DSES-60 1420 MHz Early Study

- Ted Cline N0RQV - Nov-21-2025

Thanks to Rick Hambly K0GD for installing receiving hardware and Python modules and Soapy drivers to run the experimental ezRA ezColS data collection program on the SDRplay SDR on the Deep Space Exploration Society (DSES) 60-foot radio dish, 5 miles south of Haswell Colorado, USA.

With the dish pointing almost straight up at Elevation 87.5 degrees,
and a detailed Raspberry Pi 5 command like this,

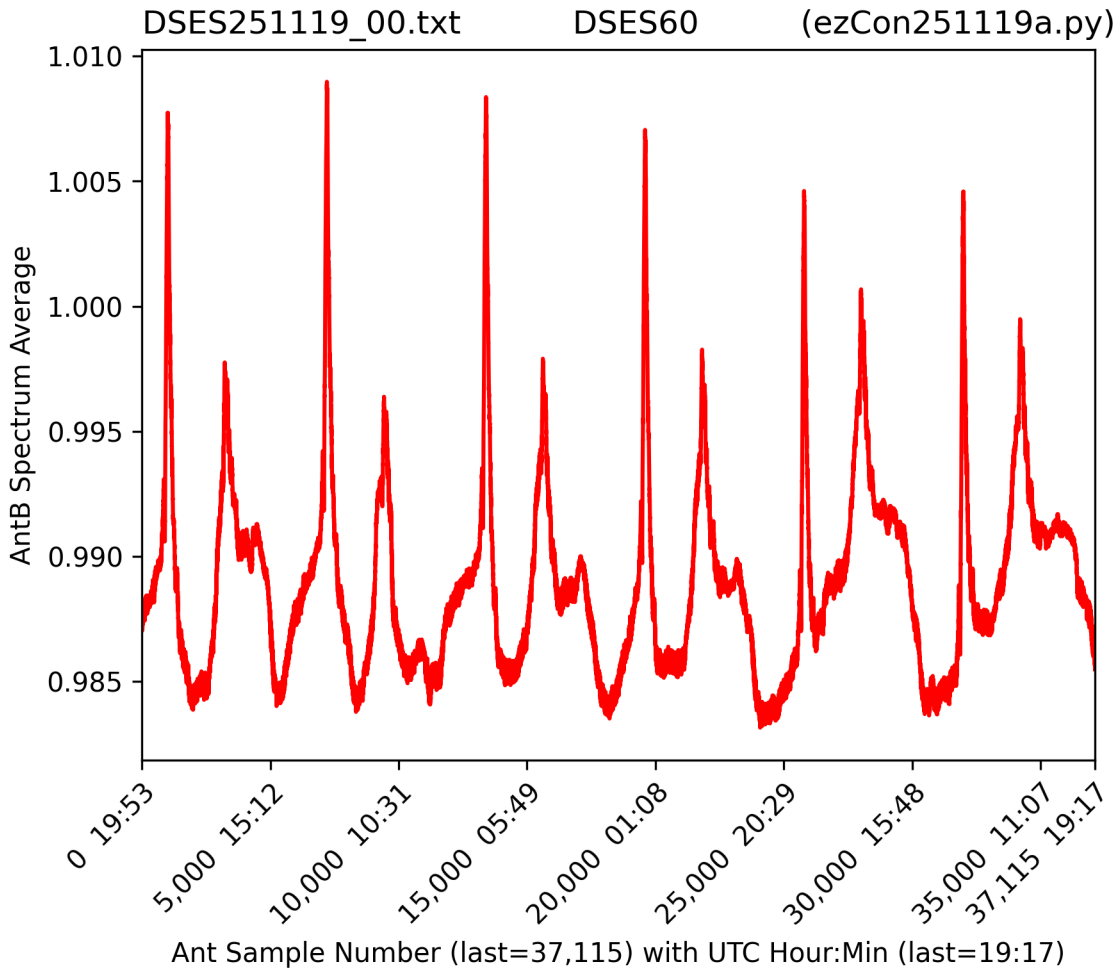
```
python3  ../ezRA/ezColS251110aP.py -ezColReadBinQtyBits 12 -ezColFreqBinQtyBits 12
-ezColReadBinMin 0 -ezColBiasTeeOn 0 -ezColSampleRate 10 -ezColCenterFreqAnt 1418.405
-ezColGain 1 -ezColYLimL 0 1 -ezColIntegQty 31e3 -ezRAObsLat 38.3808 -ezRAObsLon
-103.156 -ezRAObsAmsl 4400.0 -ezRAObsName DSES -ezColFileNamePrefix DSES
```

Rick recently remotely collected these 8 data files, with these byte counts,

DSES251113_19.txt	48,074,191
DSES251114_00.txt	280,388,568
DSES251115_00.txt	280,402,007
DSES251116_00.txt	280,347,756
DSES251117_00.txt	229,517,193
DSES251117_19.txt	50,594,196
DSES251118_00.txt	280,358,526
DSES251119_00.txt	225,305,359

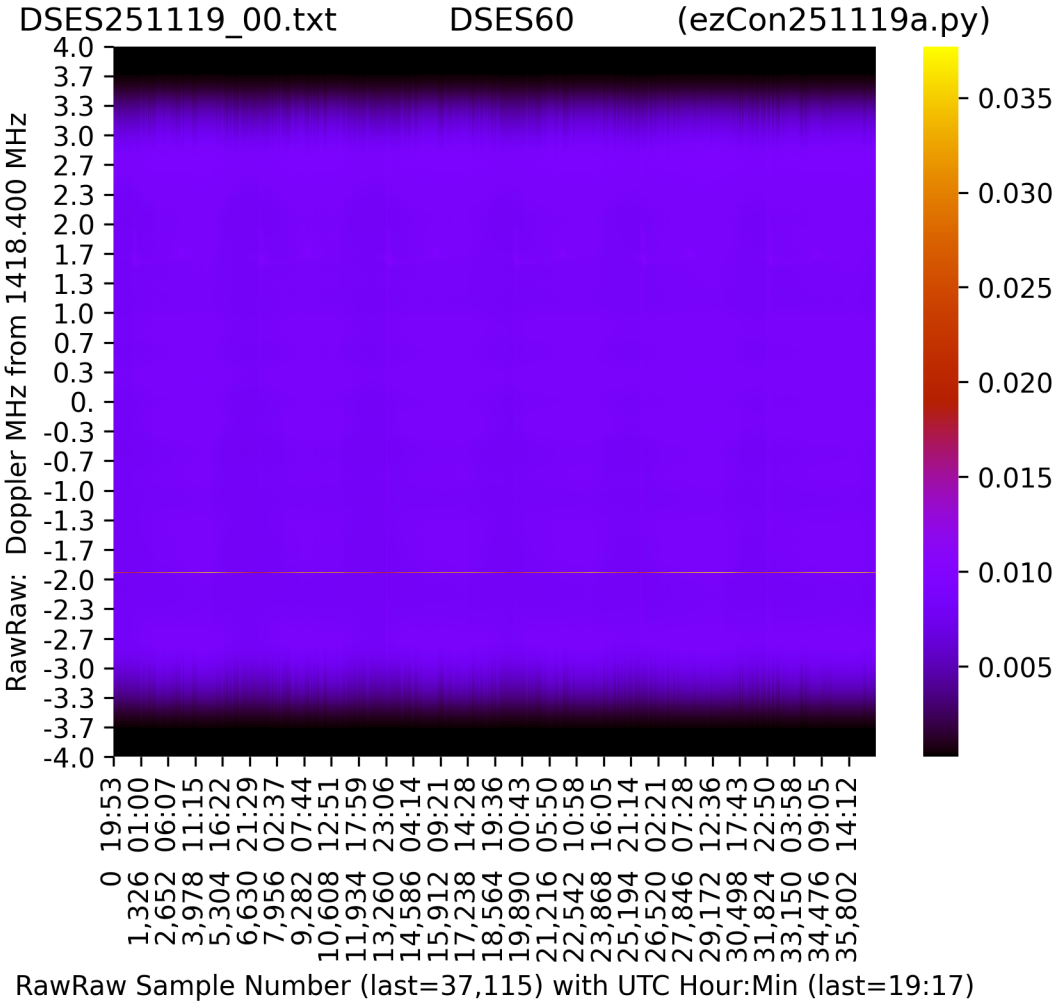
The filenames include the UTC starting date and time (2025 year, month, day, and hour).

Analyzing all those data files together, we can see a repeating received power pattern as the antenna sweeps the same Declination line (about +41 degrees) across the whole radio sky each 24 hours, over 6 days (plot ezCon114),



We see more detail in the heat map waterfall plots.

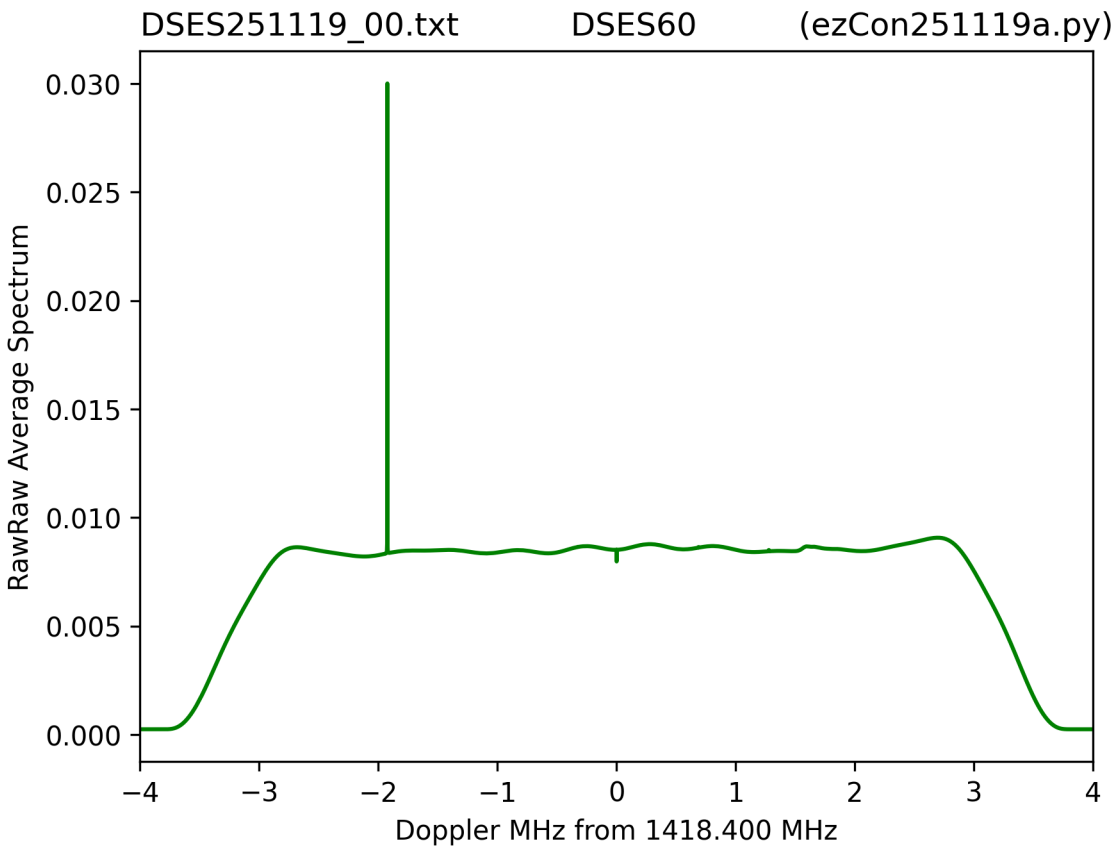
But looking at all the data initially reveals little.
We see an 8 MHz frequency bandwidth increasing vertically, centered on 1418.4 MHz,
for the 37,115 recorded samples (vertical lines), with time increasing to the right,
with a fairly constant small RFI horizontal line just above -2 MHz Doppler (ezCon000),



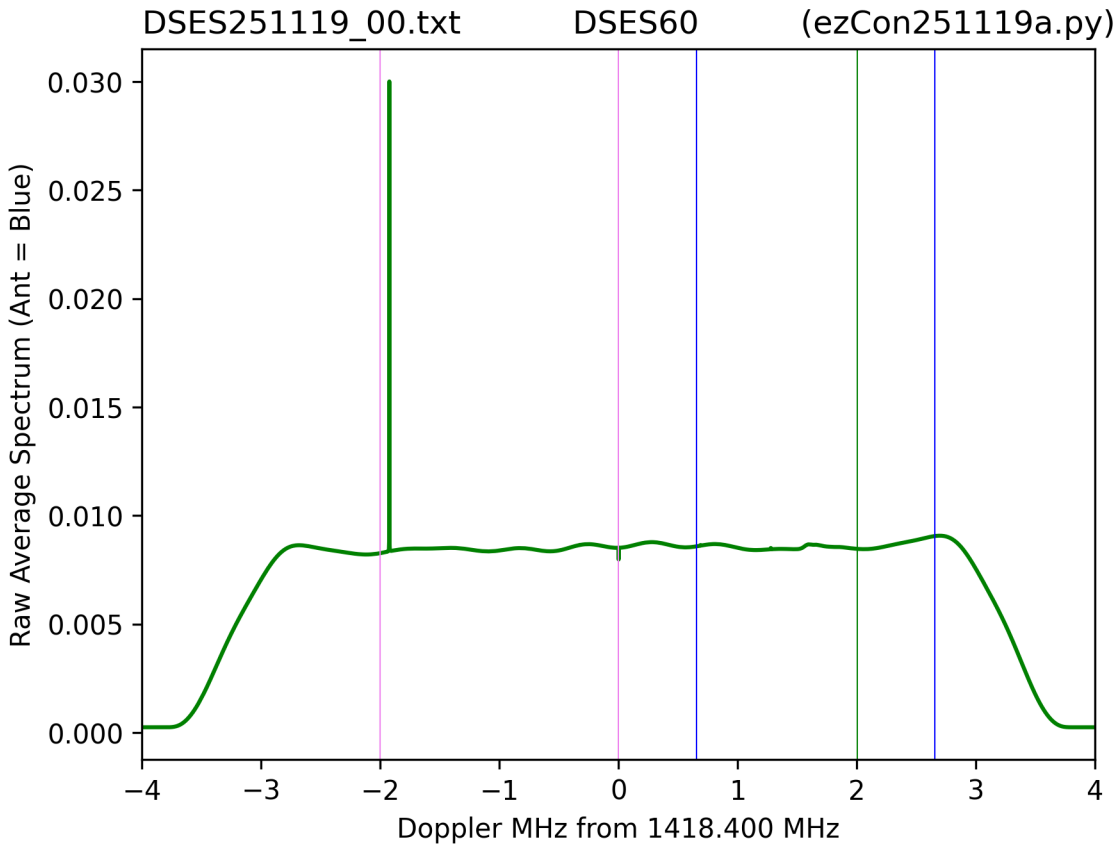
Very very faintly, I can see a small wavy line at about +1.7 MHz Doppler. Analysis will reveal more.

The darker colors at top and bottom show the typical lower gain at the highest and lowest frequencies, caused by the electronic frequency response curve of the collecting amplifier and SDR hardware.

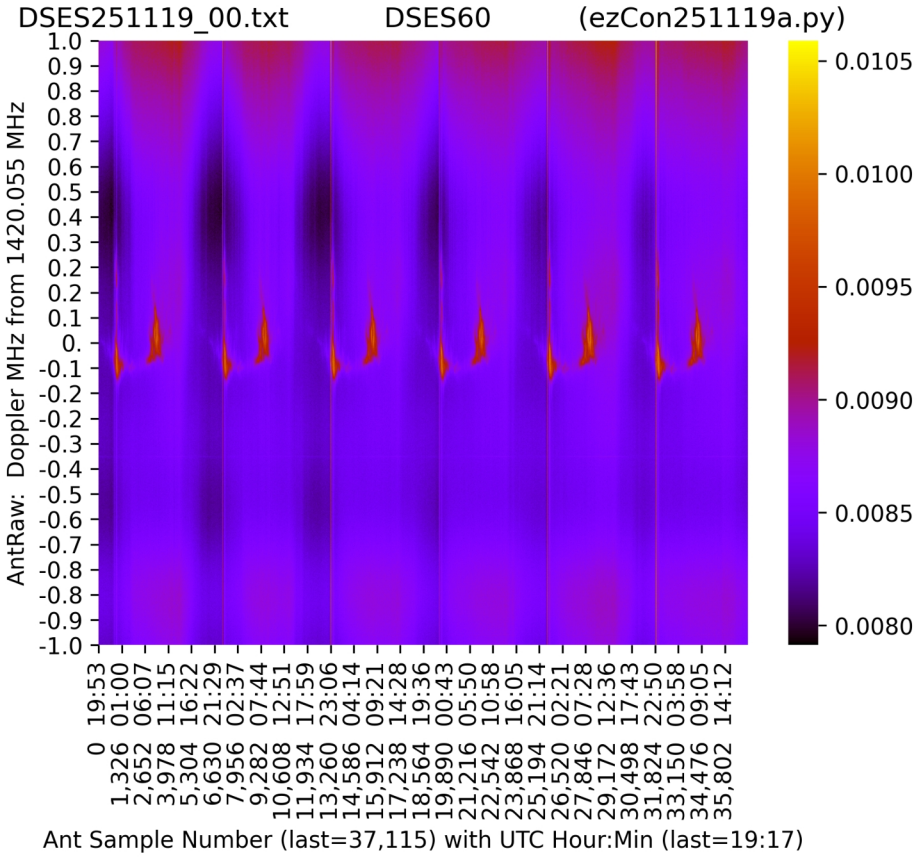
Otherwise that SDRplay response curve is fairly flat, but with a small frequency response ripple (ezCon300),



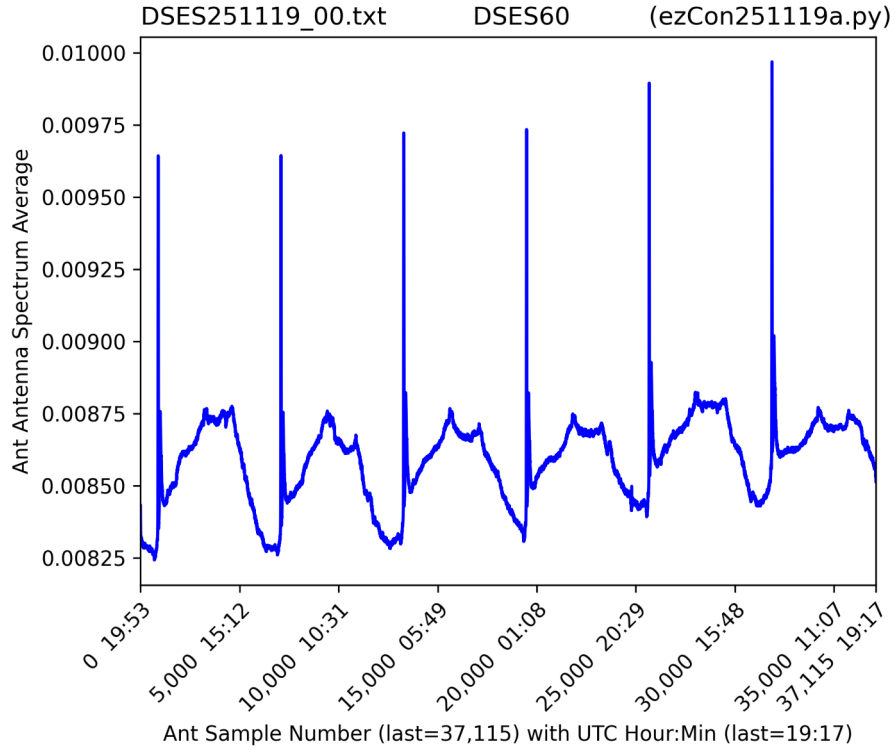
From each of the many samples, I selected
a 2 MHz Antenna (Ant) sky spectra centered on 1420.055 MHz (between the BLUE vertical lines),
and a 2 MHz Reference (Ref) comparison non-hydrogen spectra centered on 1417.400 MHz, (between the RED vertical lines).
The single GREEN vertical line marks the special 1420.405 MHz Galactic hydrogen frequency (ezCon301B),



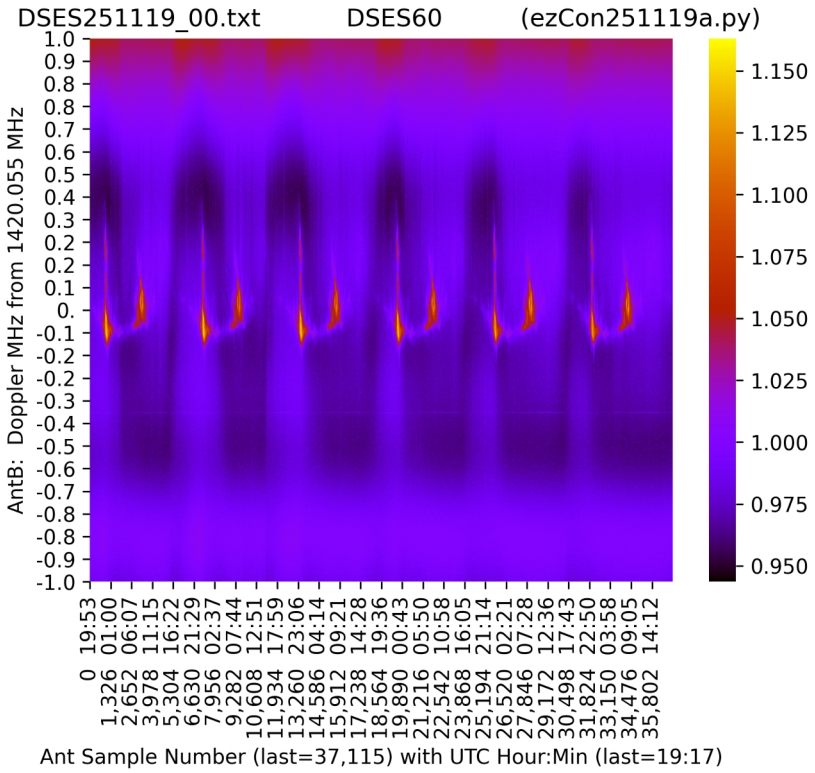
Looking at just the Ant spectra quickly enhances the repeating Galactic hydrogen signal of interest (ezCon002),



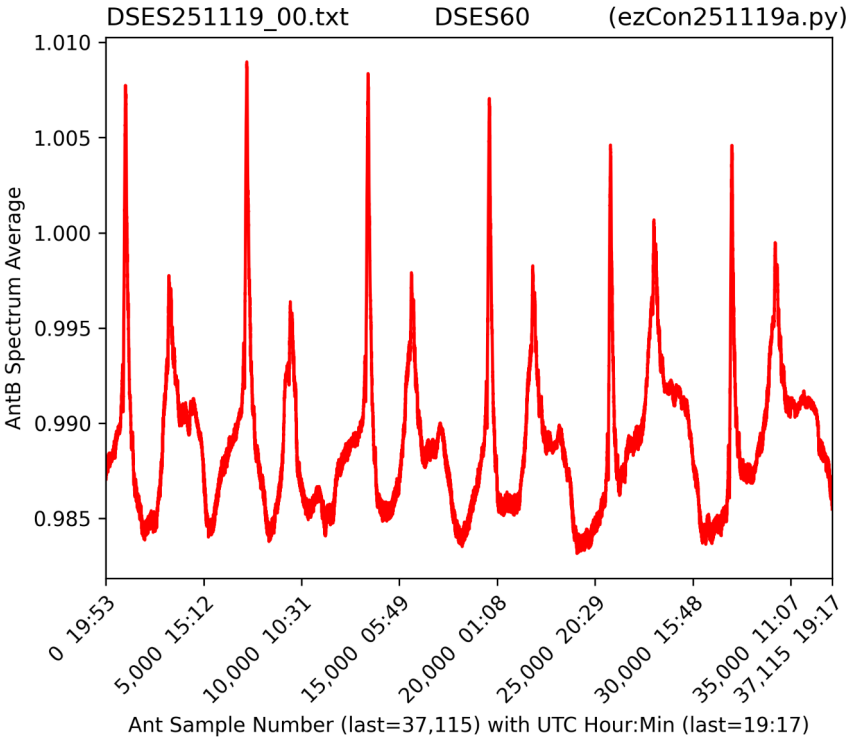
And we can plot the average value for each vertical sample line of that heat map plot (ezCon110),



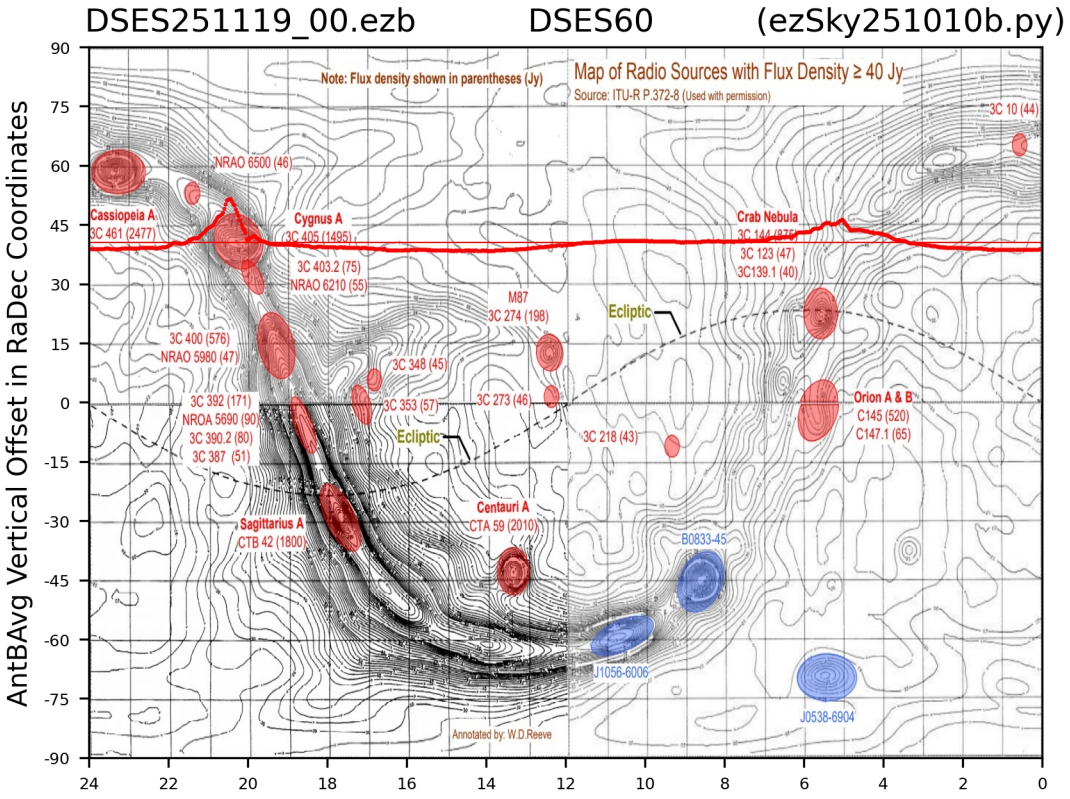
Comparing the center hydrogen frequencies to the non-hydrogen background frequencies emphasizes that Galactic hydrogen signal, to produce the AntB calculated signal (ezCon047),



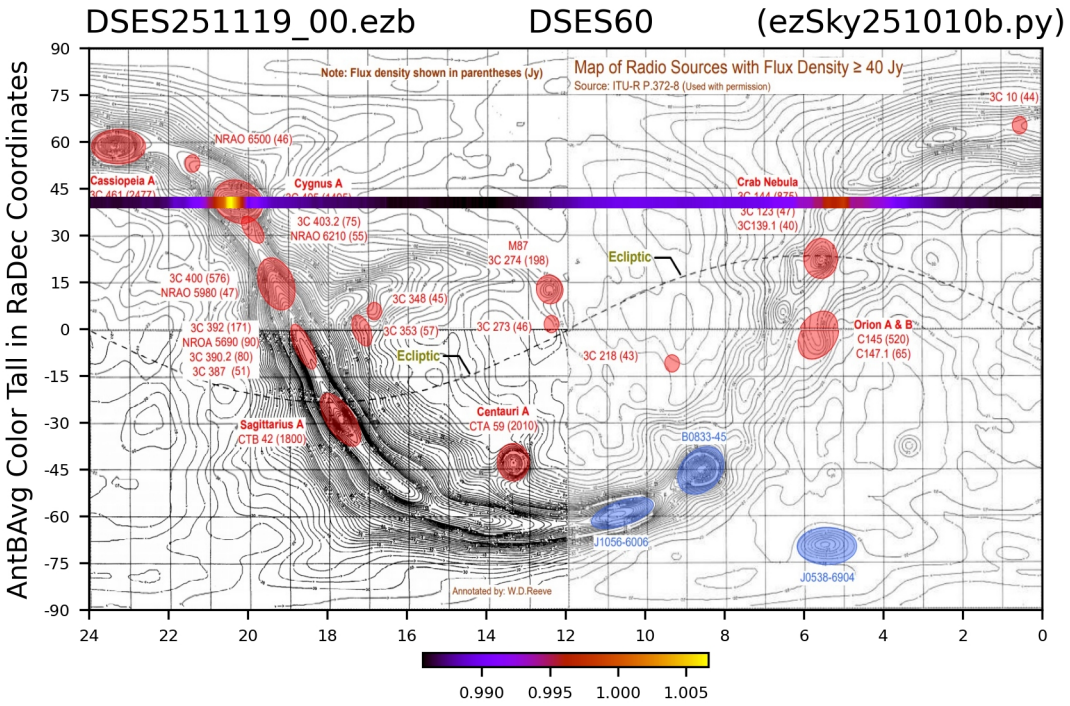
which improves the baseline in its relative power plot (ezCon114),



We can plot the average of those daily relative power values upon the RaDec radio sky, with Vertical Offset (ezSky200),



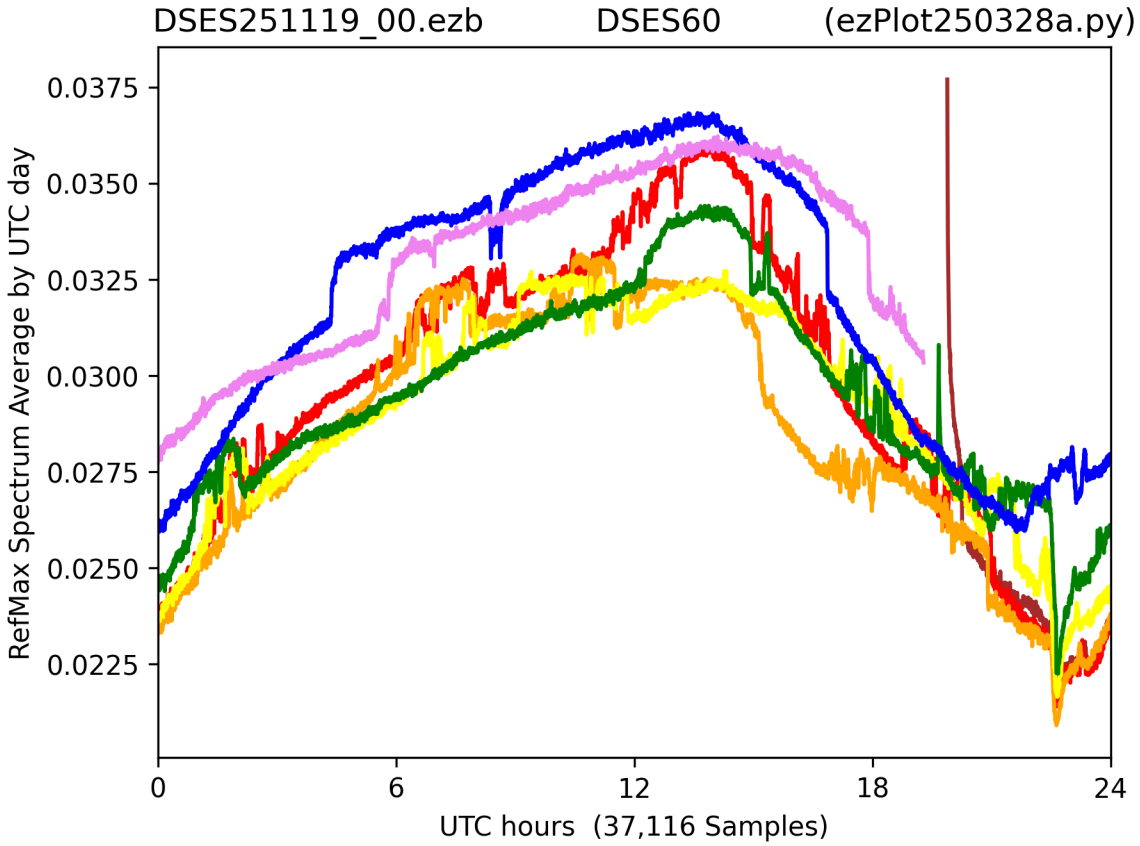
or with brighter colors indicating a louder signal (ezSky301),



Both plots show a louder signal near the crossings of the Galactic plane.

The daily temperature cycle affects the receiving system.
Lower outdoor temperatures increase the system gain.

The RefMax signal should represent fairly constant power.
But as the outdoor temperature slowly cools starting in the evening at 23 UTC (4pm local),
the system gain slowly increases until the dawn's Sun starts to warm the day at 14 UTC (7am local).
This is true for each successive each day (traces brown, red orange, yellow, green, blue, and violet)
(ezPlot330),



The AntB signal calculation tries to remove this background influence.

In the upper right, the start of the brown trace shows the gain decreasing quickly as the cold SDR and amplifier electronics warm up to their stable operating temperatures.

More analysis will reveal more detail.
I have just barely used the Ref signal spectra.

Eventually more drift-scans across the sky will paint more of the radio sky.
Data from different Declinations is needed.
But multiple day collections help to improve the data's signal to noise ratio.
I propose changing the antenna pointing only about once a week.

This data came from the SDRplay SDR.
DSES also has an Ettus B210 SDR to explore.
The latest collecting and analysis program versions are ezColS251114b and ezCon251120a.

For a taste of future possibilities, I point to the current 1420 MHz status report PDFs
of the simpler
Estes Park Memorial Observatory
https://drive.google.com/file/d/1nm6c8cvzR5tWuhANUUyU_hbSlut9NBLZ/view?usp=sharing
and the more advanced
Little Thompson Observatory
https://drive.google.com/file/d/1hOR548UmHsNuYt8eE_GFcQd1z_2Jrf9v/view

For folks starting to explore radio astronomy,
ezRA - Easy Radio Astronomy
Free 1420 MHz Galactic hydrogen data collection and analysis
Open source
Windows and Linux
https://github.com/tedcline/ezRA
https://youtu.be/kHgwEbWKhzs (13 minute Simple Overview)

Ted Cline N0RQV
Loveland Colorado USA
TedClineGit@gmail.com