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To: EDGES group

From: Alan E.E. Rogers

Subject: Tests of parameters used in analysis of EDGES-3 data from 2026

A test of the sensitivity to changes in the processing parameters from day 76 to 96 of 2026 of EDGES-3 data from the WA was made starting with the following parameters:

Antenna beam: azelq_box_perf_48_2e-2.txt

Antenna beam fit: -bfit -12

Antenna azimuth: 269 deg

Calibration: specals_210opt.txt 2023_210 30C - second entry in table 1 for test

Calibration: specal_316test.txt 2022_316 35C - used in table 1

Antenna s11: s11ant286.csv following strap change in 2023

GHA range: 1 hour blocks

Sun elevation limit: -30 deg

key acqplot parameters: -rfi 2.1 -smooth 8 -maxfm 2000 -maxrmsf 200 -nrfi 2 -fstart 56 -fstop 114

key edges3 parameters: -mfit 3 -wfstart 56 -wfstop 104 -fbstart 56 -fbstop 104 -nfit4 12

longav: -lim 0.35

Table 1 lists the tests using the data from 2026 day 76 to 96 that were made to check that the calibration which was last made just prior to the VNA failure on day 308 of 2023. All the tests, except the last were made using 1 hour blocks of all GHA for which the sun is below -30 degrees in elevation. The last test was made using one hour blocks GHA (00 01 02 22 23) which are below -30 degrees from 2025 from day 101 to 201. This was done to check that the calibration is still good enough to get a result consistent with the 2018 result. More data was needed to get a significant SNR owing to the factor of two increase in noise from the region of the galactic center.

Center MHz	SNR	amp K	width MHz	rms1 mK	rms2 mK	range	tsky K	comments	change
77.5	20	0.65	22.8	66	32	60-102	2327	map	Guzman 45 MHz
78.7	18	0.57	20.1	57	32	60-102	2335		specals_210opt
78.7	19	0.62	20.1	60	33	60-102	2566	map	Haslam 408 MHz
77.9	17	0.69	21.7	71	38	60-102	2362	rfi	3.1
77.5	19	0.66	22.9	67	32	60-102	2381		-bfit 1
77.5	14	0.61	22.9	65	40	60-102	2270	sunlim	no sunlim
77.5	18	0.61	22.9	71	32	60-102	2357		no beamcorr
79.8	8	0.32	22.9	59	35	60-102	2327		subtraction test
76.7	8	0.53	21.7	71	53	60-102	4381	galaxy.up	2025 day 101-201

Table 1. Tests of ability to get the 21-cm absorption along with some tests

All the tests in table 1 used a value of tau = 4 which in general results in a more significant detection than the larger flattening tau = 7 reported in 2018. All except the last entry in table 1 used an rms limit

of 0.35 K to filter the 1 hour blocks. A limit of 0.5 K was used for the last entry owing to the higher sky noise. Antenna beam fit using -bfit -12 makes a small improvement over -bfit 1 for no fit.

Another test of the consistency of the EDGES-3 following the failure of the VNA in late 2023 was to compare the results of using only 4 physical terms in table 2 which follows:

Center MHz	SNR	amp K	width MHz	rms1 mK	rms2 mK	range MHz	
77.3	37.2	0.61	22.3	78	22	57-104	Memo 466 fig 5 2024 300-360
79.3	33.5	0.54	19.4	83	26	57-104	Memo 475 fig 1 2025 1-80
79.3	34.8	0.65	20.3	103	31	57-106	2025 1-80 -nfit 4
77.7	10.5	0.66	23.7	33	22	60-95	2026 1-106 -nfit 4

Table 2. EDGES-3 results from WA using 4 physical terms.

It was found that while a result using only 4 terms for a reasonable global 21-cm spectrum from 2023, 2024 and 2025 was obtained the data from 2026 required 5 terms except for the last case in table 2 for which a 21-cm result was obtained with 4 terms using a reduced frequency range.

It was found that at least in the range of the current data up to day 100 the effects of the sun in 2026 are more significant. Figure 1 compares the residuals with 4 terms removed for the spectra from GHA = 12 from 55 – 105 MHz from day 1 to day 33 when the sun is more than 30 degrees below the horizon. In general the residuals in 2026 have a larger contribution from the sun at 60 MHz and a higher residual. The data from day 17 to 29 is missing owing to a lost of connectivity with the receiver but even if this data was present it would probably be necessary to use 5 terms for a reasonably result.

Memos 441 and 449 discuss the use of the maxrmsf parameter in the c-code acqplot function which sets a limit on the rms of the smoothness of the spectra from a single 3-position switch cycle. The nominal setting of maxrmsf is 200 but in some cases when there are “spikes” in the spectra a small improvement can be made using the lower value of 50 for maxrmsf.

The global 21-cm absorption results with 4 terms removed shown in memo 484 are consistent with the calibration made in 2023 continues into 2024 and into 2025 up to 2025 day 163 but based on the data after 2025 day 163 there could have been a change which requires reducing the frequency span or using 5 terms. The cause of the change is not clear. Possible causes could be an increase in solar emissions, “STEVE” emissions, change in antenna s11, or antenna loss due to corrosion due to moisture. An increase of rms from one day to the next over all GHA consistent with a change in calibration, antenna s11 or loss is not found so that a source of emission is needed to account for the increased residuals. Currently there is no published evidence of VHF radio emission from “STEVE” events as these events have mainly been seen optically so if the emissions are from “STEVE” it might be the first detection. Otherwise the emissions seen by EDGES could be Electron Cyclotron Maser Emissions (ECME) as discussed in memo 455.

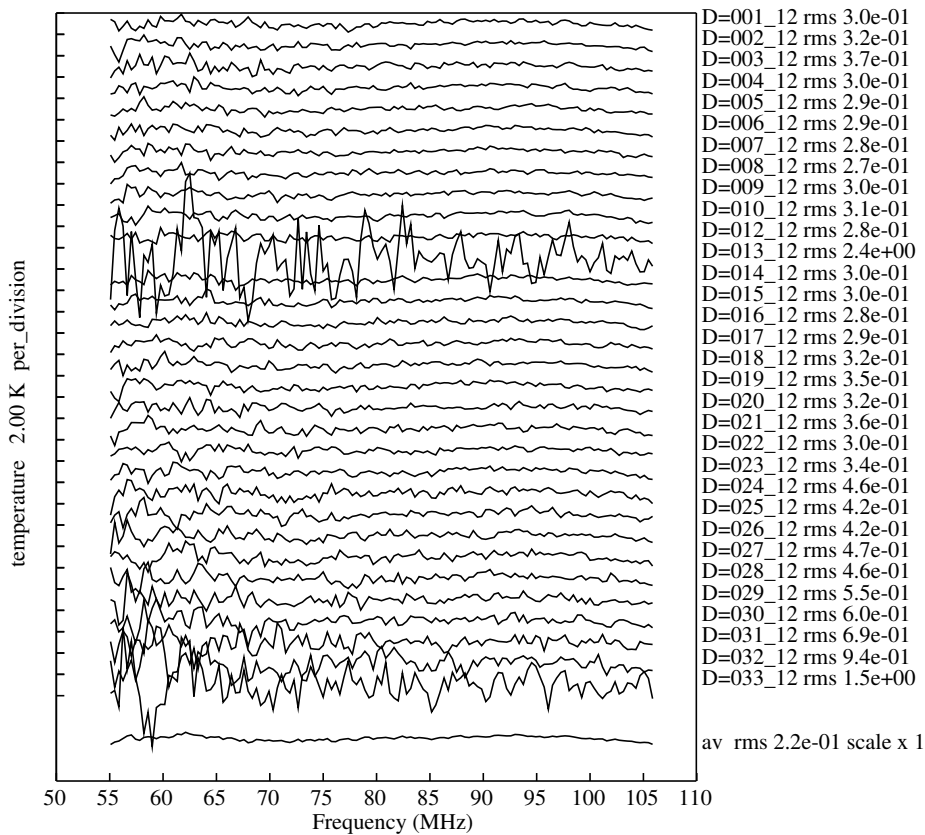
Figure 2 shows the 4 term residuals for data averaged over the 8 hours centered at GHA 22 hours that are more than 40 degrees below the horizon. These residuals show an increase in the emissions or RFI in 2025 day 45-75, 2025 day 200-250 and 2026 day 50-60 dropping back to the low residuals at 2024 day 51-240, 2025 day 75-200 and 2026 day 50. The first digit following “D=” in the plot is the last digit of the year.

Figure 3 zooms in on the data from 2025 days 244, 245 and 246 and compares 4 term residuals for 1 hour blocks of GHA with the sun below -40 deg and below 0 deg. The emissions seen with the sun below -40 deg are centered at 60 MHz and are strongest at GHA 3,4 and 5 hours. The emissions with the sun just below horizon move down in frequency with time and are strongest at GHA 23,0,1 and 2 hours. This change in frequency with GHA is on a time scale of hours compared with the frequency change on a time scale of minutes seen in the solar burst shown in memo 453.

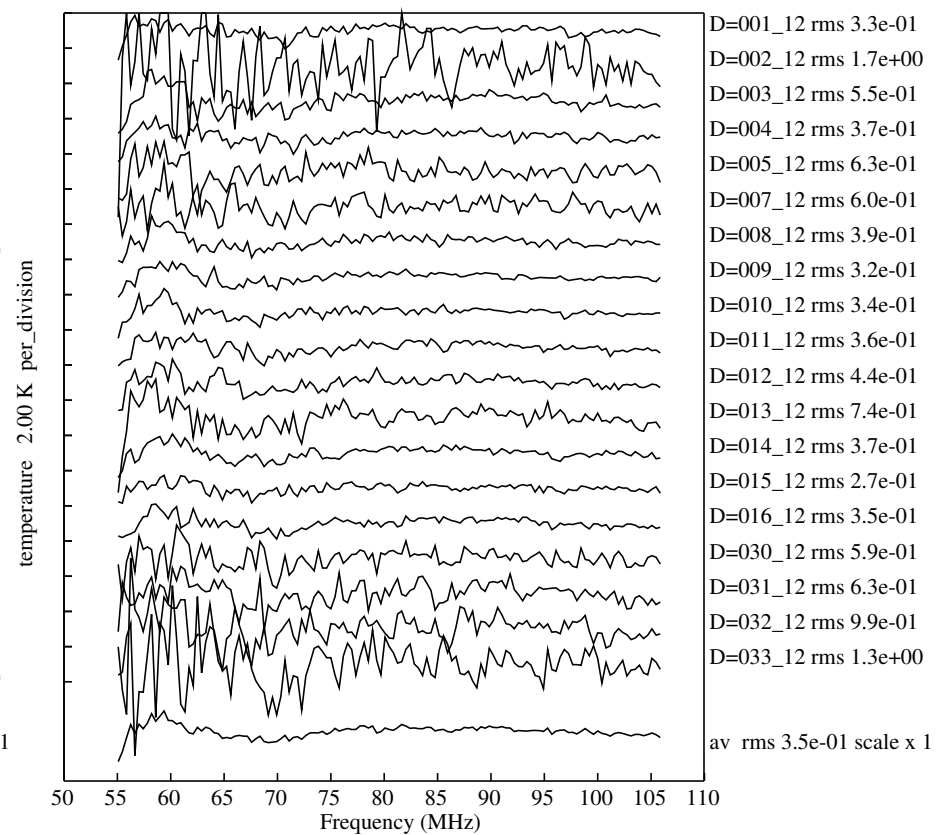
In summary these nighttime emissions could be due to Strong Thermal Emission Velocity Enhancement emissions known as “STEVE” or “ECME” via added propagation since these phenomena are probably both driven by high-energy solar coronal mass ejection events.

The residuals in both plots of figure 3 also show a sharp dip at the low end of the spectrum which could be due to the increase in the attenuation of the ionosphere below 57 MHz but there are times between the periods of activity that are flat at the low end of the spectrum.

The results in table 1 and 2 and in table 1 of memo 502 add to the list of results consistent with 2018 global 21-cm spectrum listed in memo 481.



avrms 0.4815



avrms 0.5931

Figure 1. Spectra with 4 terms removed for 1 hour blocks at GHA = 12 for 2025 on the left and 2026 on the right.

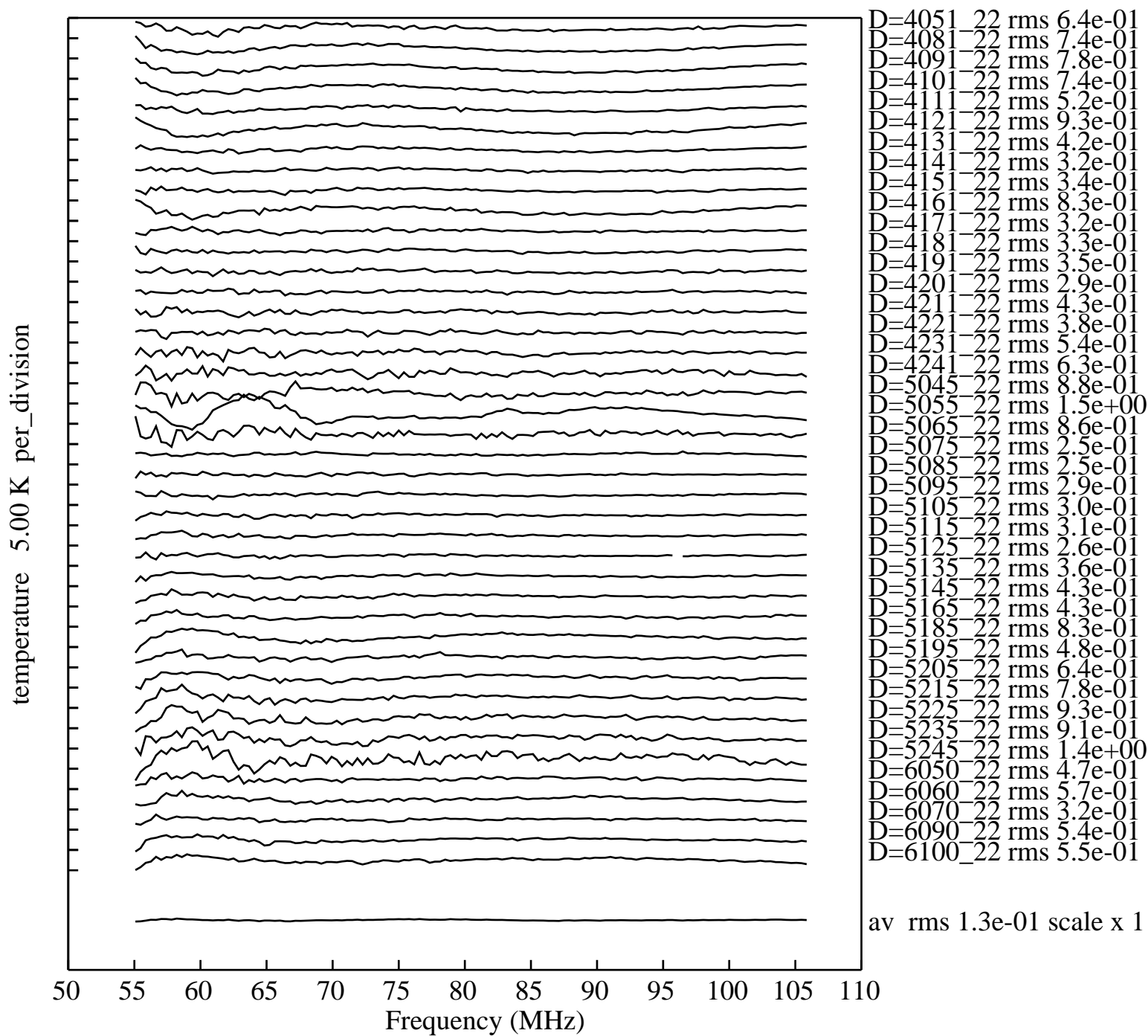
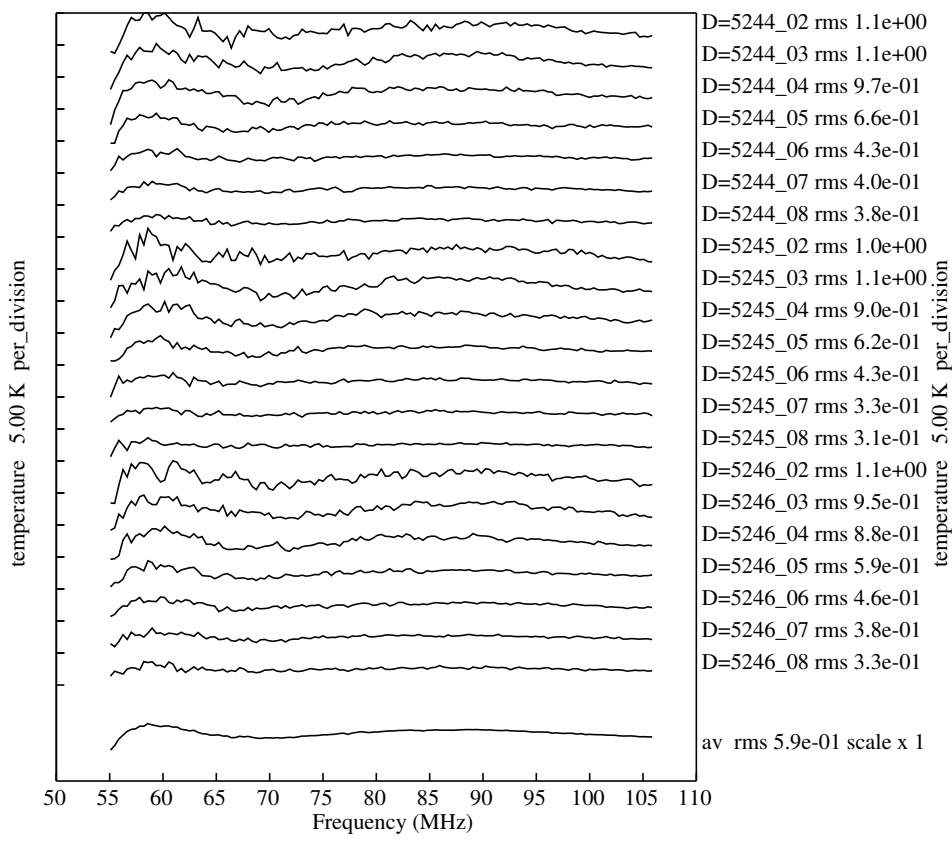
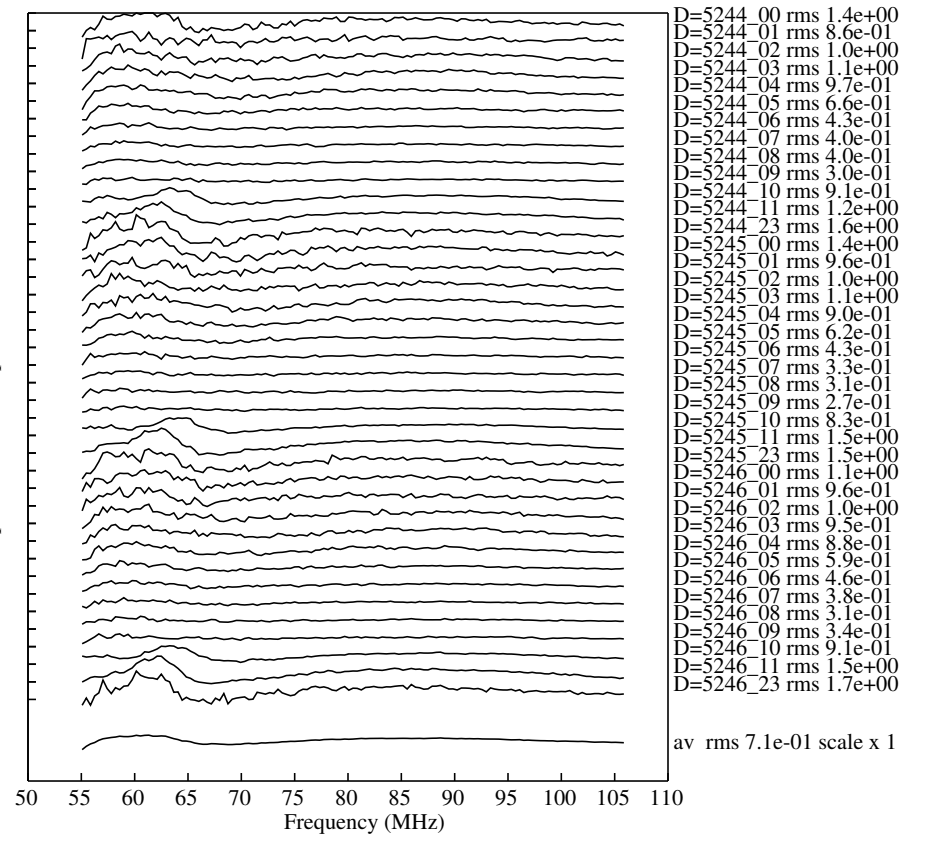


Figure 2. Spectra with 4 terms removed for GHA = 22 from 2024 to 2026 in 10 day steps for data with the sun's elevation below -40 degrees.



avrms 0.6820



avrms 0.8539

Figure 3. Spectra with 4 terms removed from 2025 days 244, 245 and 246 with 1 hour blocks of GHA with the sun's elevation below -40 deg on the left and below the horizon at 0 deg on the right.