EDGES MEMO #463

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To: EDGES group

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Subject: Simulations of EDGES-3 observations at Adak to help determine the schedule

The general plan is to take sky data at night and calibration data during the day. The time range on day 340 needed to cover the time range when the Sun is more than 30 degrees below the horizon is UT 06 – 16 (HAST 20 – 06). Simulation of a search for the 21-cm absorption expected from Adak for data with different levels of Cas-A scintillation using added additions to the sky map as described in memo 427 and using all the available 1 hour data blocks with the Sun more than 30 degrees below the horizon are listed in Table 1.

Cas A	Freq MHz	SNR	sig K	width MHz	rmsin mK	rms mK	
0.0	78.1	100	0.59	18.8	58	12	no beam corr
0.018	78.5	54	0.57	18.4	57	22	“
0.05	77.3	33	0.67	19.8	65	36	“
0.10	76.6	21	0.77	20.7	84	58	“
0.18	75.8	14	0.92	21.2	125	96	“
0.05	77.0	41	0.59	20.2	72	24	with beam corr

Table 1. Simulation of EDGES-3 at Adak 2018 21-cm absorption added to sky 55 – 102 MHz 5-terms

The simulations used the Haslam map with pixel correction for the Cas A scintillation with spectral enhanced to -2.7 as described in memo 427 in addition of the spectral index -2.5 applied to the Haslam map which was made at 408 MHz. Beam correction, based on the FEKO map used to simulate the sky noise spectrum with the 2018 absorption added was applied to the last entry without the added Cas A radio flux of the Cas A fraction of 0.05. The Cas A value 0.018 corresponds to the expected flux of 1.4e4 Jy at 100 MHz without accounting for contribution already in the Haslam map.

Cas A is the strongest of the compact radio sources at about 20,000 Jy at 100 MHz with Cygnus A at about half the strength. Simulations on the effect on the spectra are shown in figure 1 of memo 427. Simulations show that Cas A and Cygnus are too far north to have any effect on the data from the WA and of the other strong sources only 3c273 has a small effect with scintillation factor 0.18. Simulations also show that the Cas A at declination 59 N is too far north to have a significant effect at other potential radio quiet sites in the northern hemisphere like Wake Island at a latitude of 19 N.

It is emphasized that the level Cas A scintillation which was inferred from the measurements made at Devon Island is probably higher than is expected from data taken at Adak at night with the Sun more than 30 degrees below the horizon. If Cas A scintillation is a significant source in the data from Adak then its effect can be reduced by limiting the frequency range to 65 -102 MHz as shown in Table 2.

Cas A	Freq MHz	SNR	sig K	width MHz	rmsin mK	rms mK	
0.18	73.8	37	0.91	26.8	87	34	Sun -20 deg
0.18	77.7	32	0.77	19.0	62	27	65 – 102 MHz

Table 2. Simulation of EDGES-3 at Adak 2018 absorption added to sky 55 – 102 MHz

While there is no direct evidence that scintillation will be significant at Adak LOFAR reports Cas A scintillation from CS002 (latitude 53 N) in Fallows et. al. 2020. However it should still be possible to get a 21-cm absorption result with filtering of a significant amount of data as the LOFAR data shows that there are short time gaps without a significant contribution from scintillation.

Jin et al. 2018 show that GPS scintillation amplitude is correlated with the solar cycle which adds to the concern that we may have significant scintillation of Cas A in the data from Adak as we are now at the peak of Solar Cycle 25.

References:

Fallows, R.A., Forte, B., Astin, I., Allbrook, T., Arnold, A., Wood, A., Dorrian, G., Mevius, M., Rothkaehl, H., Matyjasiak, B. and Krankowski, A., 2020. A LOFAR observation of ionospheric scintillation from two simultaneous travelling ionospheric disturbances. *Journal of Space Weather and Space Climate*, *10*, p.10.

Jin, Y., Miloch, W.J., Moen, J.I. and Clausen, L.B., 2018. Solar cycle and seasonal variations of the GPS phase scintillation at high latitudes. Journal of Space Weather and Space Climate, 8, p.A4