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To: EDGES Group
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Subject: Beam effects of finite ground plane

The size of the ground plane has been determined based on the criteria for keeping the losses under about 1%. The high band antenna has a 5m × 5m solid ground plane with 4 2m × 5m mesh extensions, one on each side, which form a "plus" shaped ground plane. The current low band antenna has a 10m × 10 m mesh ground plane. The size being limited by the available resources. The effects of the 10m × 10 m or equivalently a 5m × 5m ground plane over a frequency range of 104 to 196 MHz have been examined more carefully in order to explain the results reported in memo 183.

For this purpose FEKO was used in the Green's Function (GF) mode which allows for the efficient calculation of an infinite lossy dielectric ground under the finite metal ground. In this mode FEKO computes a beam for the upper hemisphere which can be integrated in order to determine the loss and can be used to test for the additional chromaticity which is introduced by the finite metal ground plate. For the 5m × 5m ground plate the loss is about 2% at the low end of the band and the beam effects are substantial. FEKO beams were computed for a soil dielectric constant of 3.5 and a conductivity of 10^{-3} S/m. Increasing the dielectric lowers the loss and reduces the chromaticity while reducing the dielectric to unit results in a loss which agrees with the values estimated by FEKO for the fraction of the beam below the horizon in the normal MoM mode without GF.

	Residuals (mK)		
GHA	4 terms	5 terms	
-1	587	43	Infinite ground
13	46	14	Infinite ground
-1	3200	533	ε = 3.5
13	127	26	ε = 3.5
-1	4500	531	ε = 1.0
13	50	41	ε =1.0
-1	1839	351	ε = 13
13	40	5	ε = 13

Table 1 Residuals to 4 and 5 terms fits for low band 52-98 MHz.

Table 1 shows the residuals to 4 and 5 terms fits for maximum at about -1 GHA and minimum at 13 GHA. The values are in mK for low band 52 to 98 MHz. The values for high band 104 to 196 MHz can be obtained by dividing by a factor of 5.7. The limited ground plane size results in a significant increase in the beam effects. These effects are reduced by the underlying soil especially when it is wet as indicated by the FEKO GF beams obtained for ε= 13.Tests of the GF beam correction to the low band data lowers the rms residuals for 4 terms or less but has only a small effect on the rms residuals with 5 terms removed. The significance of any effects for 5 terms is still under study as is the question of whether to enlarge the low band ground plane.

Figure 1 shows the residuals for a single day of data over the full range of GHA. The residuals with 4 terms (scale, spectral index, gamma and ionospheric absorption) are shown with loss based on the GF solution for a 10m × 10m ground plate over soil with dielectric 3.5. The beam correction is made for the blade antenna on an infinite metal ground. For comparison figure 2 shows the residuals using the beam correction from the GF solution. The residuals are substantially reduced especially with the "Galaxy up." While the added beam chromaticity which results from the ground plane is not the only source of error. Using the GF beam correction may allow better use of the "Galaxy up" data to correct other sources of error in the data.

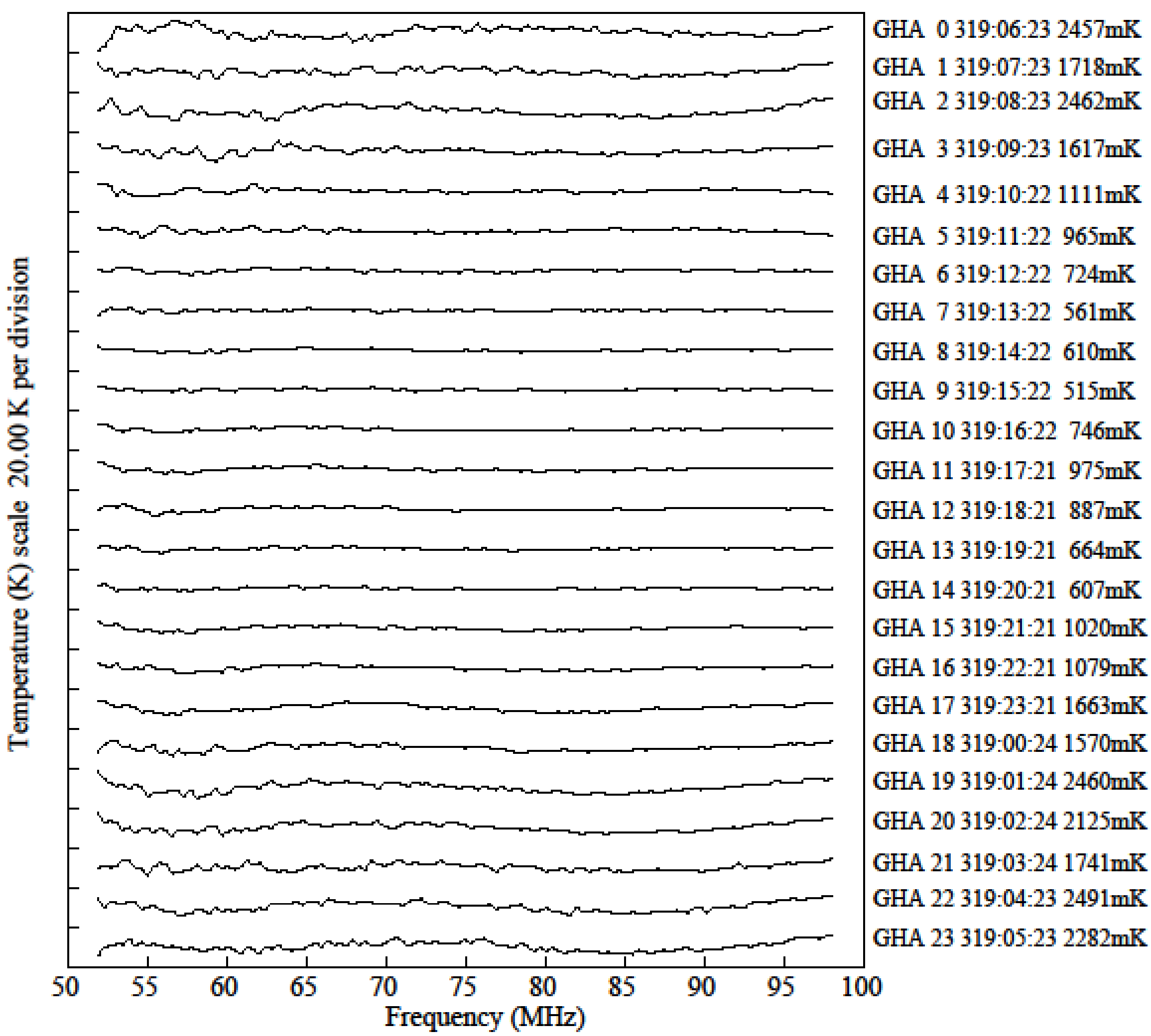

Figure 1. Residuals with 4 terms removed using GF loss and beam for infinite ground plane.

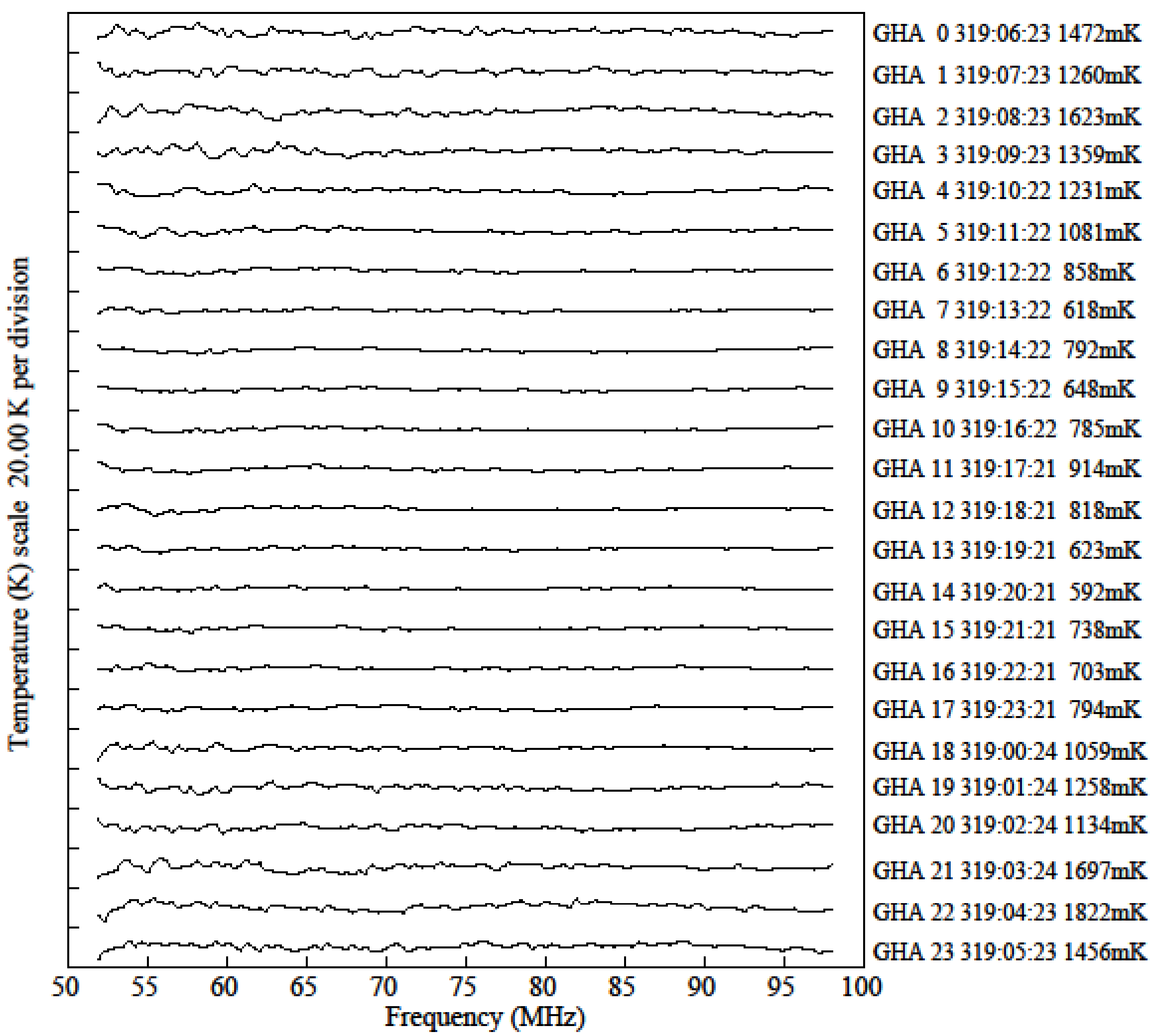

Figure 2. Residuals with 4 terms removed using GF loss and GF beam correction.