The HERA Observing Season

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1 Summary

This short memo examines the optimal observing season for HERA. Since HERA is sky noise dominated, its effectiveness depends on the observed sky brightness. When the galactic plane passes through the primary beam, the noise is expected to rise by an order of magnitude. We find that *HERA's optimal observing season is mid-September through February*, with clear observing late in the night during June and July and clear observing early in the night during March and April. [1]

2 A Simple Observing Season Calculation

The results in Figure 1 are calculated[2] by as follows:

$$T = \frac{\int T_{\mathrm{GSM}}(\theta, \phi) B(\theta, \phi) d\Omega}{\int B(\theta, \phi) d\Omega} \tag{1}$$

This beam-weighted sky sets the noise in the instrument. Here $T_{\mathrm{GSM}}(\theta, \phi)$ is the brightness temperature of the Global Sky Model [1] at 150 MHz. $B(\theta, \phi)$ is the primary beam product of two antennas (i.e. the beam of a baseline). For this simple calculation, it is taken to be a Gaussian with a FWHM of 10°. Our results show that the most important feature in T is the intersection of the HERA field of view with the galactic plane (see Figure 1). The best observing seasons are therefore when the the galactic center is below the horizon for the entire night. For easy future reference we also include a single day's temperature for a representative mid-season day in Figure 2 and hourly temperatures for that day in Table 2.

Though basically every night has some time when the galactic plane is out of the main lobe of the primary beam, the best nights are during the period from September through February. The model also predicts clear observing late at night in June and July and early in the night in March and April. However, since the Gaussian beam has no sidelobes, this season might be somewhat optimistic. It follows then that the central months of the observing season—November, December, and January—are likely to be best.

References

[1] A. de Oliveira-Costa, M. Tegmark, B. M. Gaensler, J. Jonas, T. L. Landecker, and P. Reich. A model of diffuse Galactic radio emission from 10 MHz to 100 GHz. MNRAS, 388:247–260, July 2008.

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[1] For a month by month view of the sky, see the poster linked here: http://loco.lab.asu.edu/danny_jacobs/uncategorized/southern-hemisphere-radio-eor-band-guide/

[2] The code to reproduce this calculation is available at https://github.com/jsdillon/Joint_Mapmaking_Power_Spectrum_Pipeline/blob/master/ObservingSeason.py.

Time (UTC)	T (Kelvin)
0:00	368
1:00	360
2:00	320
3:00	233
4:00	237
5:00	333
6:00	446
7:00	491
8:00	648
9:00	1249
10:00	3284
11:00	923
12:00	483
13:00	345
14:00	258
15:00	216
16:00	248
17:00	240
18:00	228
19:00	192
20:00	168
21:00	184
22:00	188
23:00	267

Table 1: Beam weighted sky temperature as a function of UTC time on December 1st. This information is the same as in Figure 2 but summarized for easy use in future calculations.

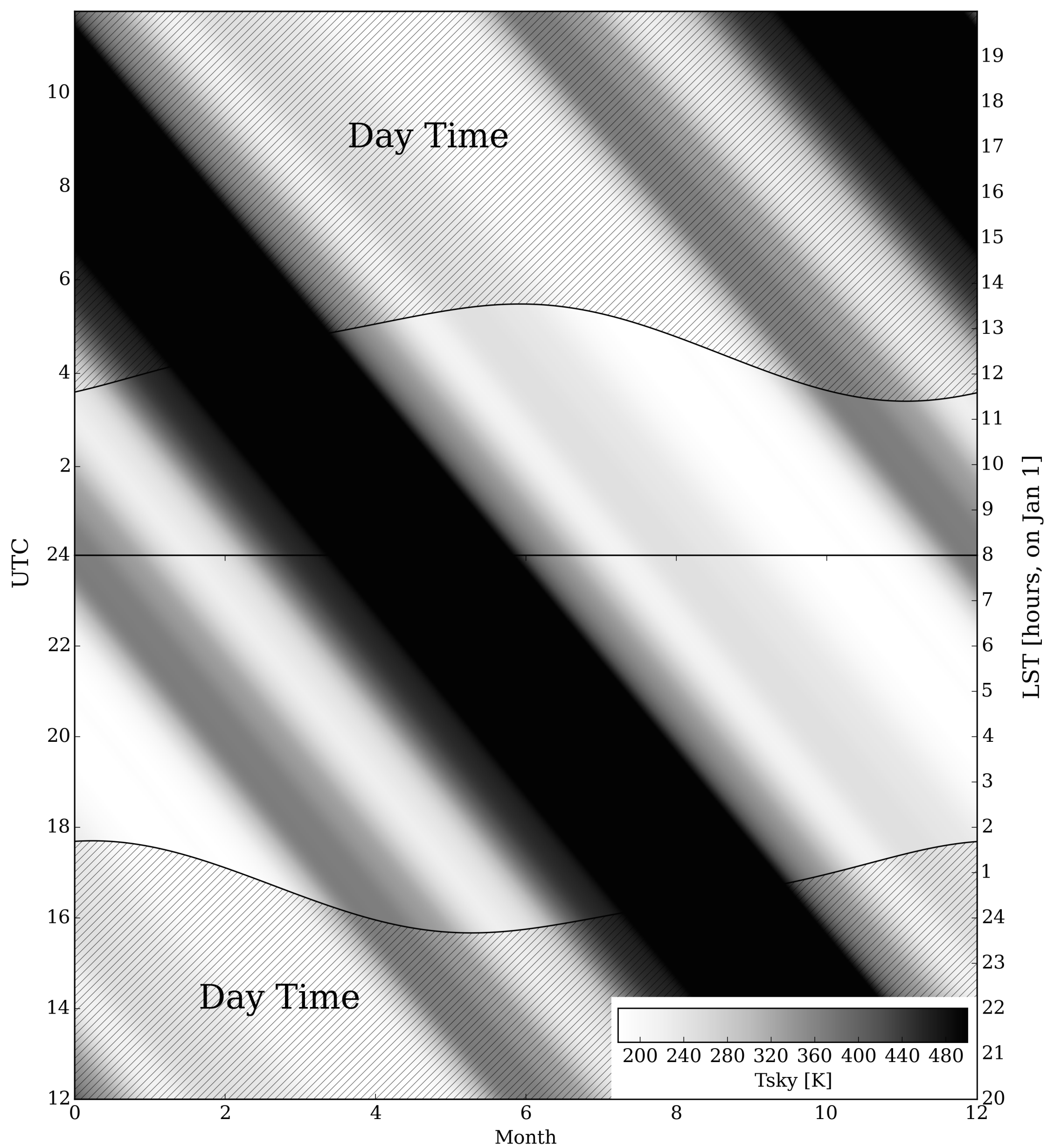

Figure 1: Beam-weighted sky brightness at 150 MHz, determines $T_{\rm sky}$ and thus instrumental noise shown here as a function of local time and date. T_{sky} is dominated by passage of the galactic plane, the black stripe. Also visible is the galactic anti-center transiting at LST of 8h. Most temperatures are under 500K (the max of the color scale) except for the galactic plane when the temperature peaks at >3000K. The optimal observing season, which keeps the galactic plane out of the primary beam for the entire night, is from September through February.

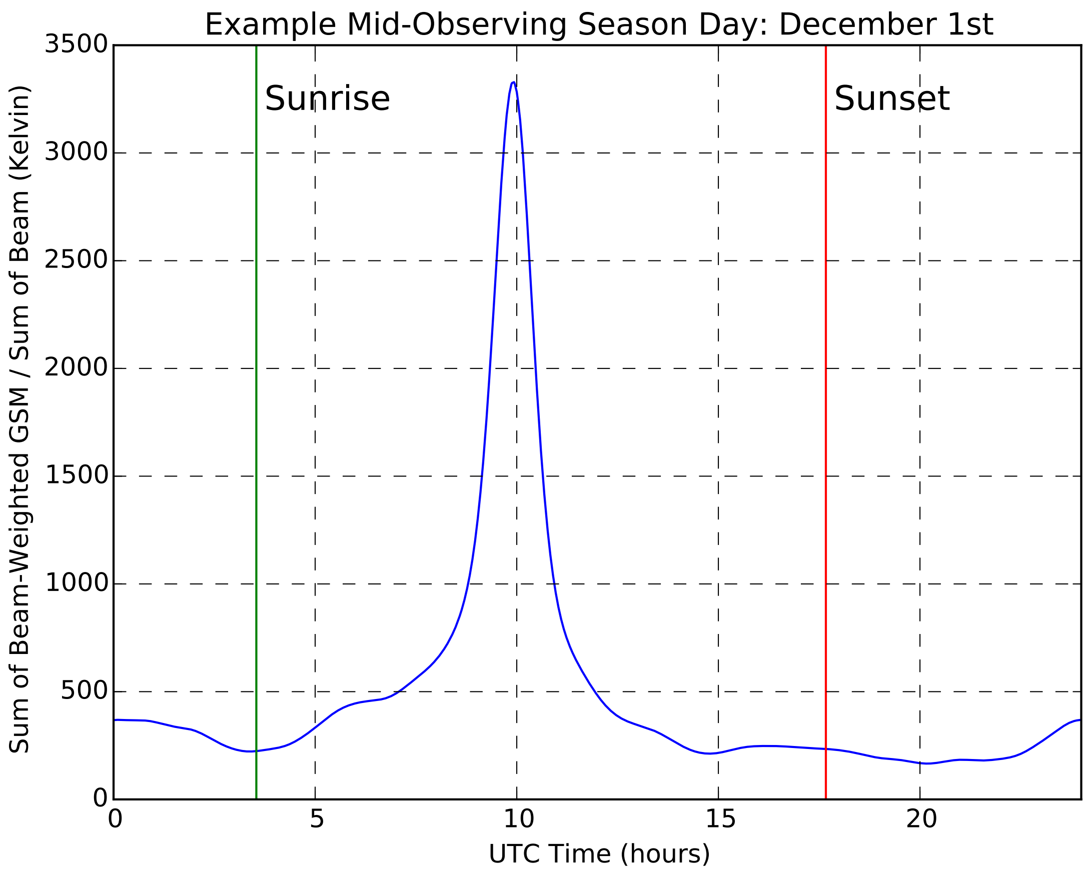

Figure 2: A single slice veritically through Figure 1 corresponding to December 1st, an example day in the middle of the observing season. As we can see, the galaxy passes through the primary beam in the middle of the day, leaving the entire night relatively free of galactic emission.