Assignment

July 19, 2022

1 Exercise

We are going to pretend that Qusai did not give you a function that automatically downloads the OMNI data into a dictionary. **This is a very cool and helpful function**, but we want you to figure out how to do this type of thing, so if you run into a different dataset, you will know how to deal with it.

1. Read the IMF-B_z and AE indices (AE, AU, and AL) from the OMNI data file during the storm on March 17, 2013? How did they vary as a function of time during the storm event?
   - OMNI data file is available here: https://omniweb.gsfc.nasa.gov/form/om_filt_min.html. You should be able to check the "create file" button, change the dates, select with data you would like, then submit.
   - what are the indices of these variables?
   - read in the data and make some plots.
2. Read the AE, AU, and AL indices during the storm on March 17, 2013 from the "sme_2013.txt" file? How did they change?
   - how many lines do you need to skip?
   - how to read the head of the file?
   - how to limit the (datetime) time range?
   - Finally, how to plot the data together?
3. Read AL indices for the entire year of 2013. Make a distribution of the day when higher activities occurred with AL<-1000 nT in 2013? Is it consistent with the date distribution for SYM-H< -100 nT (Figure 1)?
   - what is the index / variable name of AL?
   - how to chose data with condition?
   - how to make histogram plots?

2 Assignment

Using the 1-min cadence SML index in a sliding 30-min buffer, [NG11] identified substorm onset time (t_0) when four conditions are satisfied:

$$SML(t_0+1) - SML(t_0) < -15 \quad nT \tag{1}$$

$$SML(t_0+2) - SML(t_0) < -30 \quad nT \tag{2}$$

$$SML(t_0+3) - SML(t_0) < -45 \quad nT \tag{3}$$

$$\sum_{i=4}^{30} \frac{SML(t_0+i)}{26} - SML(t_0) < -100 \quad nT \tag{4}$$

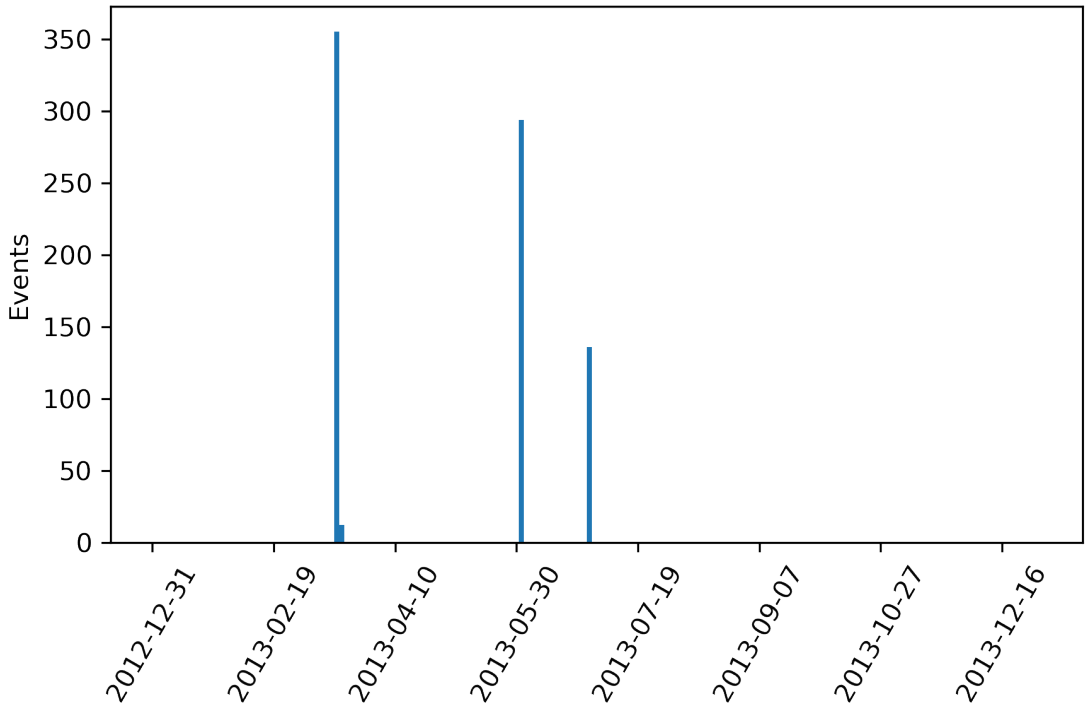

Figure 1: Histogram of SYMH<-100 nT.

1. Identify the first substorm onset with 1-min AL data in the first week in 2013. What is the time (t_0) of the onset? Please plot the 30-min AL index (begin from onset) as a function of time. What is the minimum AL (AL_min) during this period?

2. Identify all substorm onsets in January 2013. How many events did you find? Please print the list of the onset times (t_0).

3. Find all of the substorm onsets in 2013. Make a distribution of the minimum values of AL.

Some thoughts on how to do this:

- Start small - don't try to accomplish all of the problem in one go. Work through the first bit, check to see if it works, then move on.
- Suppose that the length of the AL array (1-min interval) is n. We can use for loop to go through all the data one by one (AL_i, i=0, 1, 2, ...n-31). Sometimes it is easier to work with a for loop and then think about how to do it without a loop, if you would like.
- Check each AL index at t_i and extract the 30-min data segment AL$[i : i + 30]$.
- Check if the 30-min data segment meets the substorm onset criteria. If so, a substorm onset is found; add t_0 and AL_{min} to the lists, respectively, and skip $t_{i+1} \sim t_{i+29}$ in the next loop. If not, continue to the next step (t_{i+1}).

References

[NG11] P. T. Newell and J. W. Gjerloev. Evaluation of supermag auroral electrojet indices as indicators of substorms and auroral power. *Journal of Geophysical Research: Space Physics*, 116(A12), 2011.