July 4, 2024
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Earths Magnetic Filed Monitoring Sensor Graph Program

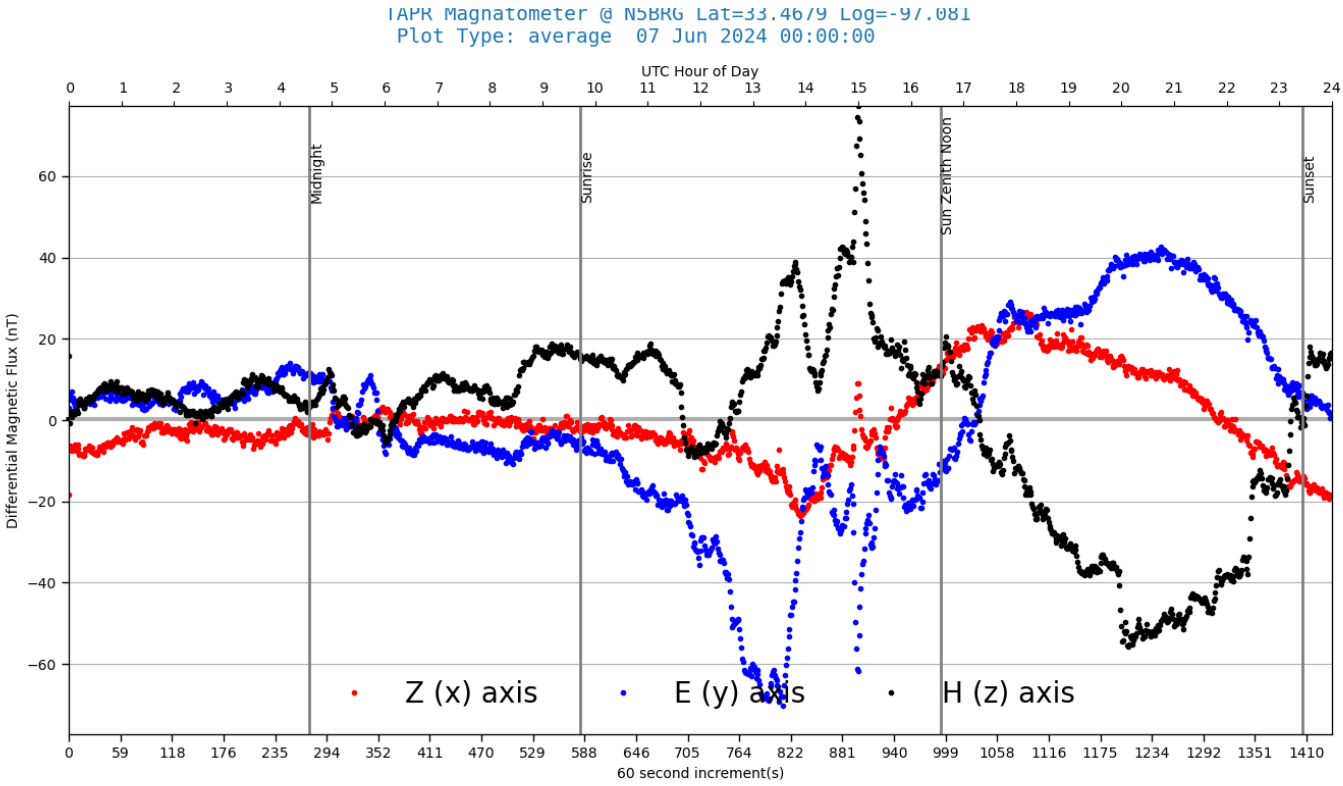
This is a collection of programs developed around magnetometer data collected over a twenty four hour period and stored in log files. The log files are text base and stored in a JSON format meaning a description of each data point and the data are captured in the file.

This is an example of one line of data from a magnetometer log file:

{ "ts":"03 Jun 2024 00:00:05", "rt":22.56, "lt":24.44, "x":-40.0122, "y":-4.9095, "z":-24.1351, "rx":-59, "ry":-7, "rz":-35, "Tm": 46.9849 }

This software only utilizes the “ts” time stamp, “rt” remote sensor temperature, “lt” temperature at the local collecting board, and the X, Y, Z magnetic data. The temperature is in centigrade and the X, Y, Z data is presented in microtesla with varations in nanotesla. The nano tesla data is everything to the right of the decimal place in the data files.

Here is an example of a resulting plot using these programs:



The programs are developed using Python 3.9. Programs were tested using version 3.10 and had issues. I also installed anaconda and then python 3.10 and the programs run fine. All testing and development was done in Ubuntu 22.04 but Windows should Work also.
Make sure you have all the required python (pip3) modules installed on your computer. The program will try to load these when launch the program and if

something is not installed and ready you will see an error.

The following modules are needed by the code:

pandas
json
datetime
time
numpy as np
matplotlib
os
configparser
math
sunrisesunsetcalculator

if you have PIP3 installed on your computer you can work though this list using this command starting with pandas:

pip3 install pandas

PIP3 will install the version of python module code supporting your python version.

The weakness of python is there are so many versions and the modules are developed by people using various versions. This can lead to some frustration but in time you can work though the issues. You must do this on your computer and OS.

The next action will be to update the configuration file to match your folders. Using a text editor review the contents of the file:

configure_mag_graph

This file is being used by the HamSci Grape project and I have added two new sections to the file and renamed it for now. This may be merged into a single configuration file for all HamSci projects later.

For this code to work you only need to update the section called [directories] by changing the information to match the location of the log files you will be working with. In the case of the current magnetometer this is typically in a directory folder called “logs”.

In addition if you know the Latitude and longitude of the sensor you are graphing you should update the latitude and longitude and elevation of the section called [location].

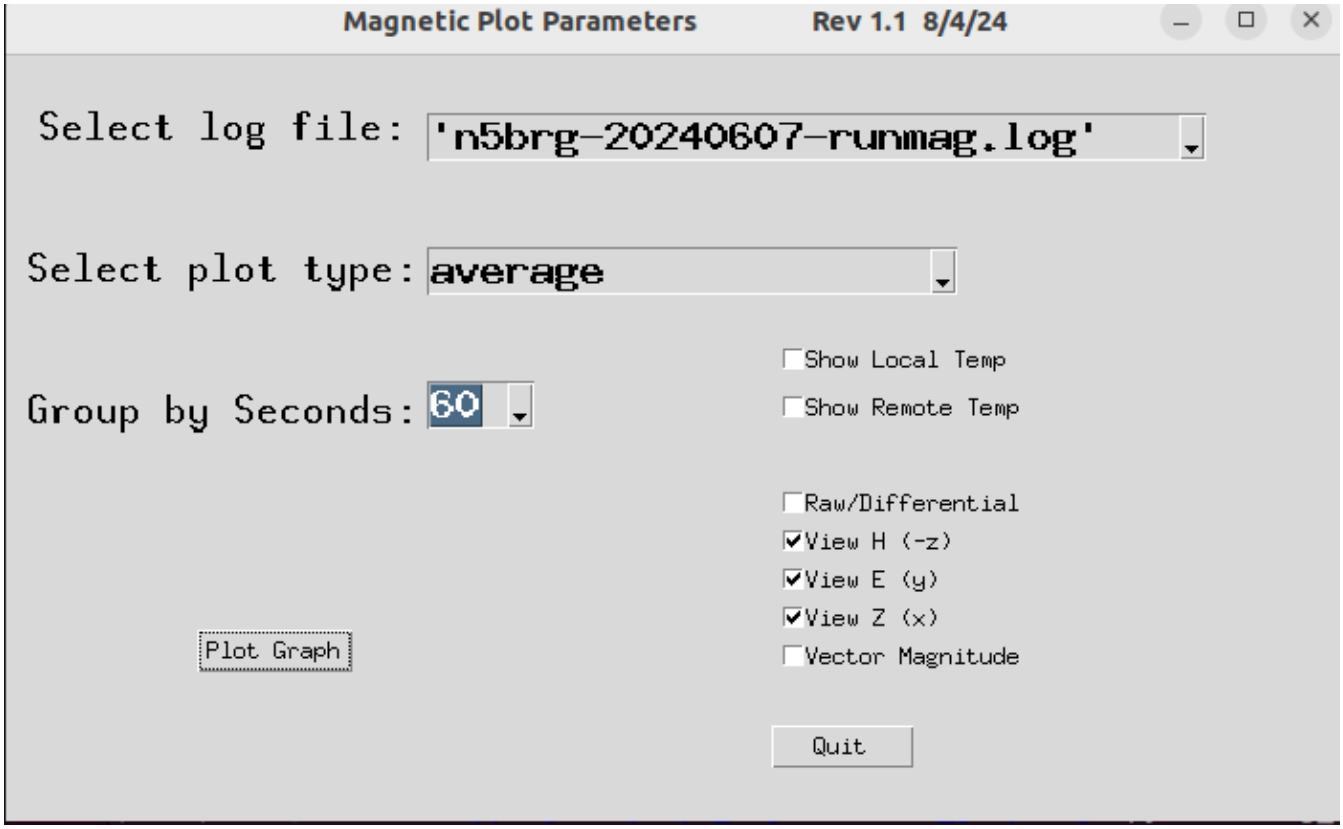
PROGRAM OPERATION

Now you can run the program using the following command:

python3 mag_view.py

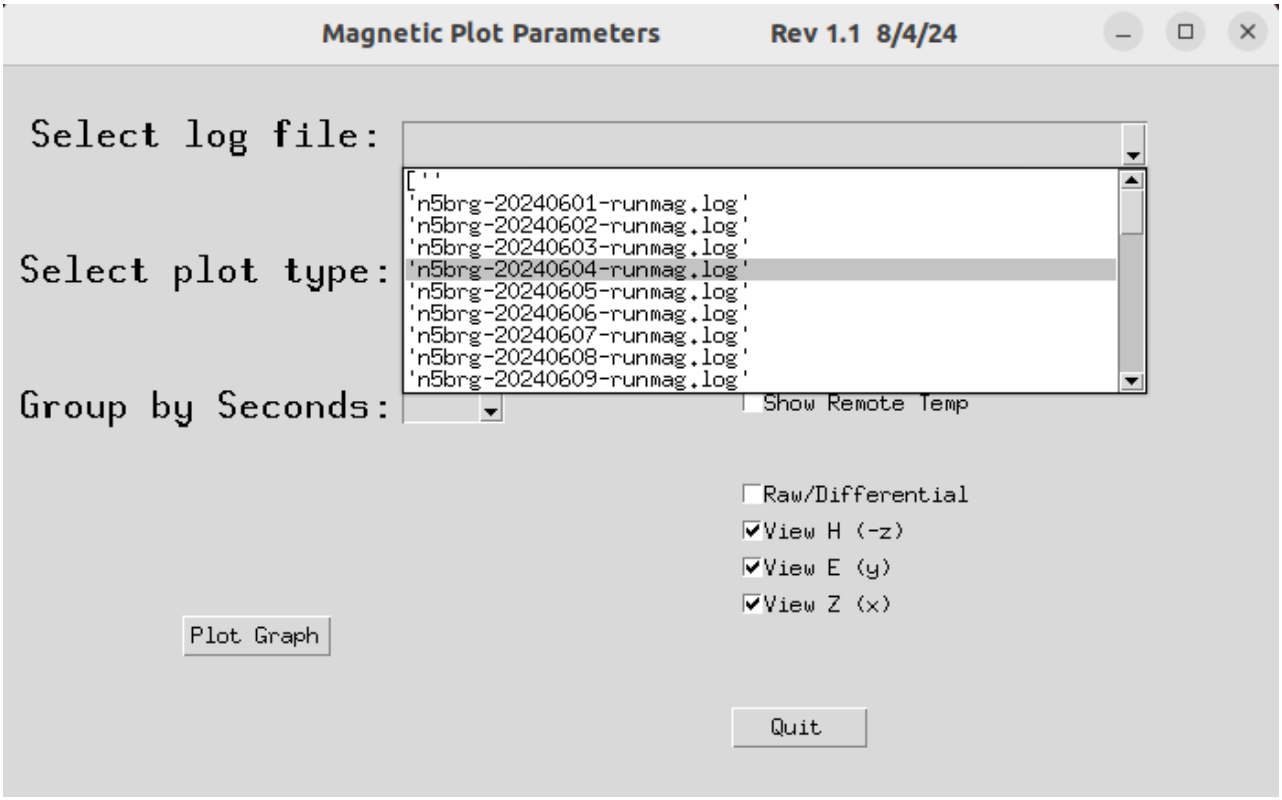
This will launch the following GUI window if all goes well;

Next you should be able to drop down the selection arrow on Select log file and pick the log file you want to work with. If you do not see a file list recheck The path you have provided in config_mag_graph.

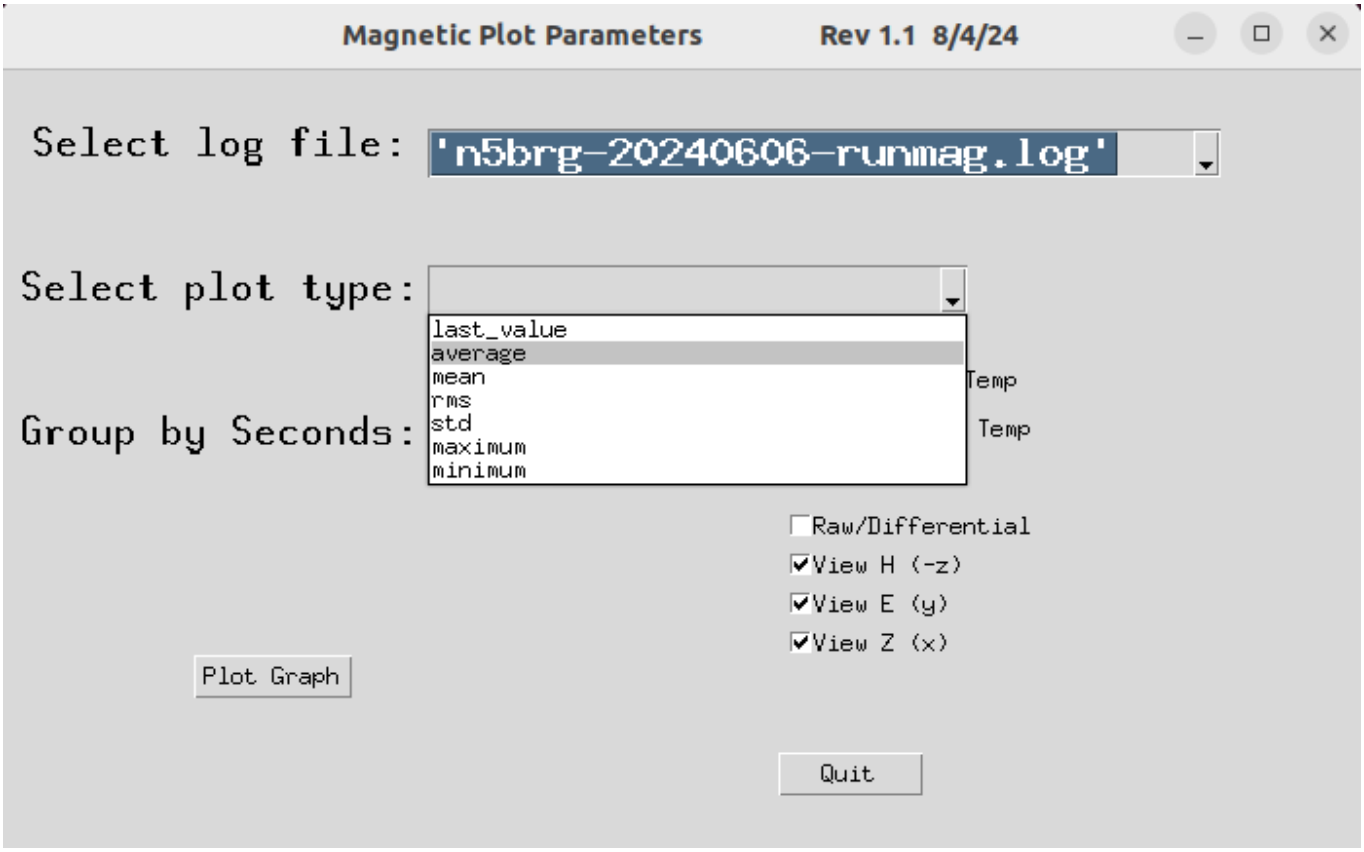


There are options on the right side of the selection window.
These allow you to:

1. Include the Local Temperature of the Rpi in centigrade.
2. Include the Remote Temperature of the sensor in centigrade.
3. Plot the raw magnetic readings and not differential values.
4. Plot the there orthogonal axis by selecting the axis you want.
   Keep in my the actual data in one axis may be so great you get
   No resolution in the plot.
5. Plot the vector magnitude of the magnetic field.



Now select the plot type you would like to use. This has to do with how a collection of data points will be used to make the plot. If you pick average for instance the grouping you will chose will be averaged over the groups plotted. This will make more since later.



Next select the grouping you would like in seconds. This means the graph will be constructed using seconds incremented in the chosen group. For instance if you pick 60 the plot will be data points set for every 60 seconds or one minute.

There were coding issues with 1 so this option is not included at this time.

Now you may tick the box indicting the sensor temperature if you would like this included in the graph. The Local temp is the temperature for the small PCB located some distance from the magnetic sensor element. The Remote Temp is the temperature of the magnetic sensor

Now if you select Plot Graph you should be rewarded with a beautiful plot. At this point you can make a second plot if you want without closing the first one or you can close the plot and continue on.

The plot includes markers for sunrise, noon,sunset and midnight. The idea is the magnetic filed should have some variation relating to these times. The field direction of the flux from the sun will shift as the earth rotates through the noon time and midnight points. The exact point of change is effected by the tilt in the magnetic filed of the earth and the sensor location on earth. These points can also move due to the current activity of the solar winds.

REFERENCES

To develop the marker lines on the graph a program module called “sunrisesunsetcalculator” this program was developed by nwestfall and more information including LICENSE data can be found at:

https://github.com/nwestfall/SunriseSunsetCalculator/

The data collection and logging program for the magnatometer was developed by Dave Witte, KD0EAG. More information can be found on the HamSci.org web pages.

Data was also used from a NOAA website located at
https://gml.noaa.gov/grad/solcalc/

More information about HamSci can be found here: https://hamsci.org

More information about TAPR can be found here: https://TAPR.org
You can also find a store on this web page which may still offer the magnetometer for sell.

These programs are provided for your use with no guarantee of accuracy or commitment to provide any support of issues.

Another option for a magnetometer data collection system would be a unit produced by Reeve.com. Mr Reeve and his associates make a turnkey system with a nice Supporting software package. This would require very little assembly or effort For you to start collecting data. For more information see:

https://reeve.com/SAMOrderInfo.htm

TODO

One day a method to plot a 3D view of the vectors on measured Going around the earth for 24 hours. The python matplotlib quiver function may help with this. Feel free to take this on as a project To add to this project.

N5BRG