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To: EDGES group

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Subject: Sensitivity of EDGES antenna s11 to ground water at Adak

Data from Adak taken on 2025 days 30, 35, 38, 41 and 43 show considerable variation in the calibrated spectra shown in Figure 1 and "comments" on the weather from

https://www.timeanddate.com/weather/usa/adak/historic

which suggest a correlation with rms are listed in Table 1 below:

Day	Date	rms range degK	Weather
2025_030	Jan 30	3.4 – 1.7	clear
2025_035	Feb 4	1.5 - 2.9	clear
2025_038	Feb 7	3.6 - 2.5	rain
2025 041	Feb 10	7.3 - 6.2	rain
2025_043	Feb 12	3.4 - 3.2	clear
Table 1 We	ather at Ada	k	

The calibrated spectra are processed with a calibration made on 2024 day 345 and the antenna s11 from 2024 day 346. The effects of moisture are studied in memo 458 but only address the effects of moisture on parts of the antenna. The correlation of rms error with the presence rain could be the result of moisture on the antenna but the antenna parts and the connection between the antenna boxes have been well sealed and coated. Another possibility is a build-up of rain water below the antenna which could also effect the antenna s11 and more frequent antenna s11 measurements might be needed.

FEKO simulations of the change in the dielectric and conductivity of the soil under the wire grid ground plane have a small effect but could have a significant effect if the water level rises above the wire grid which would decrease the effective height of the antenna which would have a large effect on the antenna s11. A full FEKO simulation of this requires placing dielectric material above the ground plane which results in FEKO errors as discussed in memo 248. Placing a small amount of dielectric above the ground is possible but requires using the reflection ground method instead of the method of moments (MoM) "Green's function" (GF). To first order the effect on the antenna s11 of 1 cm of water above the wire grid can be estimated by raising the wires by 1 cm.

Figure 2 shows the simulated effects on the spectra for days 38 and 41 using the antenna s11 from FEKO with the wire grid raised by 2 cm for generating the simulated data and wire grid left in place for processing the simulated data. The days 30, 35 and 43 use measured antenna S11 from day 29, which according to the historic weather data was a wet day for generating the simulated data and the measured antenna data from day 44, which according to the historic weather was a dry day, for processing the simulated data.

Figures 3 and 4 show the spectra and absorption using the calibration from 2024 day 345 and antenna s11 from 2024 day 346 with 6 loglog polynomial terms removed and an rms acceptance threshold of 0.2 K for each hour of data shown in figure 3.

In summary the antenna s11 data from Adak is strongly effected by rain and consequently antenna s11 data is needed at least once per day during periods of rain. Without this antenna s11 data acceptable spectral data may be limited to clear days at least in order to obtain 21-cm absorption results with the removal of 4 or 5 terms and without having to use 6-terms which is currently the case.



Figure 1. Calibrated spectra residuals from Adak 2025 data with 2 physical terms removed



Figure 2. Simulations of the effects of rain on the data



Figure 3. Calibrated Spectra from days 30, 35, 38 and 43 with 6 loglog polynomial terms removed



freq 79.3 snr 10.9 sig 0.69 wid 18.20 tau 4 rmsin 0.0601 rms 0.0384 60 - 98

