EDGES MEMO #451

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To: EDGES group

From: Alan E.E. Rogers

Subject: More tests and analysis to aid in determination of the origin of the peak at 65 MHz

Memo 449 attributed the sharp spectral feature at 65 MHz to scintillation but tests made in memo 450 show that it is not observed in data prior to about day 249 of 2023 and additional tests show the feature, which is present in daytime data at times when the strong sources 3c273 and CTA59 which are candidates for the scintillation are well below the horizon. Figures 2, 3 and 4 of memo 449 show a very strong 200 K example of the sharp 65 MHz feature which occurred at 05:30 UT on day 156 2024 which is 13:30 local time at the WA. Another example occurred on day 175 at 07:00 UT which is shown in Figures 1 and 2. These high level events are not included in the figure 1 of memo 450, which shows the time history because the event are accompanied with a strong solar burst which gets filtered out in the processing used for the global 21-cm absorption. Note that the waterfall plots of the strong events show the fine structure in the spectra which are assumed to be from the sun.

Figures 3, 4 and 5 show the dependence of the spectra for a range of the sun's elevation from -20 to -19 degrees in the top plot to -10 to -9 degrees for the bottom plot. The data is from 2024 day 135 to day 180. Figure 3 includes data from sunrise and sunset while Figures 4 and 5 are for sunrise and sunset respectively. These plots suggest that the effect of the sun starts when the sun is above about -18 degrees and the peak at about 63 MHz is slightly stronger at sunrise than at sunset. A plot of the spectra at 62.5 MHz are plotted vs UT in Figure 6.

The relatively small change of the emission with time of day and changes at sunrise and sunset look similar to local time variation of the heating of the ionosphere by Stable Auroral Red (SAR) Arcs seen throughout the daytime by the echelle spectrograph at Millstone, and the Millstone Hill Incoherent Scatter Radar from Dec 7-14 2006, which was a period of high solar activity reported by Upadhyay and Pallamraju. These variations of the electron temperature are similar to those seen by EDGES-2 in memo 143 and published by Rogers et al. Melnik 2024 shows a spectral feature from GURT which extends from about 50 – 65 MHz and peaks at about 60 MHz. There are small changes in the frequency of the peak of the bump vs time seen by EDGES in figures 4 and 5 which could be from the Doppler shift of the 400 km/sec velocity of the solar wind of +/- 0.1 MHz.

In summary starting in early September of 2023 EDGES-3 has only been able to get good data for the measurement of the global 21-cm signal by restricting the data to times when the sun is more than 20 degrees below the horizon. When the sun is about 18 degrees below the horizon a bump in the spectrum centered at about 62.5 MHz starts to appear and remains fairly constant throughout the daytime at a level of about 5 K and then drops in strength at sunset and disappears when the sun is about 18 degrees below the horizon. During the day there are occasional strong bursts from the sun some of which have the signal at about 62.5 MHz at a level of more than 100 K. These events are filtered out by the normal 21-cm processing but can be studied in detail with special processing. The origin of the signal at about 62.5 MHz is uncertain but it's characteristics appear to be similar to the type III solar bursts reported by Upadhyay, K. and Pallamraju 2024 and Melnik 2024.

references:
Upadhyay, K. and Pallamraju, D., 2024. First daytime red-line emission measurements of the stable auroral red (SAR) arcs. *Geophysical Research Letters*, *51*(3), p.e2023GL106292.
Rogers, A.E.E., Bowman, J.D., Vierinen, J., Monsalve, R. and Mozdzen, T. (2015). Radiometric measurements of electron temperature and opacity of ionospheric perturbations. *Radio Sci.*, 50, 130–137.
Spectral features of a single Type III burst in the frequency range of 10-70 MHz. *Frontiers in Astronomy and Space Sciences*, *11*, Melnik, V., Brazhenko, A., Dorovskyy, V., Frantsuzenko, A., Shevchuk, M., Yerin, S. and Bubnov, I., 2024.1369003.

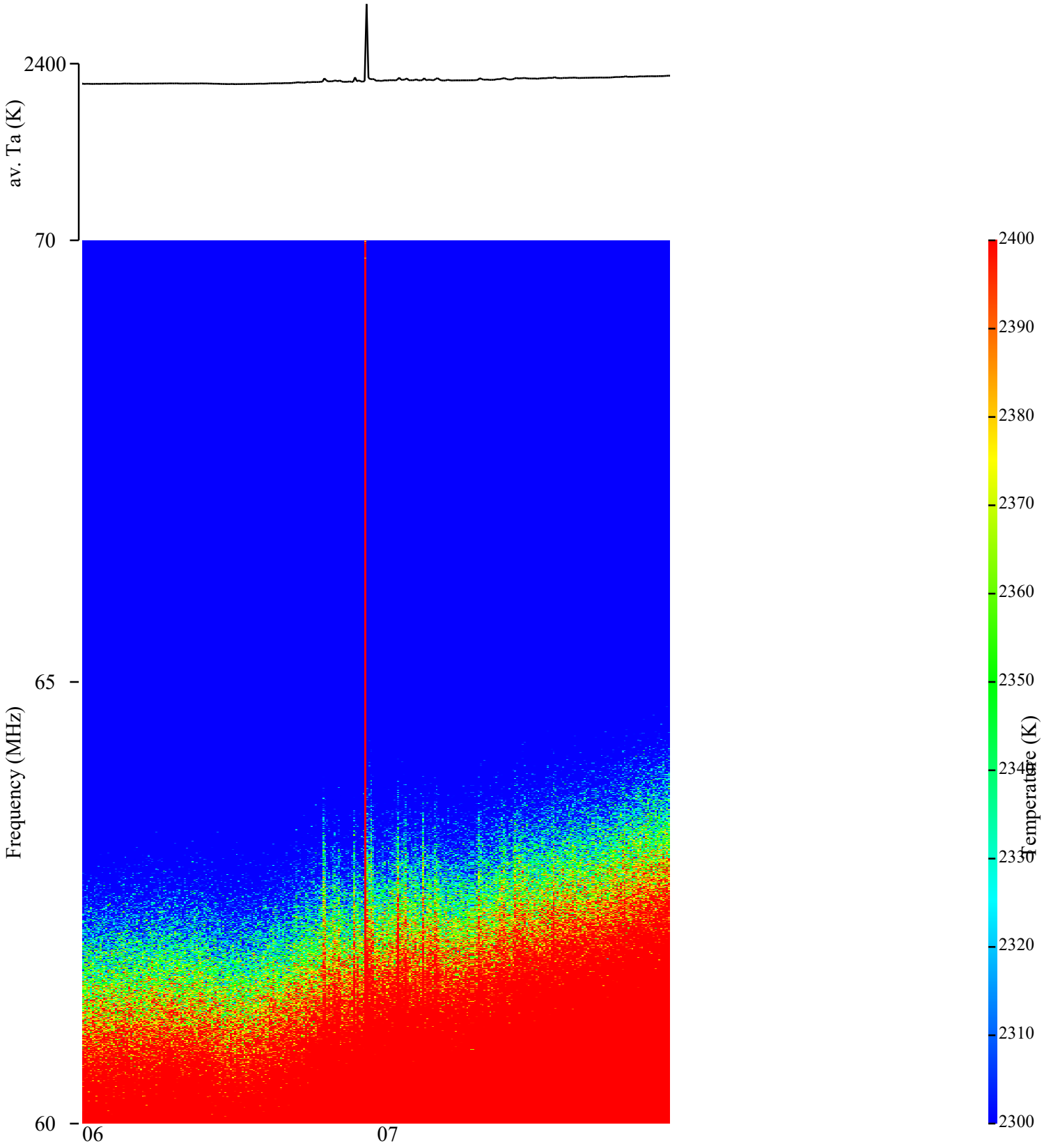

Figure 1. Waterfall plot 2024 day 175 6 to 8 UT (14 to 16 LT) data from the EDGES-3 at the WA

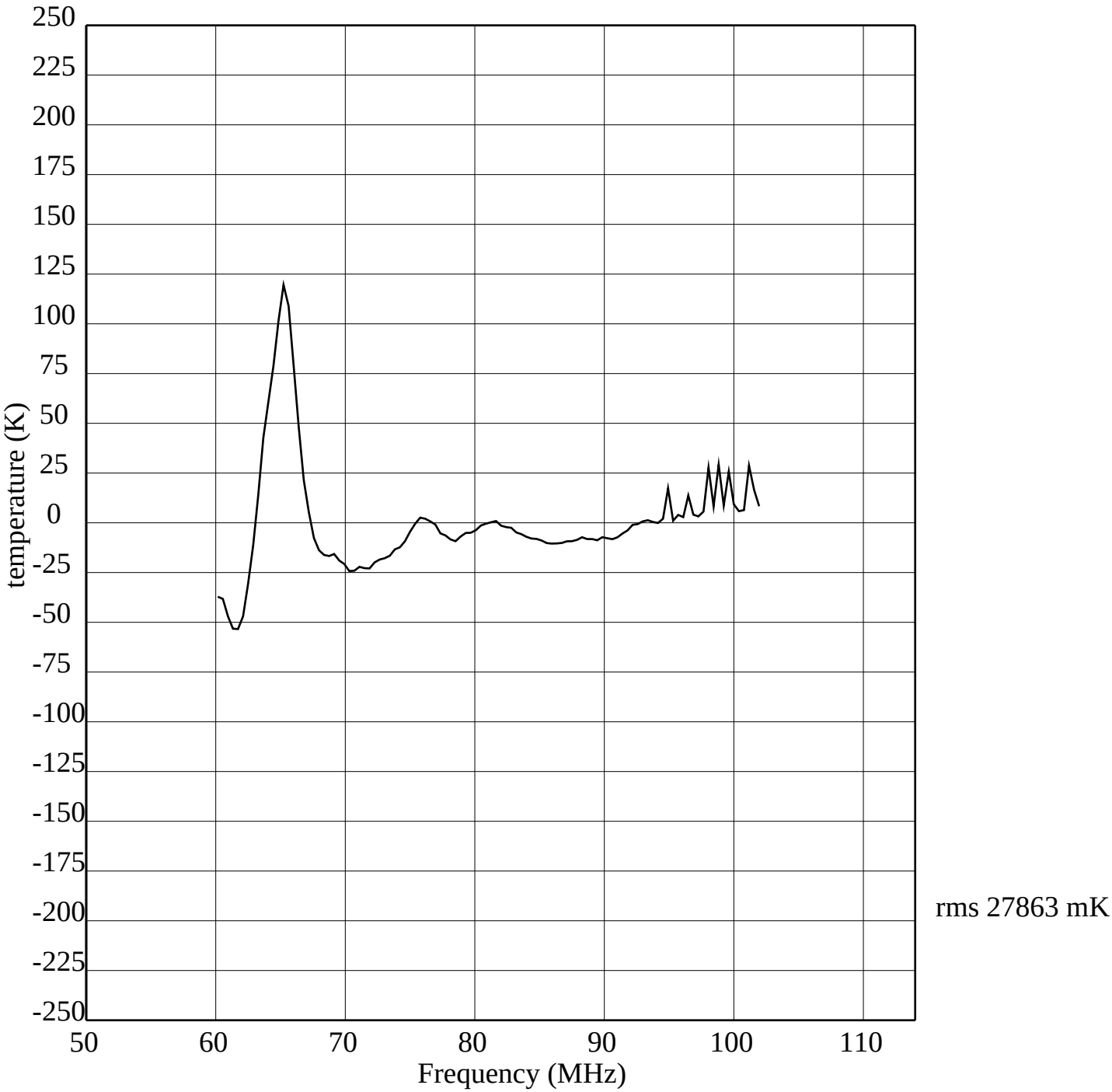

Figure 2. Plot of the spectrum with 5-terms removed for 06:58 to 07:03 2024 day 175

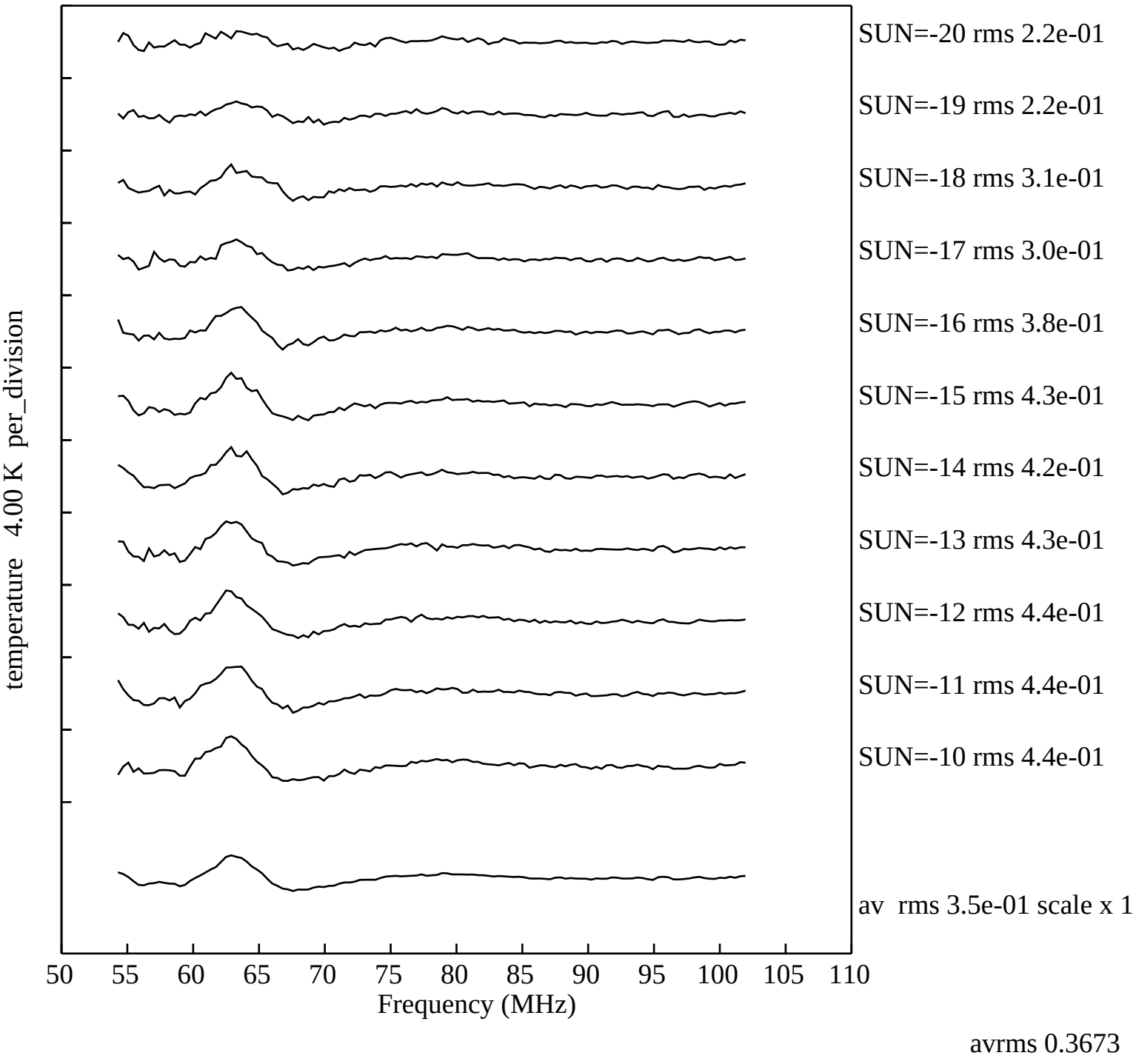

Figure 3. Average of spectra from 2024 day 135 to 180 5-terms removed vs the sun's elevation

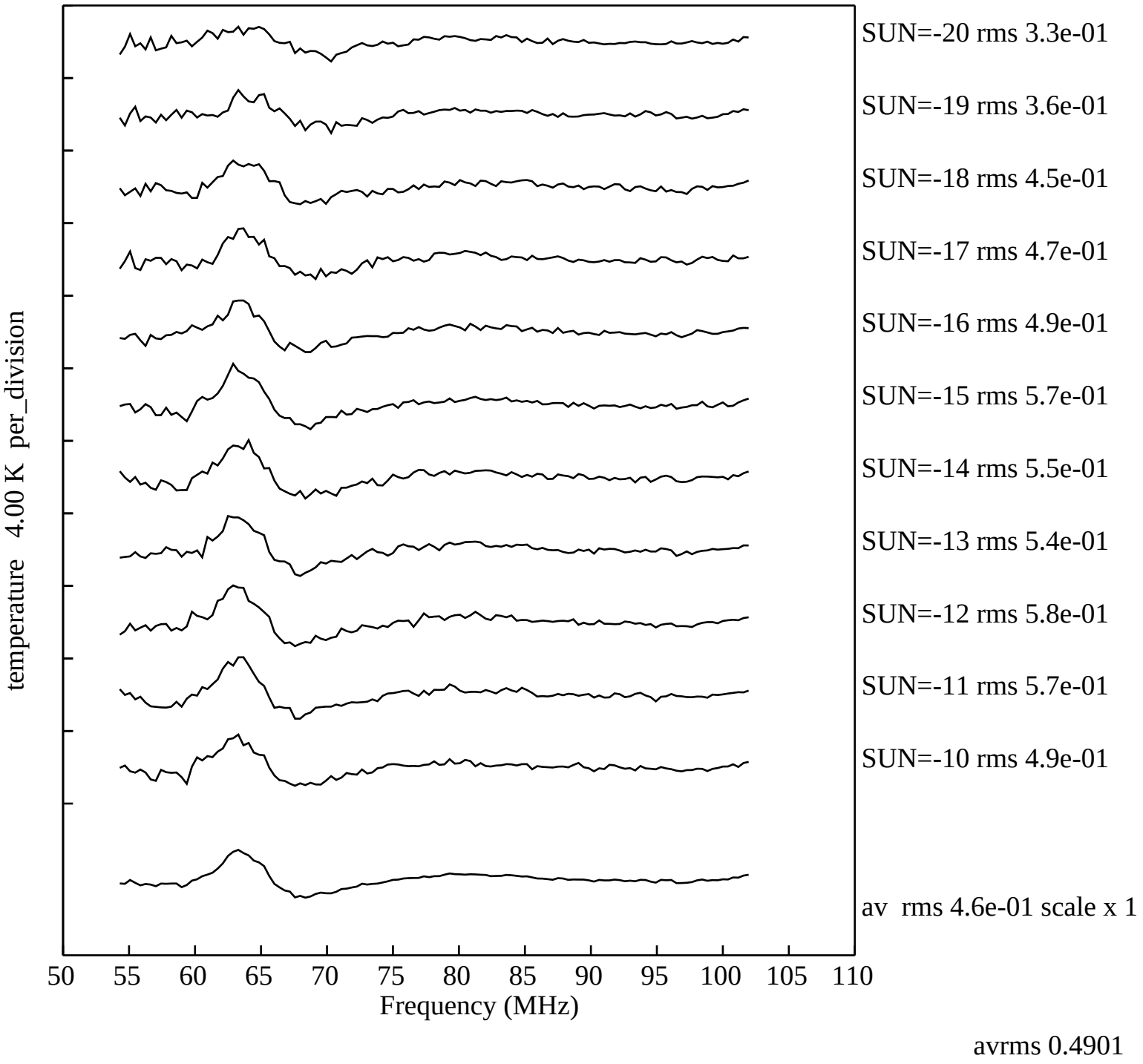

Figure 4. Spectra from 2024 day 135 to 180 5-terms removed vs the sun's elevation at sun rise

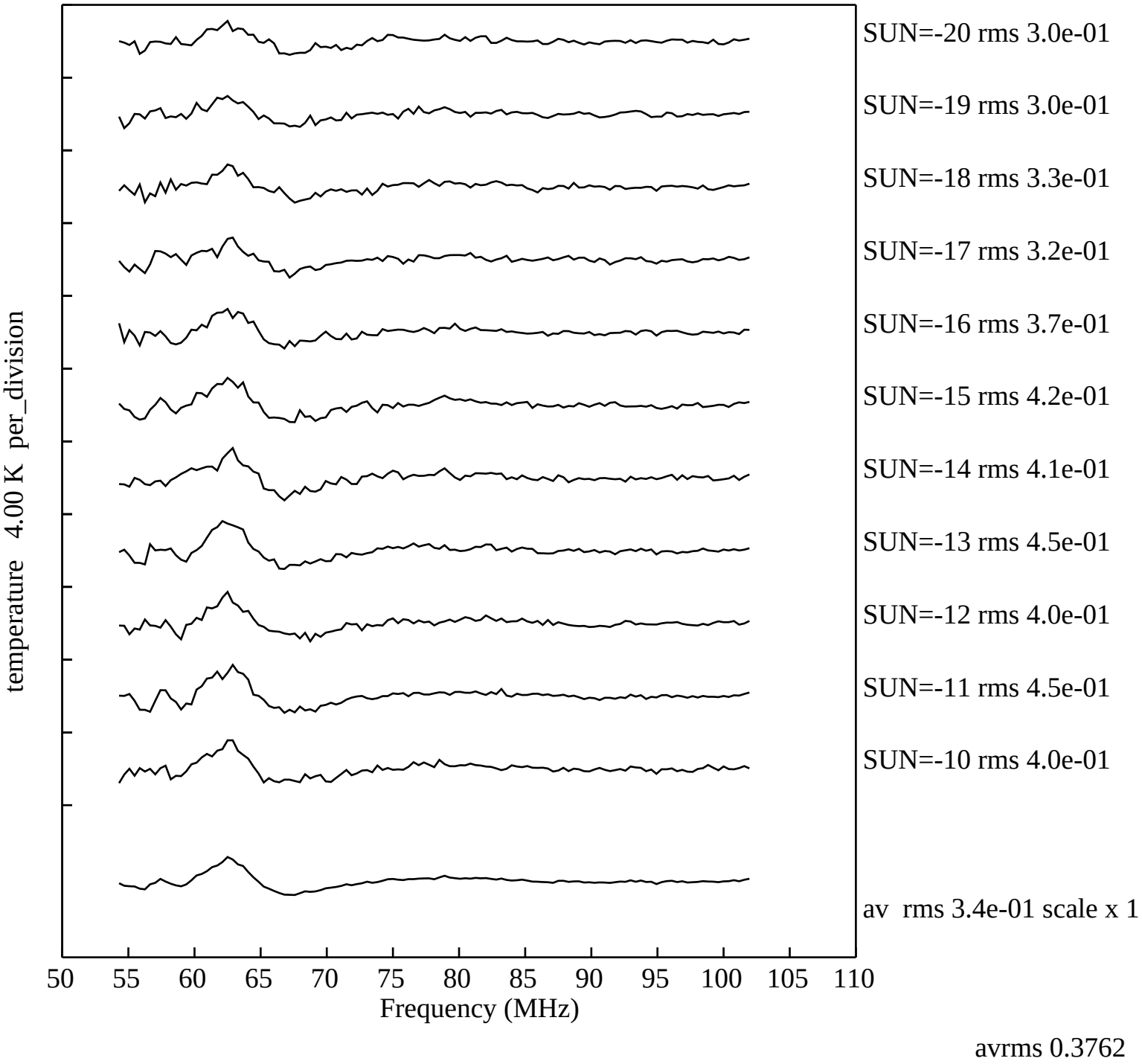

Figure 5. Spectra from 2024 day 135 to 180 5-terms removed vs the sun's elevation at sun set

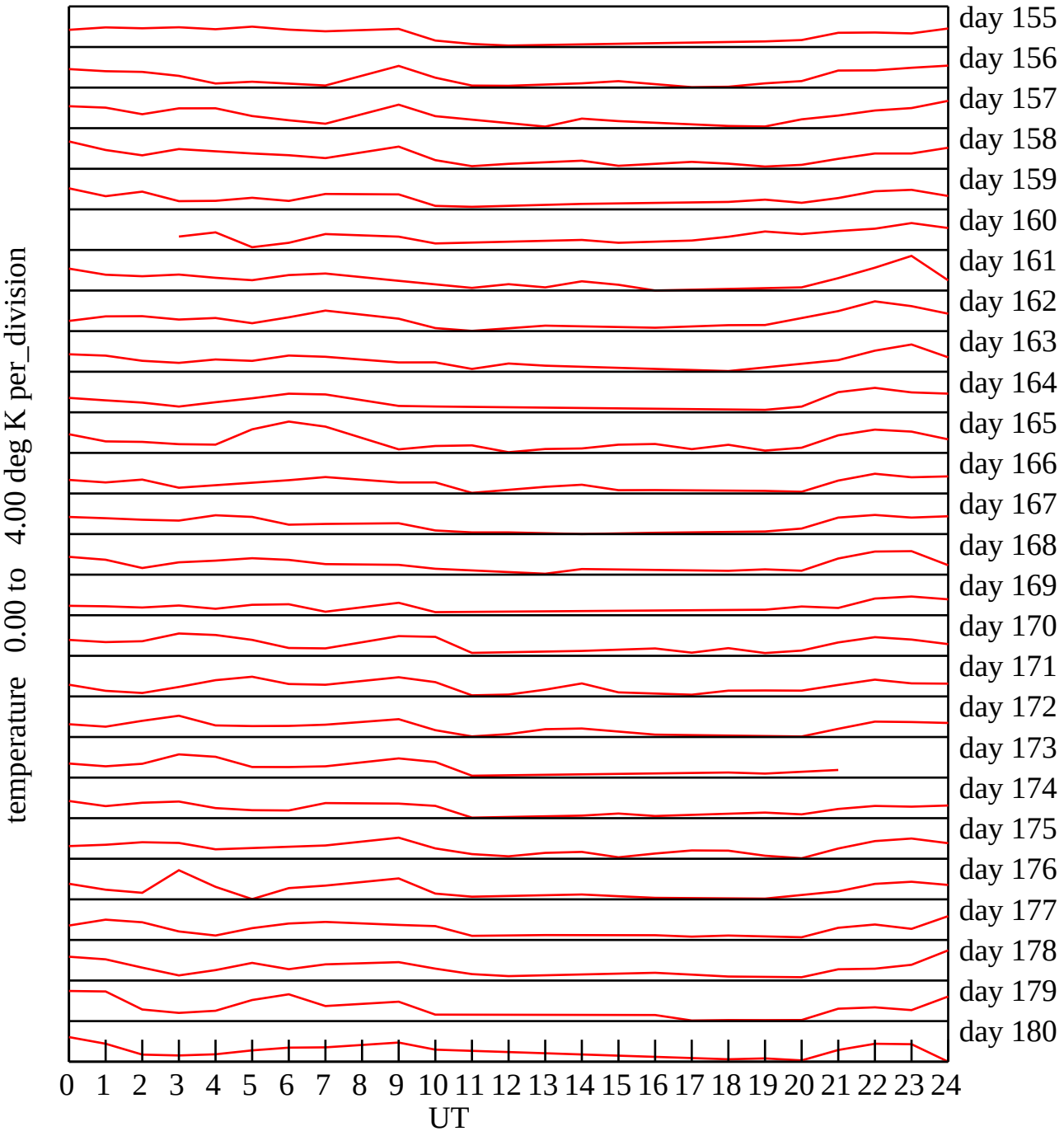

Figure 6. Plot of the peak at 62.5 MHz vs UT for 2024 day 155 to 180