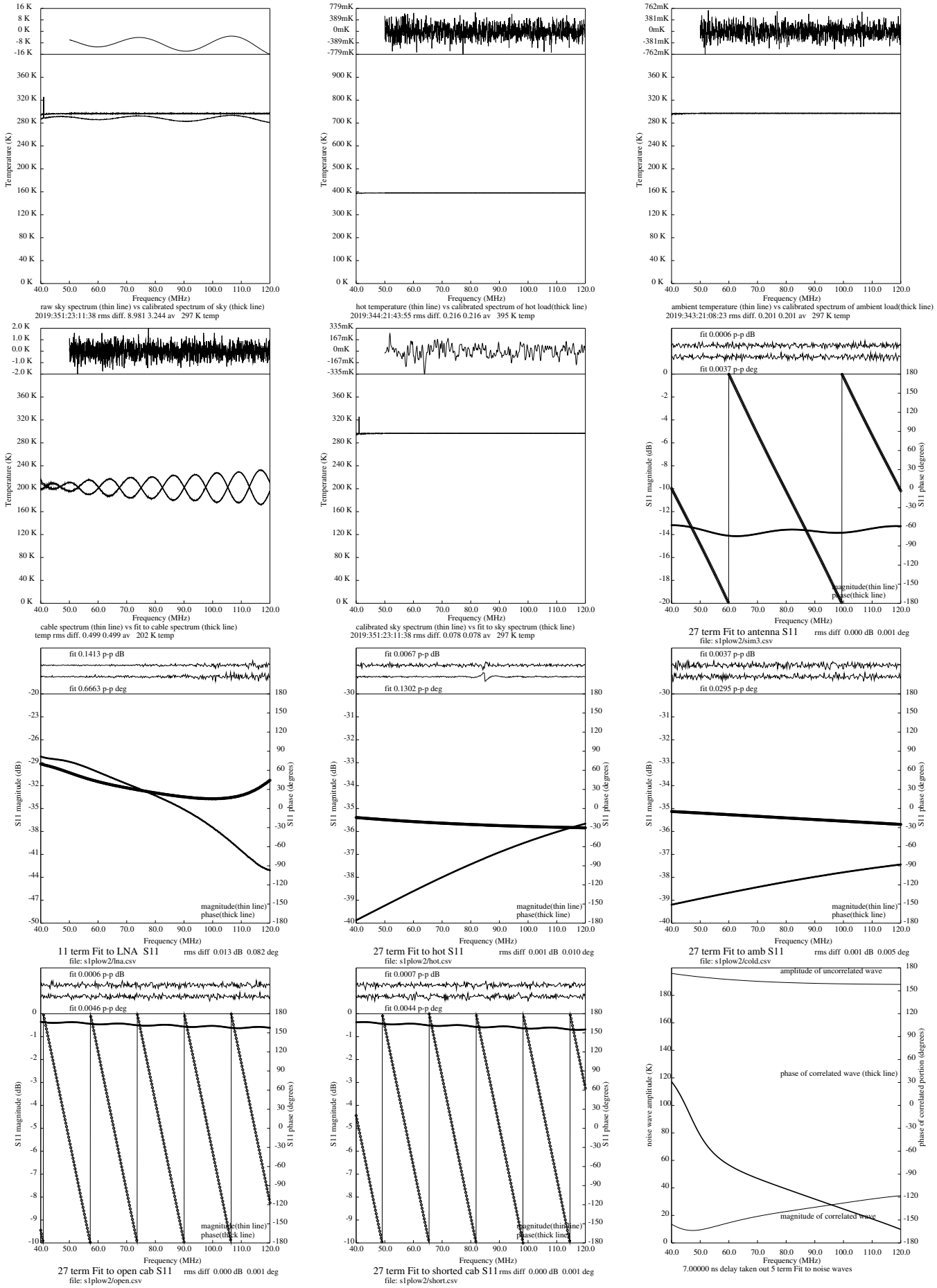


Figure 1. Plots of the Calibration using data from Receiver02_2019_12_10 at 25C

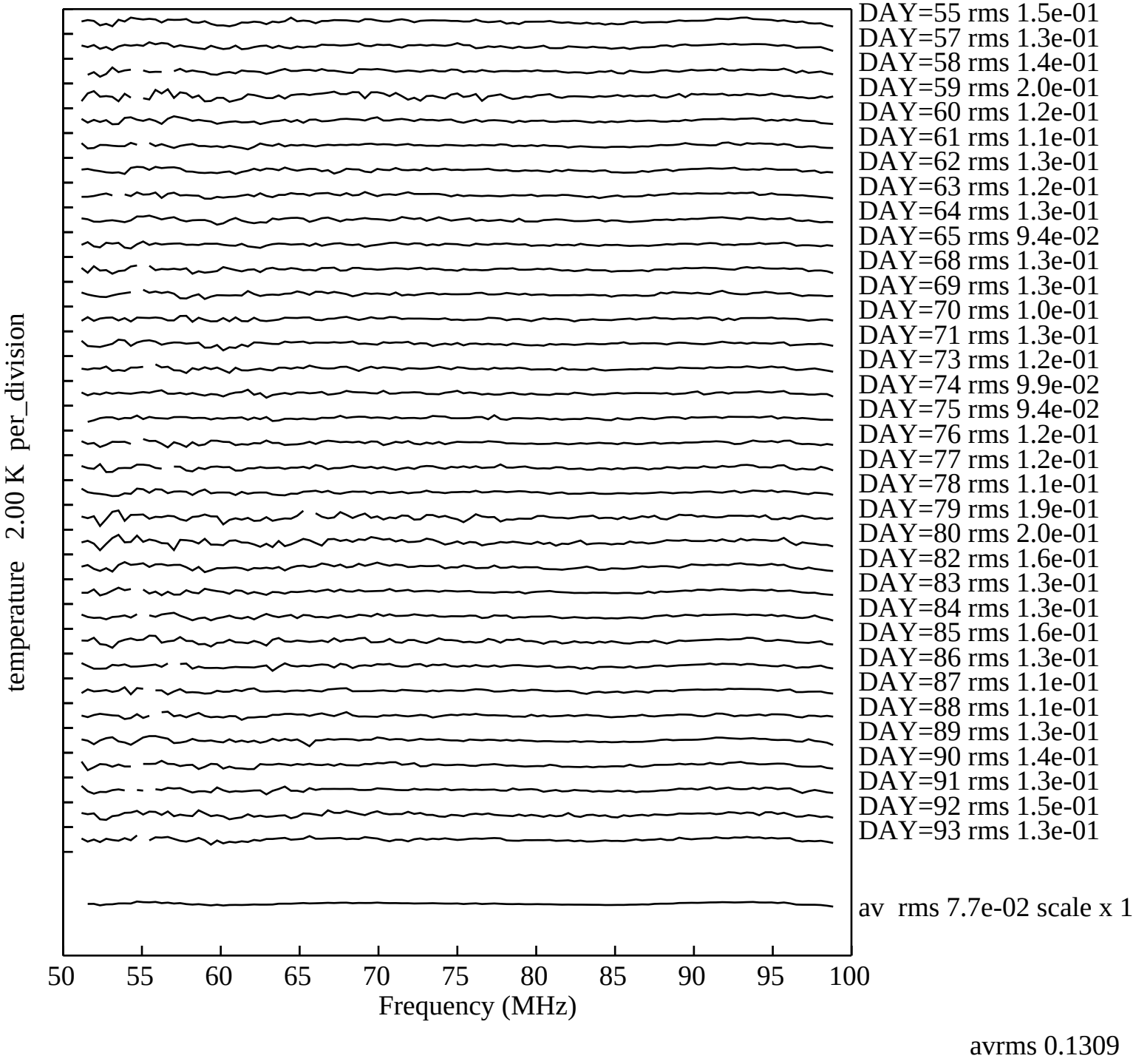


Figure 2. Residuals to a 5-term LinLog fit to spectra averaged over 12 hours centered at GHA = 12h.

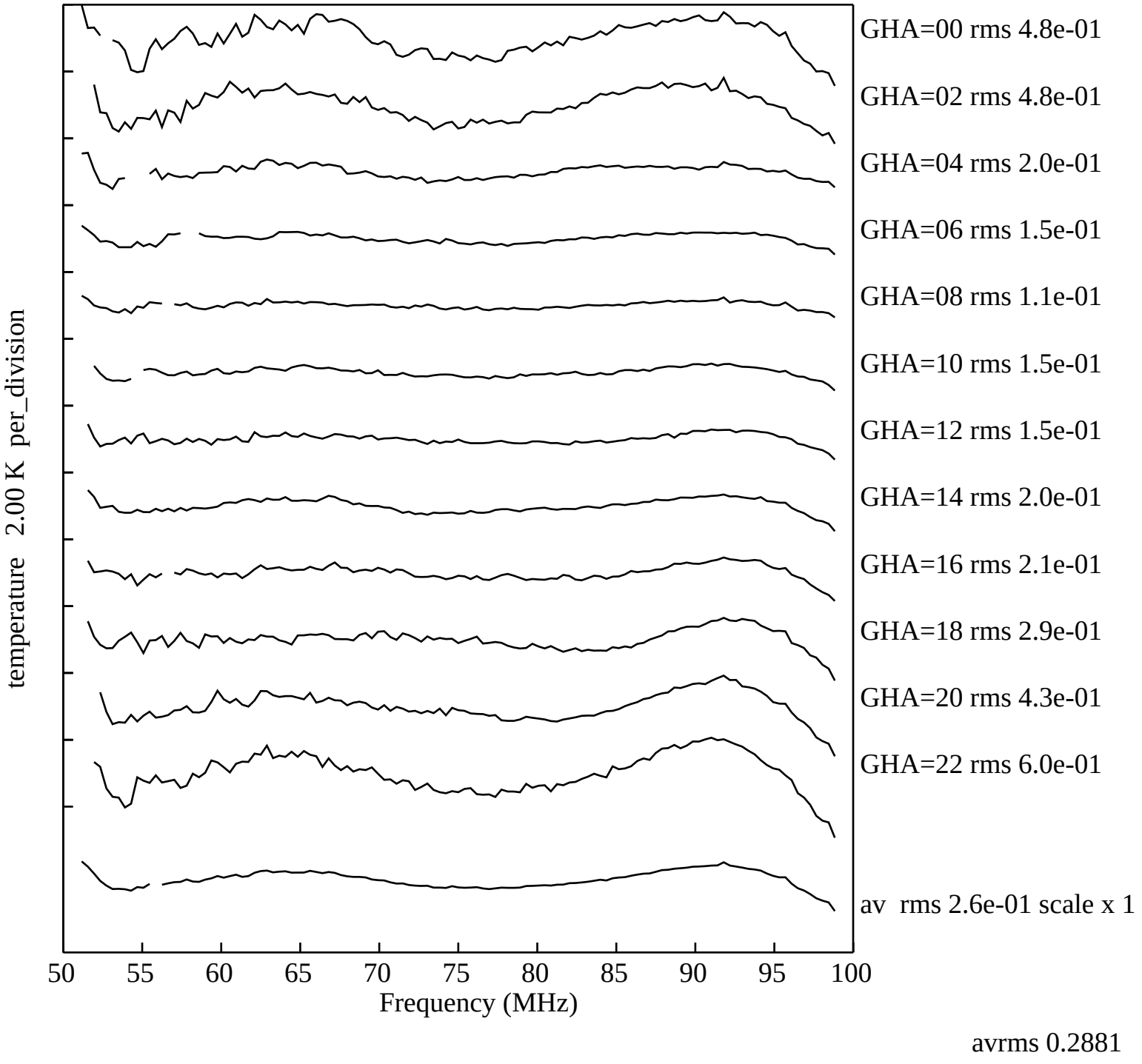


Figure 3. Residuals from an average of 2 hour blocks from all days for the range of GHA

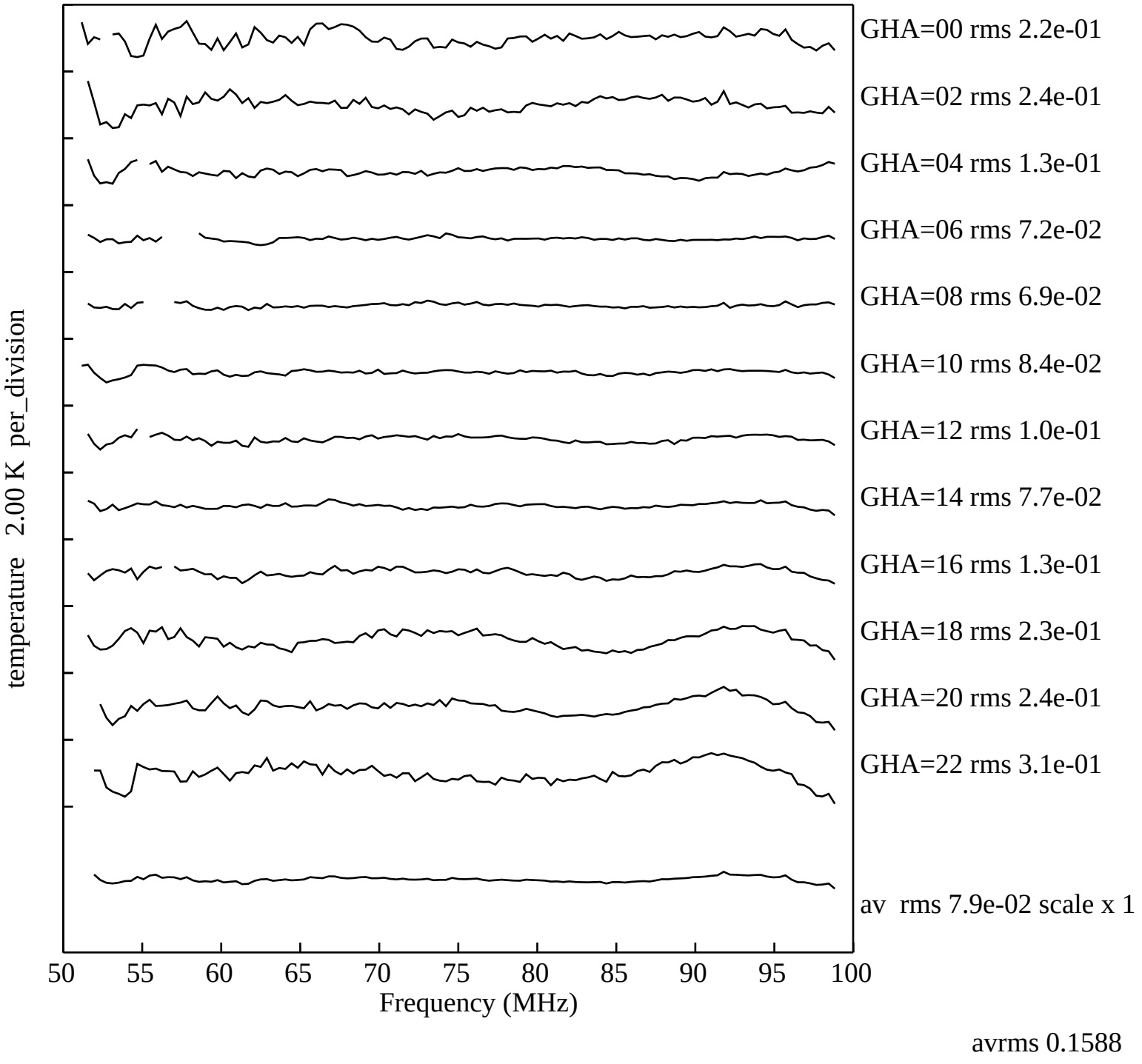


Figure 4. The result of applying an offset in the 0.5 dB in the LNA S11 as a possible cause of the structure seen in Figure 3.

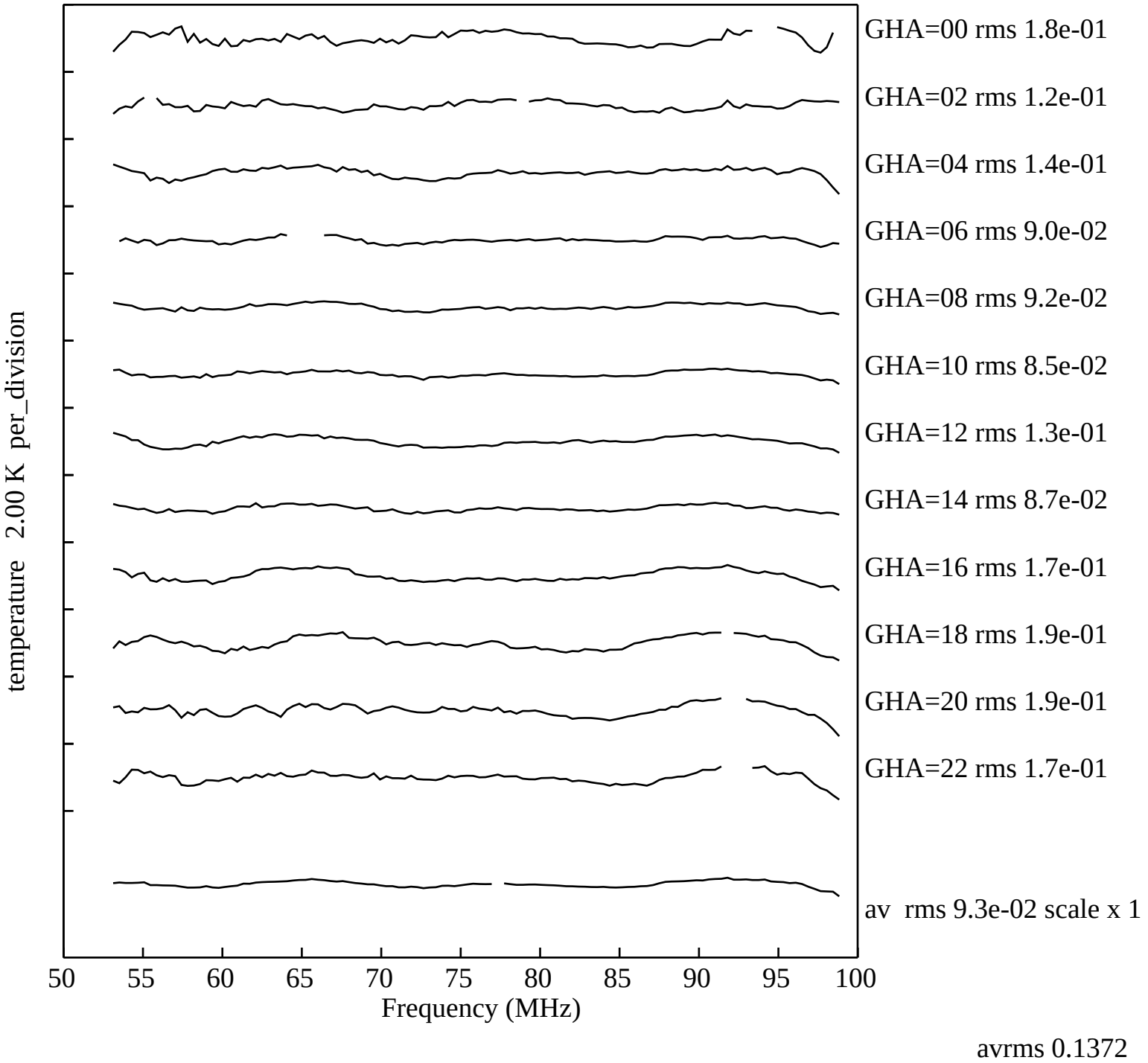
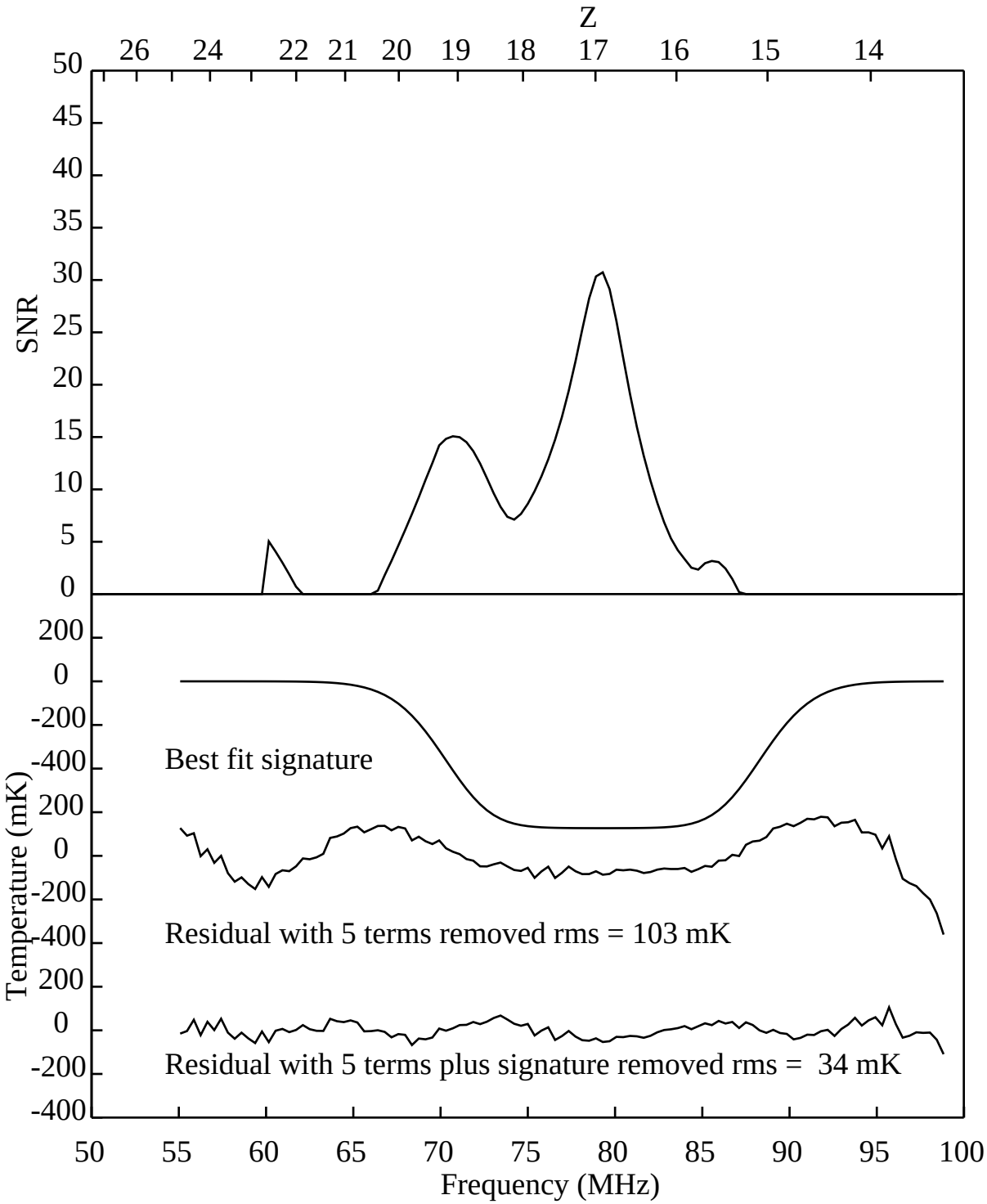
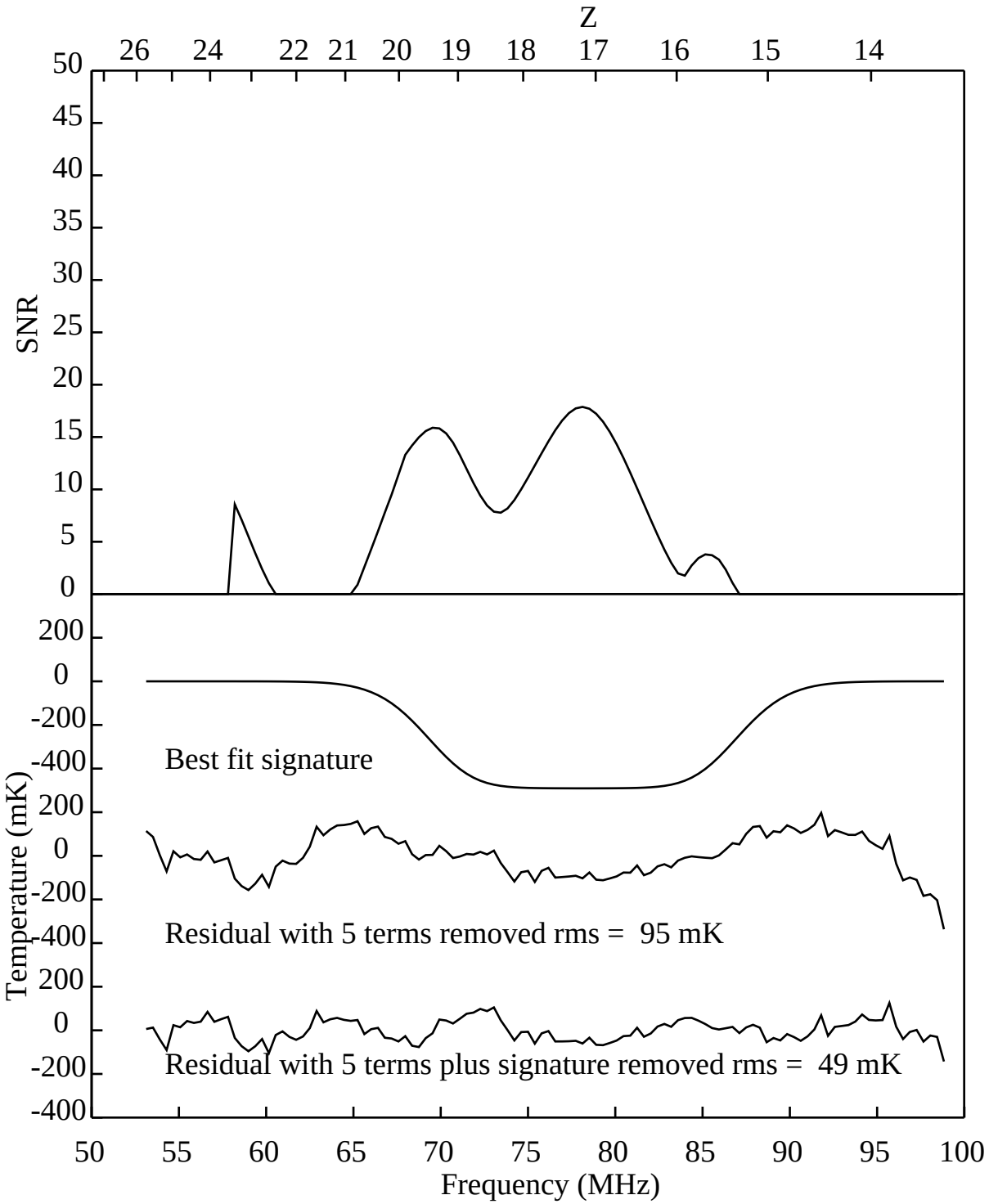


Figure 5. Residuals from an average of 2 hour blocks from all days in the same range on day numbers in low1 data from 2017.



freq 79.3 snr 30.7 sig 0.67 wid 18.40 tau 7 rmsin 0.1029 rms 0.0336 55 - 99

Figure 6. Absorption grid search for data averaged from 6 to 18 hours GHA for all days up to 2020 092.



freq 78.1 snr 17.9 sig 0.49 wid 18.00 tau 7 rmsin 0.0946 rms 0.0491 53 - 99

Figure 7. A plot of the grid search for GHA = 08 hours listed in Table 2