EDGES MEMO #456

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To: EDGES group

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Subject: The time scale of the changes in the peak at 65 MHz and the variation with solar rotation

The effects of solar emissions on the spectra from EDGES-3 deployed at the WA discussed in memo 455 show that the peak at 65 MHz can be avoided if the data is limited to times when the sun is more than 20 degrees below the horizon. However a better understanding of the origin of the peak at 65 MHz is needed for obtaining better global 21-cm data.

The EDGES-3 spectrometer has been operating in WA since day 54 of 2023 and has encountered an increasing frequency of solar bursts. The earliest detection of the peak at 65 MHz was around day 249 of 2023 as discussed in memos 451 and 454.

When averaged over 10 days figures 7 and 8 of memo 452 show relatively gradual changes of the shape and amplitude of the peak at about 64 MHz with local time. These plots also show a shift in frequency of the peak from about 65 down to about 63 MHz with local time as the sun elevation rises from -20 to -5 degrees.

To obtain more information on the time variations on the 65 MHz feature the sunrise data for each day averaged over a sun elevation of -20 to -5 degrees each day for 2024 day 225 to 235 is shown in Figure 1 and from 2024 day 185 to 235 in steps of 5 days in Figure 2.

Figure 1 shows a relatively smooth change of strength from day to day with a variation of about a factor of two. Figure 2 shows that there are larger and more abrupt changes of the scale 5 days which corresponds to a solar rotation of about 72 degrees which is enough to move the view of the sun to a different active region.

Figures 3 and 4 show the change of the 65 MHz feature with the range of the sun's elevation from -24 to -22 degrees at the top to -2 to 0 degrees at the bottom of the plot. Figure 3 is for day 205 and Figure 4 is for day 215 which are the strongest and weakest 65 MHz features in Figure 2 which shows the strength every 5 days.

The range of solar elevation up to 20 degrees below the horizon is compatible with the source of the 65 MHz feature coming from the sun via refraction from the F2 layer height of about 350 km.

Figure 5 shows the variation of the 65 MHz feature amplitude for each day obtained from the residuals to the calibrated spectra with 5-terms removed for the sunrise data when the sun's elevation is between 20 degrees below the horizon up to the horizon . The day numbers for the 25 day spacing are labeled on the horizontal scale and the vertical scale is 8 degrees Kelvin full scale.

In summary this analysis shows that there is a large level of variation in the amplitude of the 65 MHz feature on a time scale of an hour with some variation from one day to the next and a larger variation on the scale of a few days. In addition, the variation on the scale of many days appears to be correlated with the solar rotation period of about 25 days.

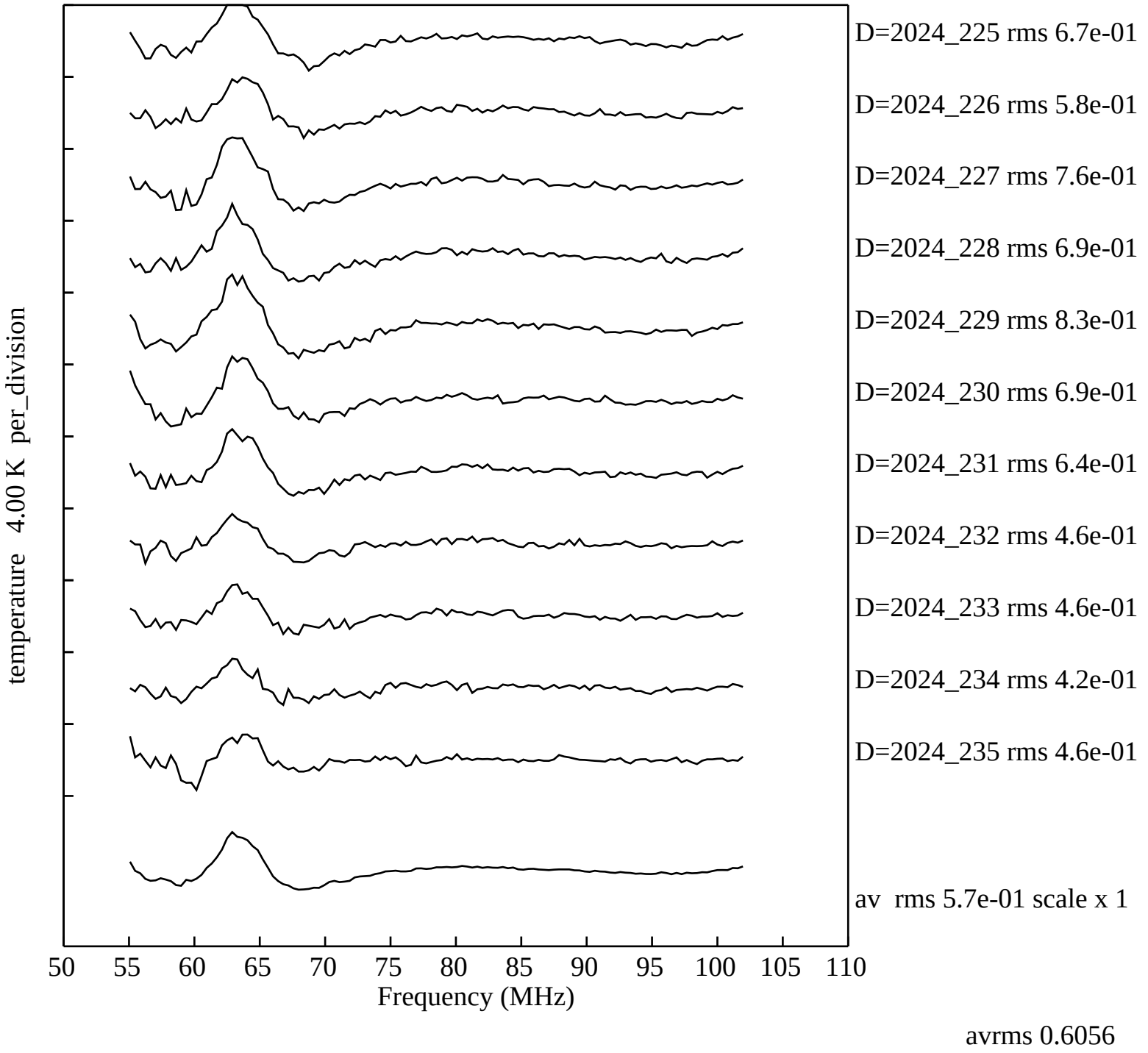

Figure 1. Average sunrise residuals for 2024 day 225 to 235 with 5-terms removed vs limits of the sun's elevation limits of -20 to -5 degrees

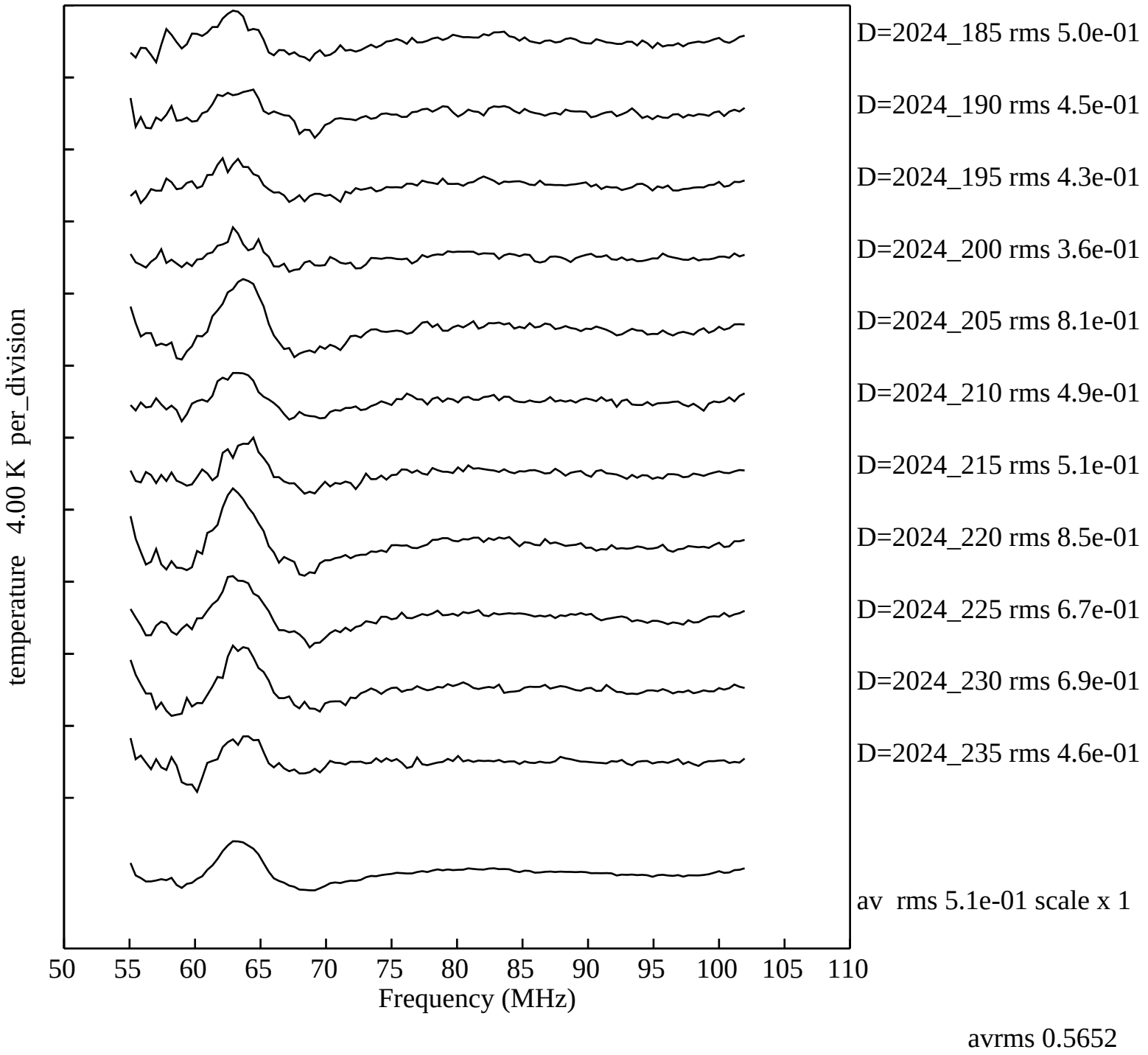

Figure 2. Average sunrise residuals for 2024 day 185 to 235 in 5 day steps with 5-terms removed vs limits of the sun's elevation limits of -20 to -5 degrees

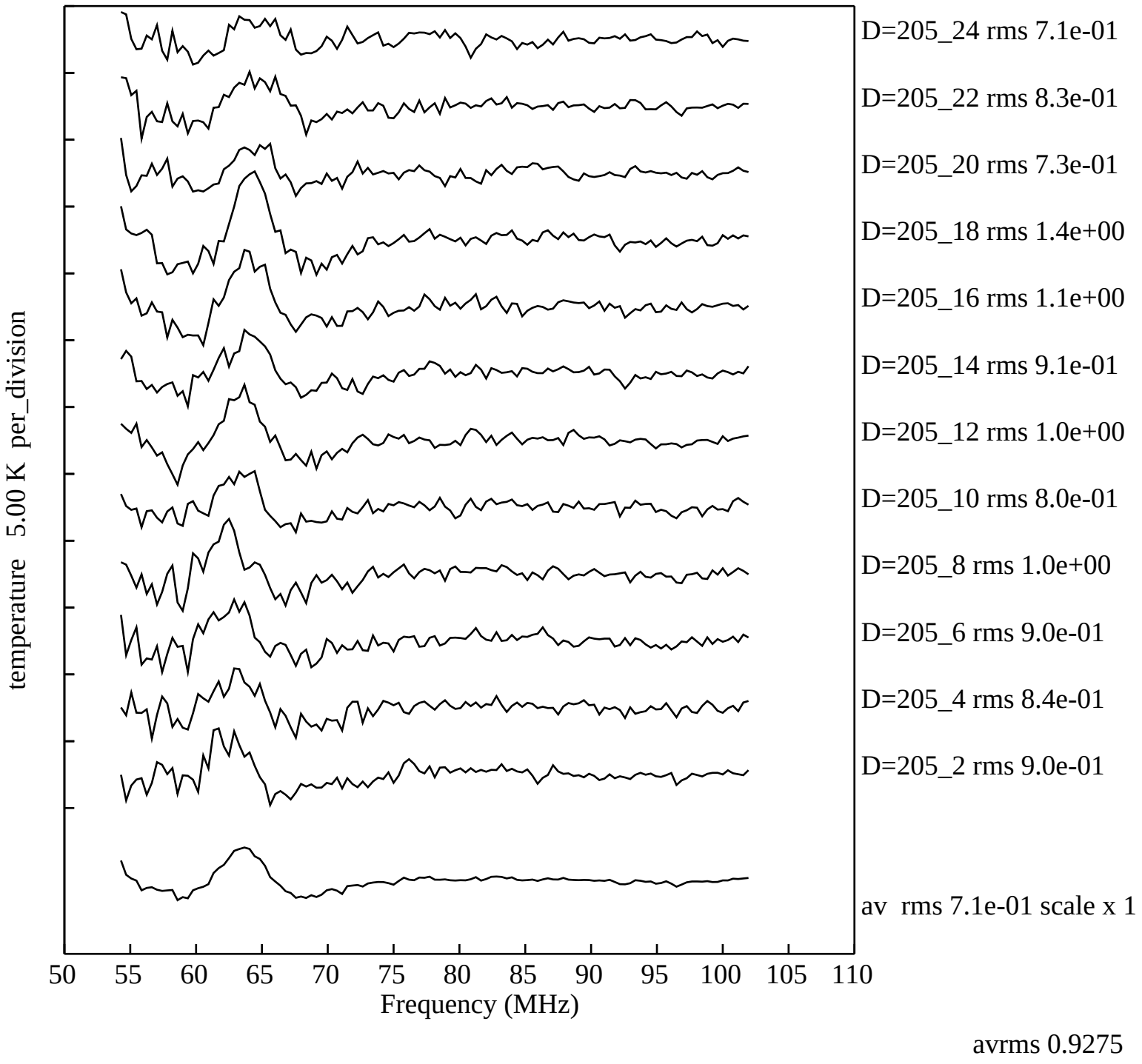

Figure 3. Average sunrise residuals with 5-terms removed for 2024 day 205 for a range of the sun's elevation from -24 to -22 degrees at the top to -2 to 0 degrees at the bottom of the plot

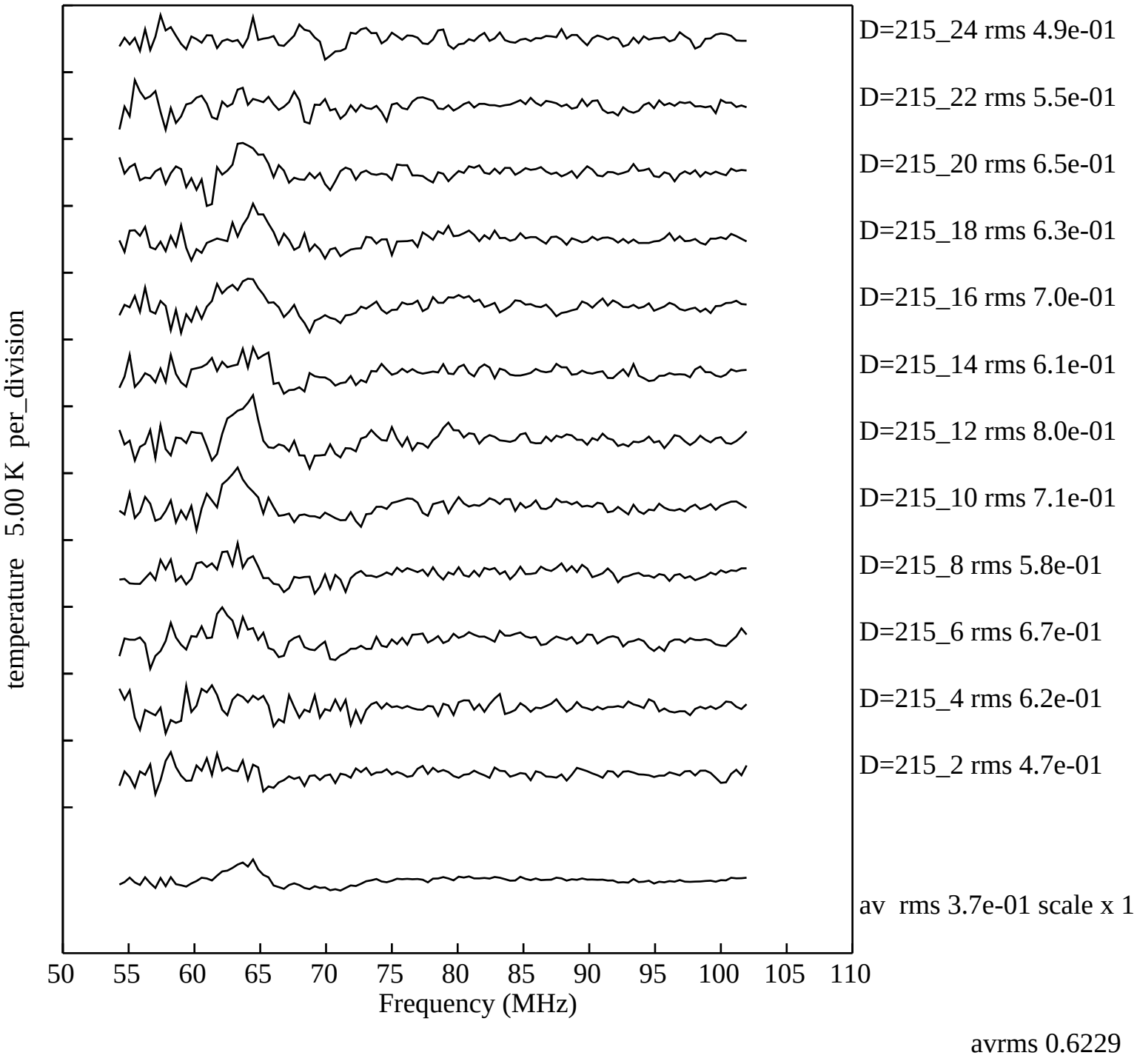

Figure 4. Average sunrise residuals with 5-terms removed for 2024 day 215 for a range of the sun's elevation from -24 to -22 degrees at the top to -2 to 0 degrees at the bottom of the plot

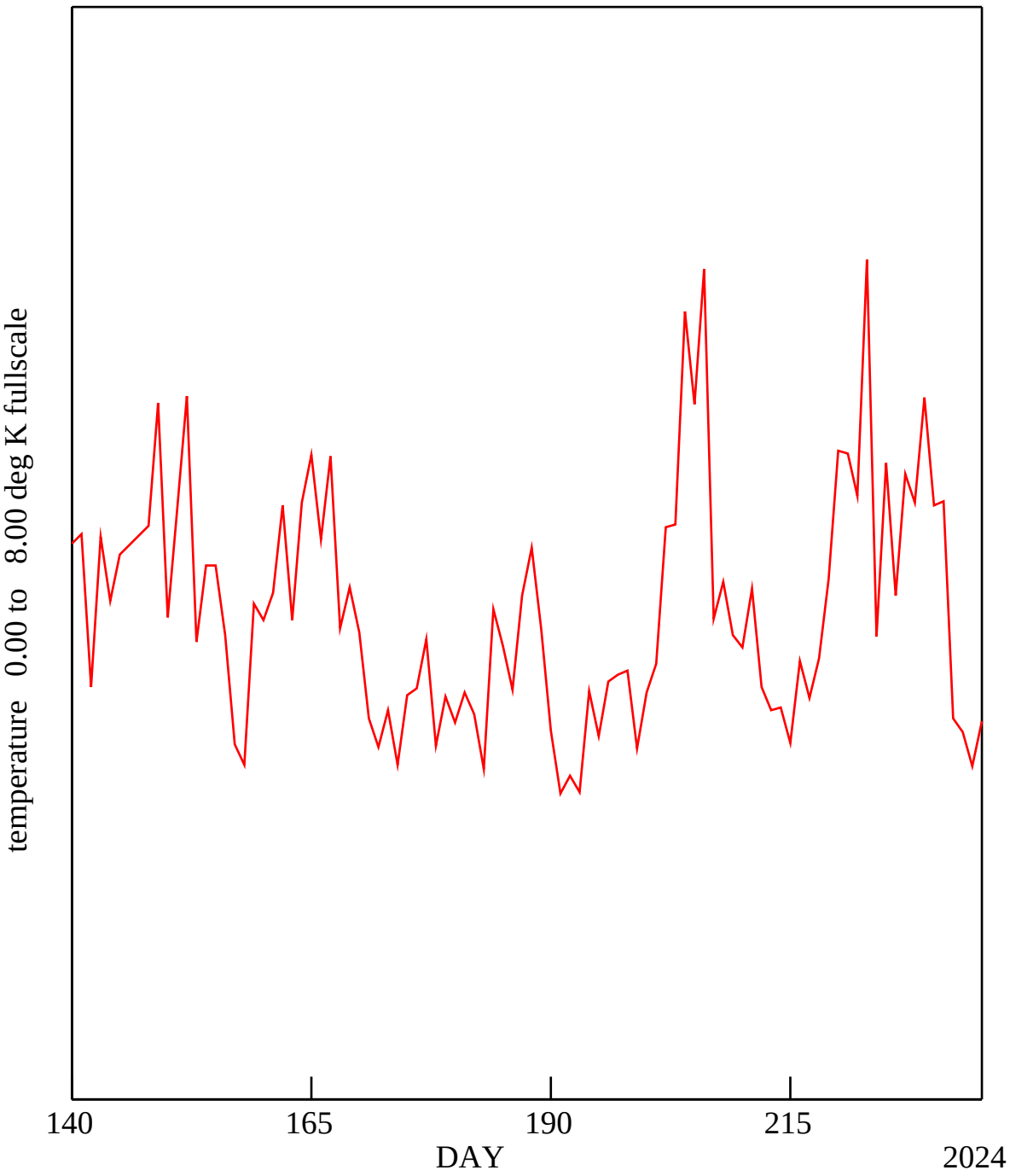

Figure 5. Plot of amplitude of 65 MHz feature averaged over the sun's elevation from -20 to 0 degrees each day from 2024 day 140 to 236