EDGES MEMO #478

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To: EDGES group

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Subject: Tests of the sensitivity of Adak results to s11 errors, sun elevation limit and other tests

Given the changing environment at Adak it was found that consistent 21-cm absorption results could be obtained using 6 loglog polynomial terms to remove the effects of the foreground and residual instrumental error. While it was found that 6 terms were needed to cover 60 to 98 MHz the advantage of EDGES-3 at Adak is that it is deployed on a fairly large wire grid 50 × 25 meter meandering wire ground which is on the highly conductive flat moist ground of the decommissioned AN/FRD-10 radio direction finder area at 51.94339, 176.5986.

This large ground plane combined with the relatively small delay in the path from the antenna to the LNA of only 0.3 ns described in memo 373 results relatively smooth changes despite the large changes in the sky noise spectrum due to the weather and ionosphere shown in memos 471 and 477. Figure 1 shows residuals for each day with 6 loglog polynomial terms removed from 55 to 110 MHz for the average of all the data with the sun 20 degrees below the horizon. The extended frequency range shows the relative spectral smoothness and changes from day to day. The difficulty of getting data from each day was mainly the result of the great difficulty in maintaining the operation of the generator.

Tests of the effects of adding offsets to the antenna and LNA s11 have a relatively small effect on the results of a grid search for the 21-cm absorption. These results shown in table 1 are for 1 hour data blocks taken with the sun below 30 degrees elevation. In each case the data is analyzed in one hour blocks for which an rms acceptance limit is set on the residuals with 6 loglog polynomial terms removed. Changes are made in the frequency range, the value of tau in the absorption, the elevation limit of the sun and the range of days used. The rms residuals after the removal of 6 foreground terms and the best fit absorption profile from the grid search are rms1 and rms2 respectively.

center MHz	SNR	amp K	width MHz	rms1 mK	rms2 mK	range MHz	tau	sun limit	limit K	days	more details of tests
78.9	19	0.72	18.1	53	23	60-98	4	-30	0.24	345-92	
78.9	17	0.64	18.1	38	23	60-98	4	-30	0.24	345-92	0.5 dB to antenna s11
78.9	18	0.76	18.3	70	26	60-98	4	-30	0.24	345-92	-0.5 dB to antenna s11
78.9	19	0.74	18.0	58	22	60-98	4	-30	0.24	345-92	1 dB to LNA s11
78.9	19	0.72	18.2	49	22	60-98	4	-30	0.24	345-92	-1 dB to LNA s11
78.9	18	0.73	17.9	67	24	60-98	4	-30	0.24	345-92	1 ns to antenna s11
78.9	20	0.74	18.4	42	22	60-98	4	-30	0.24	345-92	-1 ns to antenna s11
78.5	18	0.80	19.0	65	27	60-98	4	-30	0.24	345-92	1 ns to LNA s11
78.9	19	0.67	17.9	40	21	60-98	4	-30	0.24	345-92	-1 ns to LNA s11
78.9	19	0.45	18.0	53	23	60-98	7	-30	0.24	345-92	fit using tau = 7
78.9	19	0.73	18.1	52	22	60-98	4	-30	0.24	345-98	98 is last day for -30
78.9	19	0.68	17.7	46	21	60-98	4	-25	0.24	345-113	113 is last day for -25
79.3	15	0.54	17.7	43	20	60-68	4	-20	0.24	345-116	-20 sun limit for all days

79.3	18	0.60	17.8	47	20	60-98	4	-20	0.30	345-116	effect of higher limit
78.9	16	0.60	21.5	63	25	60-100	4	-20	0.50	345-116	to get wider bandwidth
78.5	20	0.69	22.7	87	24	58-100	4	-20	0.80	345-116	even wider bandwidth

Table 1. Results for effect of offsets in antenna and LNA s11 along with other changes.

In summary these tests show that there is little sensitivity to s11 error when 6 loglog terms are used and there are small improvements in the results reported in memo 477 by including from the days following day 92 up day 116 which was the last day obtained. Figures 2 and 3 show the plots for the grid search for the last two entries in Table 1.

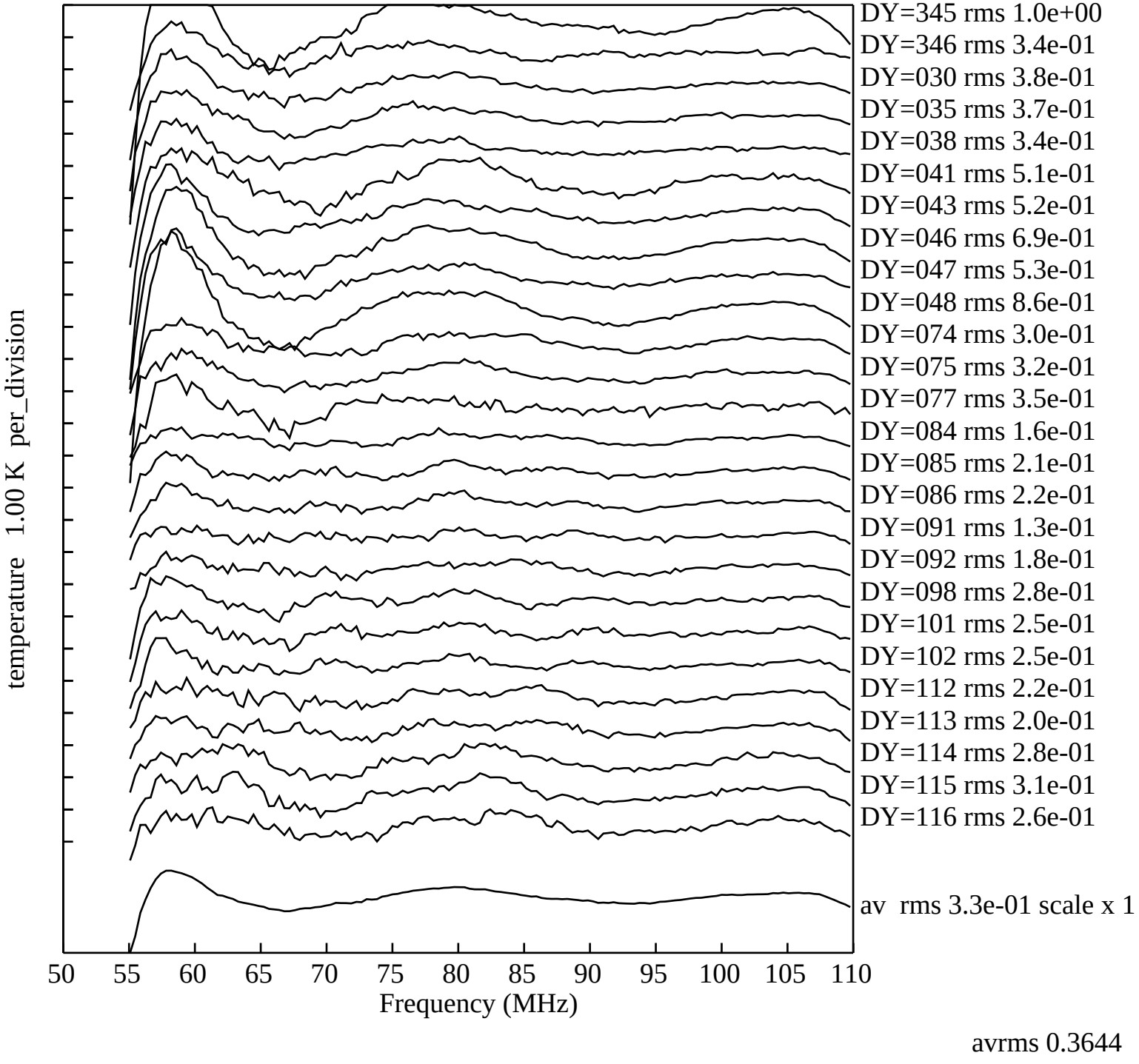
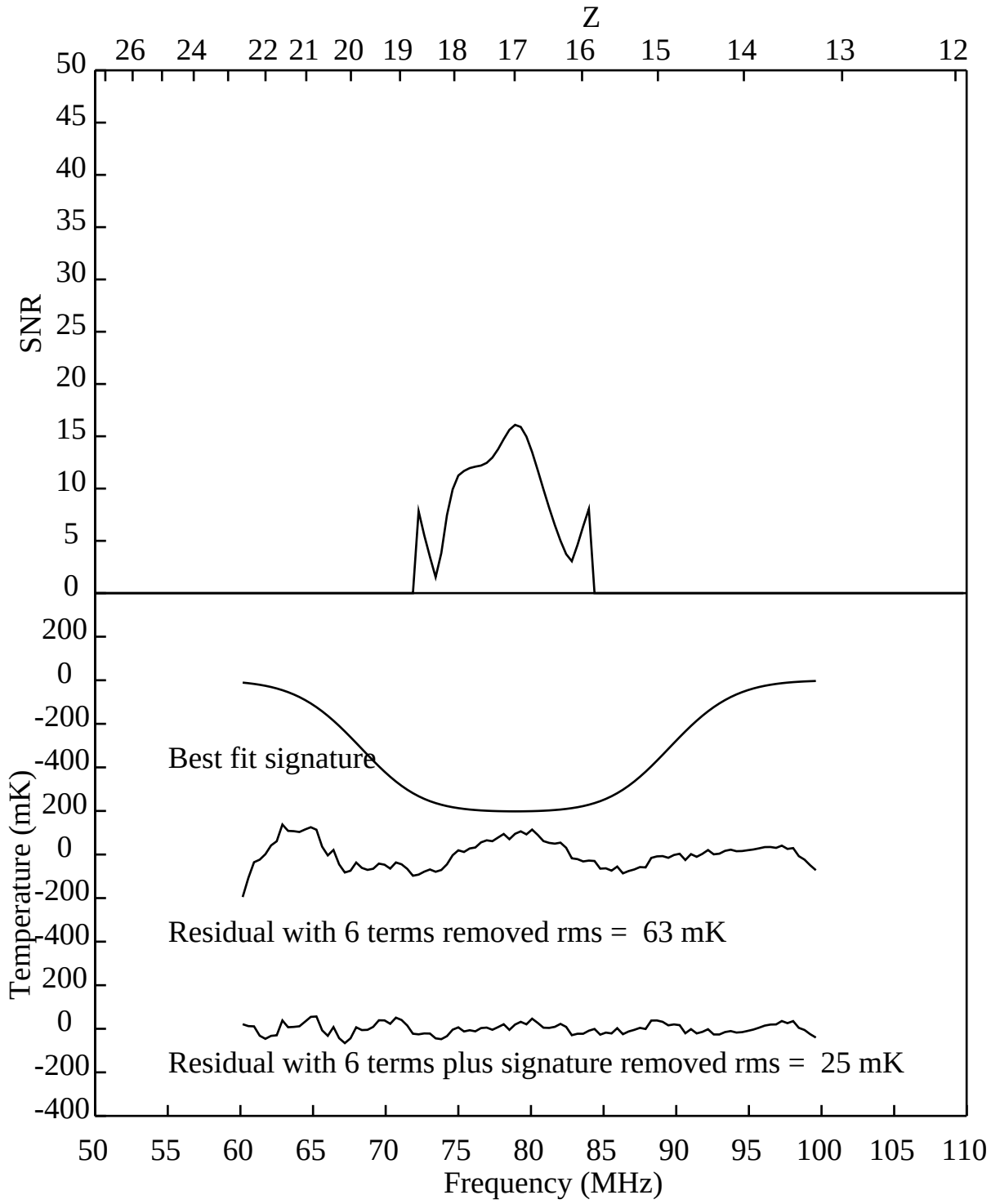
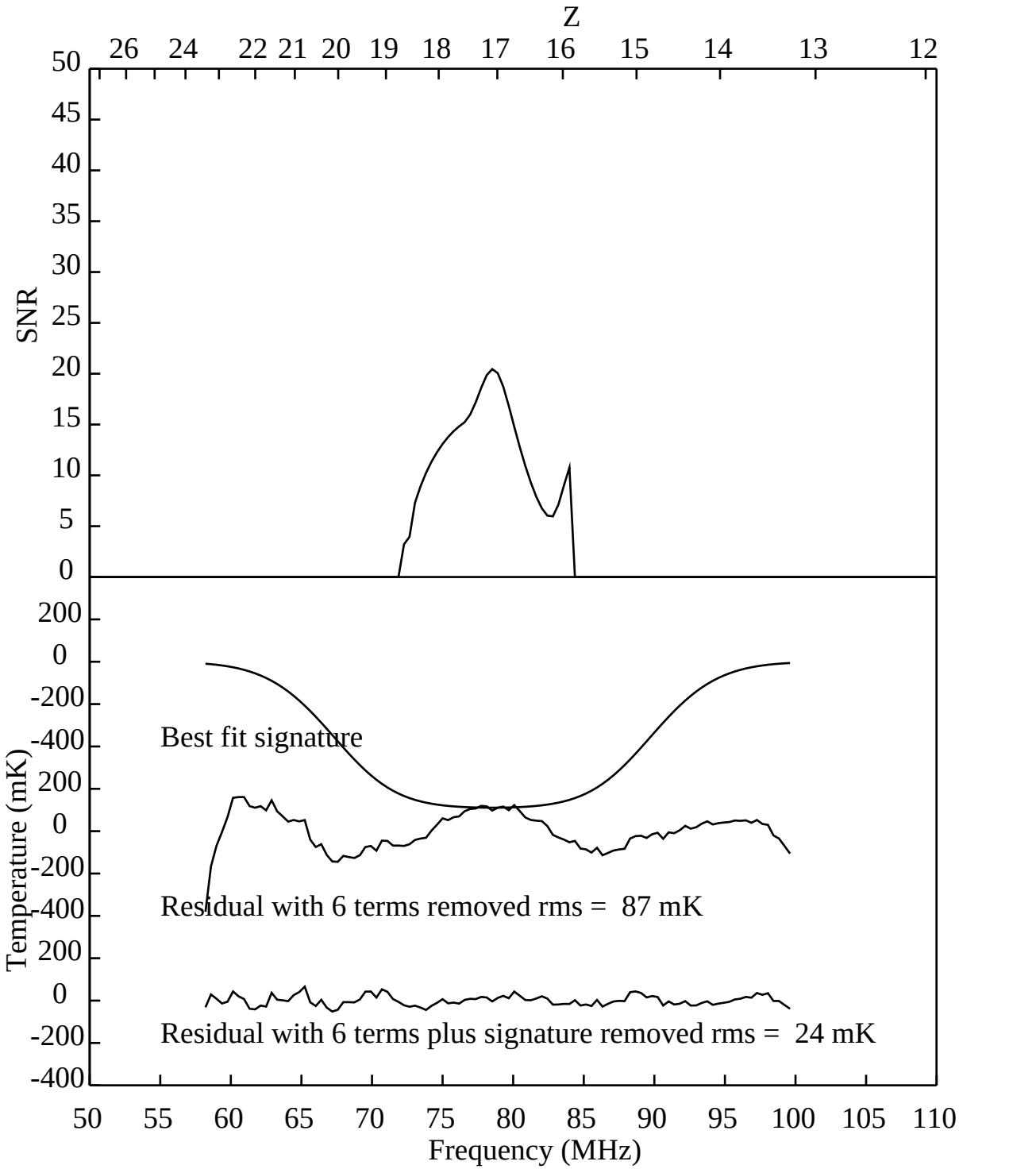


Figure 1. Data from 2024_345 to 2025_116 averaged over time with sun below -20 degrees



freq 78.9 snr 16.1 sig 0.60 wid 21.50 tau 4 rmsin 0.0627 rms 0.0252 60 - 100

Figure 2. Plot of 21-cm absorption obtained from 60-100 MHz in table 1.



freq 78.5 snr 20.4 sig 0.69 wid 22.70 tau 4 rmsin 0.0870 rms 0.0239 58 - 100

Figure 3. Plot of 21-cm absorption obtained from last entry in table 1.