EDGES MEMO #452

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
HAYSTACK OBSERVATORY
WESTFORD, MASSACHUSETTS 01886

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Telephone: 617-715-5533

To: EDGES group

From: Alan E.E. Rogers

Subject: Further analysis to aid in determination of the origin of the peak at 65 MHz

A study of a peak at about 65 MHz in the EDGES-3 data was first studied in memo 438 and thought to be from scintillations although peaks around 60 MHz in memo 403 were attributed to distant lightning and the source of the peak at 65 MHz seen in the test deployment in Oregon described in memo 306 was not identified. A resonance at 60 MHz was seen in memo 421 but this changed in frequency and was only present from GHA 4 to 6 hours. Some strong peaks at 65 MHz were seen in figures 1 and 2 of memo 449 and these strengthened the case for the peak at 65 MHz being from scintillations until a study in memo 451 showed that the bump at 65 MHz was absent when the sun was more than -18 degrees below the horizon. In addition it was seen that while the amplitude of the peak made very large changes on time scales a minute it was relatively constant when averaged over an hour as long as the extreme events, like the one in figure 2 of memo 451, are filtered out.

In order to look back in time I averaged the data from day 305 to 345 of 2023 which shows in Figure 1 that the strength of the bump at 65 MHz starts to rise when the sun is 18 degrees below the horizon declines during the day and is gone when the sun is more than 17 degrees below the horizon in Figure 2. Figure 3 shows the average spectra in one hour blocks of local time to show the asymmetry between sunrise and sunset in one plot. While from days 135 to 180 of 2024 the rise and set in figures 4 and 5 of memo 451 are more symmetrical.

A solar burst from 3 July 2024 is shown in the waterfall plot of Figure 4 and produces the large signal at 80 MHz in Figure 5 drifts down in frequency to 60 MHz over 4.2 minutes which is a drift rate of 0.12 MHz/sec. This slow drift rate is typical of type 2 solar bursts seen by e-callisto solar spectrometers. Also see the plasma emission from the particles accelerated by the magneto hydrodynamics (MHD) shock waves at the levels of the local plasma frequency or its second harmonic shown in Kumari et al. 2023.

Looking at the spectra shown in Figure 6 which are obtained by averaging the data of a time span when the sun is between an elevation of -18 to +5 degrees before noon show significant changes in the amplitude of the peak with a change in the peak from about 62.5 to 65 MHz. There is also a maximum about 3.5 K on the 5 July (day 187) dropping to about 2.0 K on 7 July (189). Figures 7 and 8 show the change of the amplitude and frequency of the peak of the spectral feature with local time for 10 day averages separated by 100 days respectively. In both cases as in the weaker feature of 2023 in figure 3 the peak drops in frequency by about 2 MHz from first appearing about an hour before sunrise to about two hours before noon. Both time blocks in 2024 show a peak amplitude at about noon while the much weaker feature in 2023 almost disappears close to noon.

In summary memo 451 provides more details of the spectral feature at 65 MHz in the data from the WA and provides details that show it is not consistent with scintillation of a strong radio source. Figure 2 of memo 451 shows an example of the high strength of the signal which is occasionally seen. The

explanation for this high strength, which occurs at 15 LT, is that this signal comes directly from the sun while the signal which is present when the sun is still below the horizon is coming from a broad angle of the sky high enough above the horizon to be picked up by the EDGES antenna which has a gain of about 4 dBi at 45 degrees elevation compared with less than -30 dBi at the horizon.

If the spectral feature at 65 MHz is from satellites the strong signals at 15 LT in figure 2 of memo 451 and at 16 LT in figure 5, which are most likely from the sun, have to be unrelated to the spectral feature at 65 MHz.

Reference: Benz, A.O., Monstein, C., Meyer, H., Manoharan, P.K., Ramesh, R., Altyntsev, A., Lara, A., Paez, J. and Cho, K.S., 2009. A world-wide net of solar radio spectrometers: e-CALLISTO. *Earth, Moon, and Planets*, *104*, pp.277-285.
Kumari, A., Morosan, D.E., Kilpua, E.K.J. and Daei, F., 2023. Type II radio bursts and their association with coronal mass ejections in solar cycles 23 and 24. *Astronomy & Astrophysics*, *675*, p.A102.

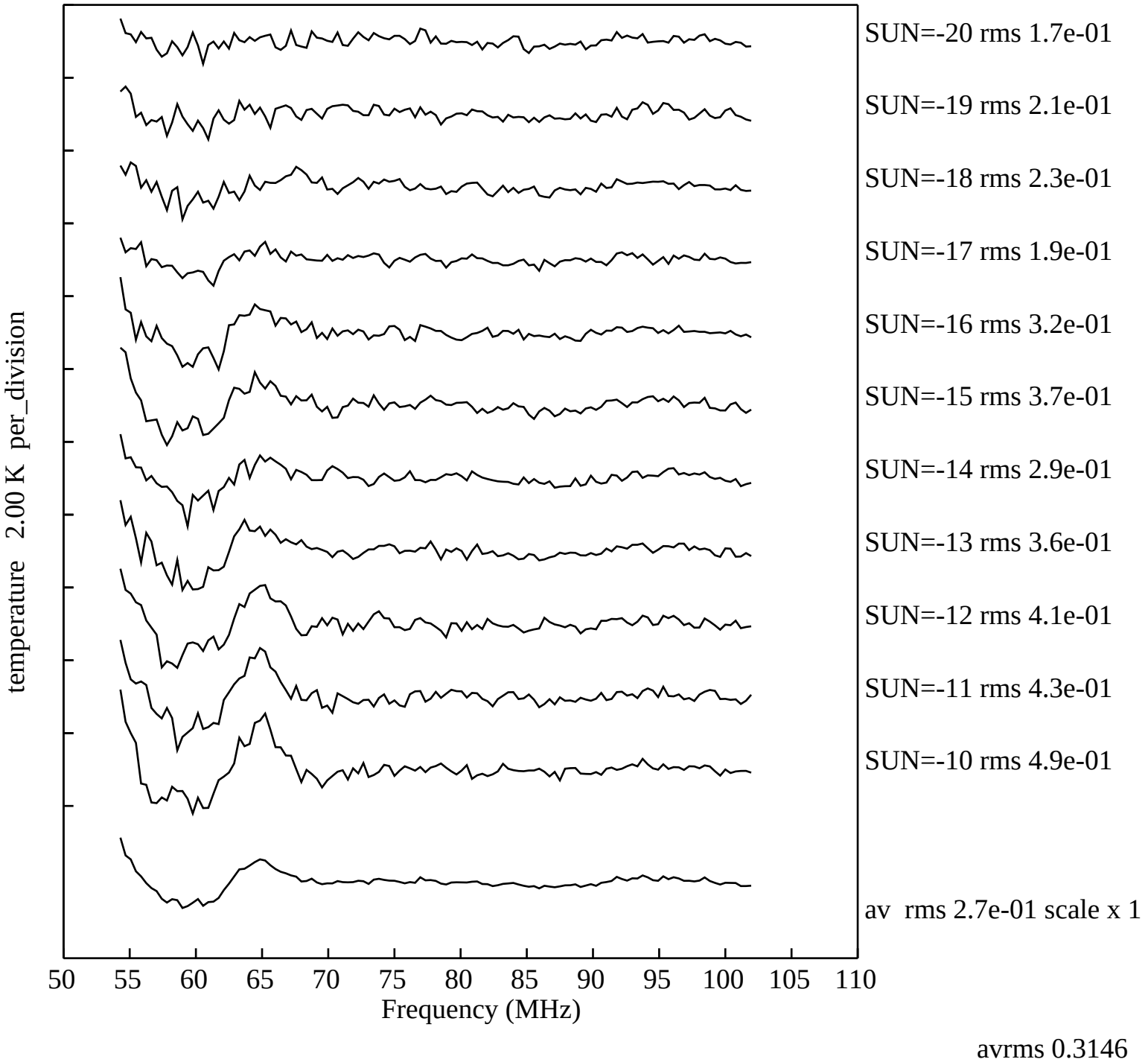

Figure 1. Average sunrise spectra residuals 2023 day 300 to 345 5-terms removed vs limits of the sun's elevation from -20 to -19 at top to -10 to -9 degrees at bottom

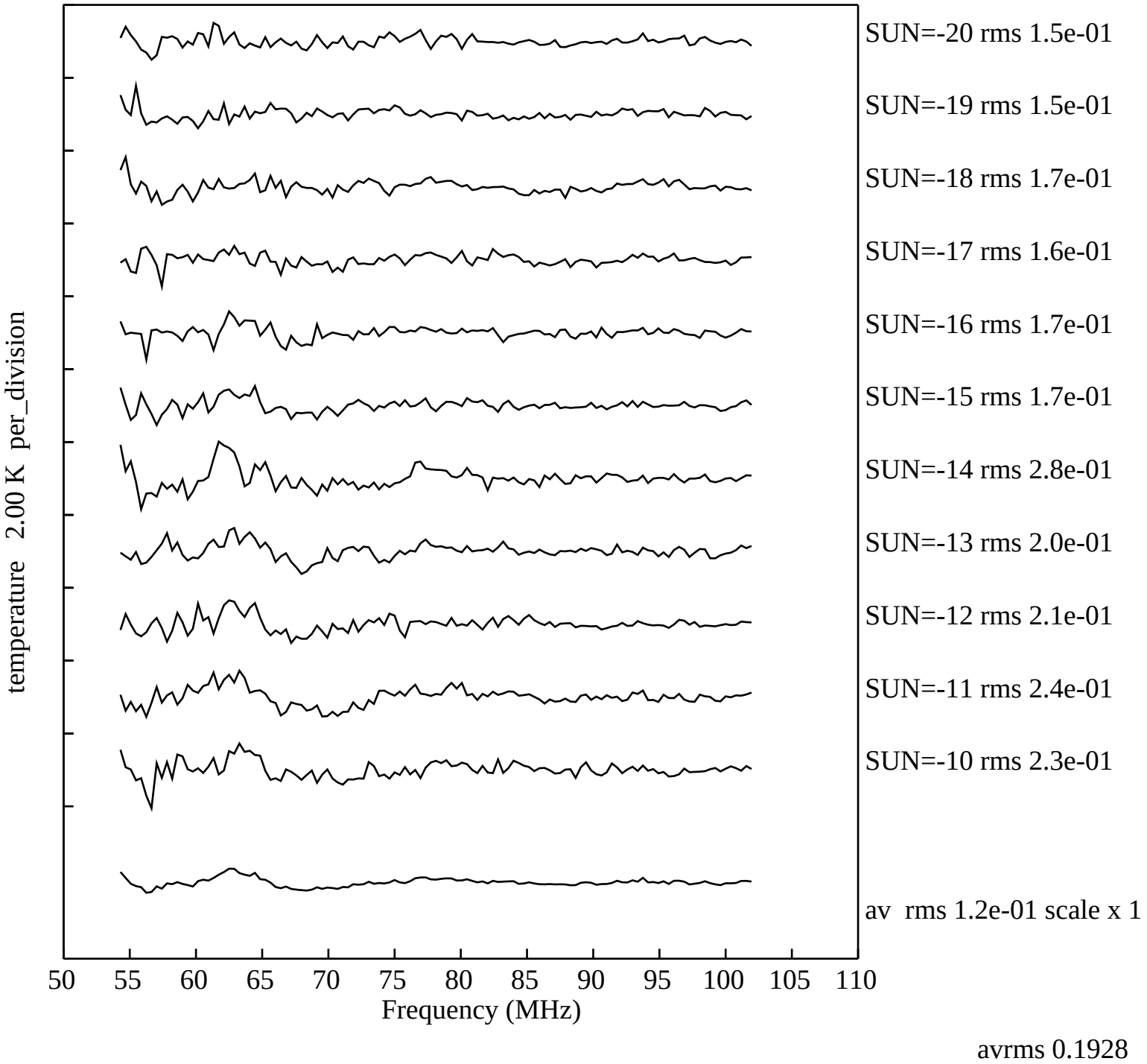

Figure 2. Average sunset spectra residuals 2023 day 300 to 345 5-terms removed

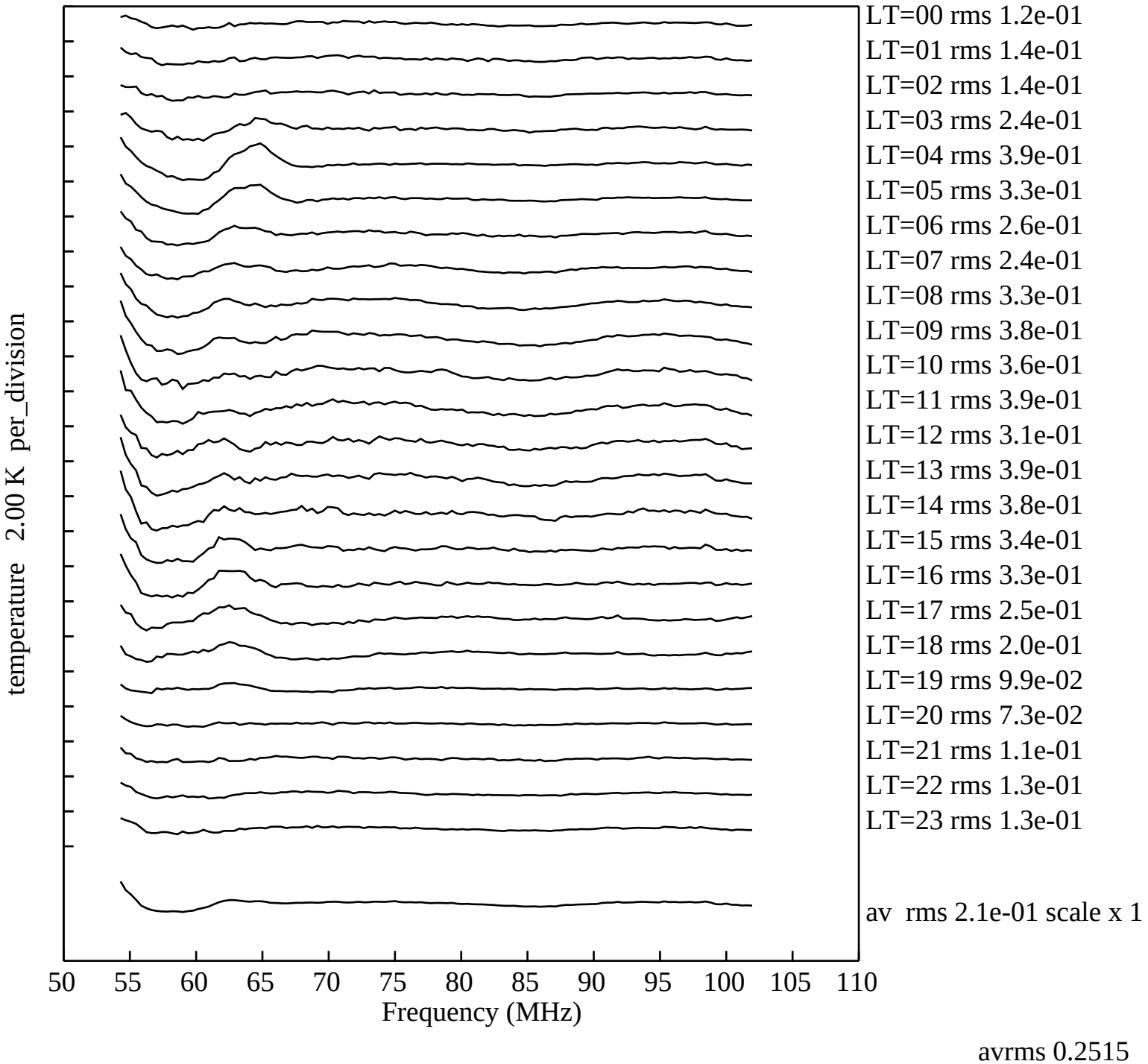

Figure 3. Average residuals 2023 day 300 to 345 5-terms removed in one hour blocks vs local time

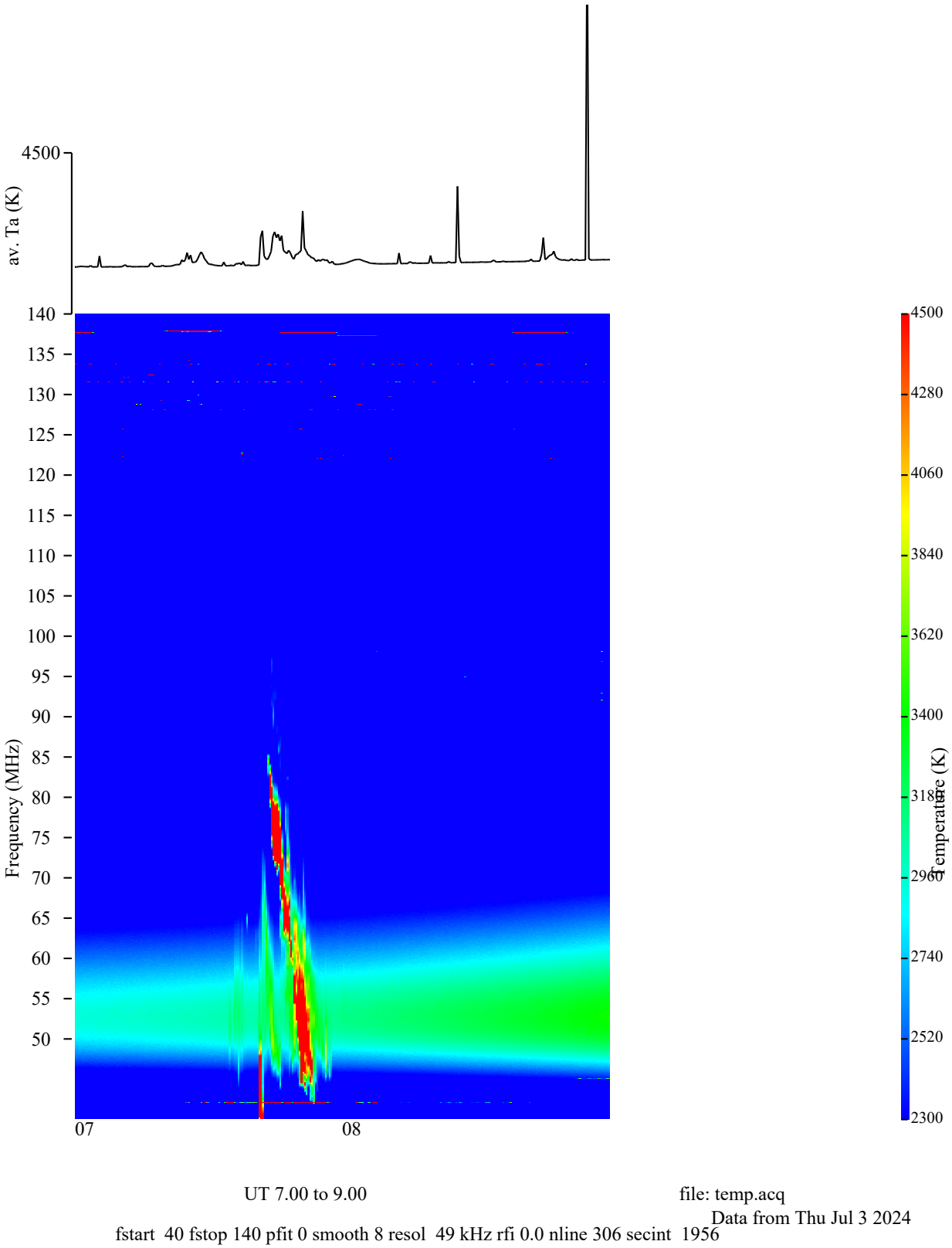

Figure 4. Waterfall plot of data from WA on 2024 day 185 (3 July) showing a solar burst

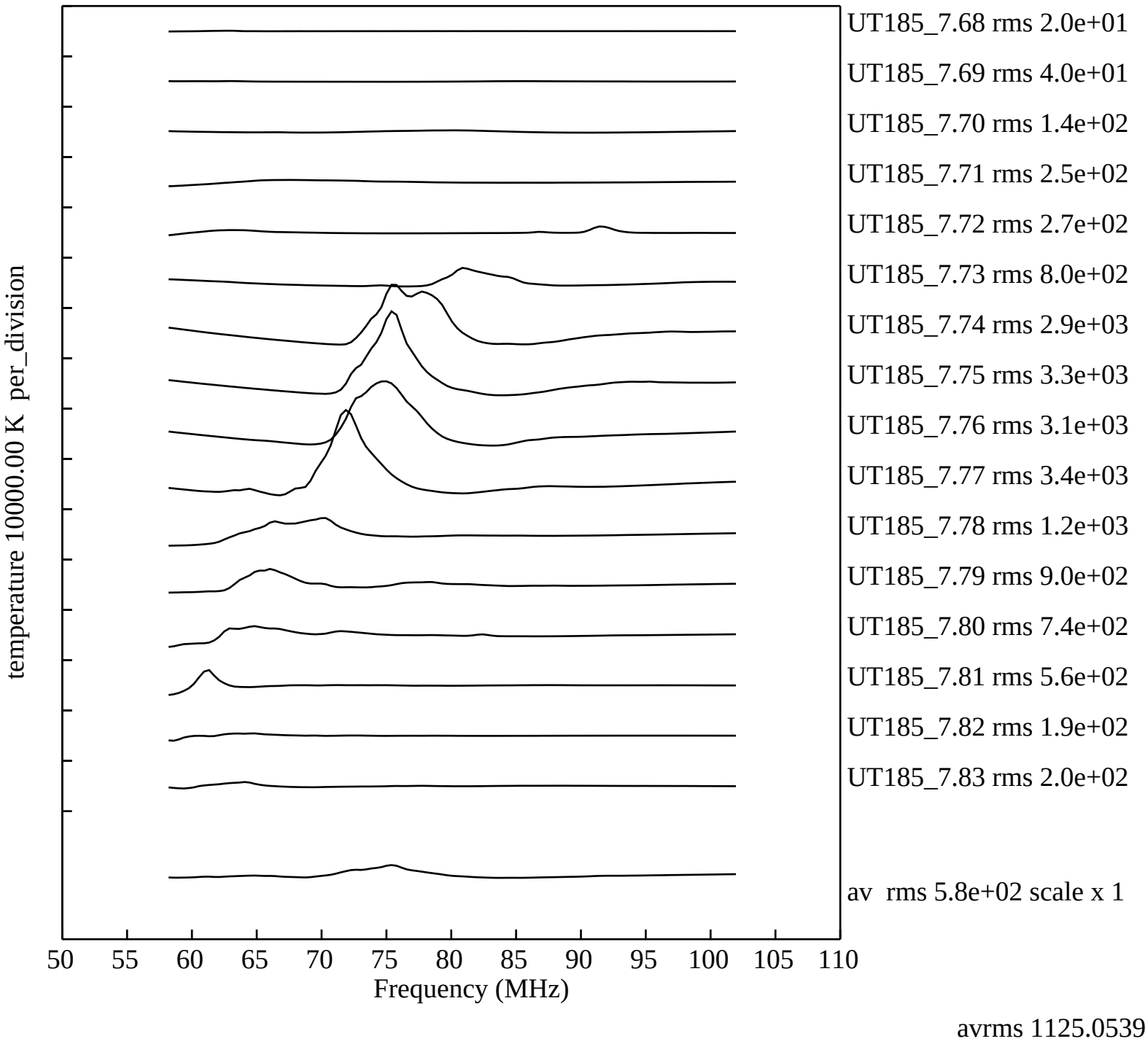

Figure 5. Residuals with 5-terms removed vs UTC blocks of 36 seconds on scale of 10,000K/division

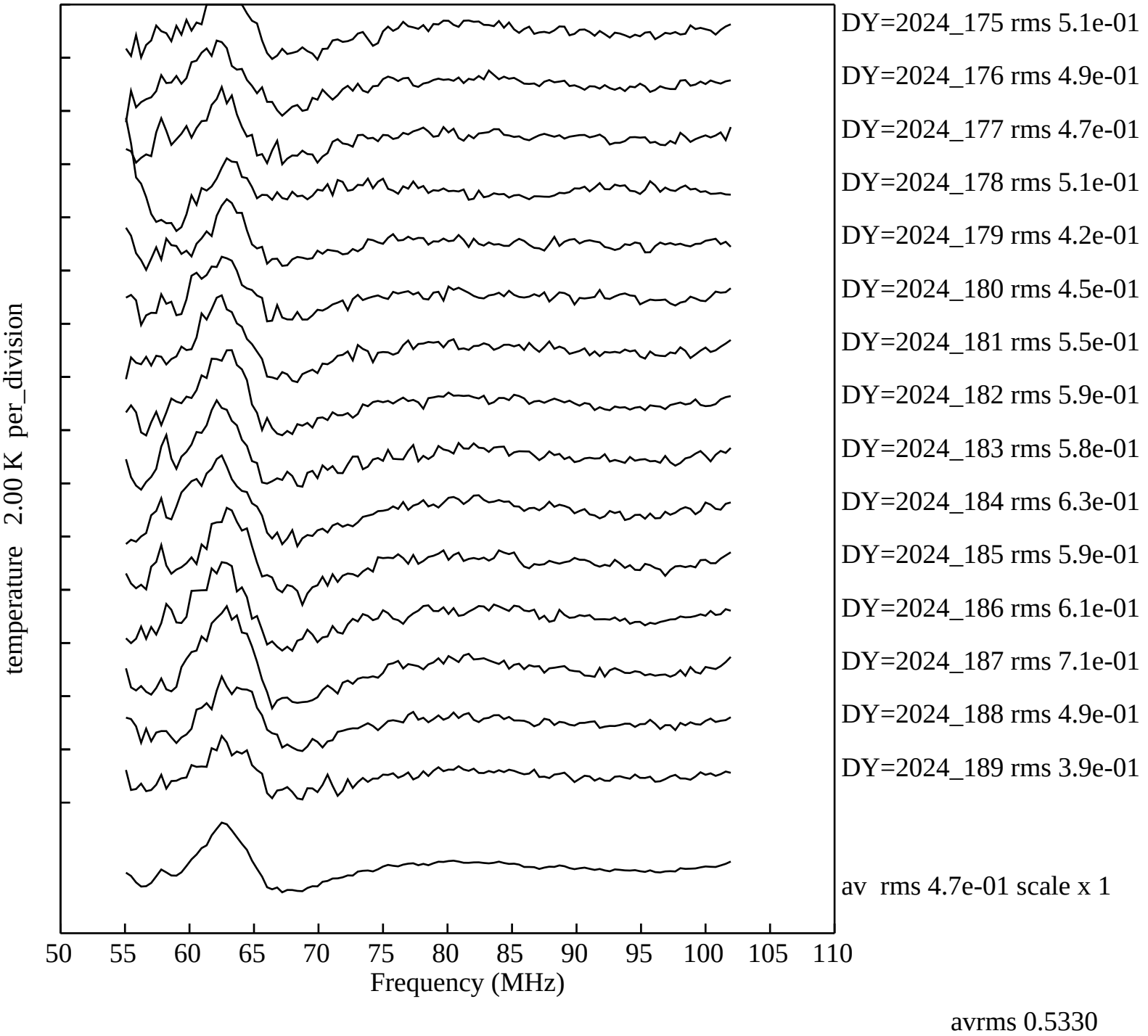

Figure 6. Day 175 to 189 with 5-terms removed averaged sun's elevation from -18 to +5 deg each day.

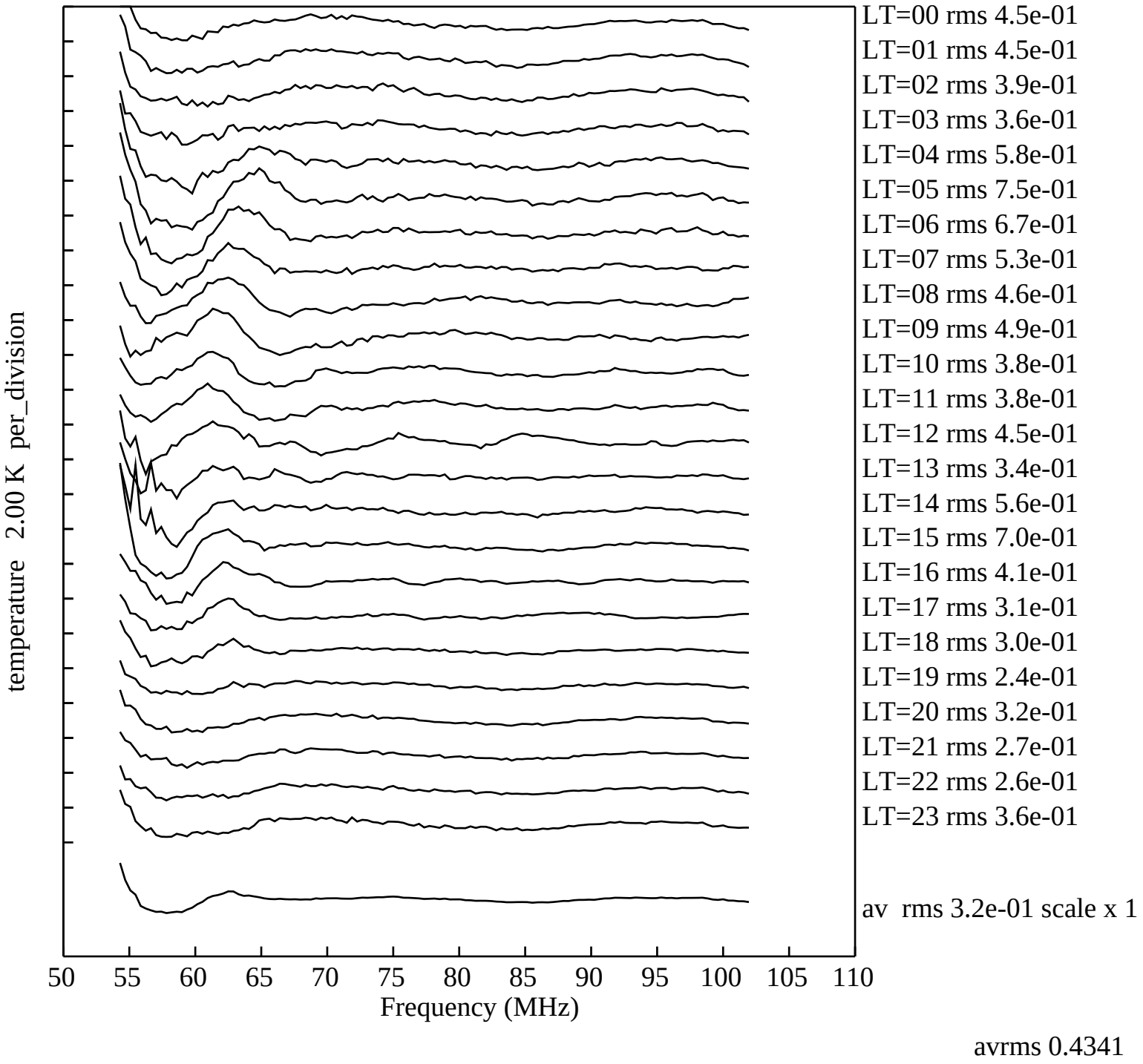

Figure 7. Average residuals 2024 day 83 to 93 5-terms removed in one hour blocks vs local time

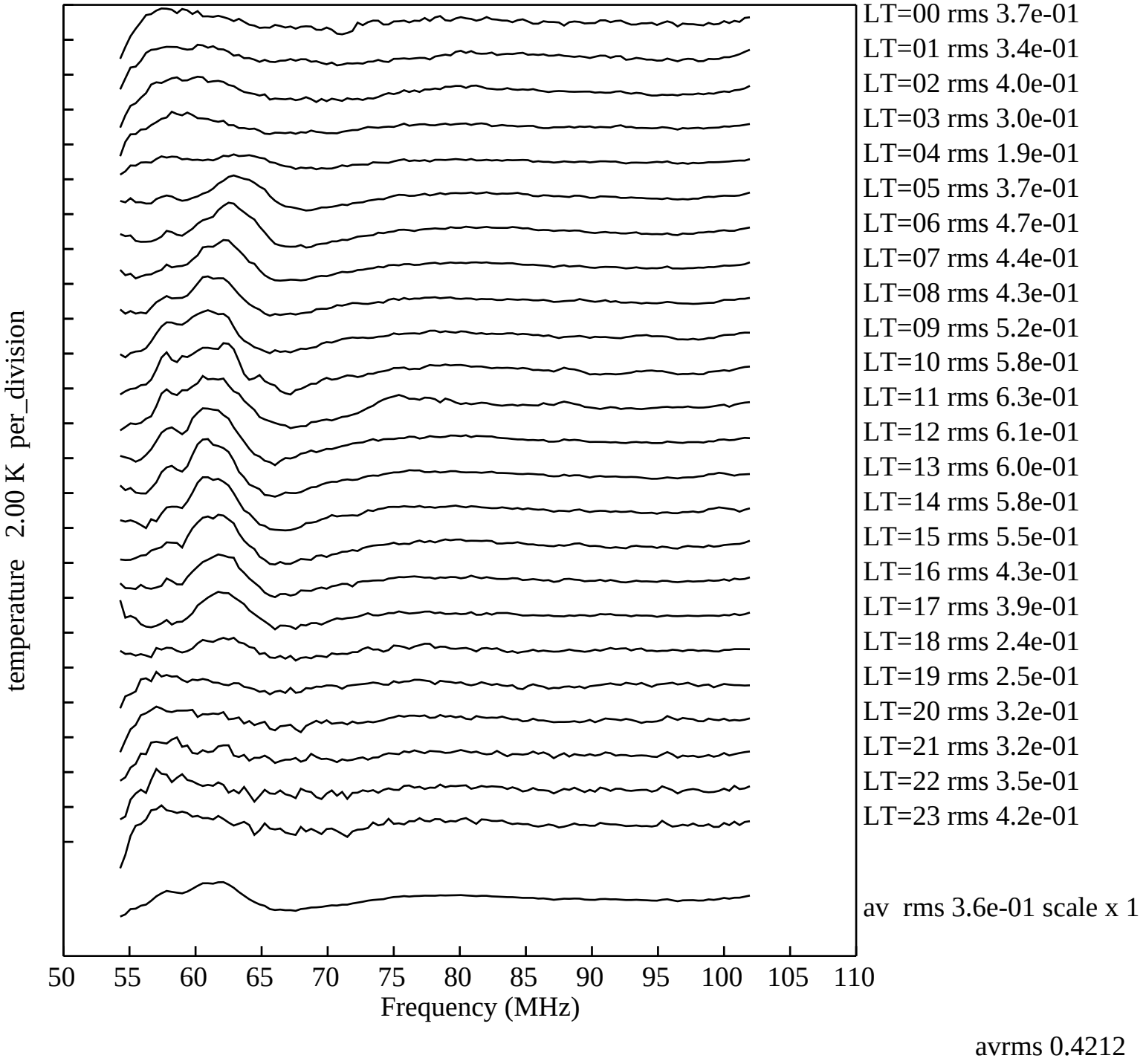

Figure 8. Average residuals 2024 day 183 to 193 5-terms removed in one hour blocks vs local time