EDGES MEMO #402

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To: EDGES Group
From: Alan E.E. Rogers
Subject: Time filtering of EDGES-3 data from Devon Island

The preliminary analysis of the EDGES-3 data from Devon Island shows a very marginal confirmation of the EDGES 21-cm absorption over a limited frequency range of 69 to 110 MHz in Figure 3 of memo 397. This result was obtained using the 1 hour blocks from each day that have a rms residual under 300 mK with 5-terms removed. The ability to obtain residuals under 100 mK is limited by the presence of RFI produced by sporadic E as discussed in memos 397 and 400.

There is also evidence for some remaining relatively smooth broadband emission from the sun after filtering out the times of active emissions shown in Figure 5 of memo 397. Figure 1 shows the residuals of the data without beam correction vs UT with 2-terms (constant vs spectral index) 60 to 110 MHz on the left compared with a simulation using the Haslam map and 50x25m wire grid used at Devon Island in the middle and with a contribution of noise from the Sun with spectral index -2.0 on the right. The overall shape of the spectrum of the data with a peak at 80 MHz for UT range 0 to 17 hours is not matched in the simulations possibly due to ionospheric absorption. The rise in the spectrum of the data below 65 MHz at about UT = 20, when the Sun is at maximum elevation is matched by the simulation with broadband noise from the Sun. Figure 2 shows that EDGES-3 data from Oregon with 2-terms removed does not show a rise at 80 MHz and it is found that changing the choice of calibration day or the choice of antenna S11 for the Devon island data has only small effects on the rise at 80 MHz. Other checks which include changes in LNA s11 etc. also have little effect on the shape of the residuals in the Devon data which suggests that the cause of the rise at 80 MHz is something other than emission from the Sun or sporadic E.

The rise at 80 MHz is reduced by a factor of about 2 by including an ionosphere opacity of about 4% at 75 MHz which corresponds to a TECU of about 25. A high polar cap absorption (PCA) is observed in riometer observations following solar flares – see Hartz and Vogan 1962. A plot of the Devon Island data with 3-terms removed with added term to account PCA is shown in Figure 3.

However, despite the possibility that strong PCA is involved there is still a concern that there could be local RFI, a problem with EDGES-3, a resonance or possibly noise leakage from the electronics.

The high variability of the sporadic E on scales of the few minutes in shown Figures 8 and 9 of memo 397 has been explored in more detail and it is found that low residuals can be obtained down to 65 MHz in about 10 percent of the data using 6 minute blocks. In order to obtain a sufficient SNR on such short data blocks the filtering is done by setting a threshold on the rms fit with 5-terms removed over frequency range of 52 to 120 MHz. The best result that could be obtained is shown in Figure 4. This added marginal confirmation of the EDGES 21-cm absorption was obtained using additional smoothing to a resolution of 780 kHz to lower the noise.

Hartz, T.R. and Vogan, E.L., 1962. A Synopsis of Riometer Observations on the Polar Cap Events of November 1960. *J. Phys. Soc. Japan*, *17*(Suppl A).

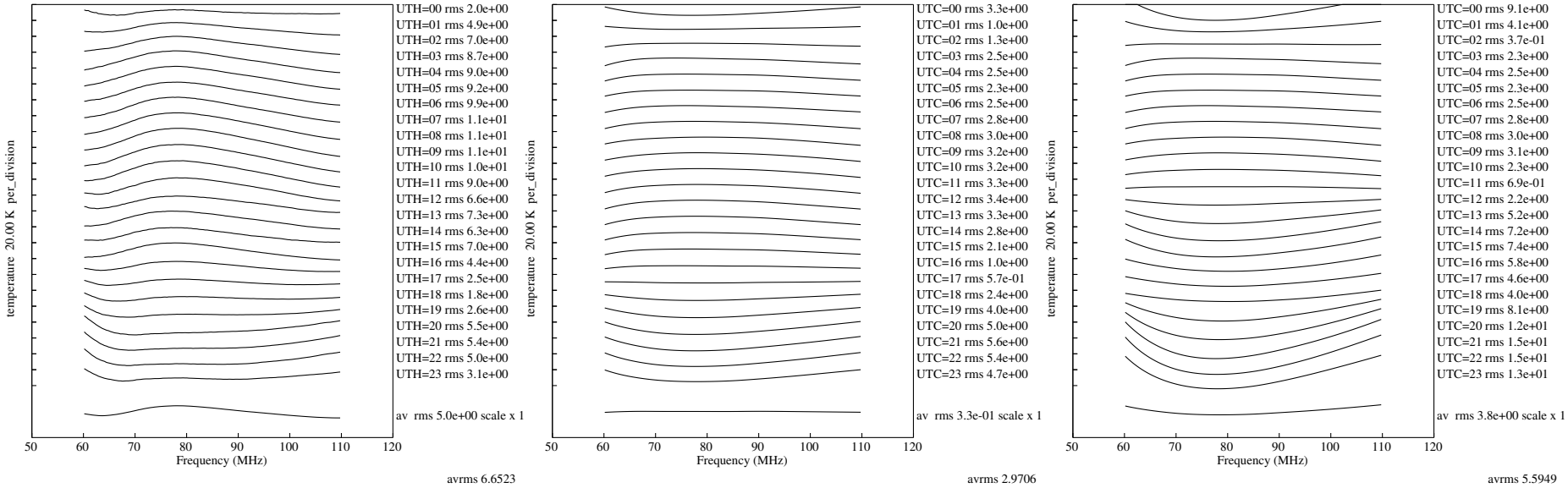

Figure 1. The plot on the left is calibrated data from Devon Island from a RFI filtered average of all days. The middle plot is a simulation of the expected spectrum from the sky using the Haslam map and the plot on the right is with added noise from the Sun. See the text for details.

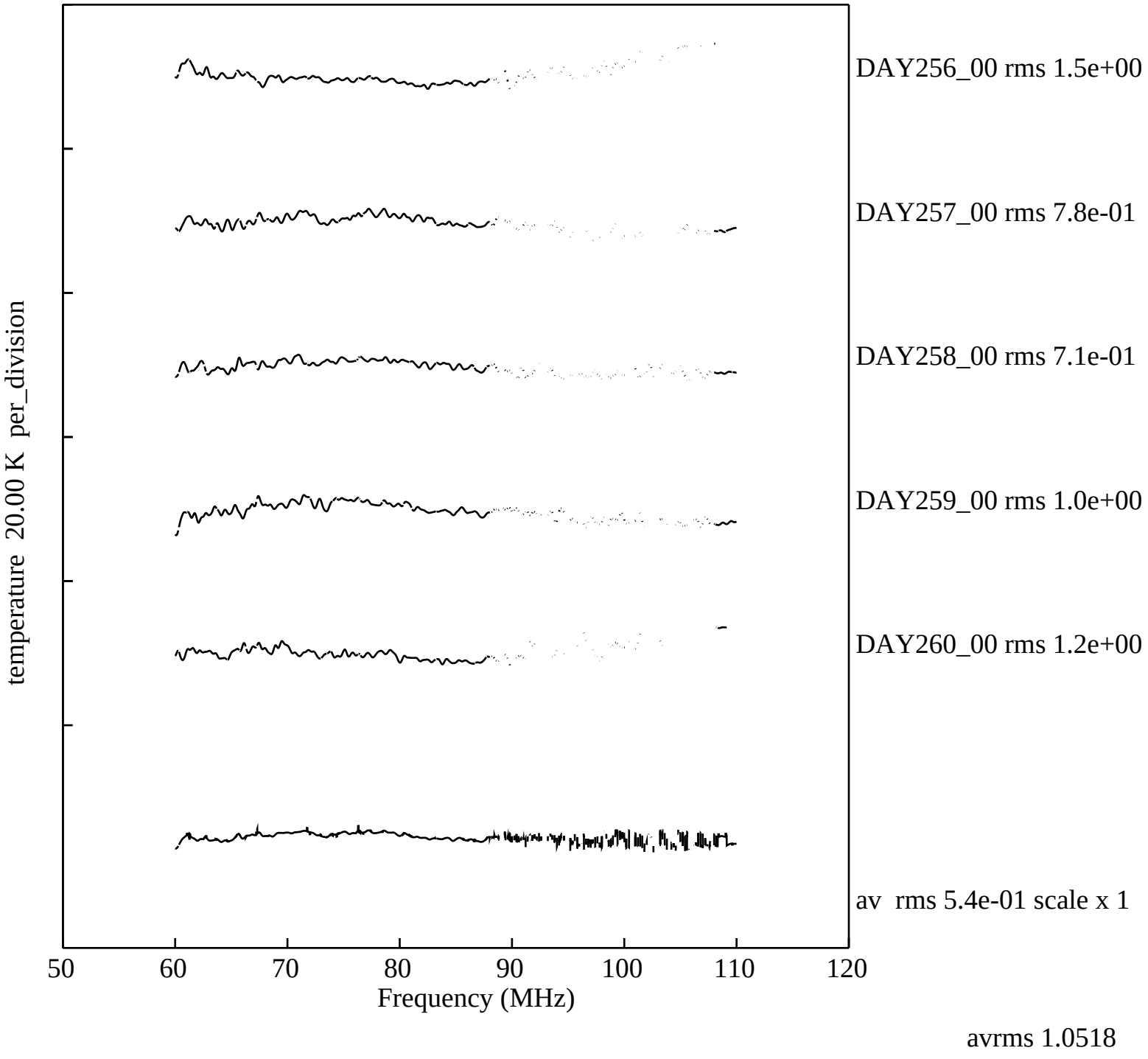

Figure 2. Plot of data from Oregon (see memo 310) with 2-terms for comparison.

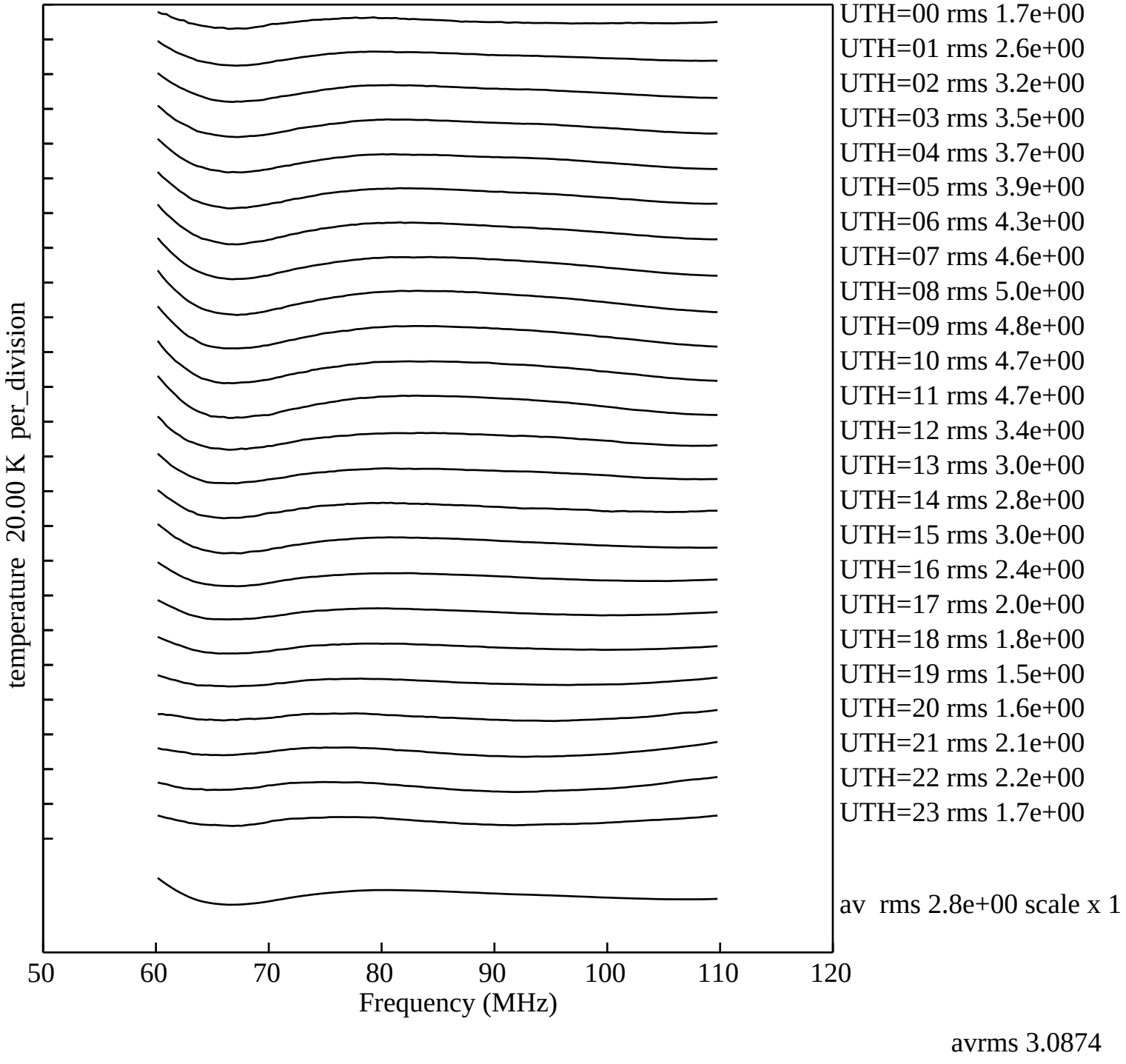

Figure 3. Devon Island data residuals with 3-terms to account for the ionospheric absorption.

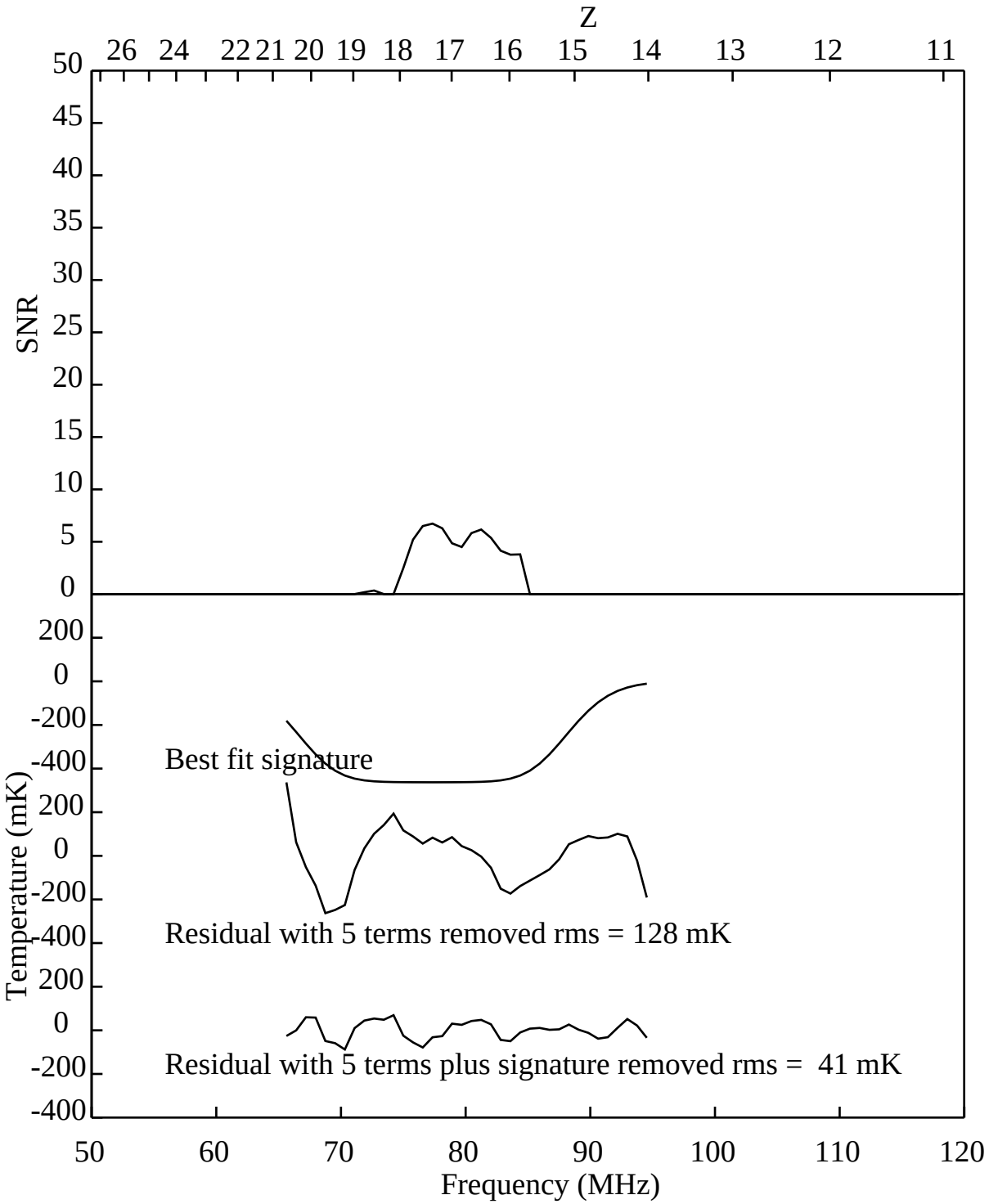

Figure 4. The best fit 21-cm signature for fixed tau = 7 using rfi filtered data blocks of 6 minutes from all days data taken from Devon Island.