EDGES MEMO #346

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
HAYSTACK OBSERVATORY
WESTFORD, MASSACHUSETTS 01886

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Telephone: 617-715-5533
Fax: 781-981-0590

To: EDGES Group

From: Alan E.E. Rogers

Subject: Tests of the number of terms needed to adequately model the lowband foreground

The number of terms needed to adequately model the foreground for the high band was studied in memo 170 using the Haslam map at 408 MHz and measured spectral index changes described in memo 160. In this memo analysis is made for lowband 52 to 99 MHz. The effects of spectral index variations across the sky are included by making a sky map with a spectral index at each of the 512x1024 pixels derived from the ratio of the 45 from Guzman and 408 MHz map at that pixel.

case	GHA hr	Freq MHz	Sig K	Width MHz	Rms1 K	Rms2 K	tau	# terms
A	0	65.6	2.21	27.2	0.039	0.008	0	5
A	0	92.2	0.18	10.4	0.039	0.015	7	5
A	0	70.7	2.24	29.9	0.018	0.002	0	6
A	0	83.2	0.26	29.9	0.018	0.002	7	6
A	12	82.4	0.20	29.9	0.005	0.000	0	5
A	12	80.5	0.02	17.1	0.005	0.002	7	5
B	0	63.7	3.18	17.1	0.232	0.013	0	5
B	0	66.0	1.14	12.7	0.232	0.077	7	5
B	0	62.5	7.06	20.5	0.094	0.007	0	6
B	0	75.8	1.48	29.6	0.094	0.015	7	6
B	12	89.1	0.27	19.3	0.012	0.004	0	5
B	12	66.0	0.06	11.3	0.012	0.005	7	5
C	0	69.9	0.30	15.6	0.048	0.026	7	5
D	0	77.7	0.13	10.0	0.048	0.035	7	5
E	0	78.1	0.68	18.5	0.111	0.029	7	5

Table 1. Simulations of effects of the foreground vs number of terms

Table 1 shows the parameters of absorption profiles obtained from the convolution of the sky map with the antenna beam model for low2-45 on an infinite metal ground plane for case A and a 30x30m ground plane on soil with dielectric 3.5 and conductivity 4e-2 S/m for case B.

The columns labeled Freq Sig Width are the best fit values for an absorption signal center frequency, strength and width. Rms1 are the rms values of the residuals when only the foreground is fit while

Rms2 are the residuals for the fit with polynomial terms plus an absorption with flattening parameter tau where tau = 0 is a Gaussian without any flattening. It is noted that significant "false" absorption signals are obtained at GHA = 0 hours while at GHA = 12 hours the effects are relatively small.

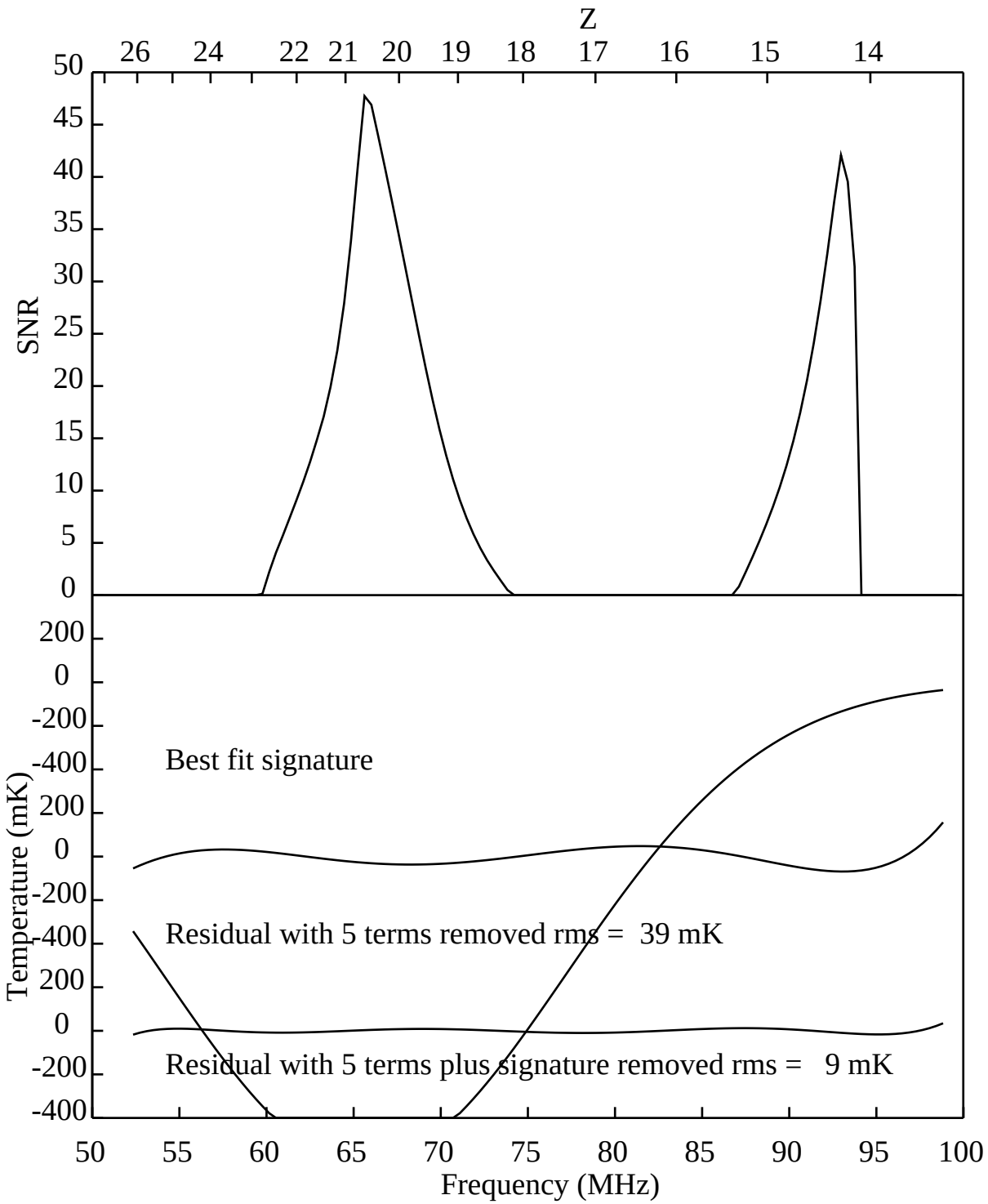
Figure 1 shows the result for case A with a 5-term polynomial to fit the foreground and a search for a Gaussian absorption with tau = 0 at GHA = 0. For case A at GHA = 0 using 6 terms to fit the foreground reduced the absorption signals which result from an insufficient number of terms to fit the foreground but it is later found that 5 terms are sufficient when averaging over 4 hours of GHA .

In case B there is a large increase in the frequency dependence of the beam and the systematics present in the beam convolved with the frequency dependent sky map increase substantially at GHA = 0.

In case C, which also uses the more complex beam for the antenna on a 30x30m ground plane on soil, the effects of the frequency structure in the foreground around the transit of the Galactic center are reduced by averaging over 4 hours centered at GHA = 0. In case D a beam correction using the normalized convolution of the beam with the Haslam map with constant spectral index is applied to case C for a further reduction in systematic error. In case E the EDGES absorption reported in Nature is added to the spectrum the map along with 35 mK noise per 95 kHz channel.

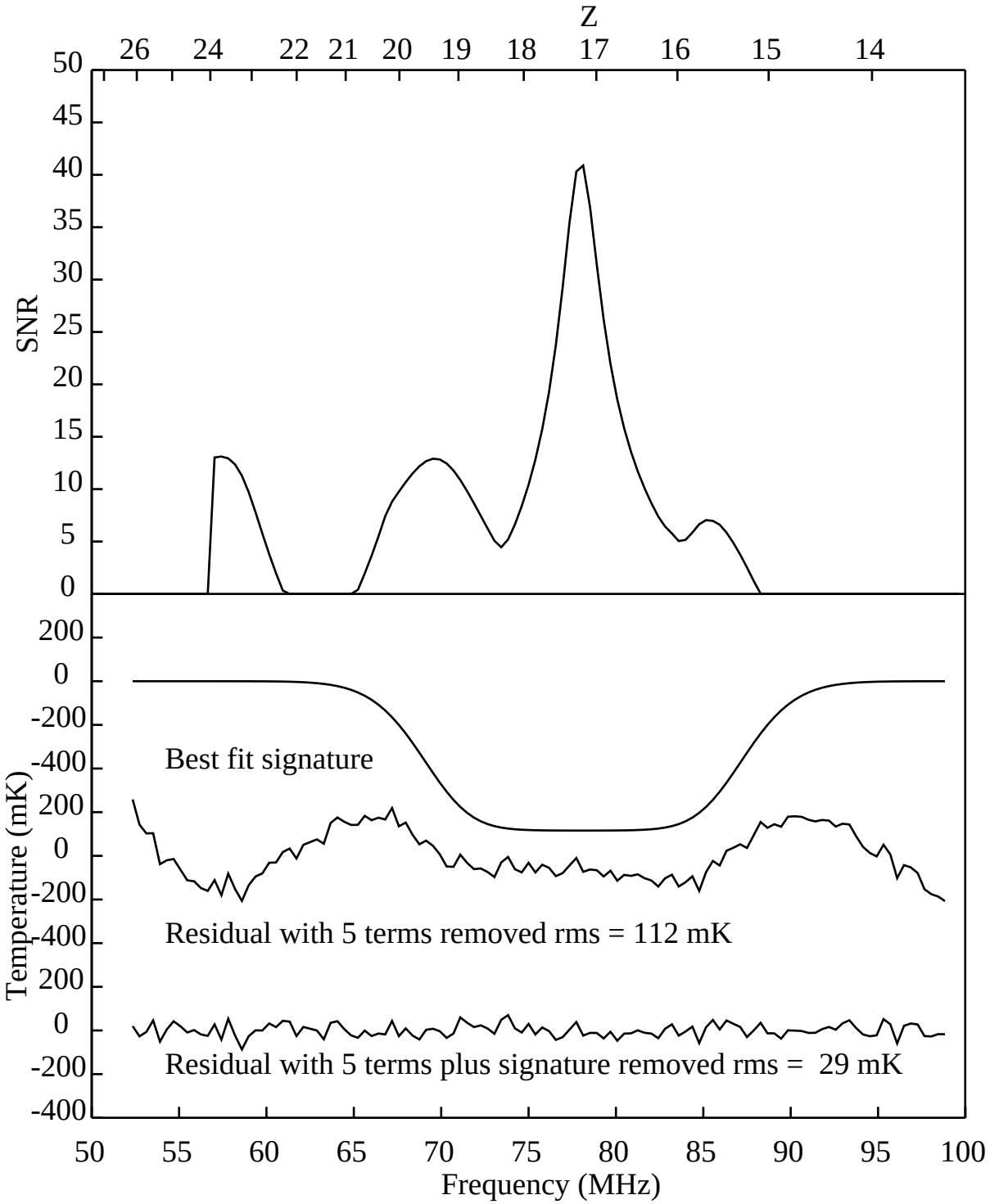
Figure 2 shows the absorption search result for Case E. No noise has been added to any of the other simulations.

In summary 5 terms is sufficient for most cases but 6 terms may be needed for the 30x30m ground plane which introduces more fine scale frequency structure. A larger ground plane introduces even finer scale structure but at a lower level for an overall improvement as long as there are no objects beyond the edges of the ground plane which result in scattering as discussed in memo 345.



freq 65.6 snr 47.7 sig 2.21 wid 27.20 tau 0 rmsin 0.0392 rms 0.0088 52 - 99

Figure 1. The results of the feature search for the first simulation in table 1.



freq 78.1 snr 40.9 sig 0.68 wid 18.50 tau 7 rmsin 0.1116 rms 0.0289 52 - 99

Figure 2. The results of the signature search for case E, the last entry in table 1, in which the EDGES result has been added to the model sky map made from sky data at 408 and 45 MHz.