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March 23, 2021

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Subject: Considerations for using a small metal ground plane on soil ground plane

There are advantages for using a soil ground plane especially for a test deployment. A study of the using the soil for a ground plane was made in memo 263 which used simulations to show that a small metal ground plane reduces the ground loss without adding significant beam chromaticity. Simulations show that the ground loss is about 36% for the lowband blade antenna on soil with dielectric 3.5 and conductivity 2e-2 S/m in the 50 – 100 MHz range. It is emphasized in memo 295 that the use of a soil ground requires a very uniform soil without layers of rock close enough to the surface to produce reflections that can be seen via ground penetrating radar. In addition, simulations show that the surface has to be level within a few cm rms out to about 20 m from the antenna.

Ground plane	Location	Antenna azimuth	Average rms mK
PEC	MRO	0	106
PEC	MRO	85	60
PEC	MIST	0	44
PEC	MIST	85	43
soil	MRO	0	86
soil	MRO	85	47
soil	MIST	0	29
soil	MIST	85	30

Table 1. Simulations of a “bump” in the ground plane. MIST is the McGill site at lat long 79N 90W

Table 1 shows the results of the average rms residuals over GHA in 1 hour blocks of the 20 cm high bump shown in Figure 5a of memo 356 which is a section of a sphere with 2.5m diameter with center 5m from the antenna at an azimuth of 330 degrees relative to the lowband antenna in a simulation pointing north. For the PEC ground the bump is metal. For the soil ground the bump has the same dielectric of 3.5 and conductivity of 2e-2 S/m as the soil. This shows that the effects of an uneven ground are as critical for a soil ground as they are for a metal ground plane.

case	loss percent	rms residual mK
Antenna on soil	36	96
Antenna on soil with added bump in the soil ground	36	83
Added 5x5m ground plane under antenna	4	47
Added 5x5 ground plane under antenna plus bump	4	91

Table 2. Simulations of frequency structure in loss with 5-terms removed from 50-100 MHz

In addition to the added beam chromaticity introduced by an uneven soil surface the uneven soil increases the frequency dependence of the loss. A simulation of the bump in table 1 results in a rms residual of about 95 mK with 5-terms removed without a small ground plane. With a 5x5m metal ground plane under the antenna reduces the loss to about 4% and the rms residuals for a 5-term fit to the loss to 47 mK and 91 mK without and with the bump respectively. Much of the frequency structure in the loss may be due to the limited accuracy of FEKO discussed in memos 179, 308 and 341. In summary the addition of a small metal ground plane may be helpful when the antenna is on soil because a large even ground plane is not available but more tests with other beam modeling software are needed.