Comparison Between Global Sky Model and Haslam Map when Convolved with FEKO Beam

Raul Monsalve

SESE, Arizona State University

June 23, 2014

Description

This report has two purposes:

- it describes the Global Sky Model (GSM)[1] in the range 100-200 MHz.
- it compares the correction of EDGES data using synthetic data produced by convolving the FEKO beams with the GSM and the scaled Haslam map.

The information is presented directly in the caption of the plots.

The conclusions are:

- in general, the GSM does not follow a simple power law, especially on the galactic plane.
- the spectral index of the GSM varies from -2.3 to -2.6 across the sky, but the residuals to the fit are large, up to $\sim$ 100 K.
- when convolved with the FEKO beam, the synthetic antenna temperature follows the trends encountered in real data only roughly, large curvatures across the frequency range are not followed closely.

[1] http://space.mit.edu/~angelica/gsm/index.html

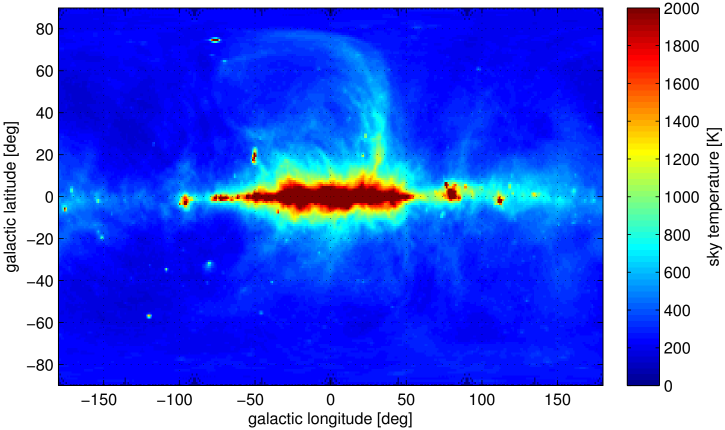

Figure : (1): Sample sky from GSM at 150 MHz.

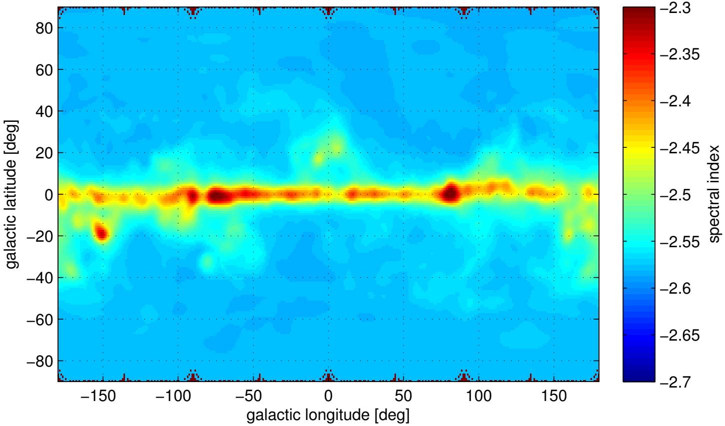

Figure : (2): Spectral index from two-parameter power law fits to the GSM in the 100-200 MHz. Contrary to the scaled Haslam map approach, the GSM does not provide a sky with constant spectral index in space. Clearly, the spectral index of the galactic plane has a smaller spectral index than higher latitudes (in absolute value), ~ -2.3 vs ~ -2.58.

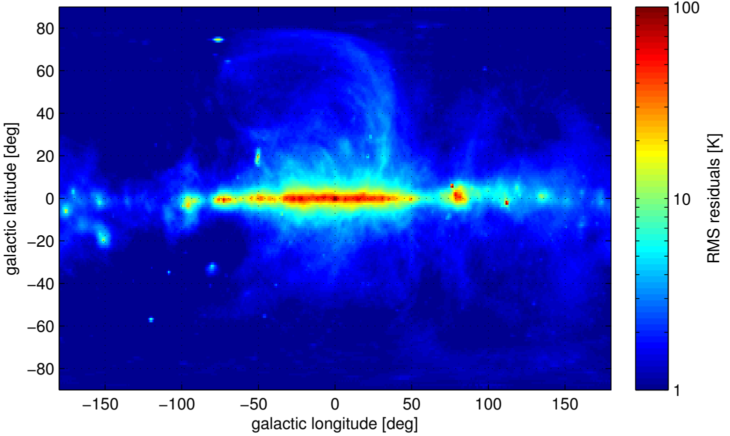

Figure : (3): The two-parameter power law does not model perfectly the GSM in the range 100-200 MHz. This plot presents the RMS residuals after subtracting the model in this frequency range. At high latitudes, the RMS residuals are below 3 K. Closer to the galactic plane (and center) the residuals increase drastically up to $\sim$ 100 K. This illustrates how the sky could depart from a simplistic two-parameter model.

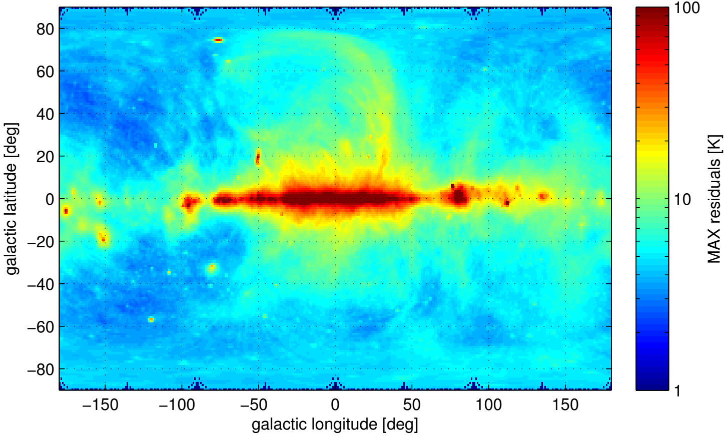

Figure : (4): Similar to figure 3, but presenting the maximum residuals (in absolute value) after removing the model. Obviously the values are larger than those in figure 3.

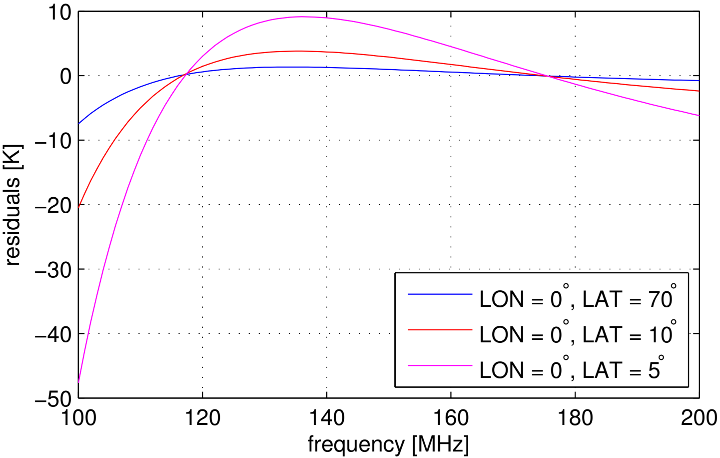

Figure : (5): Sample residuals after removing two-parameter power laws from the GSM, for three galactic latitudes. This shows that in general, the GSM does not follow a simplistic scaling in frequency.

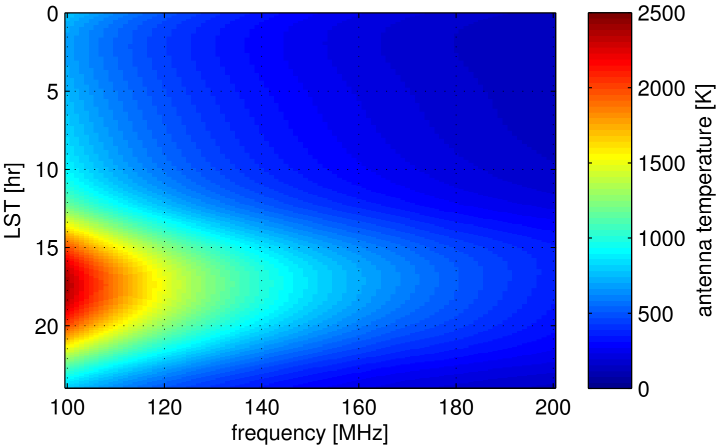

Figure : (6): Drift scans of GSM convolved with FEKO beam.

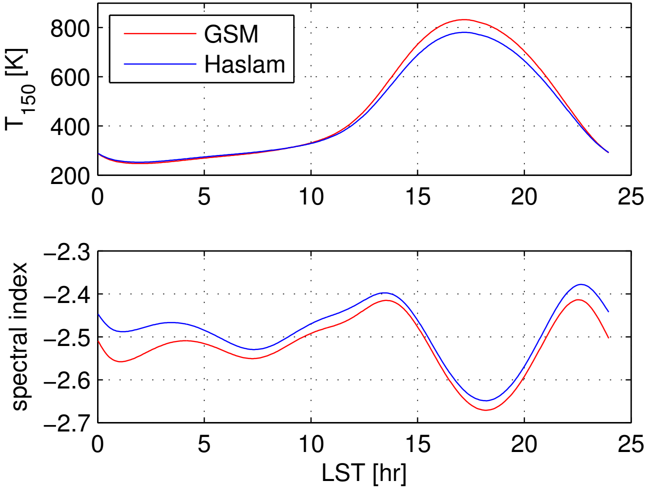

Figure : (7): Parameters from power law fit to GSM and scaled Haslam map convolved with FEKO beam. A significant difference between the two cases is that the reference temperature (T_{150}) recovered from the convolution with GSM is approximately 50 K higher than with the Haslam map during galactic transit. The spectral index with GSM is $\sim$ 0.05 higher (in absolute value) than with Haslam, but the trends with LST are consistent.

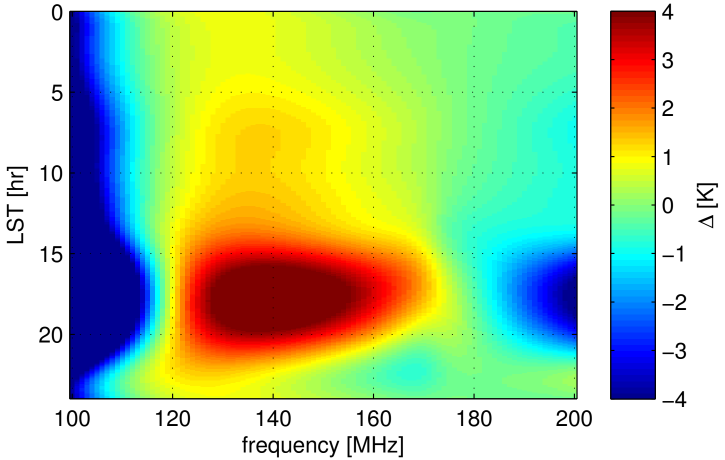

Figure : (8): Difference between residuals from two cases: $\Delta = R_{\text{GSM}} - R_{\text{Haslam}}$, where $R_{\text{GSM}} = T_{\text{GSM}} - M_{\text{GSM}}$ where T is the antenna temperature and M is its best fit power law model. This plot illustrates how different the spectra from both synthetic datasets are. In other words, the correction of measurements is sensitive to the sky model used. The differences can be as high as 1 K at low LSTs and $>$ 4 K during galactic transit. Here, the model fit was conducted in the range 100-200 MHz.

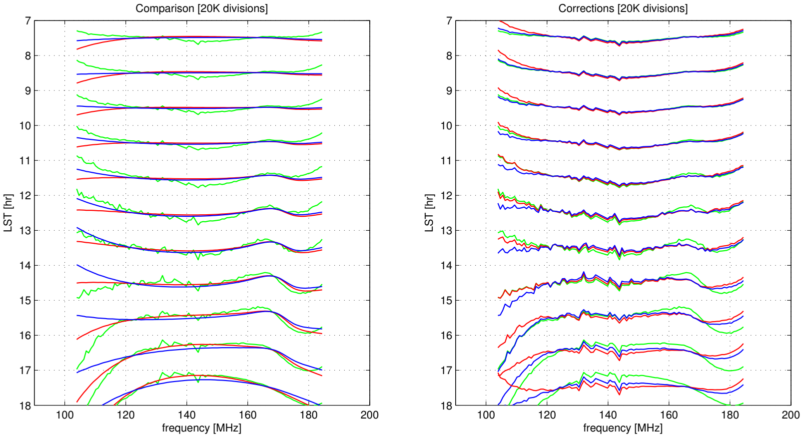

Figure : (9): LEFT: One-hour averages for residuals from uncorrected measurements (GREEN), and synthetic antenna temperatures with Haslam map (BLUE) and GSM (RED) using the FEKO beam. The measurements correspond to day 108. The model fits were done in the 110-180 MHz range. The feature at $\sim$ 170 MHz in the measurements is followed closely by the synthetic cases. On the other hand, the low frequency end is not well matched by either synthetic case. RIGHT: Uncorrected measurements (GREEN) and corrected measurements using Haslam results (BLUE) and GSM results (RED). The feature at $\sim$ 170 MHz is significantly removed by both cases for LSTs 10-16. However, notorious curvature remains.