EDGES MEMO # 226

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To: EDGES Group

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Subject: Tests of variations of absorption signature shape

The analytic shape defined in memo 220 can be augmented by adding a linear tilt by multiplying the signature by

$$\left(1+t\left(\nu-\nu_0\right)/w\right)$$

Where t = tilt

ν = frequency

w = width

ν_0 = center frequency of signature

An alternative analytic signature can be defined

$$T\left(\nu\right)=\left(a/2\right)\left[\tanh\left(\left(1/\left(\nu+w/2\right)-1/\nu_0\right)/\left(w\tau^{-1}/\nu_0^2\right)\right)-\tanh\left(\left(1/\left(\nu-w/2\right)-1/\nu_0\right)/\left(w\tau^{-1}/\nu_0^2\right)\right)\right]$$

using the hyperbolic tangent function. Where τ is the "flattening" parameter. For a range of τ from about 4 to 10 the shape of the alternate function is almost the same as the signature function defined in memo 220. At τ > 10 the alternative signature maintains the symmetry of curvature the corners of the signature whereas the function in memo 220 has a sharper transition to the flattened bottom.

Figure 1 compares the signature for τ =4, 10 and 30 and Figure 2 compares the signatures for tilts with τ =7.

Table 1 shows the best fit signature parameters for data from 2016_259 – 2016_366 covering GHA 4 to 16 hours. The second entry is the "reference" case for which the beam correction was made using the beam from FEKO with soil dielectric 3.5 and conductivity 2e-2 S/m. The signature amplitude was found using a 4 term polynomial plus a signature term whose center frequency width, τ and tilt were found from a 4 dimensional grid search.

The grid search range was limited to 70 to 89 MHz in center frequency, 1 to 30 MHz in width, 1 to 10 in flattening and -0.5 to 0.5 in tilt. To test the effect of systematics the best fit signature was found without beam correction, without balun and ground loss as well as with offsets in antenna S11. The results give fairly consistent results in center frequency and width. The amplitude is

significantly affected and while all the results point to a significantly flattened absorption adding a tilt parameter may not be justified with the limited low band data using the extended ground plane.

	# terms	typ	center freq MHz	SNR	Amp K	FWHM	τ	Tilt	note
tanh	4	Poly	78.1	32	0.57	21	6	-0.2	1
Opacity	4	Poly	78.4	34	0.52	21	7	-0.2	2
No beam corr.	4	Poly	78.9	11	0.32	22	10	-0.2	
No loss corr	4	Poly	78.5	14	0.34	21	10	-0.5	3
-0.1 dB	4	Poly	78.1	37	0.69	21	6	-0.5	4
+0.1 dB	4	Poly	78.1	30	0.41	20	8	0.2	
-30ps	4	Poly	78.1	28	0.45	21	8	-0.1	
+30ps	4	Poly	78.1	40	0.69	21	5	-0.4	

Table 1 best fit signature parameters for data from 2016_259 to 2016_366.

Notes

1. Using tanh absorption function
2. References case using absorption function from memo 222
3. Frequency range 62-99 MHz - in all other cases it was 60-99 MHz
4. Offset applied to antenna S11

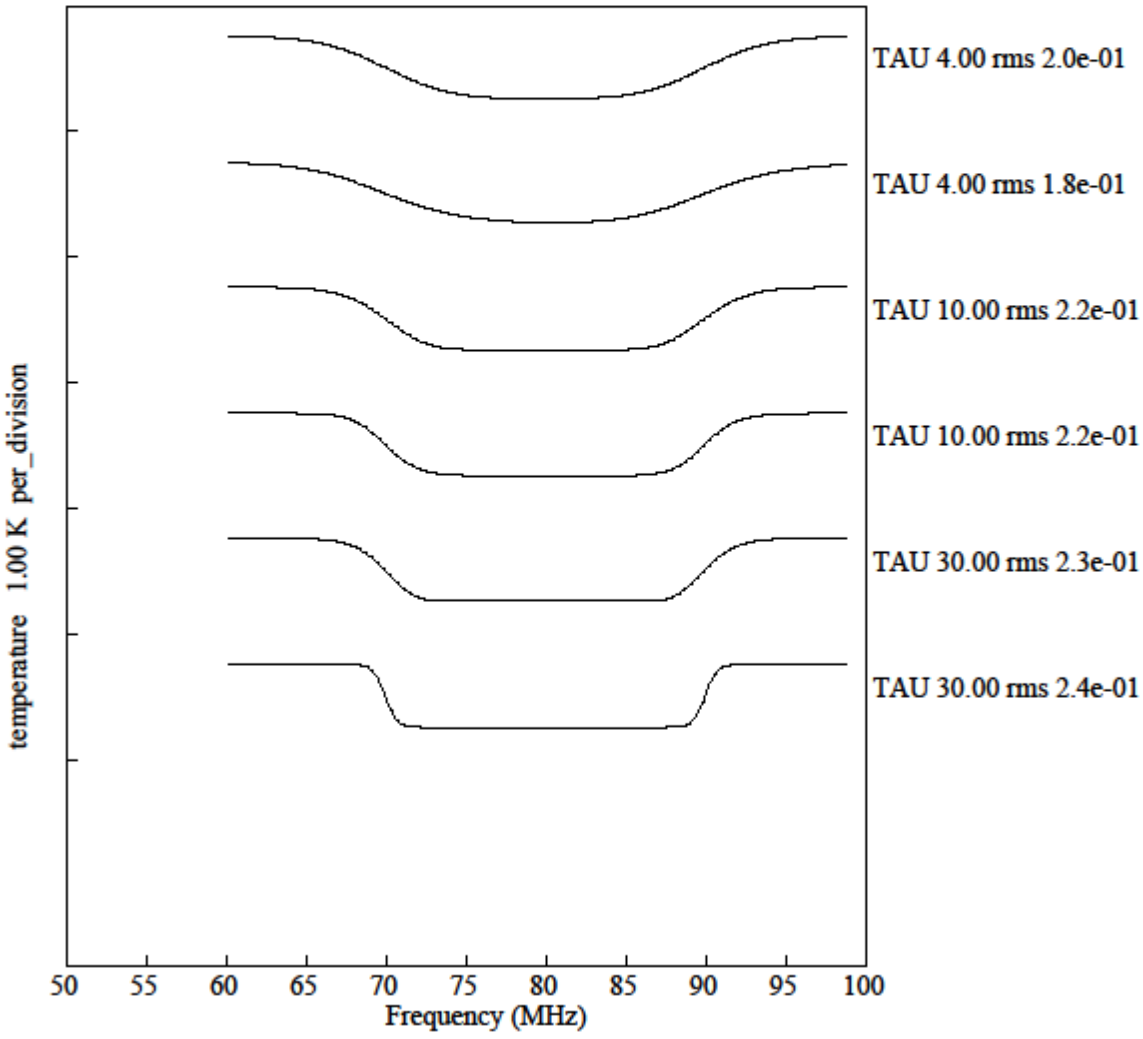

Figure 1. Absorption signatures for $\tau = 4$, 10 and 30. The top plot in each pair is the function in memo 220 while the bottom plot in each pair uses the hyperbolic tangent function.

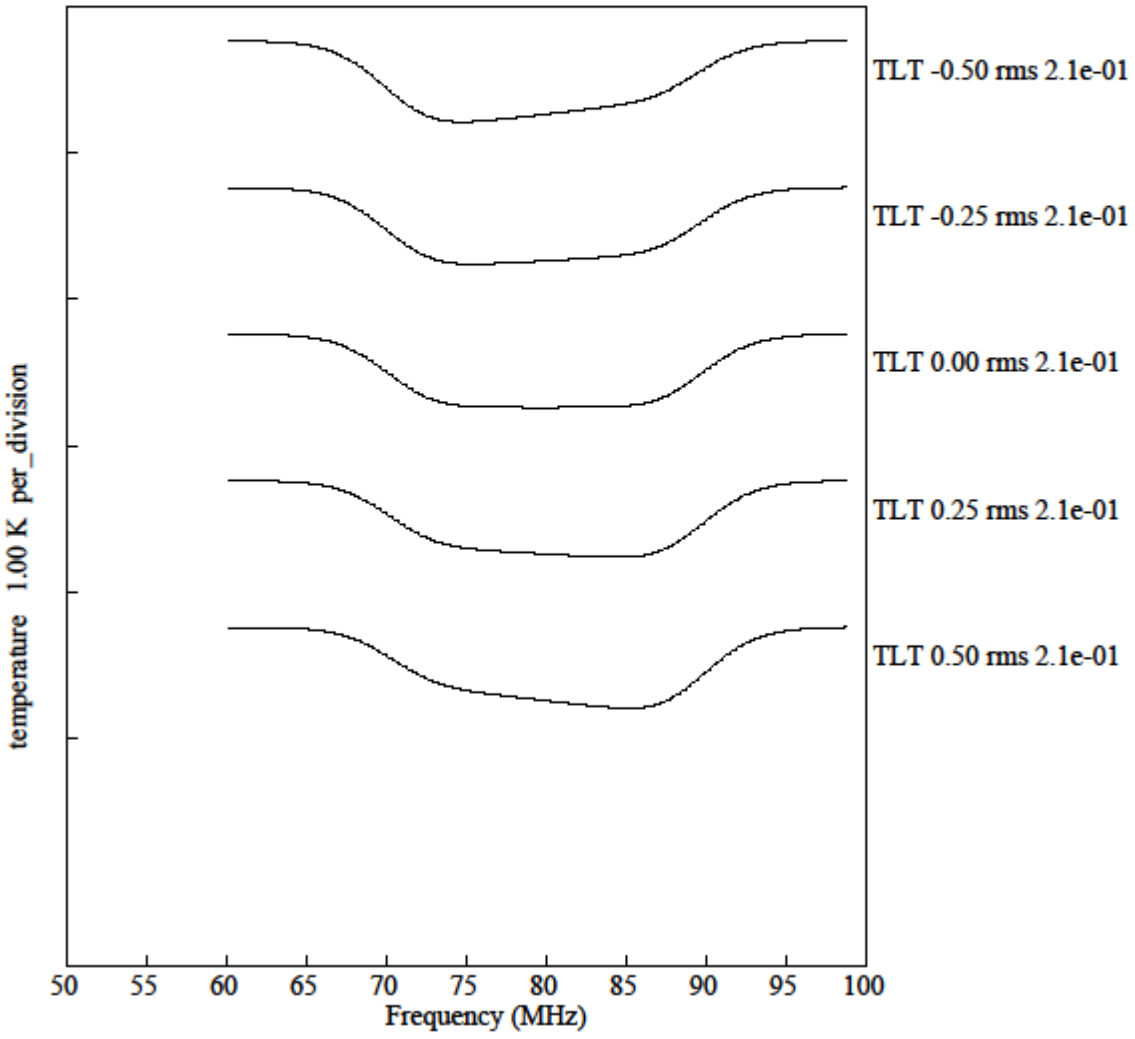

Figure 2. The signature using function from memo 220 for different values of tilt for τ=7.