EDGES MEMO #377

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To: EDGES Group

From: Alan E.E. Rogers

Subject: Possible explanations for the differences between the simulations and lowband1 at LST 13 hours

The differences between the simulations and data seen in the comparisons in Figure 1 of memo 374 at LST 13 hours (or equivalently GHA 19.25 hours) in the lowband1 may also be seen in the midband data.

Figure 1 shows the frequency structure in the beam calculated using

$$c = 10^{(b(fc)/10)} * [b(fc) - ((b(f1) + b(f2)))/2] \quad (1)$$

where f1 = 76 MHz
f2 = 80 MHz
fc =78 MHz
b = gain in dB at each azimuth and elevation
and c = the weighted curvature of the beam's center frequency fc

for lowband1 on 2e-2 S/m soil and Figure 2 shows the expected frequency structure for EDGES-3 on a 48x48m ground plane on 2e-2 S/m soil for comparison. The Haslam sky map is shown in Figure 3.

Table 1 shows where the regions of strongest weighted curvature are located in Galactic coordinates at LST 13 hours

Beam	Beam Az deg	Beam El deg	Galactic long deg	Galactic lat deg
	0	65	314	61
	180	65	306	11
Beam center		90	309	36
	All	70	298-323	16-20

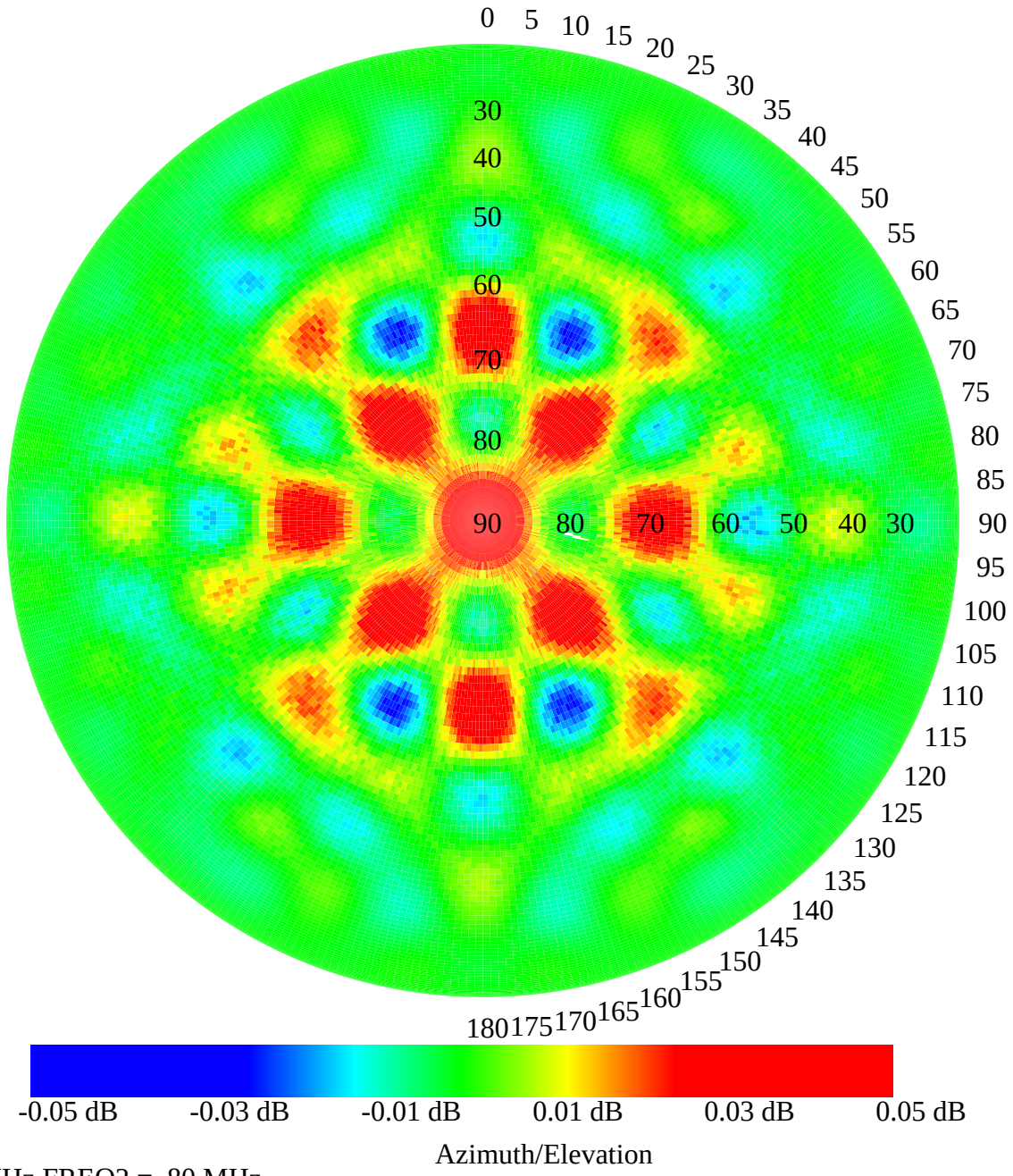
Table 1. Location of some regions of beam curvature in Galactic coordinates at LST = 13 hr

Figure 4 shows the 5-term residuals following the convolution of the beam of the 30x30m ground plane used in Figure 1 with the Haslam map on the left. The left plot is after adding a source to the Haslam map at Galactic long = 305.5 Galactic lat = 59.4 as marked by a red rectangle in color plot of the sky map shown Figure 3. The strength of the added source is about 2% of the total sky. While the plot comes close to make the residual curve at GHA = 19.25 (LST = 13) similar to that at GHA = 21.25 as seen in the lowband1 data in Figure 1 of memo 374 it requires the added source have large flux and would have been seen by GLEAM.

Another possible explanation is that the difference can be explained is that the high Galactic latitude extragalactic sources has a lower spectral index since may have a turn over spectrum at 100 MHz or higher and consequently this region of the sky needs to be corrected. The middle plot of Figure 4 shows the residuals after applying spectral correction of $(f/fc)^{2.5}$ to the sky map for a region from Galactic long -80 to -40 for Galactic lat from 20 to 50 which changes the spectral index from 2.5 to 0 without changing the strength at a center frequency, fc, of 75 MHz. GLEAN reports a distribution of extragalactic radio sources which have spectra which flatten or turn over at a frequency close to 100 MHz so this is another possible reason for the difference between data and simulations at LST = 13 hrs.

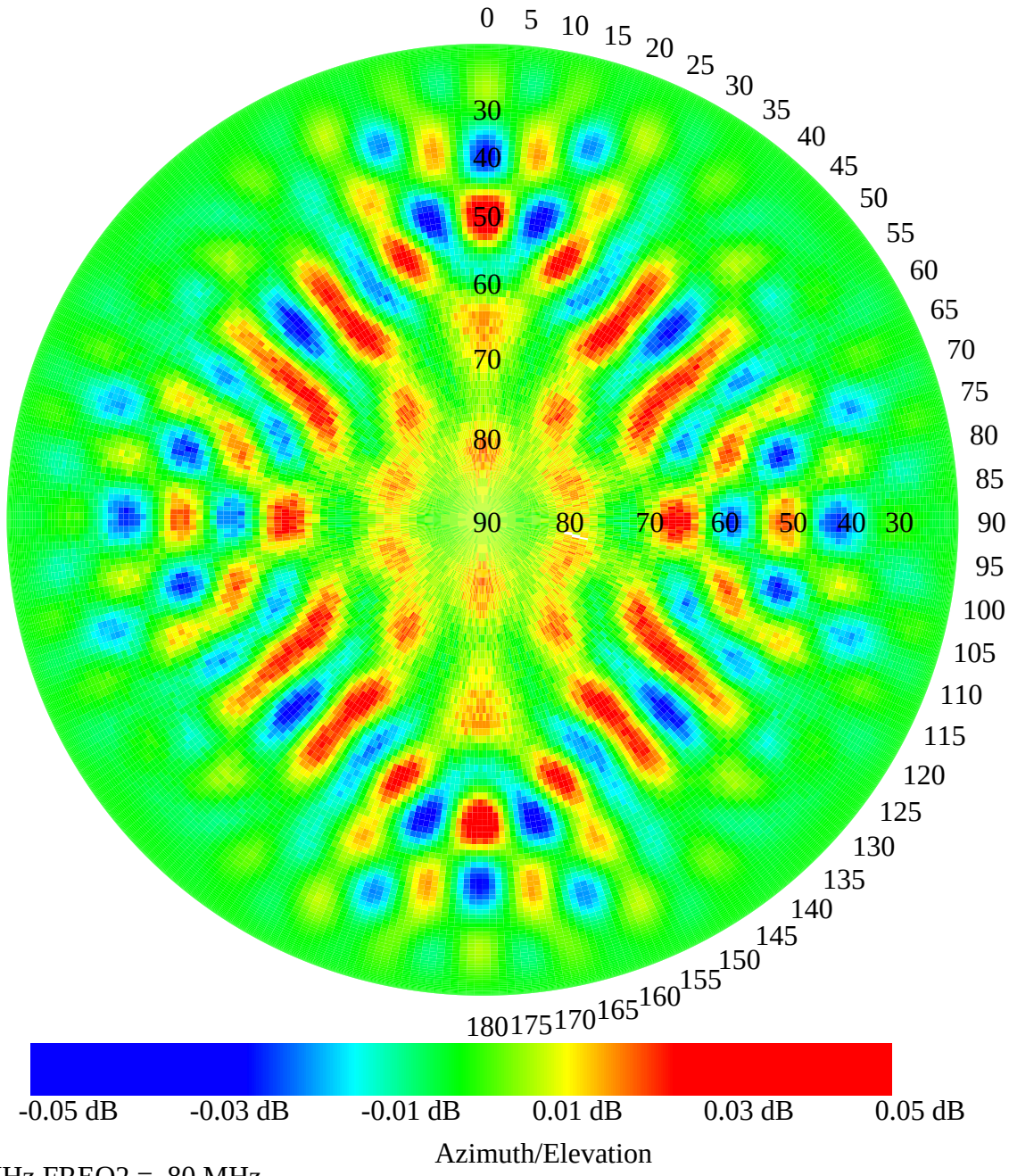
It is noted that the spectrum of the data at LST = 13 hrs in Figure 1 of memo 374 has ripples with period of about 3 MHz. These are consistent with reflections from the hut as discussed and modeled in memos 206. The hut has effects stronger and smoother effects following transit of the Galactic center but other potential scattering objects on the east and southeast of the ground plane could have a significant effect before transit. Roll of the antenna relative to the ground plane as discussed in memos 343 and 344 could also be a contributor. In fact, a combination of antenna tilt, roll and effective antenna coordinate shifts, which is shown in the plot on the right in Figure 4 looks like it partially corrects the difference between data and simulations at LST = 13 hrs.

In summary the difference between the lowband1 data residuals and simulations which appear to be most significant at 2-hour blocks centered at LST = 13 hours could be the result of added source structure in the sky, the spectral index roll-over in extragalactic sources or the antenna tilt and roll. Scatter from various objects like the hut are likely to be adding to a combination of factors making up the difference.



FREQ1 = 76 MHz FREQ2 = 80 MHz

Figure 1. Frequency curvature of the beam of lowband1 on 30x30m ground plane on 2e-2 S/m soil.



FREQ1 = 76 MHz FREQ2 = 80 MHz

Figure 2 . Frequency curvature for 48x48m ground plane on 2e-2 S/m soil for comparison.

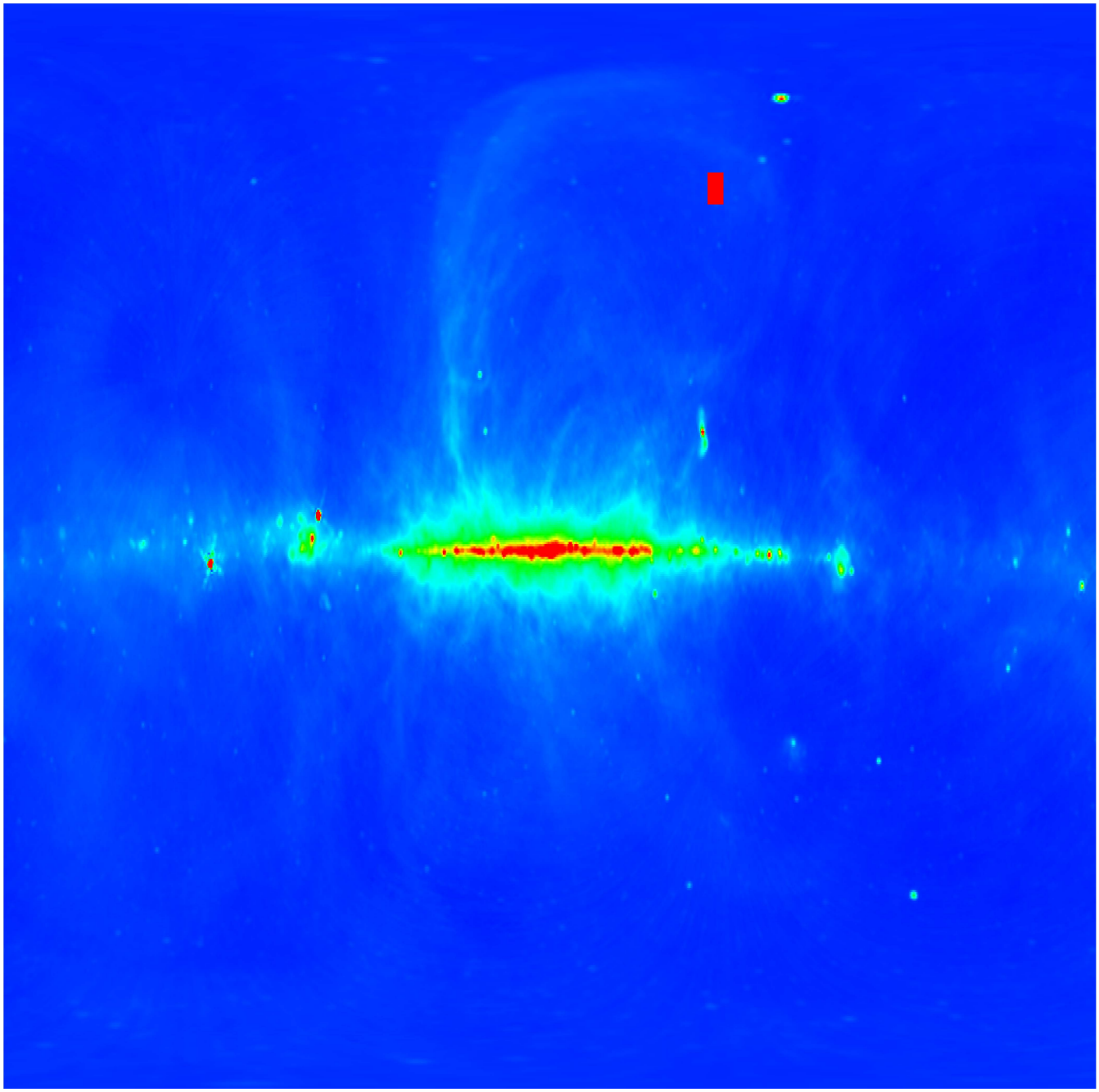


Figure 3. Haslam sky map with Galactic lat = 59.4 long = 305.5 deg marked with red rectangle.

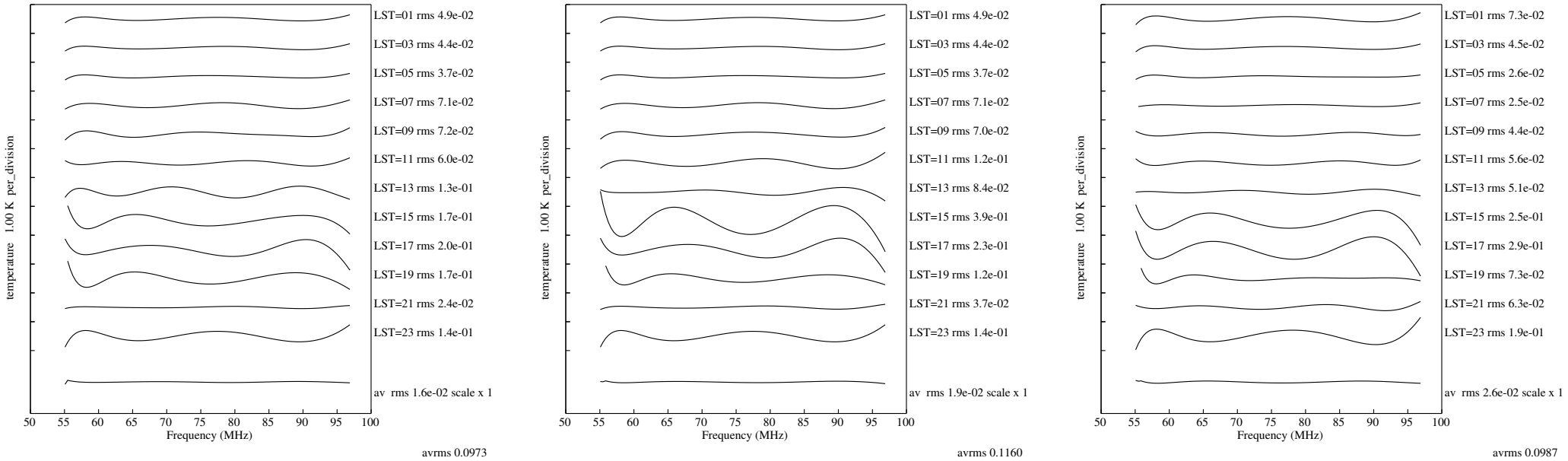


Figure 4. Simulations of an added radio source on the left a change in spectrum for a region of the sky in the middle and and tilt and roll on the right.