EDGES MEMO #467

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To: EDGES group

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Subject: Comparison of the solar bursts from late 2023 and late 2024

Occasional "bumps" at 65 MHz in the EDGES-3 data from WA were first noticed in December of 2023. An example is shown in figure 1 of memo 438 which shows the bump of about 3K on day 364 at 18 hours GHA. This bump has become more prominent in 2024 and it was noted that occasional bursts from the sun like the one shown in figure 1 of memo 449 on day 156 produced a very strong bump of 200 K at 65 MHz shown in the spectrum in figure 2 of memo 449. While it was initially thought that the 65 MHz signal was from scintillation it became clear that the sun was the more likely source. Marqué et al. reported in 2018 that strong solar emission with fine spectral structure have been observed from the sun and even seen when the sun is below the horizon. At 65 MHz the solar emissions can be scattered by the F layer of the ionosphere which at 500 km above the EDGES-3 antenna is line of sight to the sun at 20.5 deg below the horizon at the site of the antenna. Using simple geometry the path of a burst from the sun via the F layer to the zenith of the antenna from region of high electron content with radius of 10 km which scatters the solar burst isotropically is expected to return a signal about 40 dB lower than a direct path from the sun at the zenith.

Figure 1 shows a bump in the data from 2024 day 355 to 2025 day 4 averaged over the time range for which the sun's elevation seen by EDGES is from the horizon to 20 degrees below the horizon. For comparison Figure 2 shows the same days from 2023 to 2024 and raises the question has the bump become much stronger in late 2024 or have the solar bursts just become more frequent in late 2024 ? This question can be answered by looking at the example of a single burst on day 300 of 2023 in Figure 3 which shows that when analyzed on the time scale of 36 seconds the burst strength from the sun below the horizon is 20 K lasts for only about 4 minutes and averages down to about 10 K on the time scale of 9 minutes averaged in the spectra shown in Figure 3. Then there is only one solar burst of this strength in a one hour block its strength will be only about 1 K.

Figure 4 shows the spectra from 1 January 2025 with 6 minute averages of 1K or more and with the sun below the horizon. With the threshold of 1K which is above the rms noise and has the rms of the average of 0.76K which is the same the rms of the average of the rms of 0.76K for 2025_001 in figure 1. There are several bursts present in figure 4 which have a peak of about 5K averaged over 6 minutes which averaged over a duration of about 1 hour that the sun's elevation is between -20 to 0 degrees in figure 1 average to about 4K. This result is consistent with the hypothesis that the apparent increase in strength of the peak at about 65 MHz shown in figure 1 of memo 450 is due to an increase in the occurrence of the type 3 solar bursts.

Using the e-Callisto data from 2010 to 2017 Ndacyayisenga et al. show the number of type 3 solar bursts per month detected by the ASSA site near Adelaide Australia increases from 25 per month to 200 per month at the peak of the solar cycle 24 in 2014. In comparison the solar cycle 25 has a higher occurrence of type 3 solar bursts than in cycle 24. This makes the increased strength of the 65 MHz

bumps between 2023 and 2024 shown in memo 454 likely to be the result of an increased occurrence of the type 3 bursts.

References:

Marqué, C., Klein, K.L., Monstein, C., Opgenoorth, H., Pulkkinen, A., Buchert, S., Krucker, S., Van Hoof, R. and Thulesen, P., 2018. Solar radio emission as a disturbance of aeronautical radionavigation. *Journal of Space Weather and Space Climate*, *8*, p.A42.

Ndacyayisenga, T., Uwamahoro, J., Raja, K.S. and Monstein, C., 2021. A statistical study of solar radio Type III bursts and space weather implication. *Advances in Space Research*, *67*(4), pp.1425-1435.

Figure 1. Variation of feature at 63 MHz averaged over sun elevation -20 to 0 degrees

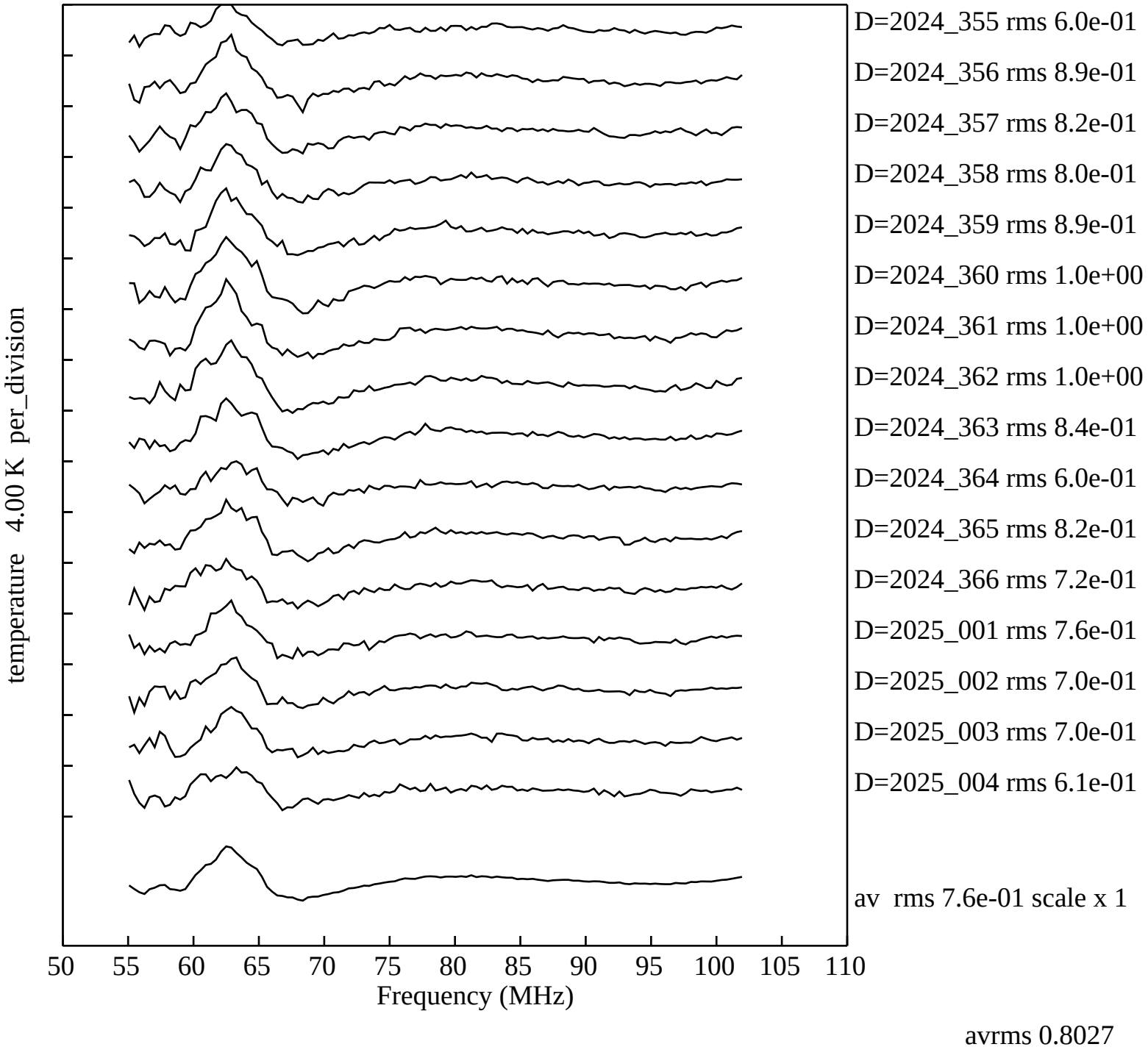
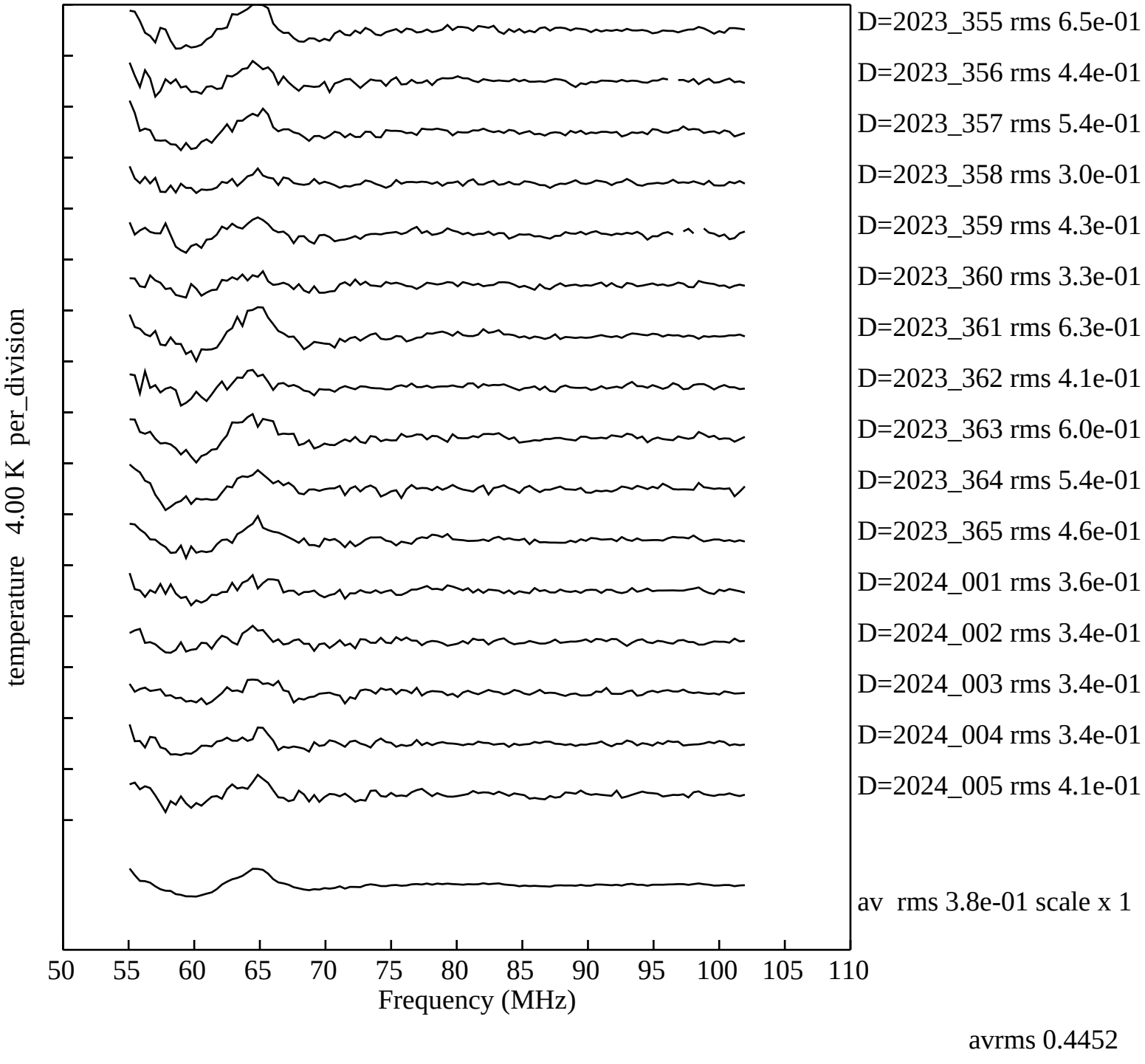


Figure 2. same as figure 1 using data from one year earlier



avrms 0.4452

Figure 3. Solar burst on 2023 day 300 with sun elevation -7 deg using 36 second integrations

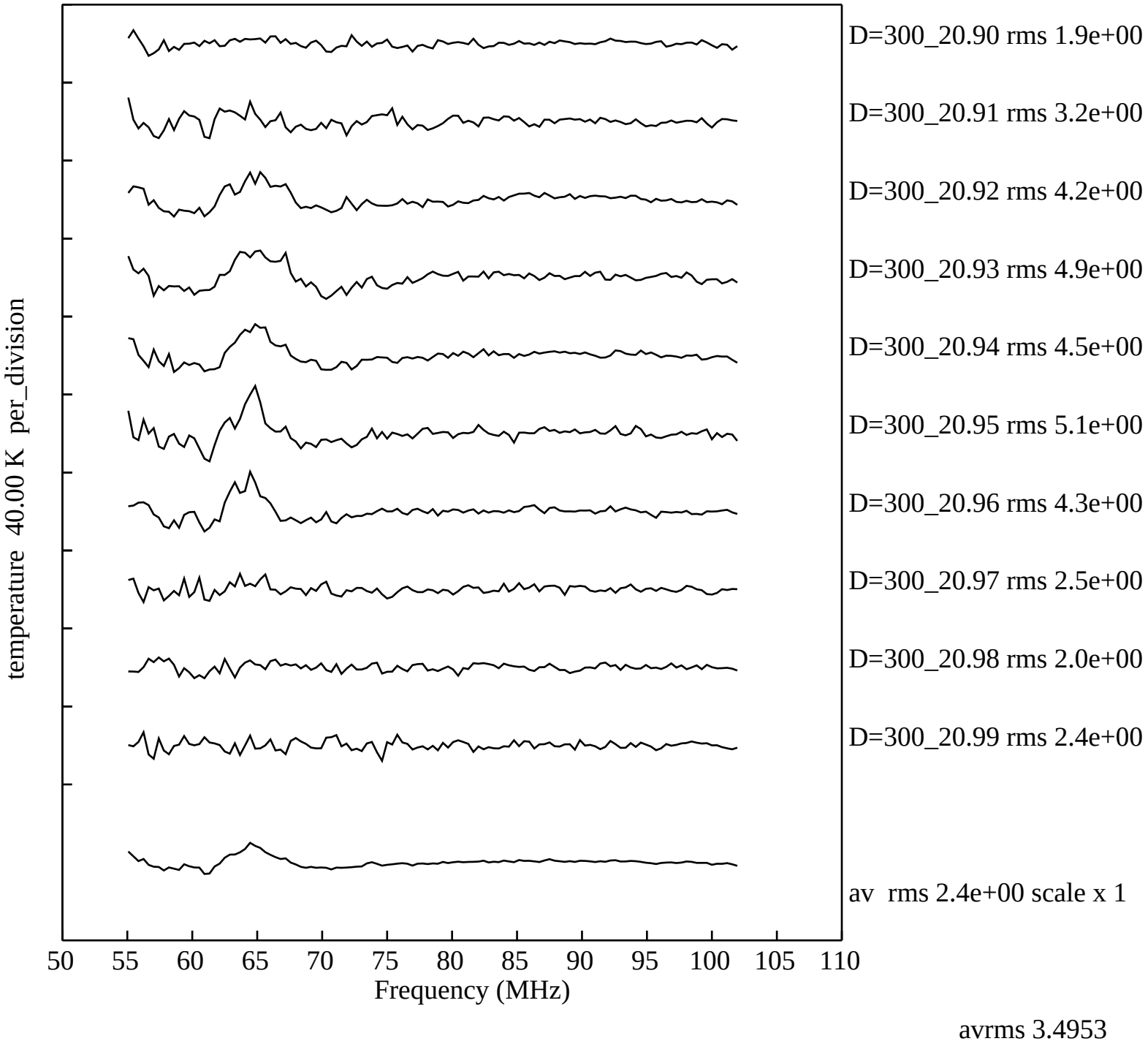


Figure 4. Spectra from 1 January 2025 using 6 minute averages with rms greater than 1K