EFFECT OF AMBIENT TEMPERATURE VARIATIONS ON THE LONG CABLE

EDGES MEMO

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ABSTRACT

This memo determines the magnitude of effects of ambient temperature drift on long cable measurements made in the lab. The context for this investigation is that the long cable (especially open load) seems to display oscillations in its residuals after calibration, and we are trying to determine what their source is.

1 Introduction

The long cable used for lab calibration seems to display oscillations in its residuals after calibration. The source of these oscillations is somewhat perplexing, and persist even when high-order (11-term) polynomials are used for the noise-waves. One possible explanation would be that there is a temperature gradient over the long cable causing unaccounted loss.

To partially investigate this, we here look at the difference induced in the calibrated residuals when accepting only spectra taken while the recorded ambient temperature is within a more narrow range.

2 The Effect of Temperature Variations

Our setup is as follows. We use the observation `Receiver01_25C_2015_09_02` created by `edges-cal` in the following way:

```
CalibrationObservation(
    path,
    f_low=50.0,
    f_high=100.0,
    freq_bin_size=16,
    run_num={"receiver_reading": 6},
    repeat_num=1,
    cterms=6,
    wterms=8,
    load_kwargs={"t_load": 300, "t_load_ns": 1000.0},
    load_spectra={
        "hot_load": {"ignore_times_percent": 10},
        "ambient": {"ignore_times_percent": 7},
        "open": {"ignore_times_percent": 7, 'temperature_range': open_temp_range},
        "short": {"ignore_times_percent": 7},
    },
    load_s11s={"lna": {"n_terms": 11, "model_type": "polynomial"}},
)
```

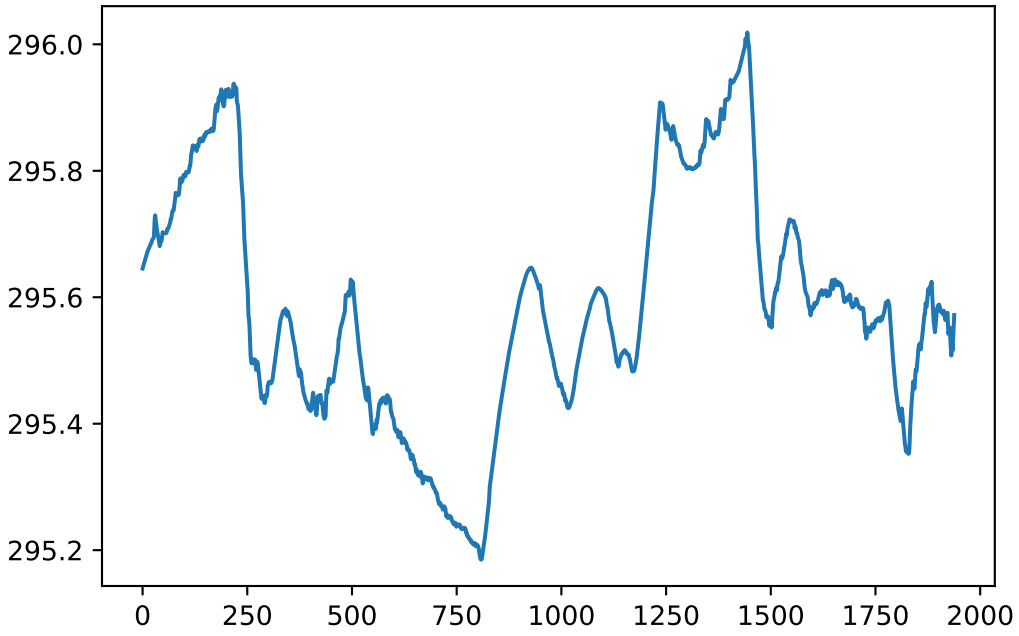

Figure 1: Temperature of the open load measured by the thermistor during the calibration observation used in this memo.

The `open_temp_range` variable is a new option in `edges-cal v5.2+`, and is set to different values for different curves in this memo. It is a 2-tuple that specifies the `(lower, upper)` temperature measured *by the thermistor* whose associated spectra will be used in the calibration.

Note that we only restrict the temperatures for the OPEN load, whose calibrated spectra are most distressing. The measured temperatures of the open load are shown in Fig. 1, showing $\sim$1K systematic variation over the observation.

We perform three calibrations: (i) using all the open load spectra, (ii) using open load spectra measured where the temperatures are between (295, 295.5) (low temp), and (iii) with temperatures between (295.5, 296).

The results of the calibration are shown in Fig. 2. Calibration of the ambient and hot loads are unaffected. Calibration of the long cable loads are affected, especially the open load (whose input data is being sliced up). For reference, the blue line shows the calibration using only the lower half of temperatures, orange the upper half, and green all temperatures. While there are differences between the calibrations, they are small are seemingly noise-like compared to the overall oscillations.

This indicates that temporal thermal variations are not the culprit for the systematics we are seeing. It may also indicate that *spatial* thermal variations along the cable are less likely to be the cause, but that it less clear.

3 Takeaways

- Temporal thermal variations during long cable measurement are not a significant factor in the calibration if kept within a $\sim 1K$ bound.
- These variations are not the cause of the spectra ripple seen in calibrated long cable measurements.

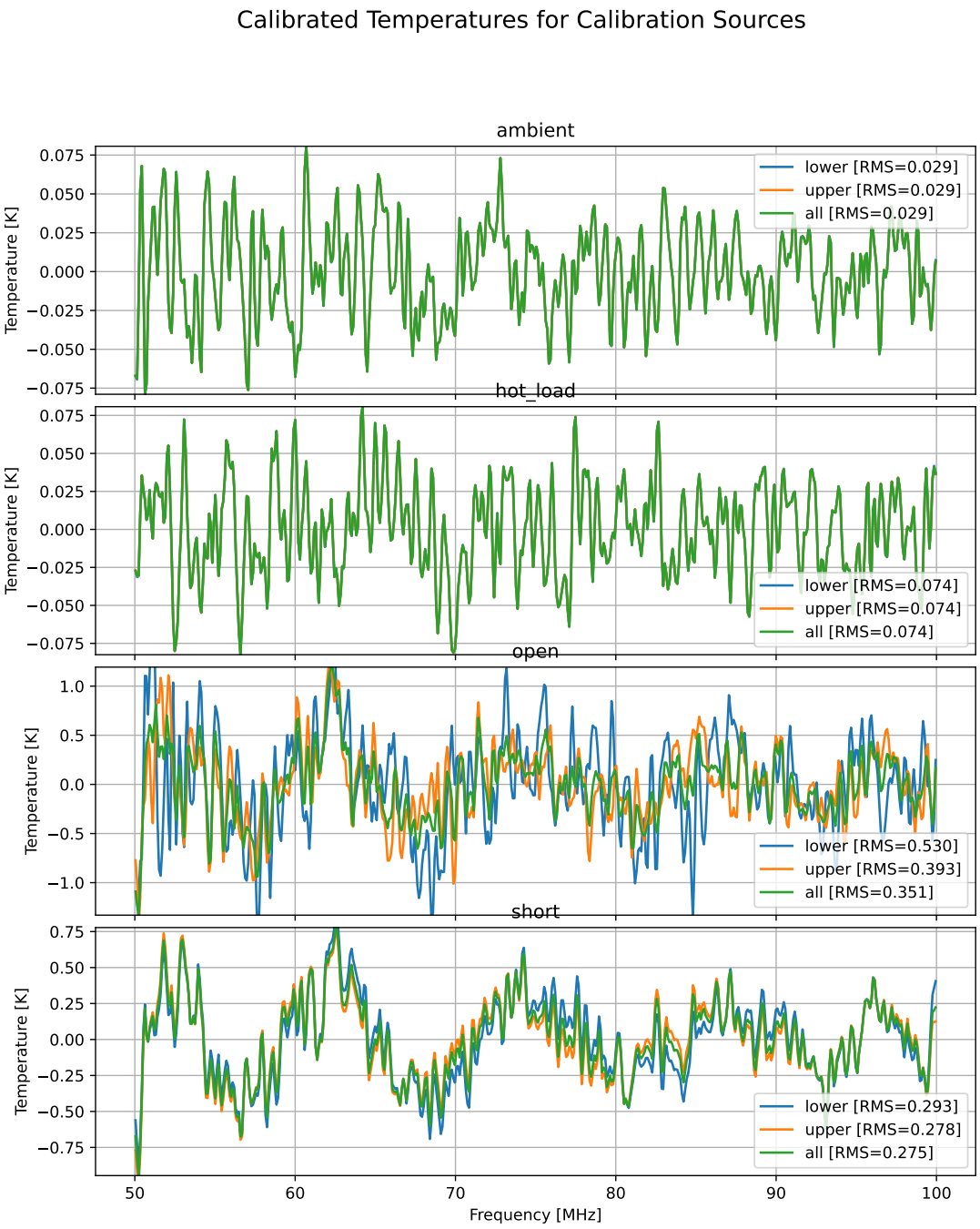

Figure 2: Effect of temperature of open load on calibration. The differences between calibrated residuals appear to be essentially noise-like.