EDGES MEMO #508

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To: EDGES group

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Subject: Tests of the increase in reflected FM radio signals from satellites

A study of the FM signals that are reflected from satellites is made in memo 424. In this memo the changes from 2023 to 2026 are studied and shows a lot of variability and an increase with time as more satellites are launched. While these reflections can be filtered by not accepting the three position switch cycles that exceed a rfi threshold of 2.1 sigma. However this results in a significant loss of data used for the measurements of the global 21-cm absorption signal as discussed in memo 507.

Figure 1 shows the spectra from day 140 of 2023, 2024, 2025 and 2026 for one hour blocks for GHA 0,4,8,12,16,20 hours. The rms filter for each 3 position switch cycle has been turned off so the FM carrier signals can been seen. The “smooth” parameter of the acqplot function has been set to 8 so an averaging over eight 6 kHz which equals 48 kHz has been applied. Figure 2 shows the spectra with the “smooth” parameter reduced from 8 to 4 for 24 kHz smoothing to show the weaker reflected FM extends to cover more of the FM band. The overall conclusion from this test shows the increase in the FM from 2023 to 2026 which is probably due to the increased number of satellites in orbit.

Tests made using “waterfall” plots which show in figure 3 that:

1] That the FM stations are 94.9, 96.5, 98.1, 98.9, 99.7 and 101.3 MHz all of which are within western Australia.
2] These are seen, with only changes in strength on the scale of minutes over 24 hours without significant change between day and night so only free space propagation without sporadic E is involved.
3] There are days when FM is reflected from meteors and there are changes in the starlink satellites most recently in May 2026 with many new launces and changes in orbit.

Satellite radar cross section (RCS) are estimated from Henry et al. to be -10 to 0 dBsm for Kuiper and 3 to +5 dBsm for Starlink (V2 Mini/V3) at 100 MHz. The origin of the FM reflections is most likely Starlink but it is clear there are changes from day to day as shown in Figure 4 which has a strong event at 09:27 UT on day 143 whose origin has not been determined. Figure 5 shows the increasing levels FM reflections from day 140 (May 20) to day 145 (May 25) during which many Starlink satellites were launched.

A FM signal strength of 35 K is estimated to be the expected signal from a single Starlink in memo 424 for 6 kHz, distance 550 km, RCS 20 dBsm, EDGES gain 6, FM transmitter 100 kW with antenna gain 1. The typical strengths in Figure 2 are about 50 K for 24 kHz resolution. If the Starlink RCS +5 dB then 30 starlink satellites are needed to be above the horizon which is close to what is expected for 10,000 around the globe.

Ref: Radar Cross-Section Modeling of Space Debris. / Henry, Justin K.A.; Narayanan, Ram M.; Singla, Puneet.

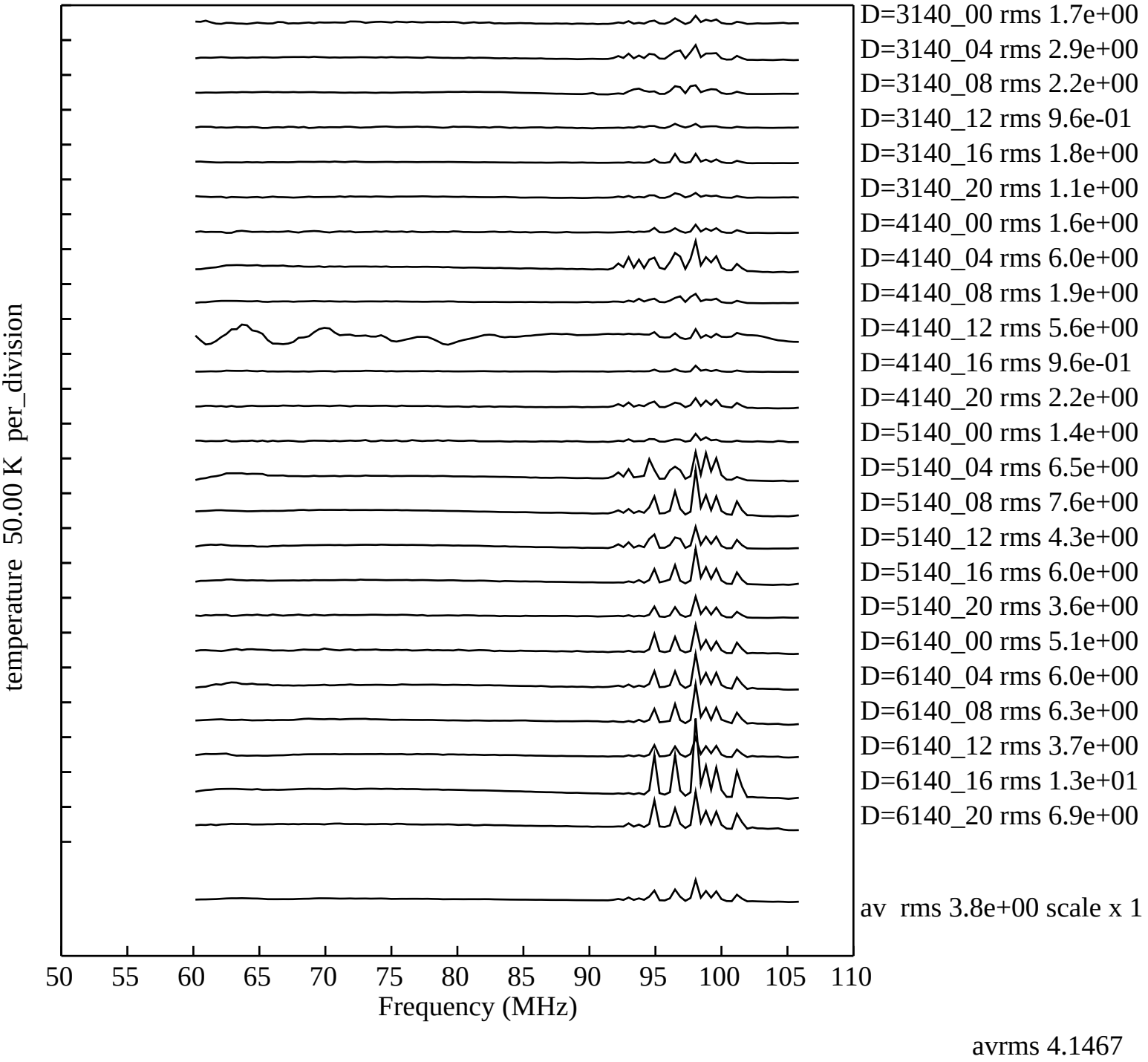


Figure 1. Spectra from EDGES-3 at the WA for 1 hour blocks at GHA 0,4,8,16 and 20 hours day 140 of 2023, 2024, 2025 and 2026 using 48 kHz resolution.

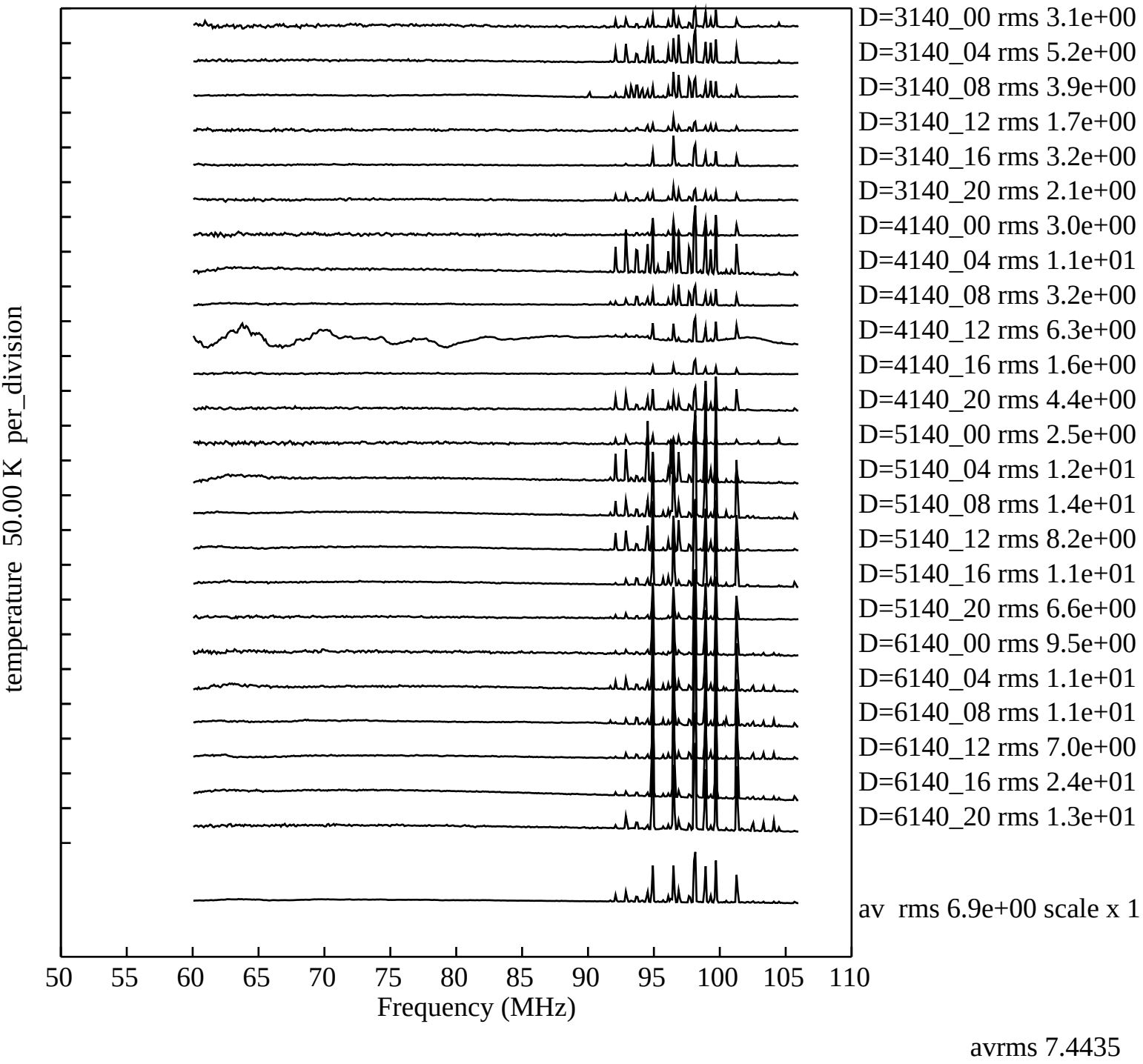


Figure 2. Spectra from EDGES-3 at the WA for 1 hour blocks at GHA 0,4,8,16 and 20 hours day 140 of 2023, 2024, 2025 and 2026 using 24 kHz resolution.

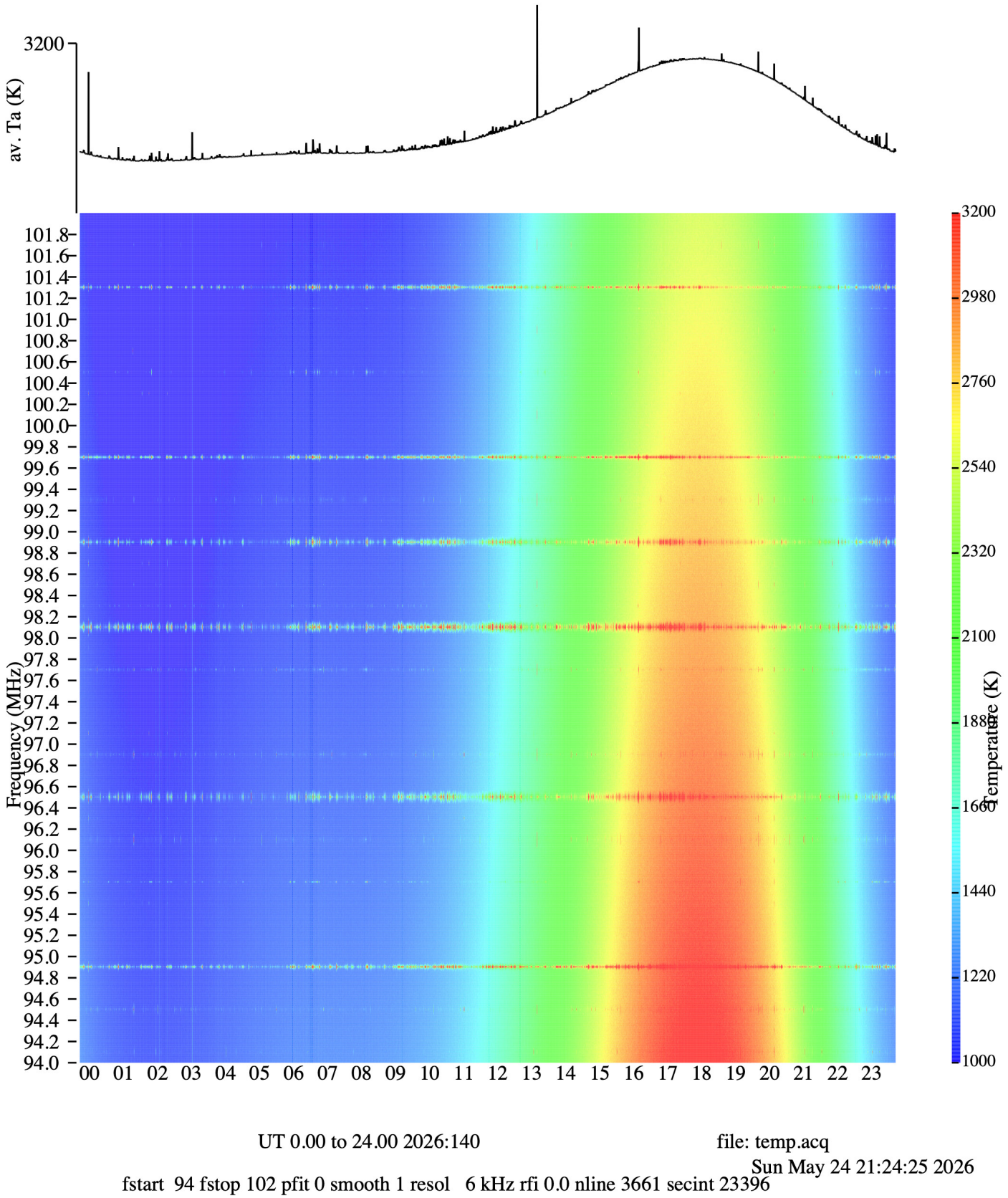
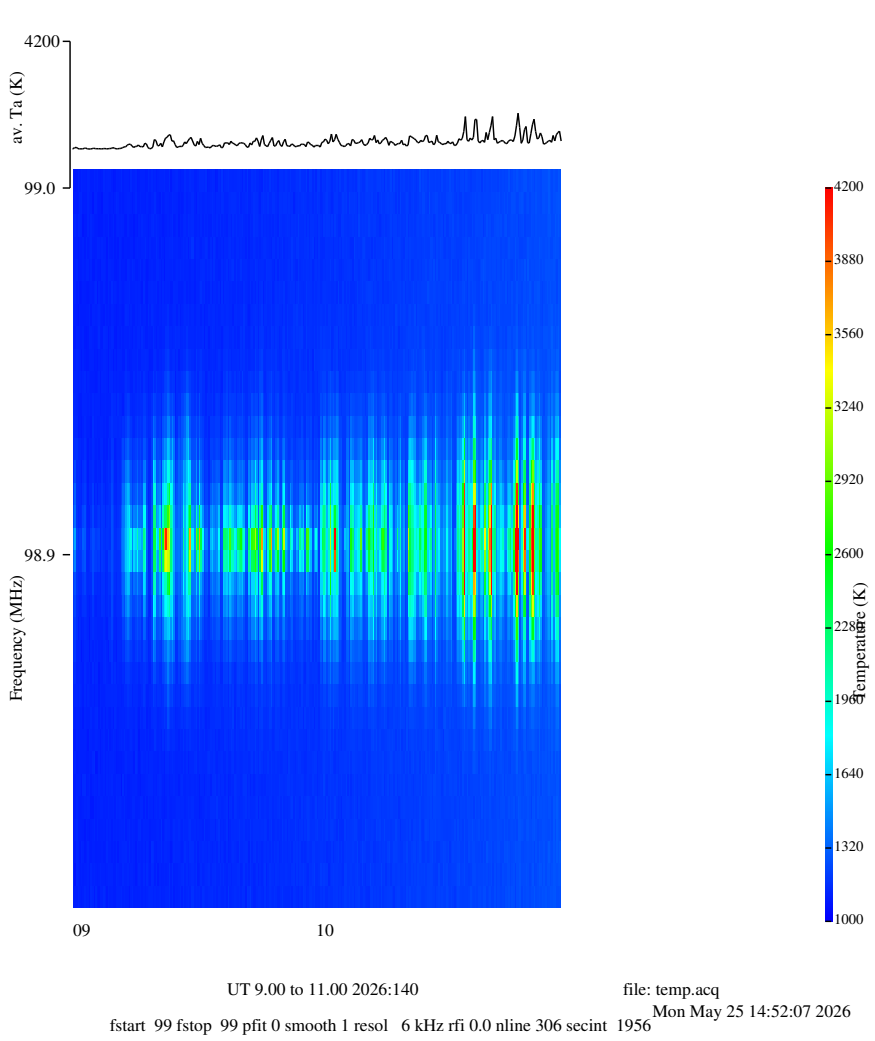


Figure 3. Waterfall plot of data from 2026 day 140 with 6 kHz resolution and rfi = 0



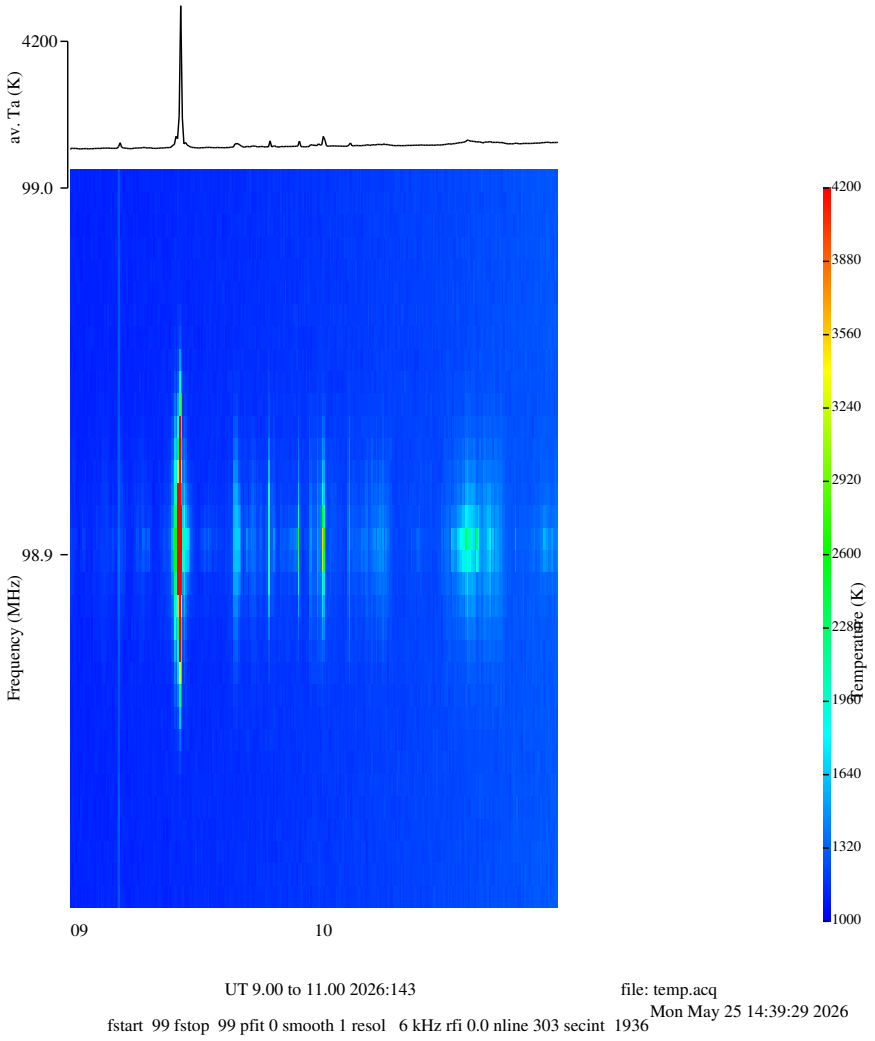


Figure 4. Waterfall plots for days 140 and 143

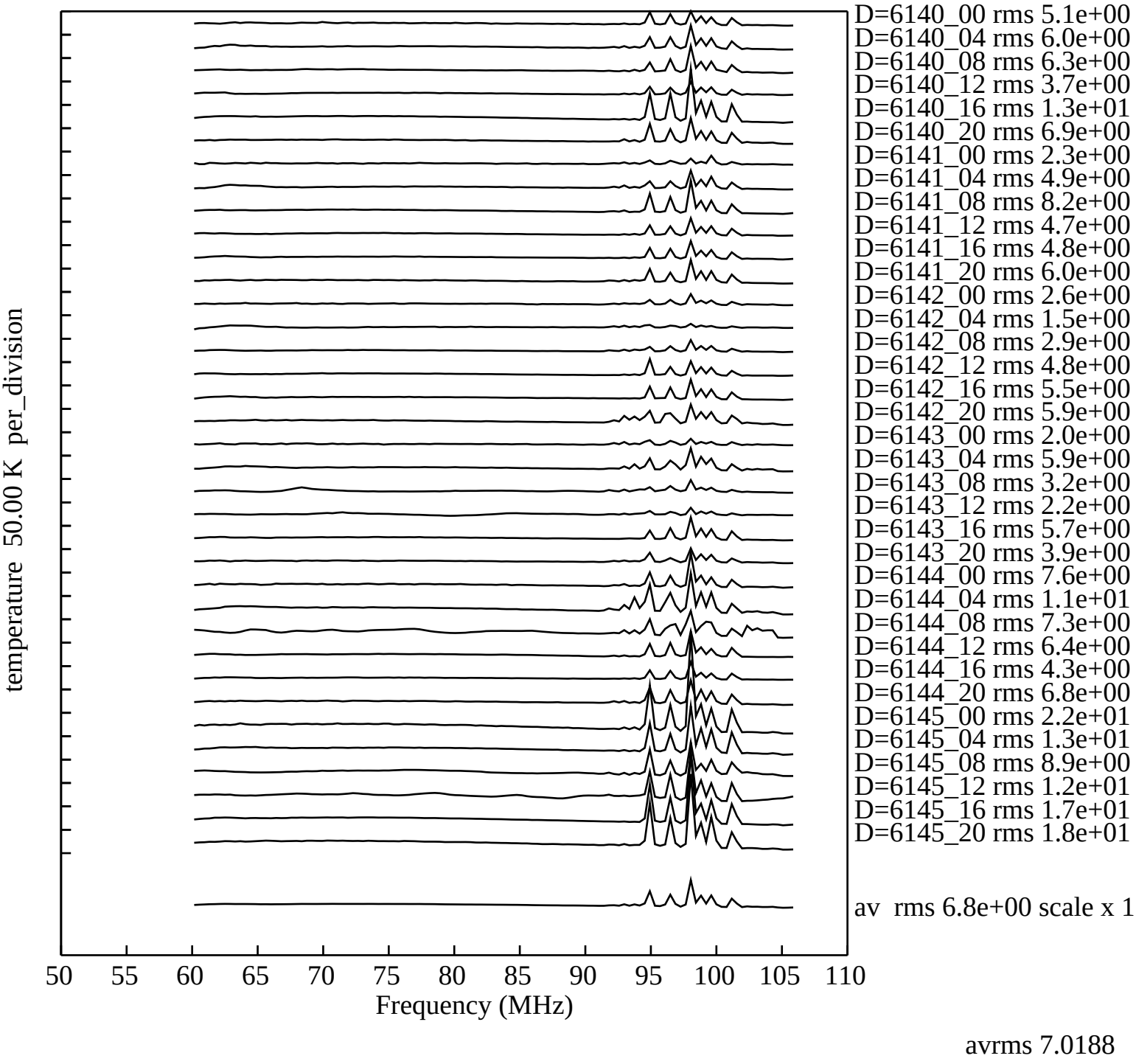


Figure 5. Spectra for GHA 0,4,8,16 and 20 hours for 2026 days 140 to 145 with 48 kHz resolution.