EDGES MEMO #430

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To: EDGES group
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Subject: Study of the source of occasional strong RFI bursts in EDGES data

Occasional strong RFI bursts of uncertain origin have been seen in EDGES data. Their origin has been attributed to lightning, local welding operations, solar flares and VHF radiation from an "AKR-like" plasma instability in the upper ionosphere.

The latest case of these bursts has been observed in the EDGES-3 data from the WA where we are now seeing strong RFI bursts every day of the week, including Sunday. It was thought that they are probably from local welding operations but further study suggests that they not are from welding so other possible sources are being explored. For example when 4 physical terms are fit to the spectra high electron temperatures are obtained as might be expected from the heating of the electrons involved in the Auroral Kilahertz Radiation (AKR).

for example at 2023:246:05:39:04

t75 = 4525.197K
spec index = -1.8
ion abs = -7%
electron temp = 2874271K

In general I get a large variability in the index, ion abs and electron temperature but I would expect this to be the case for any major disturbance of the ionosphere. I looked at day 246 (3 September 2023) which is a Sunday using

https://www.spaceweatherlive.com/en/archive/2023/09/03/aurora.html

and the only high numbers I saw at 6 UT were for Bz magnetic field at 5 nT. There was a solar burst 3 Sep 23 M6.01 at 09 UT but there no burst in the data anywhere close to 09 UT. A burst which has been identified as a solar burst is seen in the Devon Island data. Figure 1 of memo 397 shows Waterfall plot of the data from day 229 17 August 2022 showing solar burst which is identified as being from M2.05 14.5 hrs.

Lightning is known to produce very strong short radio bursts but these are typically too short to have a significant effect on longer time scales. Nearby lightning effects are shown in memo 325. These short bursts saturate the ADC and have little effect on the spectra when the saturated ADC samples are excluded.

We can't rule out lightning and I note that the occurrence typically peaks in the summer around noon local time. See figure 13 of memo 144 for some sample spectra taken by Raul in Nevada in 2014. These bursts were attributed to lightning and the color waterfall plot before RFI excision looks similar what we are now seeing at the WA. The RELAMPAGO Lightning Mapping Array (Lang et al 2020)

which operates with stations at at 60-66 MHz shows an activity area that runs for about 10 minutes in figure 12 of Lang et al. during which there could have been a flash rate of about ten per second so that individual pulses would not be resolved by EDGES. For distant lightning the ADC might not saturate on the individual pulses and effectively make the distribution of many flashes over a large area look like long duration burst. Another possibility is that the long duration could be from a "Megaflash" of lightning as reported by Peterson et al. 2020. These are long duration lightning discharges over distances of hundreds of kilometers seen in the analysis of Geostationary Lightning Mapper satellite data.

Figure 1 shows the water fall plot of a recent burst from the EDGES-3 at the WA. In this case the strong burst which peaks with over 4000K added to the foreground at 5.26 UT is followed by several smaller bursts at 5.34, 5.5.35 and 5.36 UT. The spectra with 2 physical terms removed from each 3-position cycle are shown is Figure 2.

Bursts that look similar to the recent bursts from the WA are seen in the 2016_330 data from the EDGES-2 lowband at the WA and the waterfall plot and spectra are shown in Figures 3 and 4.

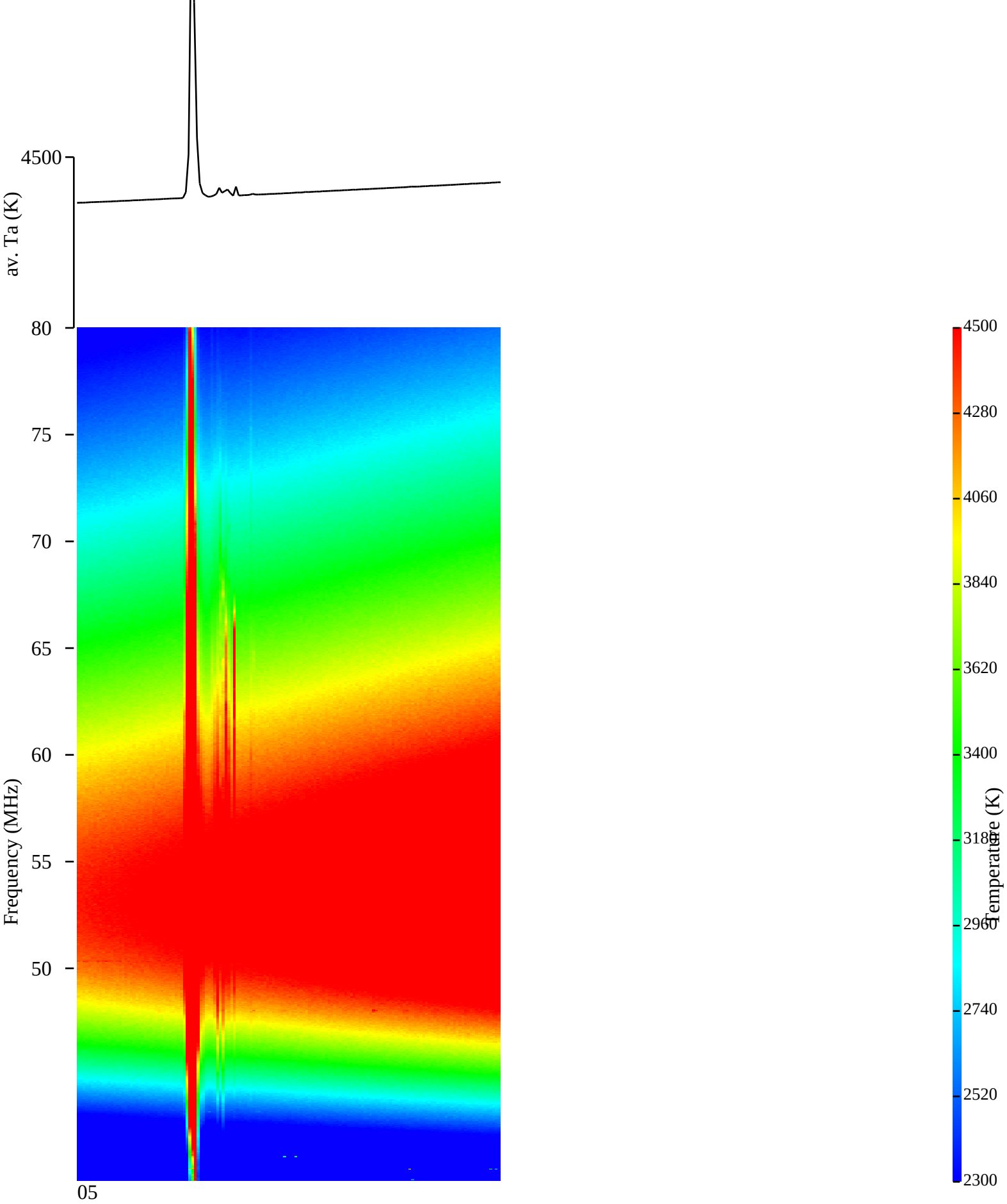
Conclusions

The origin of the bursts are unclear and there is a large amount of EDGES data which could be analyzed and correlated with data on solar flares, lightning and satellite AKR measurements. The possibility that the bursts are from welding operations will be checked with the personnel at the WA.

References:

Lang, T.J., Ávila, E.E., Blakeslee, R.J., Burchfield, J., Wingo, M., Bitzer, P.M., Carey, L.D., Deierling, W., Goodman, S.J., Medina, B.L. and Melo, G., 2020. The RELAMPAGO lightning mapping array: Overview and initial comparison with the geostationary lightning mapper. *Journal of Atmospheric and Oceanic Technology*, *37*(8), pp.1457-1475.

Peterson, M.J., Lang, T.J., Bruning, E.C., Albrecht, R., Blakeslee, R.J., Lyons, W.A., Pédeboy, S., Rison, W., Zhang, Y., Brunet, M. and Cerveny, R.S., 2020. New World Meteorological Organization certified megaflash lightning extremes for flash distance (709 km) and duration (16.73 s) recorded from space. *Geophysical Research Letters*, *47*(16), p.e2020GL088888.



UT 5.00 to 6.00

data: 2023_280

Mon Oct 9 11:16:23 2023

fstart 40 fstop 80 pfit 0 smooth 8 resol 49 kHz rfi 0.0 nline 153 secint 978

Figure 1. Waterfall plot of data from 2023_280 5 to 6 UT.

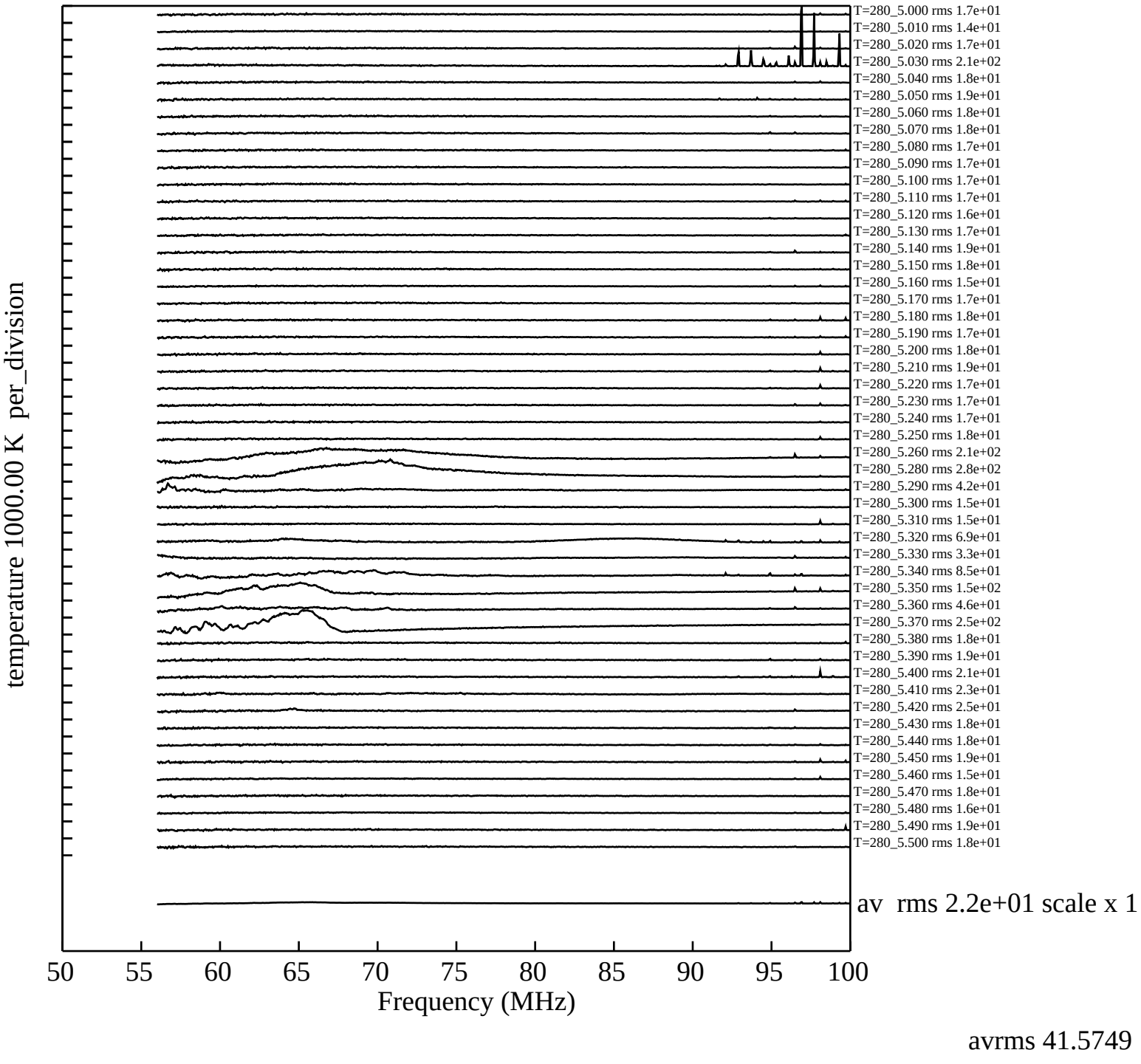


Figure 2. Calibrated spectra of each 3-position switch cycle from 5.0 to 5.5 UT with 2 physical terms removed.

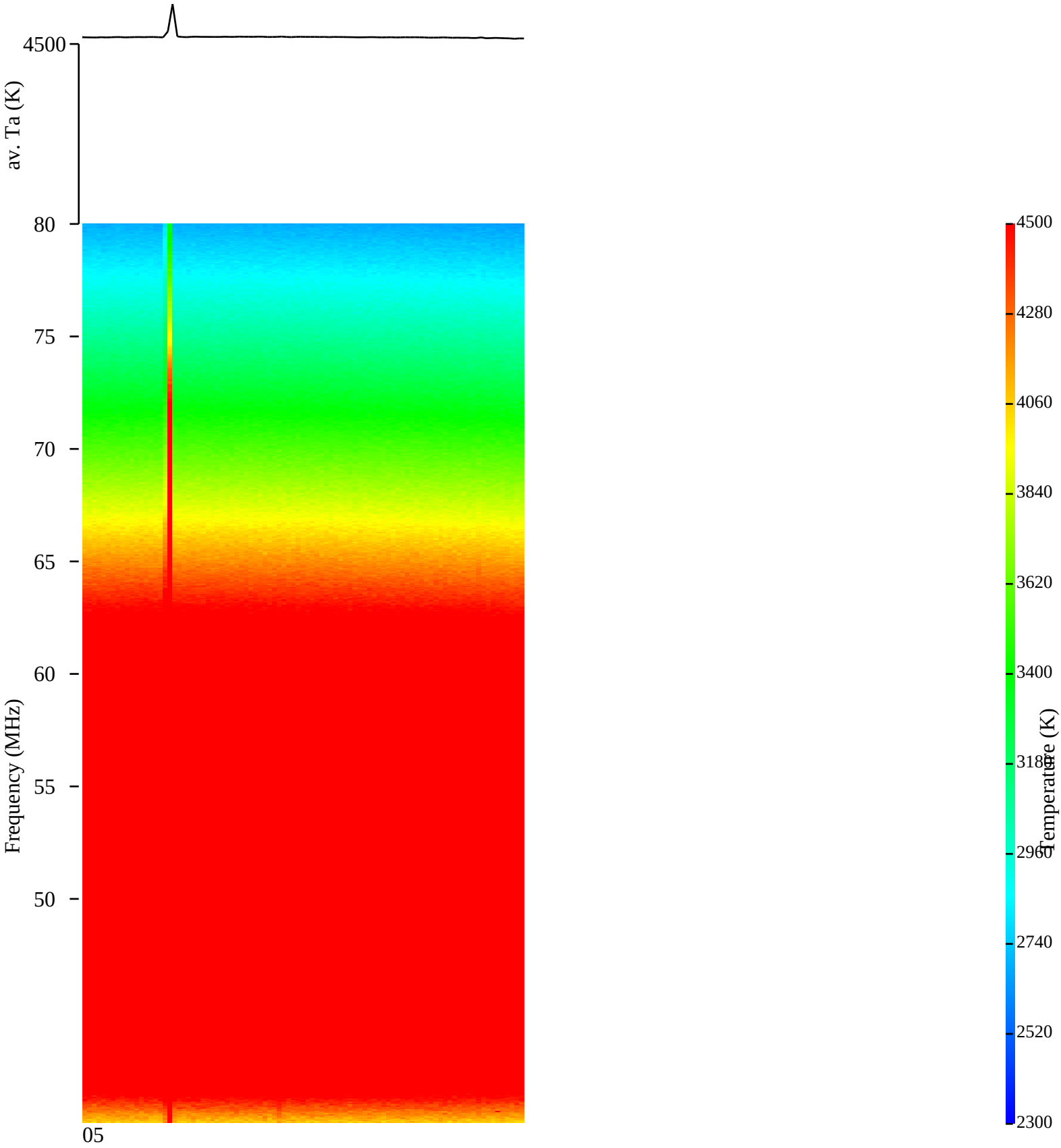


Figure 3. Waterfall plot from 2016_330 5 to 6 UT

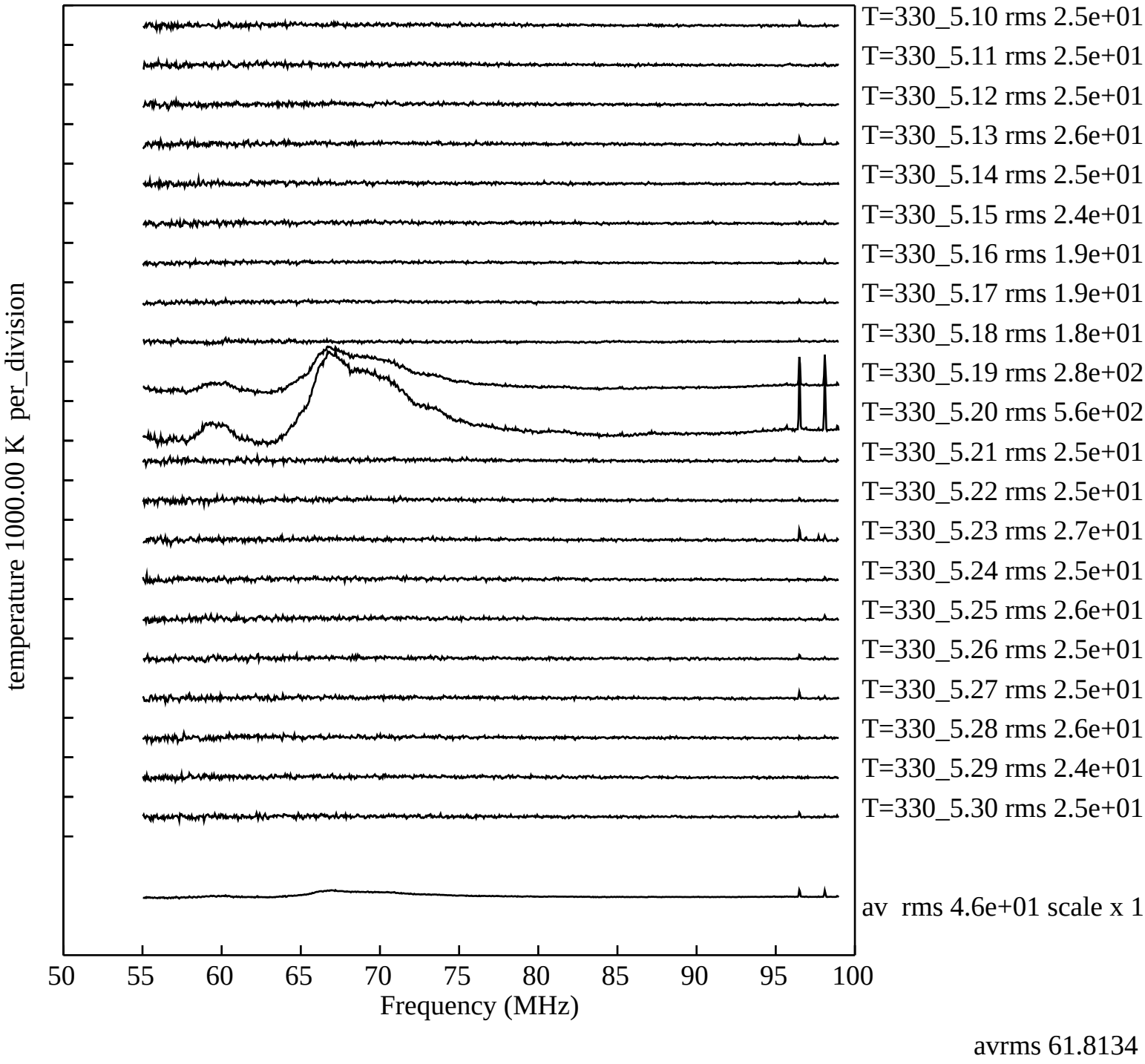


Figure 4. Calibrated spectra of each 3-position switch cycle from 5.0 to 5.3 UT with 2 physical terms removed.