EDGES MEMO #487

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To: EDGES group

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Subject: Details of Analysis and tests of data from Adak using c-code pipeline

EDGES-3 data from Adak has been analyzed in memos 477, 478 and 479. Memo 477 shows the results of an analysis of the data from 2024 day 345 to 2025 day 92 and memo 478 extends the data to 2025 day 116 which was the last day of data. Memo 479 looks at the dependence of the results on the elevation limit set for the sun needed to avoid the solar emissions.

More checks have been made on the sensitivity to the sun's elevation limit for acceptance of a data block. Little difference is found between 20 and 25 degrees below the horizon as shown in table 1 of memo 479. Table 1 below shows the effects of number terms used for the fitting the antenna s11 which shows that 8 terms is not sufficient and 10 terms is the best choice but the selection is not critical. The last entry is for fitting the antenna s11 using a 37 term Fourier series which raises the rms owing to the presence of noise in s11 which is smoothed out when a polynomial is used.

center MHz	SNR	amp K	width MHz	rms1 mK	rms2 mK	s11 filter -nfit4 #terms	
79.3	17	0.58	17.5	45	20	10	-wfstart 51 -fstp 110
83.2	23	2.95	29.5	47	28	8	-wfstart 51 -fstp 110
79.3	18	0.61	17.6	40	20	9	-wfstart 51 -fstp 110
79.3	18	0.63	17.8	49	21	12	-wfstart 51 -fstp 110
79.3	16	0.55	17.4	43	21	11	-wfstart 51 -fstp 110
79.3	16	0.59	17.8	48	21	10	-wfstart 54 -fstp 110
79.3	16	0.57	17.3	43	21	10	-wfstart 51 -fstp 104
79.3	16	0.65	17.8	62	24	37	-wfstart 51 -fstp 110

Table 1. Effect of smoothing and filtering the antenna s11 used frequency range 60 to 98 MHz

The c-shell script is shown below with the values of the first entry in the table 1. All the results obtained from Adak were found to require 6 loglog polynomial terms, which is set by -nfit 6 and -sig 30 in longav, for a reasonable 21-cm absorption result. The results discussed in memos 477 and 478 show little sensitivity to beam correction and offsets in antenna and LNA s11. The need for 6 loglog polynomial terms is due to the large residuals with 3 or 4 terms removed shown in memo 465. These large residuals are a combination of changes in antenna s11 and loss on time scale of hours. In addition there are changes with time on a scale of 3 minutes shown figures 1 and 2 of memo 465 which are most likely due to scintillation of Cas A as studied for Adak in memo 463.

Similar effects of Cas A scintillation are seen in the EDGES-3 data from Devon Island which also requires the use of loglog polynomials are reported in memo 419 for which 5 terms only gets down to 64 MHz. A separate test on the data from Devon island using 6 loglog terms instead of 5 loglog used in memo 419 extends the grid search in figure 1 down to 62 MHz but with marginal SNR.

While tests of applying an antenna s11 offset correction to each block does reduce the residuals in the one hour blocks with 3-terms removed shown in figure 5 of memo 465 the results from Adak in table 1 above still require 6 loglog terms to obtain low rms2 residuals for frequency coverage down to 60 MHz.

Other tests which make small improvements set -nrfi 0 and lower -maxrmsf from 50 to 20 and the result of a grid search with these parameters along with a subtraction test with tau=4 shown in Figure 1. These small changes also allow a grid search over an increased frequency range which covers 58 – 98 MHz which is shown in Figure 2 which has the one hour block rms limit increased from 0.25 to 0.3K. These results are similar to those in figures 2 and 3 of memo 478 but have lower residuals.

```
#!/bin/csh -f
cp specal_test2.txt specal.txt   # best from /home/aeer/data/nuvo2/edges3/ADAK/adak/docalant_test
cp /home/aeer/cem_old_home/MWA_aeer/azelq_adak_cable_box29.txt azelq.txt
cp s11antav.csv s11ant.csv # from dos11antav
rm spesum.txt
foreach d (345 346 30 35 38 41 43 46 47 48 074 075 077 081 084 085 086 091 092 098 101 102 112
113 114 115 116) # 2024 for 345 346 others 2025
set fstp = 110 # was used in wide case
set d = `echo $d |awk '{printf("%3d",$1)} '`
rm temp_20
set yr = 2025
if($d <= 9) set day = `echo $d |awk '{printf("00%1d",$1)} '`
if($d <= 99 && $d > 9) set day = `echo $d |awk '{printf("0%2d",$1)} '`
if($d > 99) set day = `echo $d |awk '{printf("%3d",$1)} '`
if($d > 300) set yr = 2024
echo day $day year $yr
cat /home/aeer/data/nuvo2/edges3/ADAK/adak/ant/$yr/$yr\_$day*ant.acq >>! temp_20
foreach UT (00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23)
rm spe.txt
/home/aeer/data/nuvo3/edges3/acqplot7amoonc  temp_20 -tstart $UT -tstop $UT -rfi 2.1 -tcal 1000 -
pfit 37 -fstart 40 -fstop $fstp -smooth 8 -pkpwrm 40 -peakpwr 10 -minpwr 0.7 -nrfi 2 -dloadmax 1000 -
adcov 0.4 -maxrmsf 50 -maxfm 2000  -sunlim -20 -sunmin -90 -site 5 |grep zswpos\ 2 # sunlim -20
rm spe0.txt
/home/aeer/data/nuvo3/edges3/edges3g -fstart 50 -fstop $fstp -spant spe.txt -s11ant s11ant.csv -mfit 3 -
wfstart 51 -wfstop $fstp -lmode 1 -tant 283 -skymode 384 -antaz 240 -wtmode 100 -nfit4 10 -smooth -8
-mdd 4 -delayant  0.0e-12 -cmb 2 -ldb 0.0 -delaylna 0.0e-12 -adb -0.0 -delayant 0.0e-12 -test 8 -eoramp
-0.0 -eorwid 19 -eorcen 78 -tau 4 -site 5 -fbstart 50 -fbstop $fstp -bfit 1 -aloss 0.0  #  lmode 1 2.5”
echo DY= $day >>! spesum.txt
cat spe0.txt >>! spesum.txt
end
end
/home/aeer/data/nuvo3/edges3/longav spesum.txt  -lim 0.25 -nfit 6  -dmax 0.5  -fstart 60 -fstop 98 -
schk 0 -tchk 200 -rfi 0  -ti DY= -sig 30 -tau 4 -md 1 -seor -1 -pmode 0 -fsmax 85 -fsmin 75
# maxfreq  79.3 snrmax  17.1 sigmax  0.58 widmax  17.5 rmsin 0.0447 rms 0.0197 fstart  60.0 fstop
98.0 -sunlim -20
```

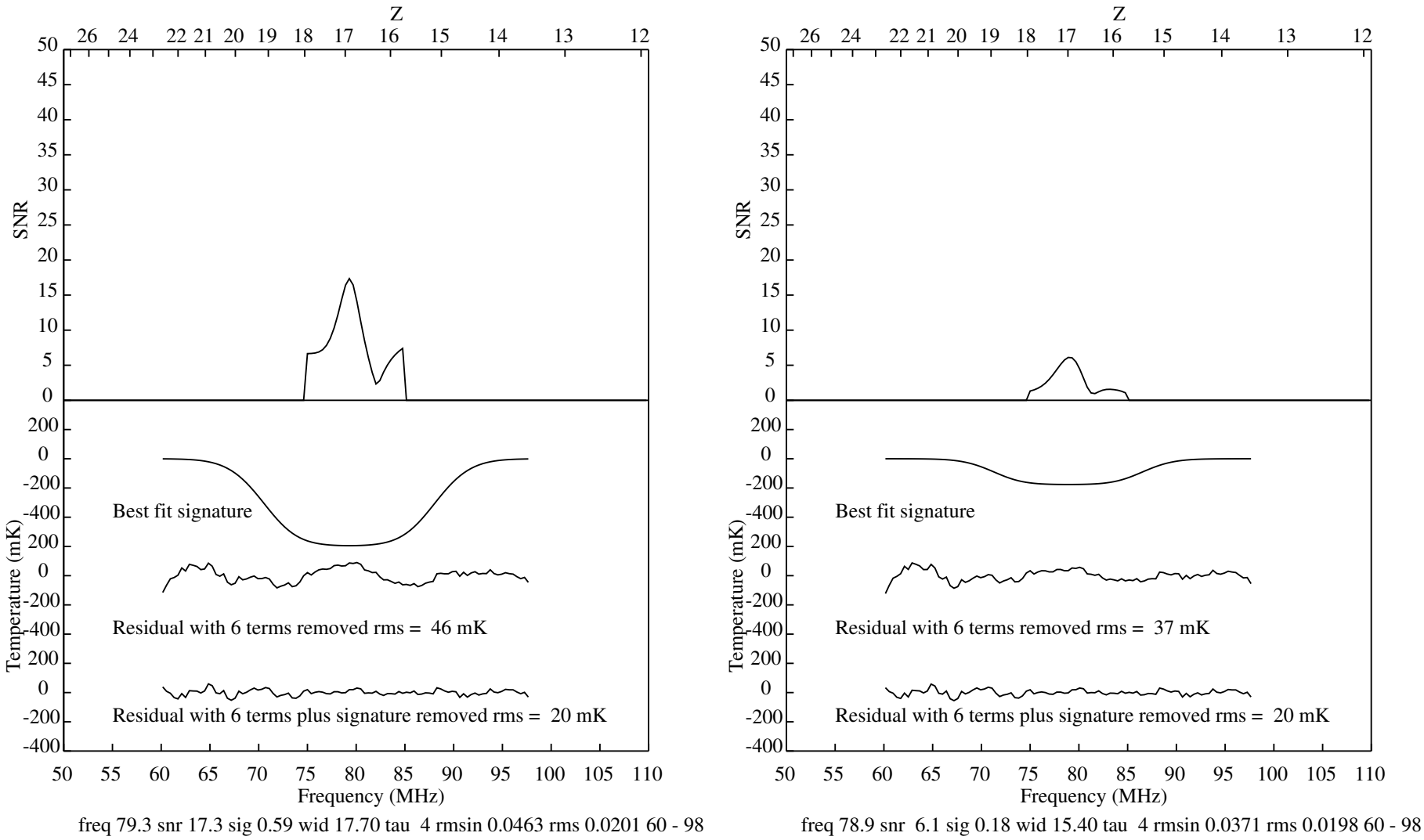
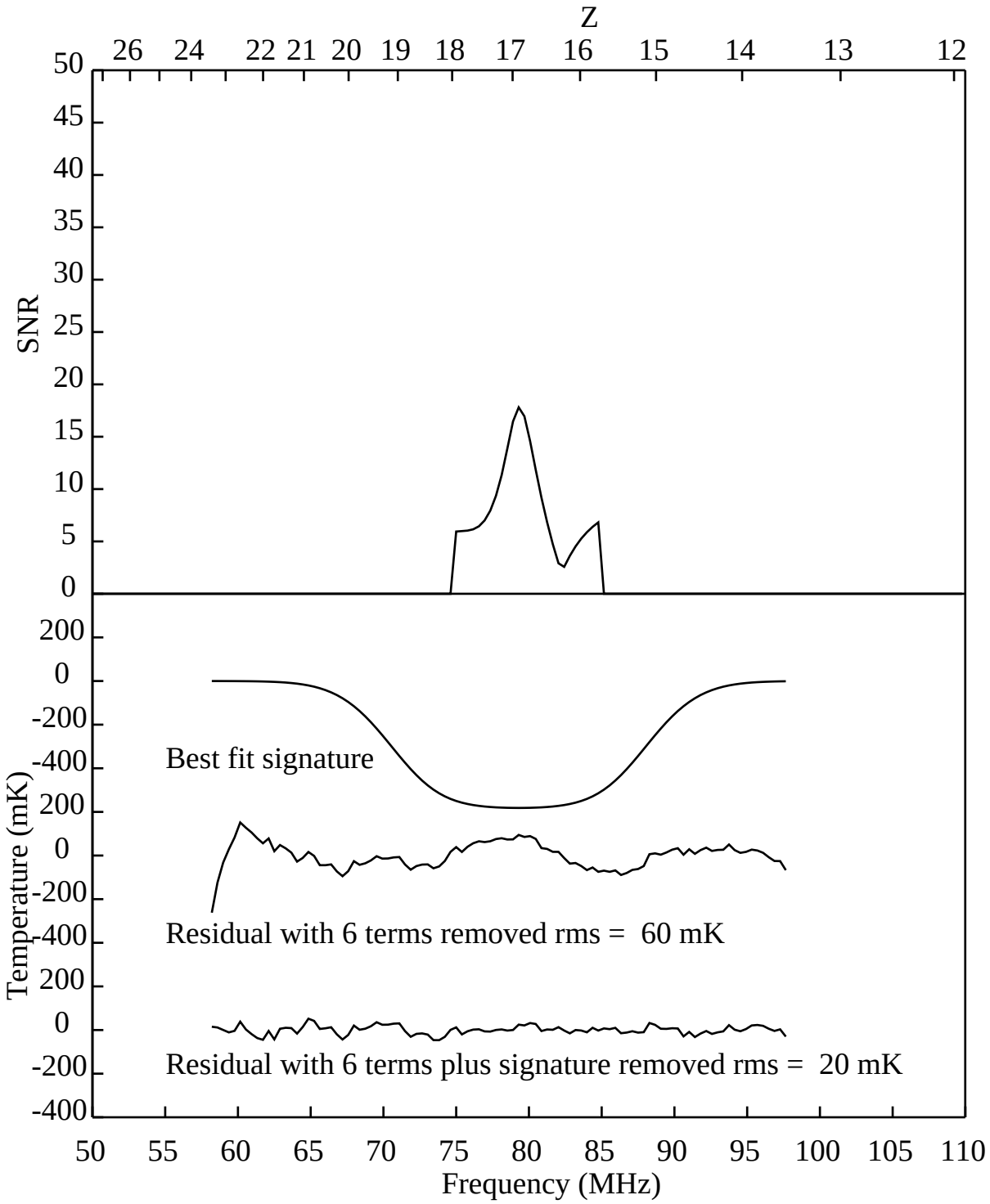


Figure 1. Grid search for global 21-cm spectrum on the left and subtraction test on the right



freq 79.3 snr 17.8 sig 0.58 wid 17.70 tau 4 rmsin 0.0596 rms 0.0199 58 - 98

Figure 2. Grid search for global 21-cm spectrum from Adak data from 2024 day 345 to 2025 day 116