EDGES MEMO #375

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November 9, 2021

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To: EDGES Group

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Subject: FEKO simulations of beam and loss chromaticity for lowband antenna on layered soil

In order to get an indication of the effects of non uniform soil FEKO can be used to model the beam for an antenna on infinite layers of soil (as in memo 231) to obtain an indication of the sensitivity to vertical structure in the soil. In memos 263, 280, 292, 294, 309 and 370 the chromaticity of the beam and loss on ground planes of various sizes on uniform and non uniform soil was simulated using FEKO. In this memo all simulations are with the antenna on the ground without any ground plane.

The results of simulations with 2 layers of soil are summarized in Table 1.

| site | Upper level depth m | Upper level dielectric | Upper level conductivity S/m | Lower level dielectric | Lower level conductivity S/m | Loss rms mK | Average beam rms mK | Beam rms over 24h mK |
|---|---|---|---|---|---|---|---|---|
| 79N | 2.0 | 3.5 | 2e-3 | 5.0 | 2e-3 | 1840 | 671 | 53 |
| “ | 2.0 | 3.5 | 2e-3 | 4.0 | 2e-3 | 651 | 216 | 27 |
| “ | 2.0 | 3.5 | 2e-3 | 3.5 | 2e-3 | 7 | 33 | 8 |
| “ | 2.0 | 3.5 | 2e-3 | 3.5 | 1e-3 | 218 | 37 | 14 |
| “ | 2.0 | 3.5 | 2e-3 | 3.5 | 3e-3 | 229 | 82 | 18 |
| “ | 2.0 | 3.5 | 2e-2 | 3.5 | 1e-3 | 21 | 39 | 9 |
| “ | 0.5 | 3.5 | 2e-2 | 3.5 | 1e-3 | 5 | 35 | 9 |
| “ | 0.2 | 3.5 | 2e-2 | 3.5 | 1e-3 | 12 | 35 | 9 |
| “ | 0.05 | 3.5 | 2e-2 | 3.5 | 1e-3 | 12 | 37 | 9 |
| “ | 0.05 | 70 | 4.0 | 3.5 | 1e-3 | 37 | 62 | 13 |
| 27S | 2.0 | 3.5 | 2e-3 | 5.0 | 2e-3 | 1840 | 2352 | 350 |
| 42N | 2.0 | 3.5 | 2e-3 | 5.0 | 2e-3 | 1840 | 1248 | 110 |
| MRO | 30x30m | | | | | 24 | 131 | 18 |
| 79N | 30x30m | | | | | 24 | 74 | 9 |

Table 1 Beam and loss for 5-physical terms removed from 55 – 95 MHz for changes in dielectric and conductivity.

The loss chromaticity is calculated using the sky temperature on 300 K at 150 MHz with spectral index 2.55 as in memo 370. The frequency dependence of the loss, or loss chromaticity, is of most concern as like the average beam rms along with calibration and s11 errors depends on the strength of the sky noise and doesn't average down with averaging over 24 hours of GHA.

The last entry for 79N with a 5 cm layer with dielectric 70 and conductivity 4.0 S/m is to simulate a thin layer of sea water or very high conductivity soil under the antenna.

The last 2 entries in table 1 are for the lowband antenna on the 30x30m ground plane for comparison. In this case the loss chromaticity rms is significantly increased by glitches in FEKO calculations as discussed in memo 370. The third entry for which both layers have the same dielectric and conductivity was checked and found that it gave the same result as a single layer to minus infinity.

These results show that for small changes the loss and beam chromaticity scale with the change in dielectric and conductivity. It also shows that the loss and beam chromaticity are reduced to very low levels if the upper layer of soil has high conductivity of 2e-2 S/m. Simulations in memos 337, 356 and 358 show that the ground also needs to be flat within about 5 cm out to about 25 m from the antenna. The results in Table 1 are given for the arctic sites at 79 degrees North along with sites at the latitudes of Oregon and the MRO.