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To: EDGES Group

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Subject: Comparison of ground loss from LOW3 data with FEKO model

Lowband 3 data was taken with a lowband antenna on the highband ground plane with preliminary results in memo #285. The change of spectrum with and without beam correction with only 3-terms removed is shown in Figure 1. Figure 2 shows the effect of making a ground loss correction. The ground loss and beam corrections were made using FEKO with soil dielectric constant of 3.5 and conductivity of $3e^{-3}$ S/m.

While the low3 test was successful in showing that an absorption profile consistent that reported in Nature is obtained when the beam effects are small at GHA=12 hours it shows that an intermediate sized ground plane has very large beam chromaticity.

Simulations show that going to a small ground plane or using no ground plane, which will be possible when the receiver is part of the antenna, leads to very low beam chromaticity. If it can be shown via Ground Penetrating Radar (GPR) that a site has uniform soil to depths of tens of meters it should be possible to deploy EDGES without a ground plane since FEKO simulations show that the ground loss is smooth and can be modeled with a 5-term polynomial. However, the antenna still needs to be off the ground in order to minimize the ground loss. If the box is 50 cm off the ground the ground loss factor ranges from 0.75 at 40 MHz to 0.36 at 140 MHz but is smooth to with 20 mK rms with a 5-term polynomial removed. Even though the ground loss is smooth the antenna S11 needs to be accurately measured by the receiver to avoid having to use 8 or more terms to model the combination of the foreground, ground loss and antenna S11 measurement error.

A test of the effect of the ground loss correction on the same data used for the signature search shown in Figure 1 of memo 285 has been made. In order to apply the ground loss correction without introducing some fine structure present in the FEKO estimate of ground loss the FEKO result was first fit with a 4-term polynomial before applying to the EDGES data. The results shown in Figure 3 is a better fit to the signature with rms of 40 mK with less ripple compared with an rms of 51 mK without loss correction.

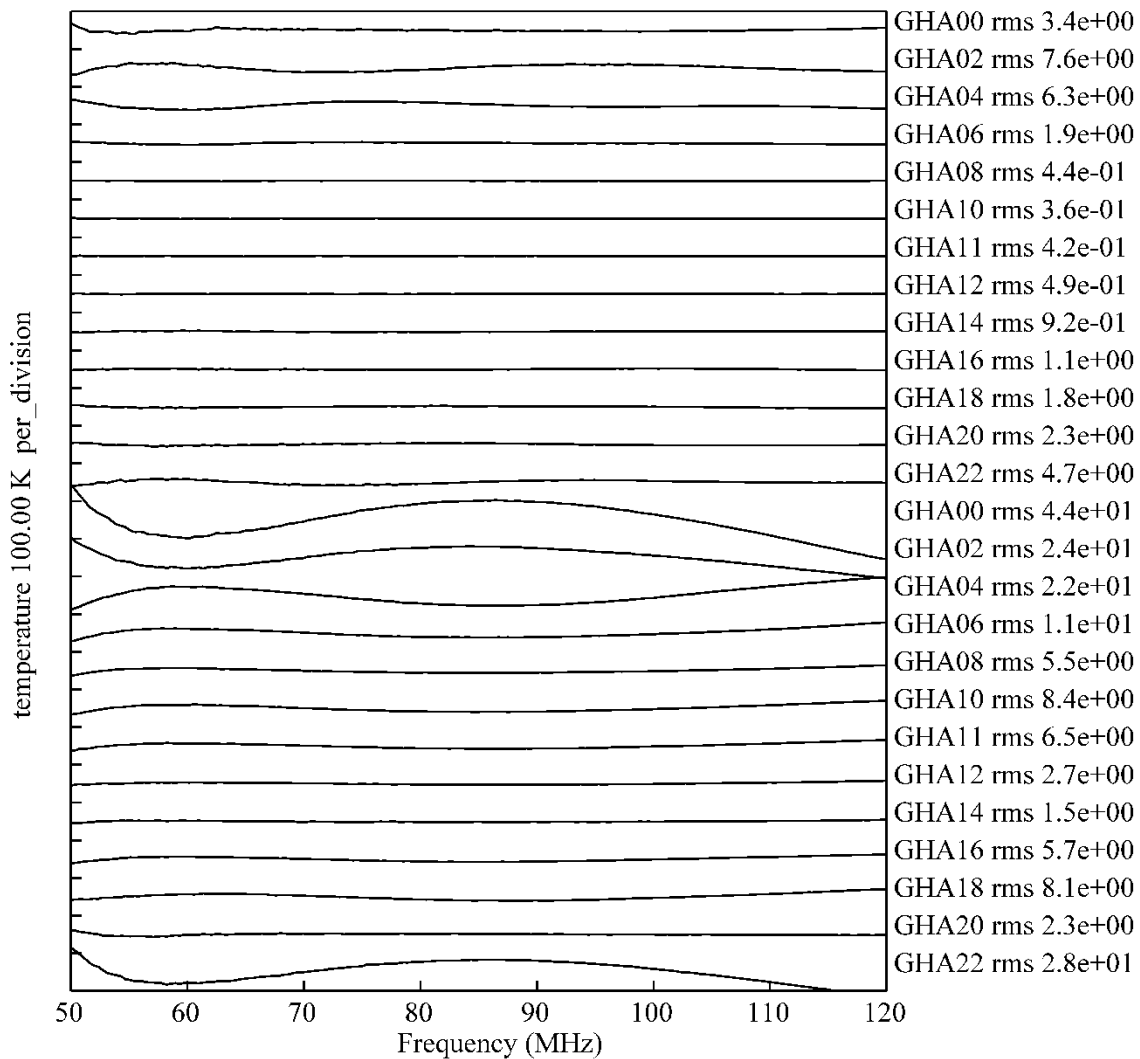


Figure 1. Residuals with 3-physical terms removed vs GHA with beam and loss correction in the upper half and with only loss correction in the lower half.

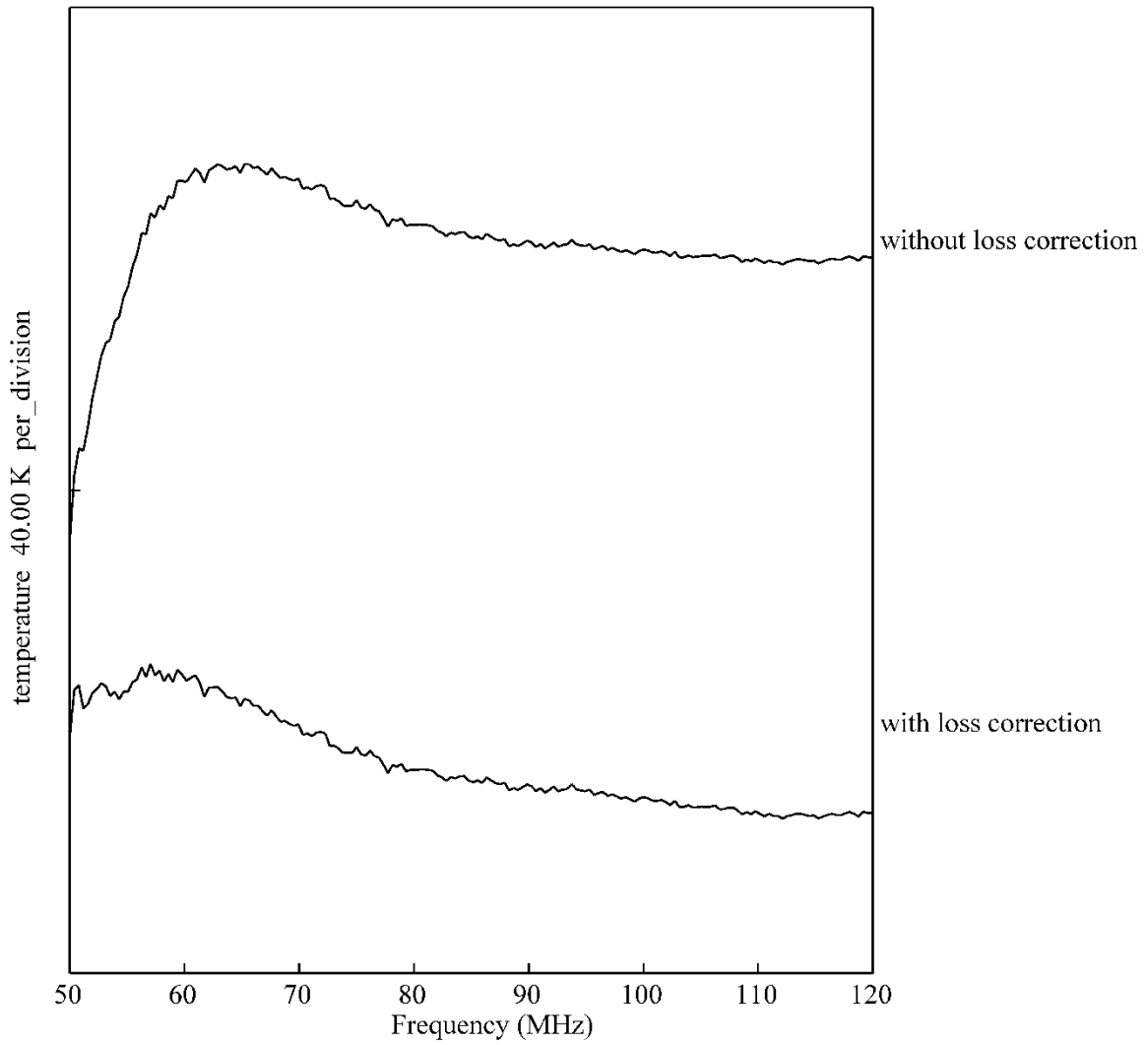


Figure 2. Corrected spectrum with beam chromaticity correction at GHA= 12 hr on 2018_235 with and without ground loss correction with only 1-term removed.

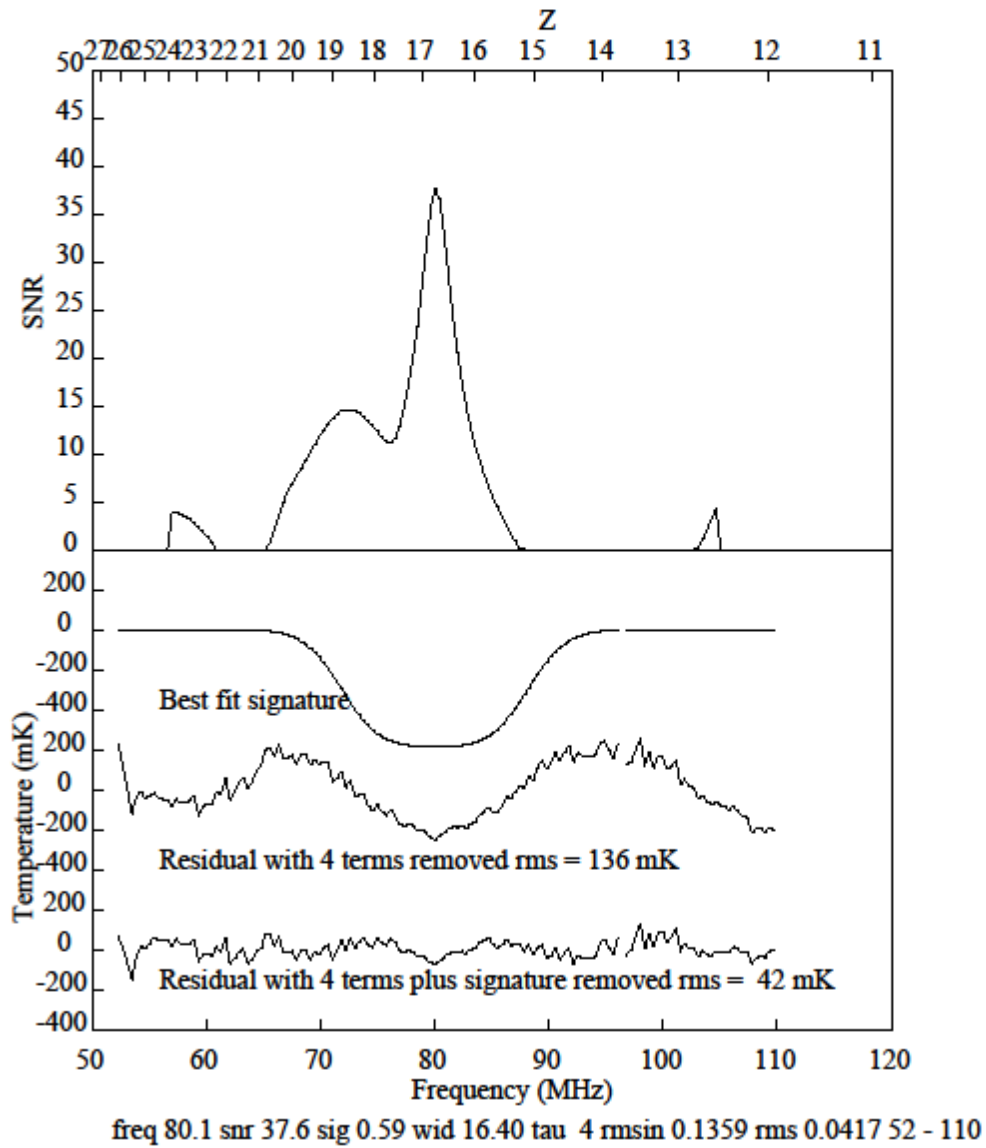


Figure 3. Signature search after applying ground loss correction for comparison with Figure 1 of memo #285.