ARIZONA STATE UNIVERSITY
TEMPE, ARIZONA 85287

Open-switch verification test with Low-2

Judd Bowman
August 2, 2018

Introduction

A number of verification tests have been formed on the EDGES system to assess if the observed feature at 78 MHz in low-band observations is consistent with originating from the sky. Many of these tests are summarized in the Bowman et al. (2018) detection paper. Assuming a linear system, the EDGES instrument response function can be described with a simple equation:

$$T_{meas} = A\ T_{sky} + B \qquad (1)$$

where T_{meas} is the recovered sky temperature from the data after applying calibration and corrections, T_{sky} is the intrinsic true sky temperature and A and B are multiplicative and additive constants that encapsulate any errors in the measurement process. The most stringent tests of the deployed instruments in the Bowman et al. (2018) paper (such as the amplitude of the feature recovered as a function of LST) tend to be best at disfavoring multiplicative errors (errors in A in Equation 1). Additive errors (errors in B in Equation 1) that might cause of the feature reported are disfavored primarily through tests that were conducted in the laboratory before the instruments were deployed. These tests include laboratory measurements through a receiver of the artificial sky simulators at 300 K and 10,000 K. In these tests no feature matching the observed sky signal was found and this taken as evidence that additive errors are not responsible for the reported feature. However, since the test was not performed in-situ at the deployment site, there are small differences in the instrument used for the test and for the observations. In particular, a different backend is used in the field compared to the lab and the length of cable between the frontend and backend is longer in the deployed instrument compared to the lab.

Measurements

We have performed a test using the low-2 instrument at the MRO on March 24-25, 2018. We set the first switch between the LNA and the antenna to a state where the LNA sees an open instead of the antenna. We then ran the system for approximately 48 hours “observing” this electrically open transmission line instead of the antenna. Figures 1 and 2 show the resulting 3-position switch corrected spectrum. After fitting and removing low-order polynomial models (standard polynomials, not EDGES polynomial) no evidence of a feature analogous to the report detection remains in the data. The data are next calibrated using the usual EDGES equations, but setting the antenna S11 to zero since there is no antenna attached. Figure 3 shows the results of a 21cm model profile search in the calibrated data. The best fit model is a shallow profile centered at 90 MHz with relatively low significance.

Conclusion

From the above analysis, we conclude that the open-switch test disfavors additive errors after the antenna as the source of the observed profile feature.

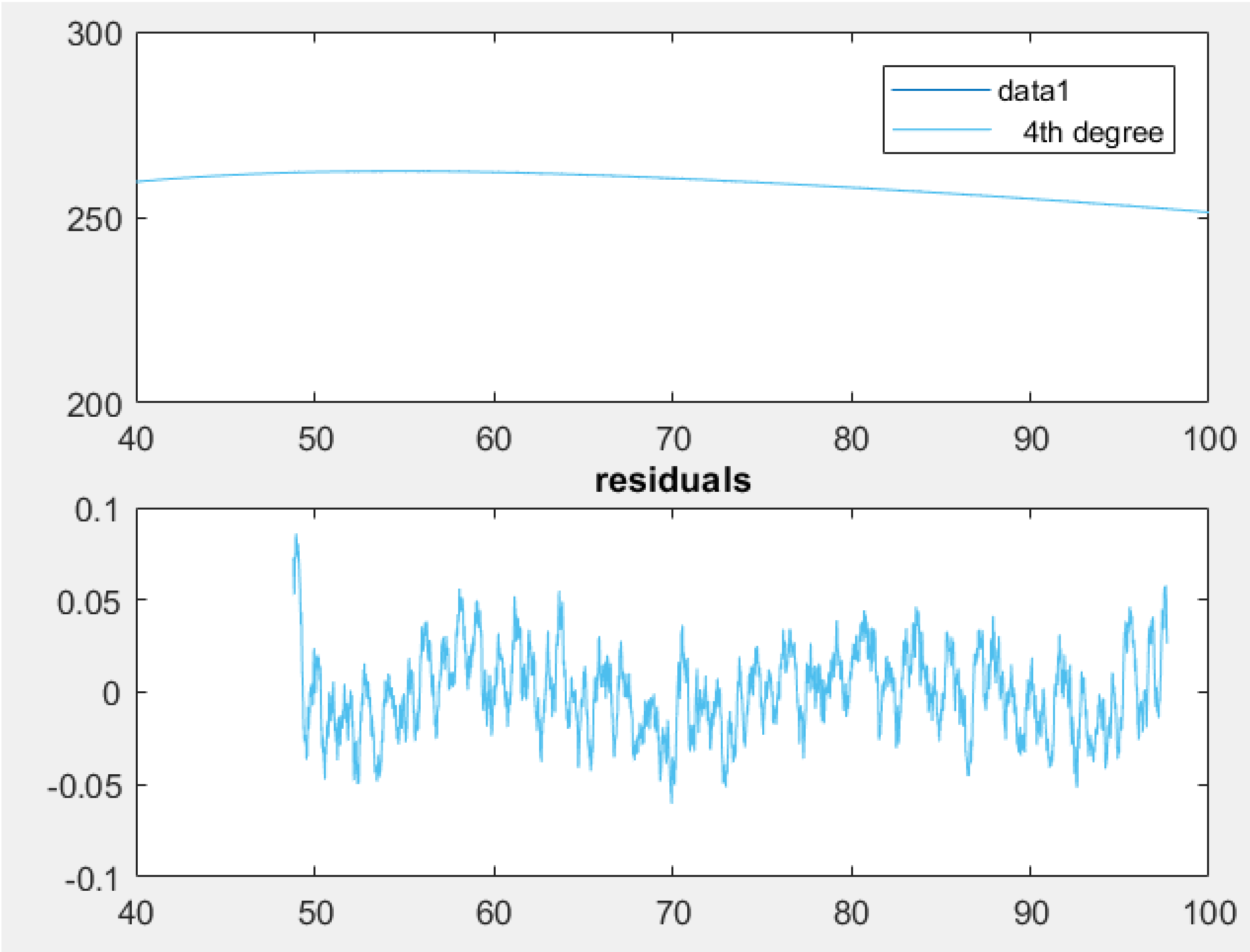

Figure 1. *Residuals to a 5-term polynomial fit (standard polynomial) from approximately 49-98 MHz. The residuals are consistent with generally smooth structure in the spectrum and do not show structure similar to the 0.85 K residuals of the observed feature when fit by a similar 5-term polynomial. X-axis is frequency in MHz and y-axis is brightness temperature in K.*

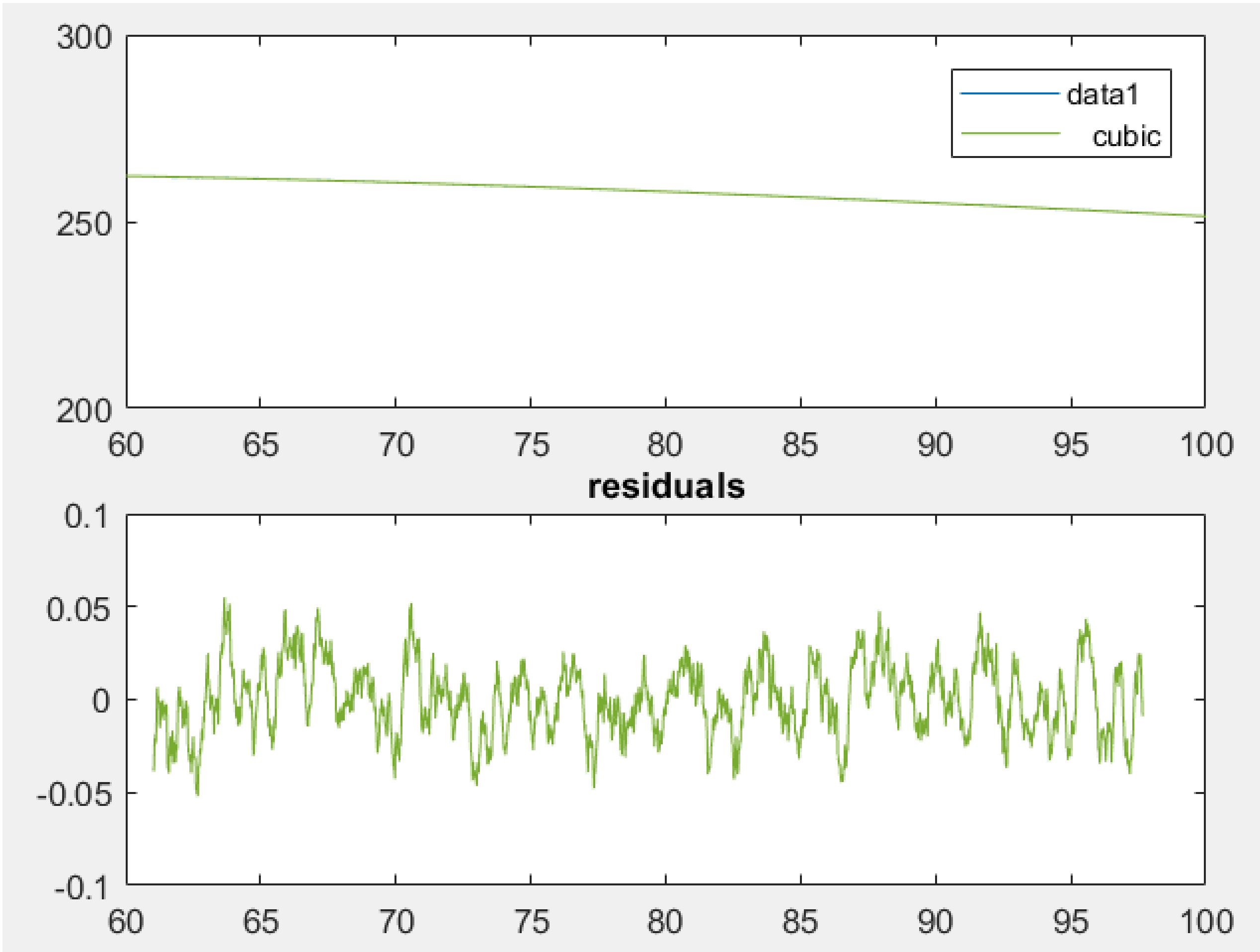

Figure 2. *Similar to Figure 1, but for a narrower sub-band from 61-98 MHz and with a 4-term polynomial model fit.*

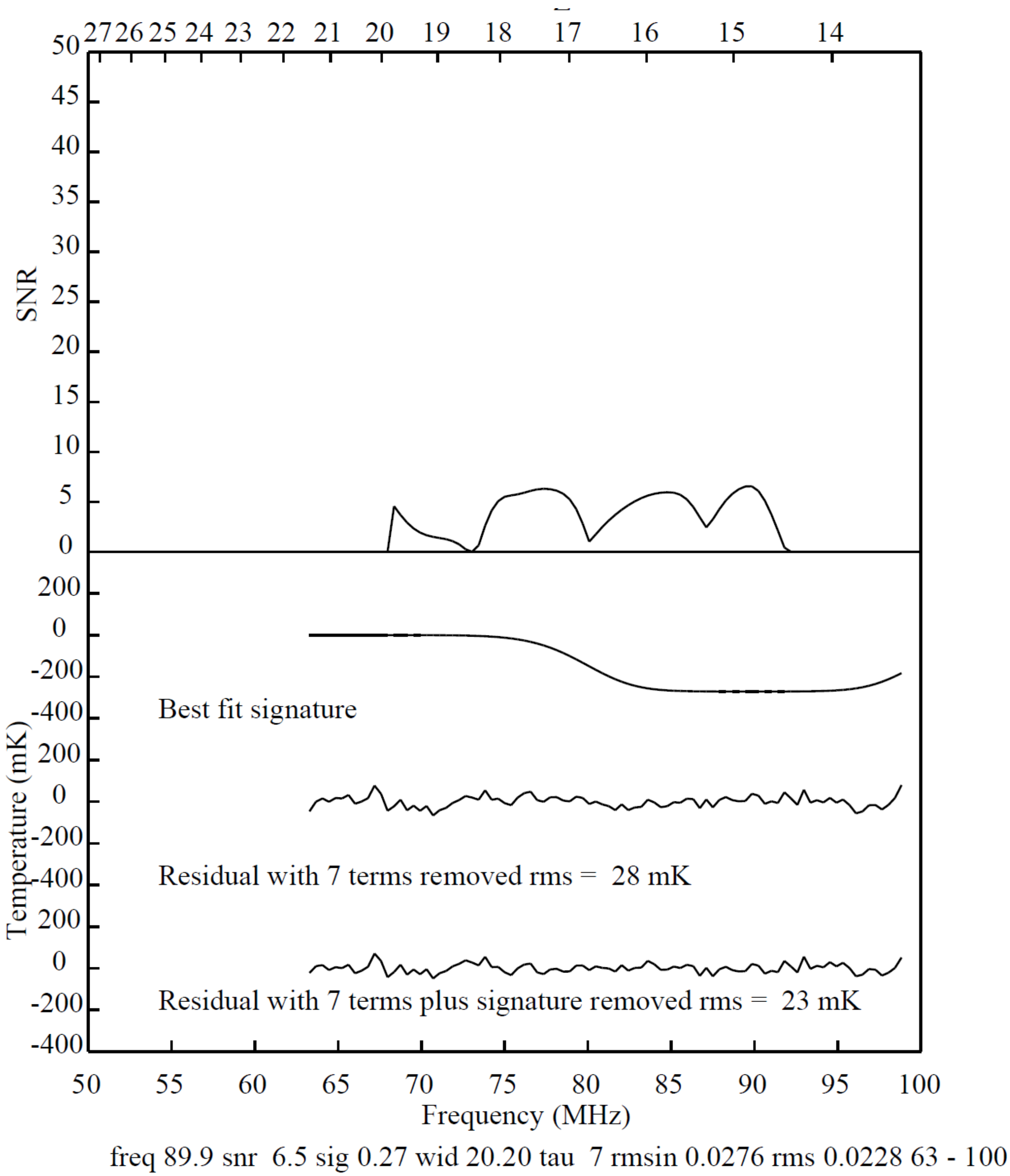

Figure 3. *Results of a 21cm model search in the open-switch data. The best-fit model is not significant compared to other trials and returns a shallow profile (0.27 K) centered at 90 MHz instead of 78 MHz.*