EDGES MEMO #412

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
HAYSTACK OBSERVATORY
WESTFORD, MASSACHUSETTS 01886
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Telephone: 617-715-5533

To: EDGES group
From: Alan E.E. Rogers
Subject: Analysis of EDGES-3 data from MRO following averaging of the VNA s1p data

Averaging of the VNA s1p data to reduce the effects of the large temperature variations as described in memo 411 was started on 9 March 2023 (day 68). Figure 3 of memo 411 shows how the repeatability of the s11 derived from data at 18 and 21 UT was improved by a factor of about 10.

An analysis of the data shows that in the frequency range 60 to 100 MHz low residuals and an absorption grid search result consistent with the 2018 result is achieved using the calibration and antenna s11 from day 70. An example is shown in Figure 1 using only nighttime data and 5 loglog polynomial terms.

In order to get low residuals below 60 MHz the result of an absorption grid search, like that shown in Figure 2 is sensitive to the choice of a calibration. In this case the calibration from 2022_316 is needed to get low residuals and a grid search result consistent with the 2018 Nature result. A close examination of the difference between the calibration on day 316 and the calibration on 2023_070 is the phase of the LNA S11 which is just as critical as the antenna S11 as discussed in memo 368 owing to the high sensitivity of F (see memo 368 for calibration equations)

$$F = (1 - |(\Gamma_l)|^2)^{1/2}/(1 - \Gamma_a\Gamma_l)$$

to antenna and LNA s11 phase.

A test of the sensitivity of the LNA S11 was made in memo 218 and found to be about 1e-4 fractional parts per degC.

A check on the prototype EDGES-3 was made from the difference in calibrated S11 made with the temperature controlled at 30degC and then at 35degC from which an average 1.4e-3 was obtained which corresponds to a fractional coefficient of about 3e-4 per degC.
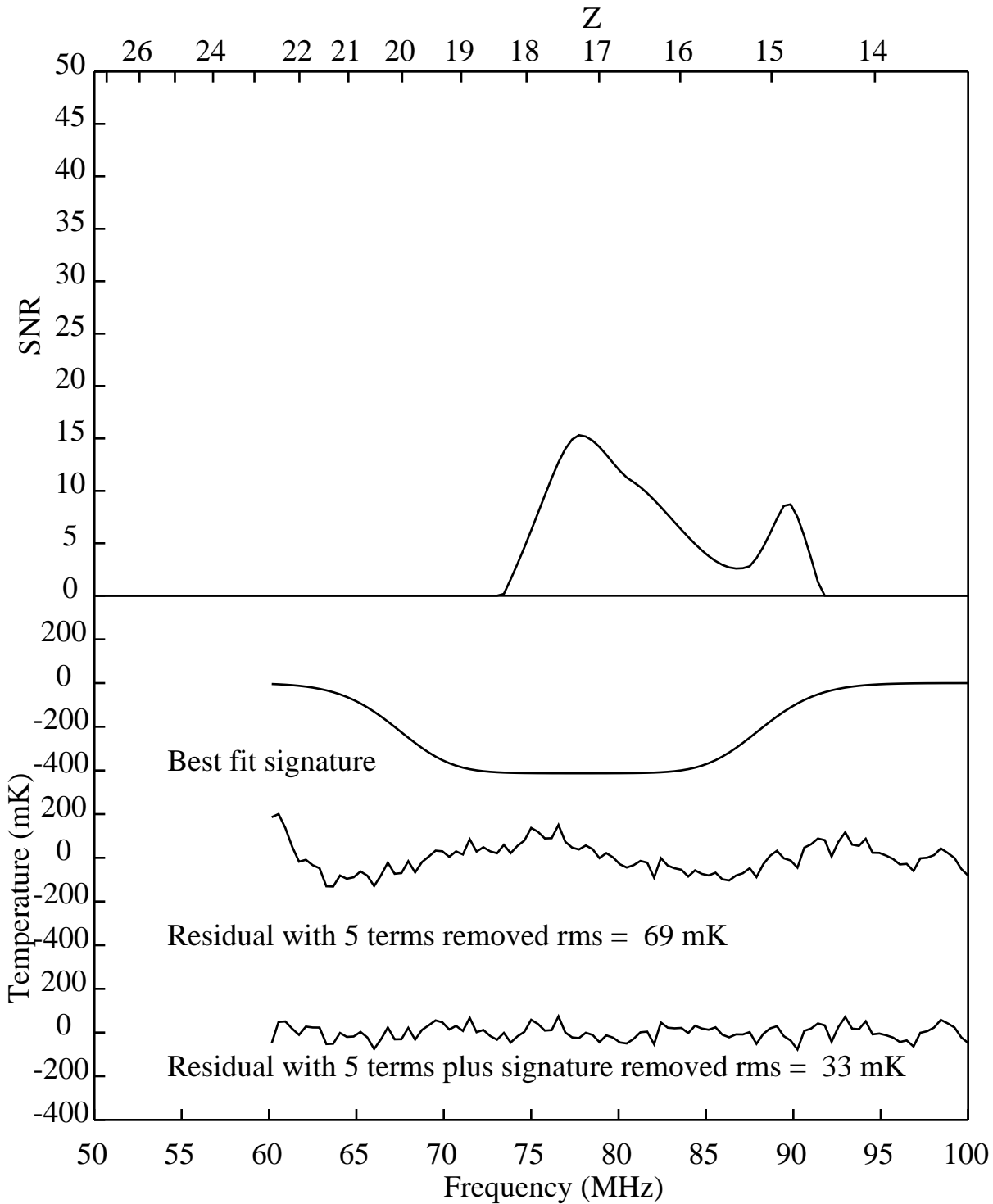
freq 77.7 snr 15.3 sig 0.41 wid 20.90 tau 7 rmsin 0.0687 rms 0.0334 60 - 100

Figure 1. Analysis of data from day 54 to 71 using calibration and antenna s11 from day 70 using beam correction and 5 loglog terms for the foreground.

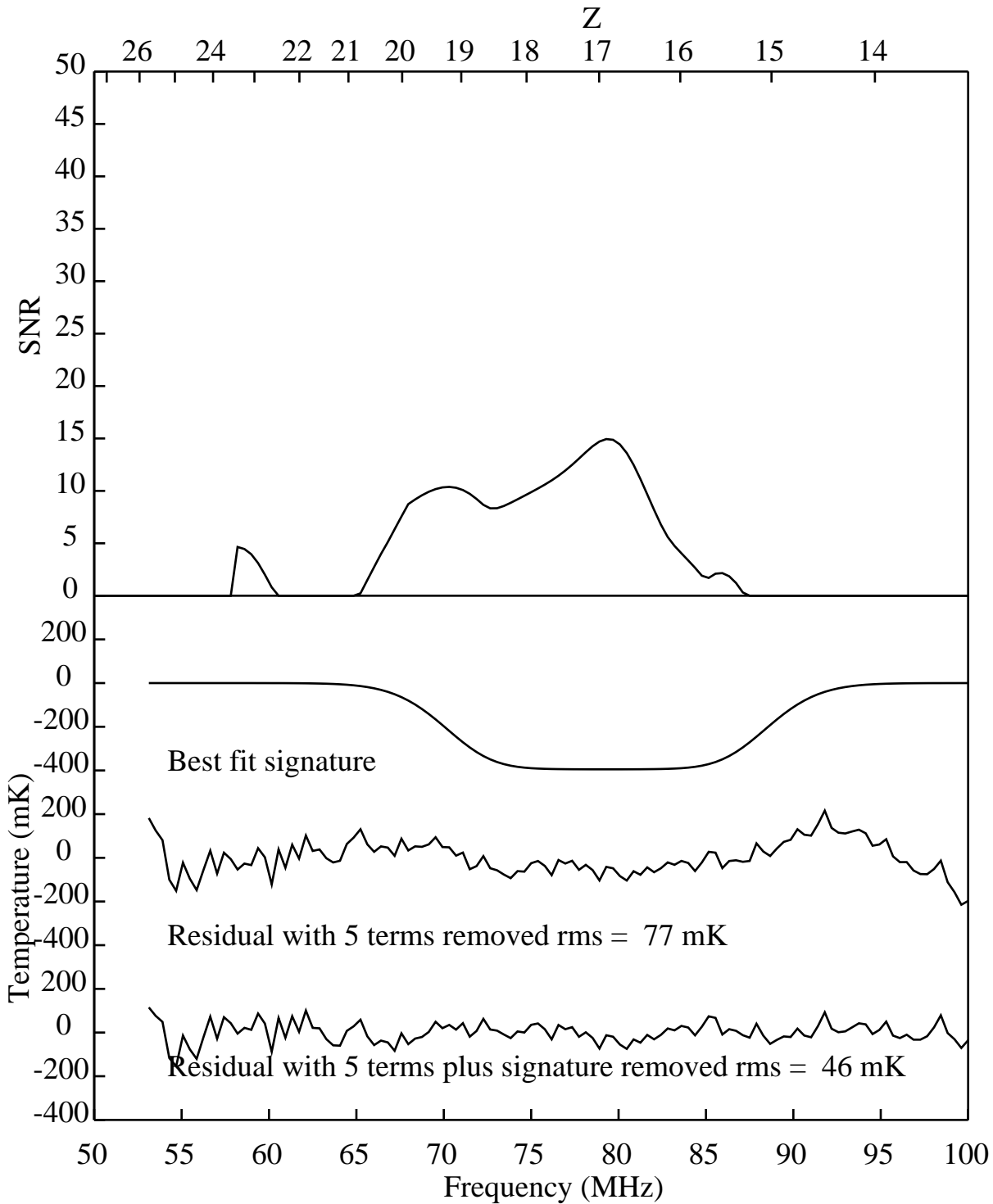freq 79.3 snr 14.9 sig 0.39 wid 18.60 tau 7 rmsin 0.0774 rms 0.0459 53 - 100

Figure 2. Analysis of data from day 54 to 65 using calibration from 2022_316 and antenna s11 from day 70 using beam correction and 5 physical terms for the foreground.