Evaluation of Terrestrial Sites for Global EOR Signal Detection via the RMS Error Metric of a Sky-Beam Convolution Polynomial Fit.

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Removal of the sky foreground is critical to the success of the Experiment to Detect the Global Epoch of reionization Signature (EDGES) program. We evaluate terrestrial locations for the ease of removing the sky foreground from the convolution of the antenna beam with the frequency scaled Haslam skymap. We use two dipole antennas: 1) a ½-wavelength dipole whose beam can be expressed in a closed-form equation and 2) the EDGES dipole antenna, both over ground planes.

The metric used is the RMS error of a polynomial fit of $T_{ant} = \Sigma_{i=0,N-1} \{a_i(\nu/\nu_0)^{(-2.5 + i)}\}$ to the antenna's response to the sky foreground radiation, represented by an ideal power law (-2.5) in frequency. The RMS error is due to the frequency dependent directionality structure of the beam pattern interacting with the structure of the sky foreground. Since each terrestrial location has a different view of the sky, the foreground removal is evaluated as a function of latitude and LST for various order polynomials. Figure 1 shows the results for a 6 term polynomial fit to the convolution using the EDGES antenna over the frequency range of 100 to 190 MHz. Since 26 S passes near the location of the current EDGES deployment, a more careful examination of this latitude is made by taking a slice of constant latitude from Fig. 1 and plotting it in Fig. 2.

We find that taking the normalized beam derivative with respect to frequency reveals the smoothness of the beam and is a quick qualitative visual estimator of the difficulty one will have in removing the foreground. The ½-wavelength dipole's beam is very smooth and its sky response can be fit to sub mK RMS errors with 5-term polynomials.

The beam pattern of the EDGES antenna was derived via extensive computer simulations. We provide results showing the most favorable terrestrial latitude and LST locations for various order fits, and set a floor for the RMS error that can be achieved for a given number of polynomial terms for the EDGES antenna.

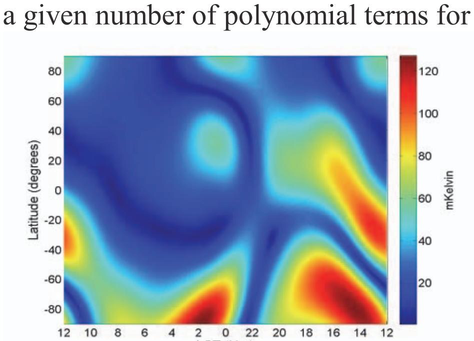

Figure 1. RMS error for a 6-term polynomial fit to the EDGES antenna's response to the sky over the frequency range of 100 to 200 MHz.

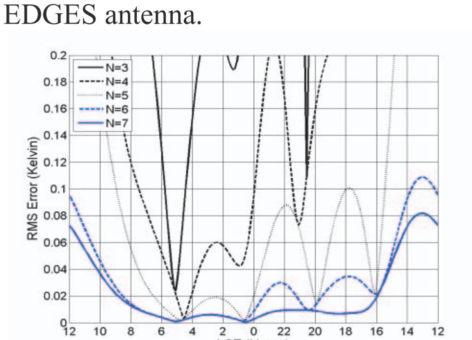

Figure 2. RMS error vs LST for a fixed latitude of 26 S after fitting various length polynomials (3 to 7 terms) to the response of the EDGES antenna.