LoCo Lab EDGES Memo 146
Mid-Band Spectral Residuals

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1 Description

Here we show and discuss both, daily and integrated Mid-Band residuals to help inform the computation of the 'full-season' integrated Mid-Band spectrum.

The residuals are computed by averaging data in the GHA range $6-18$ hr, and then fitting and removing a five-parameter foreground model.

In some cases we averaged together both daytime and nighttime data, while in other cases only nighttime. We do this for comparison, under the assumption that nightime observations will capture the sky spectrum with higher fidelity.

In all the figures of this document we have applied the same nominal calibration.

Figure 1 shows the daily residuals.

Figure 2 shows two-day average residuals.

Figure 3 shows integrated residuals for the day period 146-182, using BOTH, daytime and nighttime data.

Figure 4 shows integrated residuals for the day period 146-182, using ONLY nighttime data.

Figure 5 shows integrated residuals for the day period 186-219, using BOTH, daytime and nighttime data.

Figure 6 shows integrated residuals for the day period 186-219, using ONLY nighttime data.

Figure 7 shows integrated residuals for the day period 146-219, using BOTH, daytime and nighttime data.

Figure 8 shows integrated residuals for the day period 146-219, using ONLY nighttime data.

2 Discussion of Figures

2.1 Figure 1

Figure 1 shows the daily residuals including both day and nighttime data. Here the data are binned at a resolution of 780 kHz to reduce noise and highlight the broadband spectral features.

We see that the shape of the residuals remains roughly consistent between days 146 and 182. However, the shape changes starting on day 186 and remains roughly consistent again until day 219. The difference between these two time periods is subtle but significant. In the range 146-182 there is a 'tail' at the low-frequency end ($\sim$ 60 MHz), as well as structure at higher frequencies ($\sim$ 115 MHz). However, after day 186 only a minority of days shows such features.

From prior analyses, a large low-frequency tail is a strong indication of 'errors' in antenna S11. In the Mid-Band antenna the magnitude of the antenna reflection coefficient increases toward low frequencies. Therefore, the sensitivity to S11 errors increases toward low frequencies, and small S11 errors would lead to larger errors in the spectrum. The structure at $\sim$ 115 MHz on days before 182 could also be due to calibration errors.

The change in residuals between days 182 and 186 can be attributed to changes in the antenna on days 183-185. On these dates the humidity was $\sim$ 100% a large fraction of the time. See LoCo Memo 145.

2.2 Figure 2

Figure 2 shows the residuals after averaging every two days, over the GHA range $6 - 18$ hr. This is done to reduce noise even more and highlight the change in residual shape between days 182 and 186. Specifically, the low-frequency tail in days 146-182 is seen more clearly.

2.3 Figures 3 Through 8

The main conclusions from these figures are:

1. In the day period 146-182 the low-frequency tail (60 MHz) is seen in both, daytime and nighttime data. In the period 186-219 the low-frequency tail is not seen significantly, daytime or nighttime. This supports the idea that the low-frequency tail is due to calibration errors in the period 146-182 — which went away starting on day 186, instead of being due to solar/ionospheric/high-temperature effects.

2. The high-frequency bump (115 MHz) is seen mainly in the period 146-182 during daytime. It is not seen during nighttime — although the noise is higher —, or in the period 186-219. This suggests that the bump is produced by a calibration error (probably antenna S11) that manifests itself during the day; maybe due to high temperature?

3. Because in the period 186-219 we neither see a significant low-frequency tail (60 MHz) nor a high-frequency bump (115 MHz), it would be recommended to use this period to compute the nominal integrated spectrum. Moreover, it would be preferred to use both day and nighttime data to reduce noise.

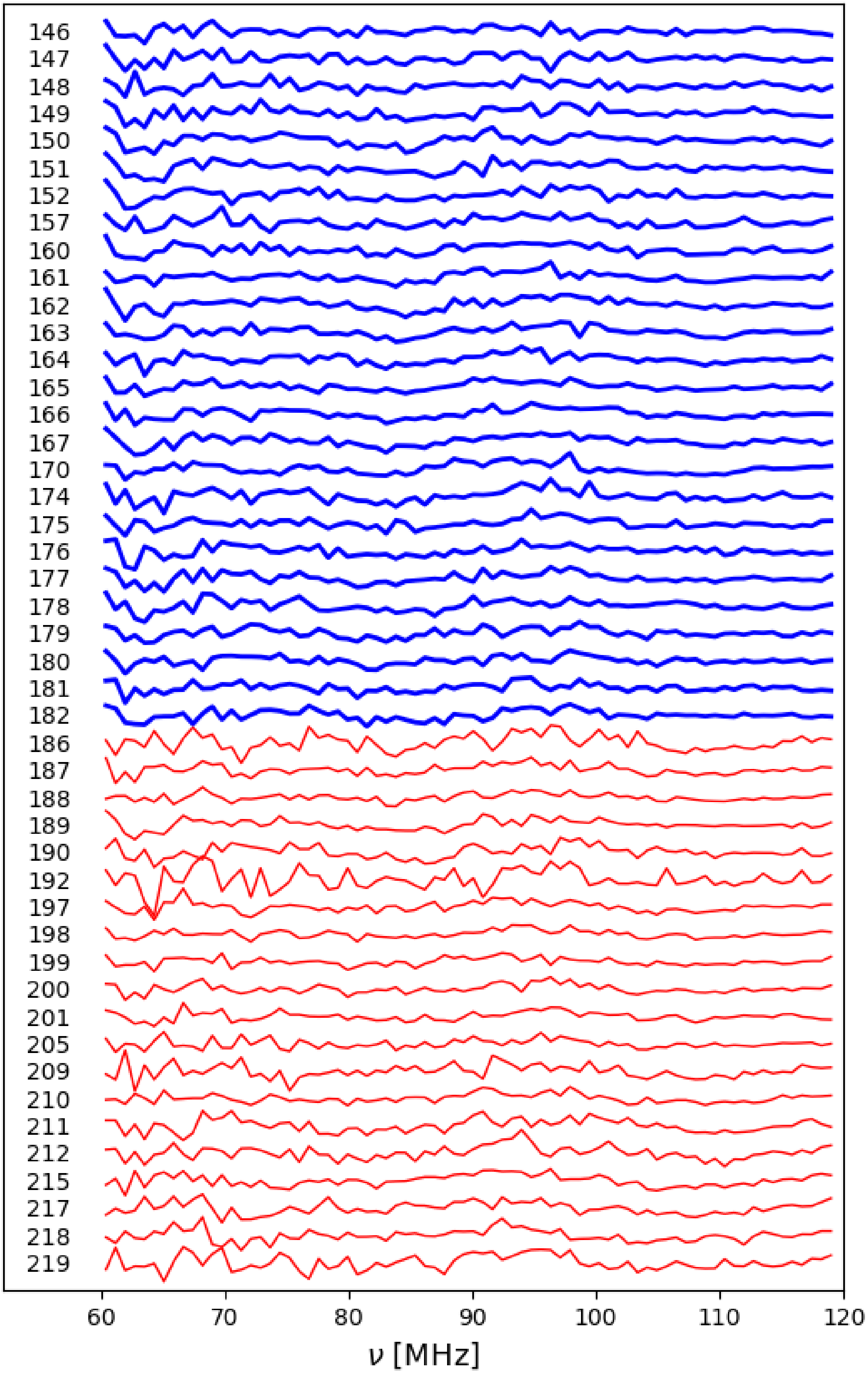

Figure 1: Daily Mid-Band residuals. For these we averaged both daytime and nighttime. The first ∼ half (days 146-182) is shown in blue and the second ∼ half (days 186-219) is shown in red. This is done to highlight the change we see in the residuals between the two periods. Specifically, there is a 'tail' at low frequencies (< 65 MHz) and a low-level bump at ≈ 115 MHz in the residuals of days 146-182. There are a few exceptions to this in this date range. On the other hand, in most days from the range 186-219 there is no 'tail' or low-level bump. A few exceptions could be days 189 and 201.

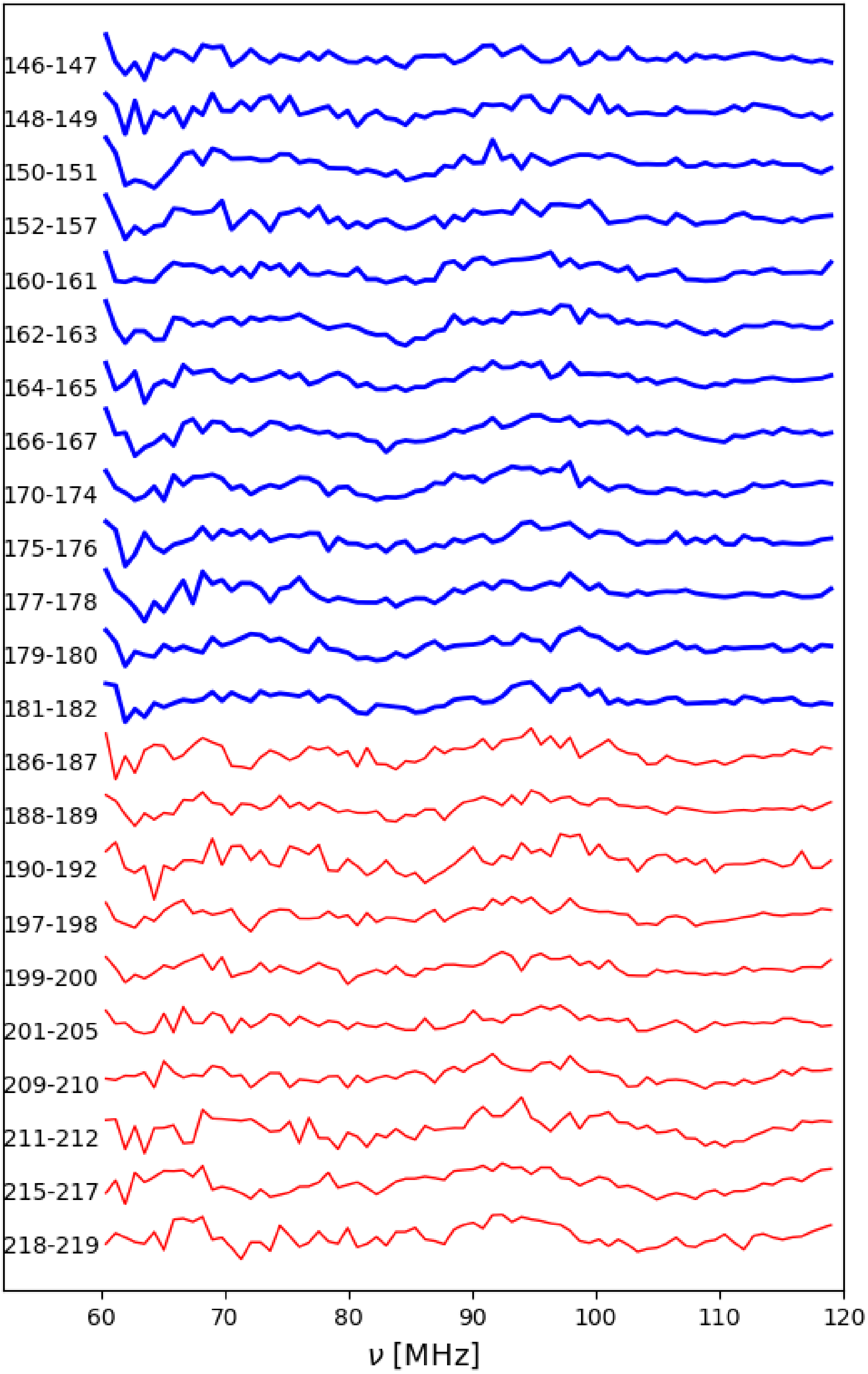

Figure 2: Residuals for two-day averages, including daytime and nighttime data. This figure shows more clearly the change in residuals, especially at the low-frequency end, between the day ranges 146-182 (in blue) and 186-219 (in red).

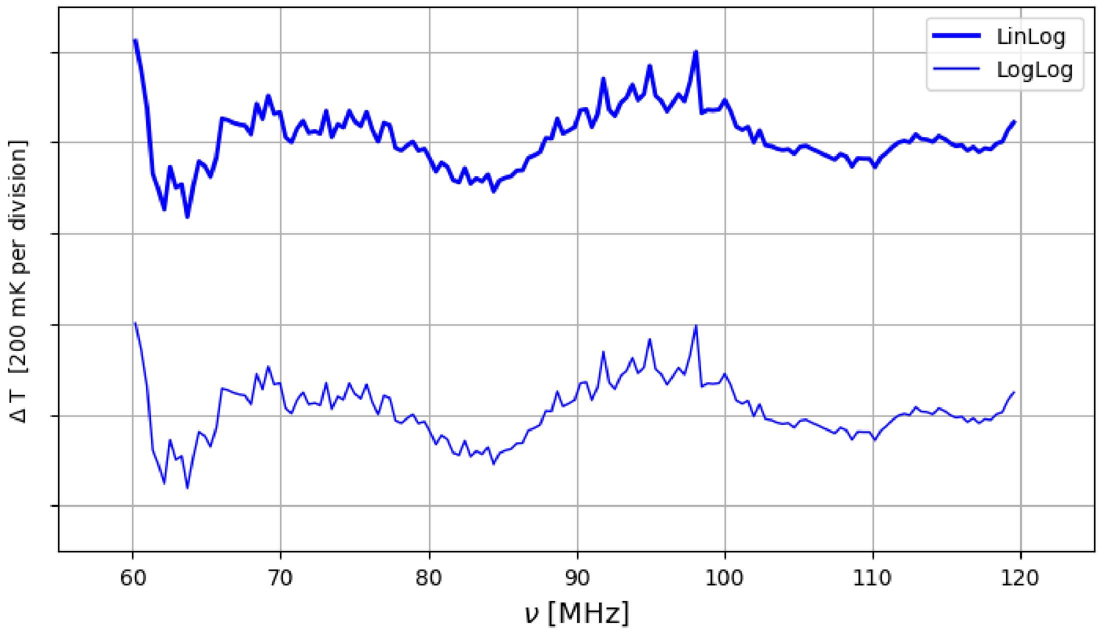

Figure 3: Integrated residuals for the range 146-182, using both daytime and nighttime data. We see a low-frequency (60 MHz) tail and a high-frequency (115 MHz) bump.

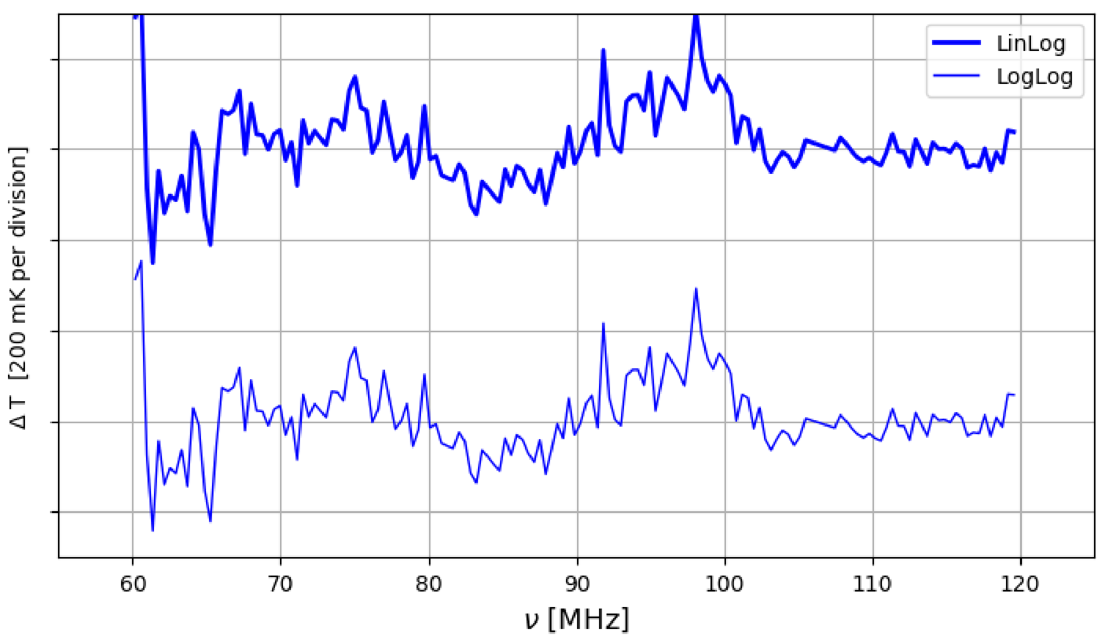

Figure 4: Integrated residuals for the range 146-182, using ONLY nighttime data. We see a low-frequency (60 MHz) tail but not a high-frequency (115 MHz) bump (although the noise level is higher than in Figure 3).

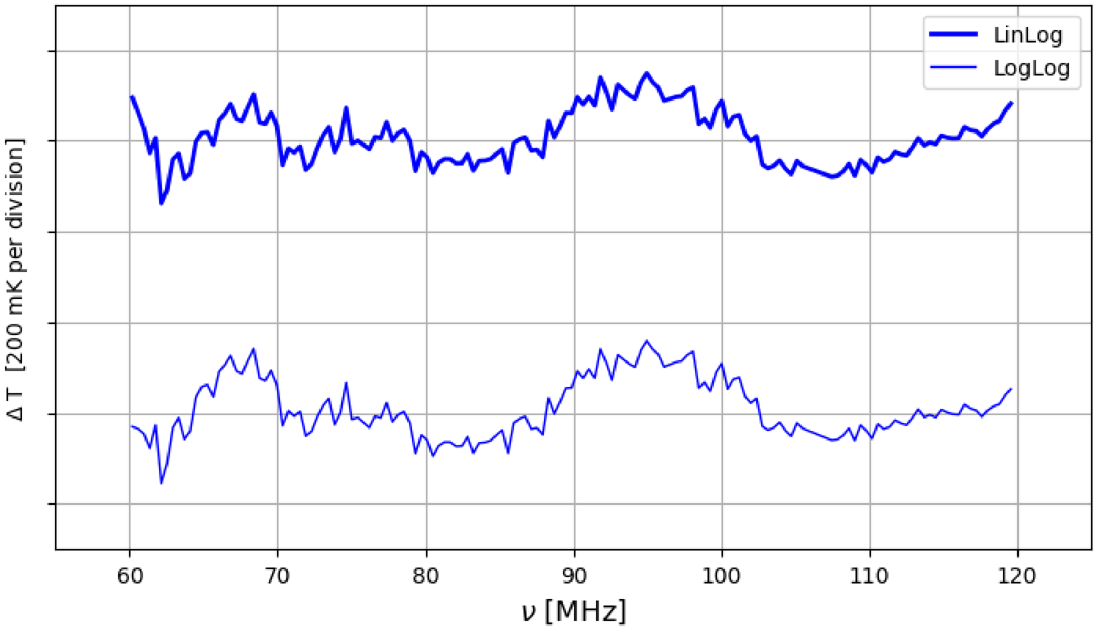

Figure 5: Integrated residuals for the range 186-219, using both daytime and nighttime data. We neither see a (large) low-frequency (60 MHz) tail nor a high-frequency (115 MHz) bump.

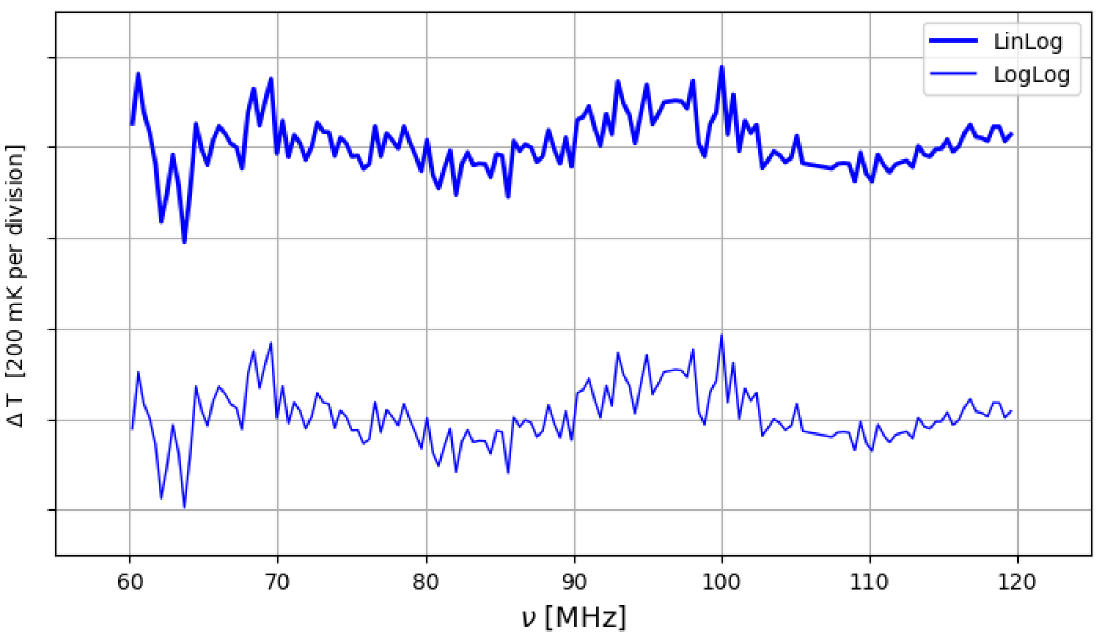

Figure 6: Integrated residuals for the range 186-219, using ONLY nighttime data. We neither see a (significant or large) low-frequency (60 MHz) tail nor a high-frequency (115 MHz) bump.

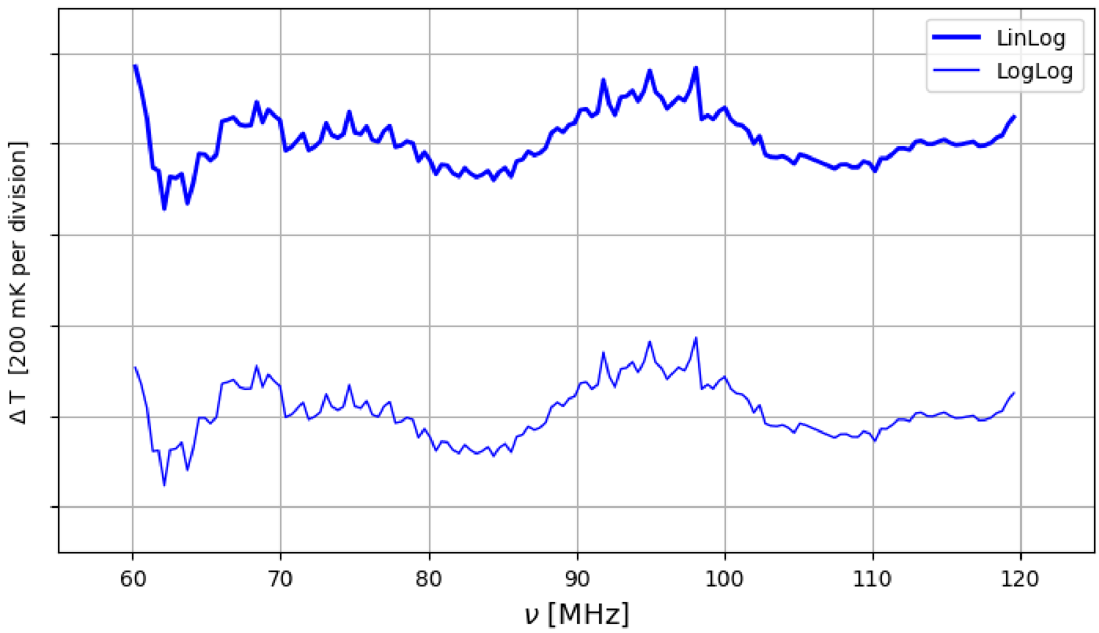

Figure 7: Integrated residuals for the full range 146-219, using both daytime and nighttime data. We see both, a low-frequency (60 MHz) tail and a high-frequency (115 MHz) bump. There is also some residual FM RFI.

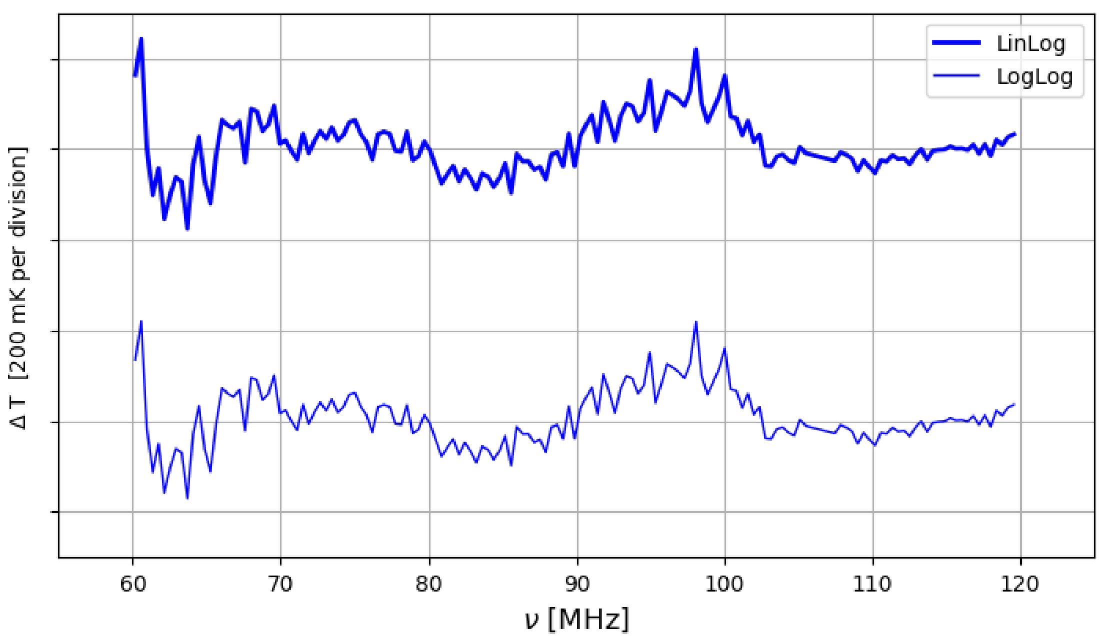

Figure 8: Integrated residuals for the full range 146-219, using ONLY nighttime data. We see a low-frequency (60 MHz) tail but not a high-frequency (115 MHz) bump.