EDGES MEMO #263

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To: EDGES Group

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Subject: Beam chromaticity and ground loss vs ground plane size

This memo extends the study in memo #251 of signature detection using small ground planes. It includes details of the effects of non uniformity in the soil.

Table 1 shows the maximum minimum and average rms residual for 4 polynomial terms removed from 60 to 99 MHz. The simulated data are generated using the Haslam map with CMB correction scaled to the lowband with spectral index -2.5. In general, the maximum rms residual occurs close to GHA=0 while the minimum occurs in the vicinity of GHA=12 hrs. The simulations were done for the lowband1 blade antenna and a short vertical monopole driven with a source at the base connected between the vertical rod and the metal ground plane. Most simulations were done over soil with dielectric constant 3.5 and conductivity 2e-2 S/m except the last 4 in which the soil had a layer of rock with dielectric constant 8.5 was placed below the soil.

Comments on the results

The general trend for the blade is for the beam effects and the loss to increase as the ground plane size is reduced while the vertical antenna has much smaller beam chromaticity than the blade for small ground plane size. However, the vertical antenna is much more sensitive to reflections from the edges of the ground plane so that using a large ground plane to reduce the loss raises the beam chromaticity. A serious issue which a very small ground plane is the need for a uniform soil layer of greater than about 20 cm thickness. The use of an absorbing material below the antenna ground plane might be required to provide isolation from a non-uniform soil.

Antenna	Height (m)	Ground plane	Ground	Max rms	Min rms	Av. Rms	Gnd loss %	Note
Blade	1.04	Perf	Soil	190	16	76	0.5	A
Blade	1.04	10×10 m	Soil	1300	28	298	0.7	B
Blade	1.04	5×5 m	Soil	700	13	116	3.0	C
Blade	1.04	2×2 m	Soil	2500	21	98	15.0	
Blade	1.04	1×1 m	Soil	850	14	39	30	
Blade	1.04	No gnd plane	Soil	810	13	41	30	
Blade	0.502	No gnd plane	Soil	93	14	38	40	
Vert	0	Perf	Soil	160	6	54	0.5	D
Vert	0	2×2 m	Soil	97	8	43	15.0	
Vert	0	1×1 m	Soil	21	2	8	75	
Blade	1.02	5×5 m	Rock	700	18	200	3.0	E
Vert	0	1×1 m	Rock	760	21	260	70.0	
Blade	1.02	5×5 m	Rock2	570	24	100	3.0	F

Vert	0	1×1 m	Rock2	21	2	8	80	

Table 1. Simulated effects of beam chromaticity and loss for different ground planes.

Notes for table 1:

Note A: "Perf" is extended ground plane described in memo 204

Note B: "Soil" is $\varepsilon = 3.5$ $\sigma = 2e\text{-}2$ S/m

Note C: "Vert" is antenna described in memo 210

Note D: "Vert" is 0.5 m high monopole over ground plane.

Note E: "Rock" $\varepsilon = 8.5$ $\sigma = 2e\text{-}2$ S/m 1 m below solid with $\varepsilon = 3.5$ $\sigma = 0$

Note F: "Rock2" is layer of rock $\varepsilon = 8.5$ $\sigma = 2.0\ e\text{-}2$ S/m
20 cm below soil with $\varepsilon = 3.5$ $\sigma = 2e\text{-}2$ S/m.