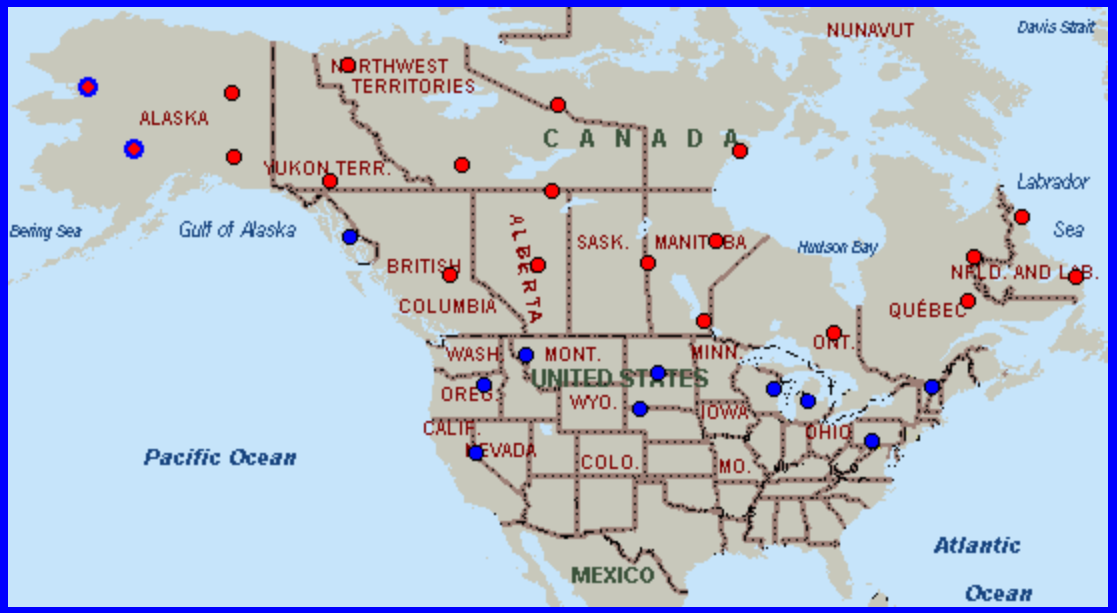
GEONS

Geomagnetic Event Observation Network By Students



Calculating **B**, and **K** using ASCII Data

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Objectives

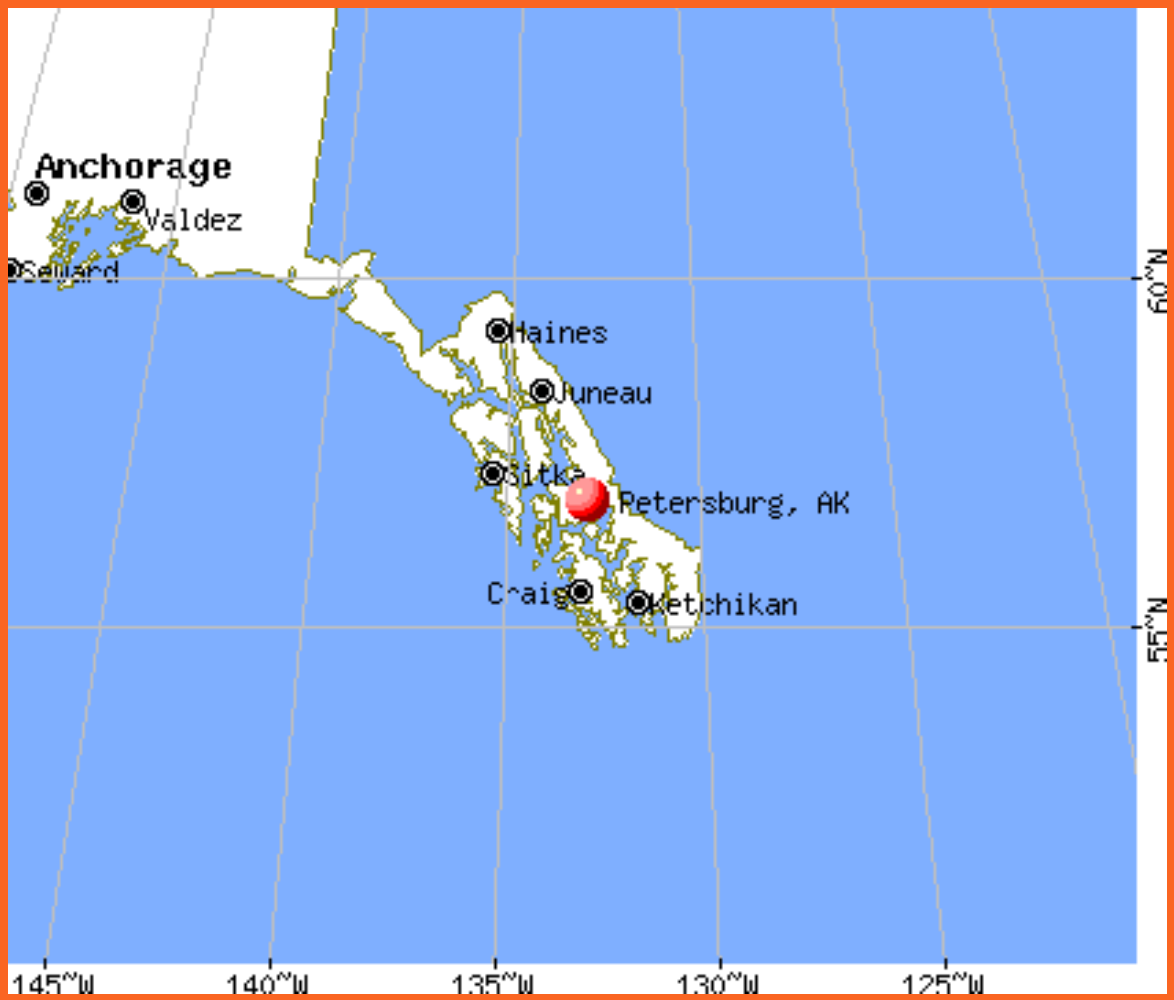
- This presentation will show how to use THEMIS data to calculate the **K index** using archived ASCII data for Petersberg, Alaska.

- **Geographic Latitude, Longitude, and Altitude:**
  - 56.83 N, 133.16 W, Alt: n/a

- Calculate local **B-values** for the above mentioned location.

- The following locations and months are shown in this presentation as “working” examples.
  - THEMIS Magnetometer Data for Petersburg, Alaska.
  - June 1st, 2008 through September 30th, 2008.

Petersburg, Alaska



Magnetic Flux Density (B)

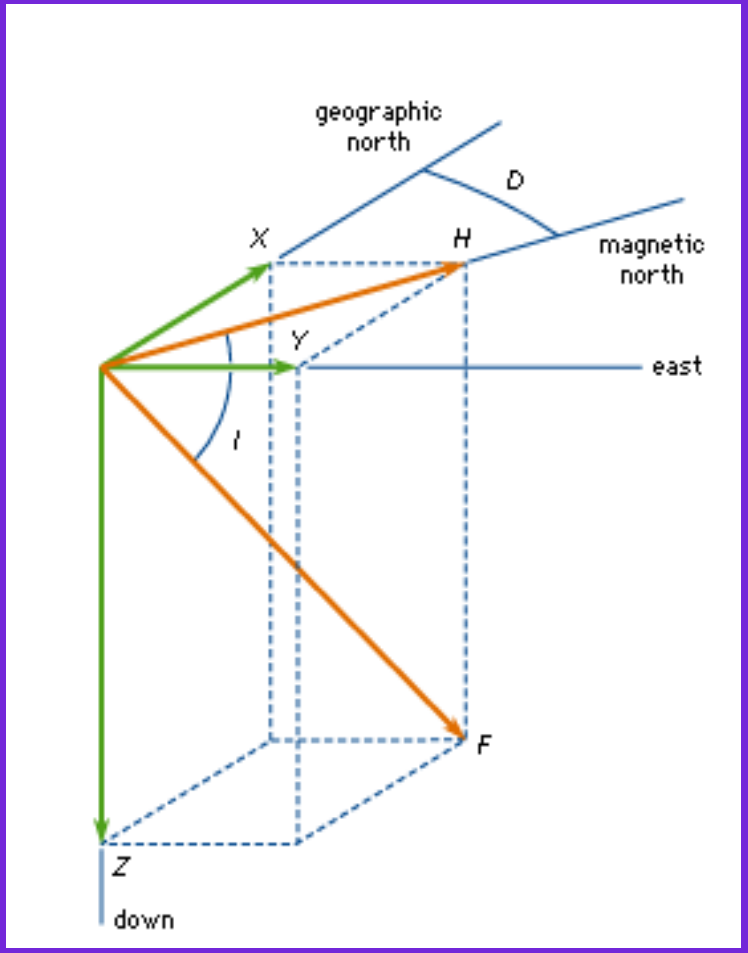
- The measure of the strength of a magnetic field.
- The scientific unit is Teslas (T)
- Calculated by:

$$B = \sqrt{x^2 + y^2 + z^2}$$

- Where:
  - X= The strength of the magnetic field in the direction of the north pole
  - Y= The strength of the magnetic field in the eastward direction
  - Z= The strength of the magnetic field pointing down
- This is demonstrated in the graph on the following slide

Magnetic Flux Density (continued)

- For more information, see Dr. Peticola's presentation at: http://ds9.ssl.berkeley.edu/themis/presentations/peticolas_mag_science06/peticolas_mag_science_files/frame.html



Coronal Mass Ejections

- Plasma clouds consisting of protons and electrons that are released from the sun.
- These clouds of charged particle cause disruptions in the Earth's magnetic field.
- We are trying to chart these disturbances.

Definitions

- The **K-index** is a code that is related to the maximum fluctuations of horizontal components observed on a magnetometer relative to a quiet day, during a three-hour interval.
  - K-index is determined after the end of prescribed three hourly intervals (0000-0300, 0300-0600, ..., 2100-2400) in Universal Time (UT)

- **The relationship between K, and K_p**
  - The official planetary K_p index is derived by calculating a weighted average of K-indices from a network of geomagnetic observatories. For more information click on the link K-index
  - The table below shows the relation of **K** and **ΔB**

K	(nT)
0	0-5
1	5-10
2	10-20
3	20-40
4	40-70
5	70-120
6	120-200
7	200-330
8	330-500
9	>500

Observations and Limitations

- Space weather operations use near real-time estimates of the **K_p index** which are derived by the U.S. Air Force 55th Space Weather Squadron.
- The **K_p index** is derived using data from ground-based magnetometers at Meanook, Canada; Sitka, Alaska; Glenlea, Canada; Saint Johns, Canada; Ottawa, Canada; Newport, Washington; Fredericksburg, Virginia; Boulder, Colorado; and Fresno, California. (http://www.sec.noaa.gov/rt_plots/kp_3d.html)
- These estimated of **K_p** are based on a network of observatories reporting in near real-time.
- Due to real-time requirements it is possible that a local magnetometer, i.e. Petersburg, AK may detect a highly localized disturbance.
- The highly localized disturbance will affect the region, but the severity of the disturbance is underestimated on a planetary scale.
- The NOAA scale describes effects for various levels of activity, but with regards to geomagnetic activity, it needs to be kept in mind that there can be differences in the responses of local **K-values** that are a function of the location of the user.
- Therefore, the **K_p** values may be incomplete due to local “real-time” data not being reported.

Using ASCII Data

- Tips on using MS Excel
  - ASCII Data is in UT time
  - 00:01 hrs to 24:00 hrs
  - Two (2) data points per second
  - 1-day = 172, 800 data points
  - Excel has column restriction to about 65,000
  - Making 3-columns in order to divide up the data is convenient
    - Column 1 = 0- 32,400 data points (Time Period #1)
    - Column 2 =32,400- 64,800 data points (Time Period #2)
    - Column 3 = 64,800-86,400 data points (Time Period #3)
  - In each of these divisions, there will be four more columns:
    - Column 1: Shows the time (in seconds)
    - Column 2: Shows fluctuations in the x-axis
    - Column 3: Shows the fluctuations in the y-axis
    - Column 4: Shows the fluctuations in the z-axix
  - Be patient for “copy-paste.” It takes about 20-30 seconds using a 1.66 GHz dual core processor.
  - Be familiar with the “**Text to Column**” feature in the “**Data**” section of Excel
  - A template had been previously made

Example of Partial Template

Date								
Time Interval	Average x	Average y	Average z	Average B	¬x	K	a	
00:01-03:00	22051.08	-902.922	45017.88	**50136.57**	37.616	3	15	
03:00-06:00	22050.27	-897.812	45015.65	**50134.11**	19.313	2	7	
06:00-09:00	22052.84	-905.79	45013.06	**50133.06**	24.582	3	15	
00:09-12:00	22058.64	-910.753	45012.25	**50134.97**	10.305	2	7	
12:00-15:00	22058.78	-921.341	45010.2	**50133.39**	16.262	2	7	
15:00-18:00	22050.64	-901.333	45007.56	**50127.08**	12.758	2	7	
18:00-21:00	22054.49	-915.377	45000.18	**50122.4**	10.627	2	7	
21:00-24:00	22064.23	-918.559	45010.21	**50135.74**	14.242	2	7	
Daily B	**50132.16**							
Daily A	**9**							
K_{max}	**3**							

time	x	y	z	time	x	y	z	time	x	y	z
0.407	22037.75	-915.417	45012.88	32400.9	22053.78	-913.814	45012.25	63800.9	22047.2	-900.336	45001.02
0.907	22037.78	-915.385	45012.94	32401.4	22053.75	-913.781	45012.2	63801.4	22047.17	-900.325	45001
1.407	22037.69	-915.363	45012.95	32401.9	22053.83	-913.803	45012.1	63801.9	22047.19	-900.314	45000.97
1.907	22037.67	-915.374	45012.97	32402.4	22053.87	-913.868	45012.06	63802.4	22047.22	-900.347	45000.96
2.407	22037.68	-915.341	45013.07	32402.9	22053.89	-913.846	45012.13	63802.9	22047.23	-900.325	45000.99

- This only shows part of the time. The actual template will be much longer.

Using ASCII Data

- Calculating “maximum” fluctuations
  - In the x-axis column, determine $\Delta x = x_{max} - x_{min}$
  - To determine K-value, compare Δx to the following chart values:

K	(nT)
0	0-5
1	5-10
2	10-20
3	20-40
4	40-70
5	70-120
6	120-200
7	200-330
8	330-500
9	>500

- Researchers must be cautious of magnetic field component values (x, y, or z) values that are erroneous, i.e. too high, too low, or negative.
  - Spectrograph plots are an invaluable tool to help differentiate between true solar “storminess” and “human” caused effects.
  - If more than a single data point is affected, the corresponding 3-hour period should be deleted.
  - Consequently, this will affect the calculation of **B** for the day. (Activity 20)

OUR DATA

Data for June

Date	B-Field (nT)	k-max
6/1	n/a	
6/2	n/a	
6/3	47476.696	0
6/4	47476.689	0
6/5	n/a	
6/6	n/a	
6/7	n/a	
6/8	n/a	
6/9	n/a	
6/10	n/a	
6/11	n/a	
6/12	n/a	
6/13	54572.523	3
6/14	54573.925	5*
6/15	54579.717	6

Date	B-Field (nT)	k-max
6/16	54571.647	5
6/17	54579.56	9
6/18	54579.66	9
6/19	54575.793	9
6/20	54583.426	5
6/21	54582.779	4
6/22	54590.632	4
6/23	54586.982	9
6/24	54587.377	4
6/25	54605.581	9
6/26	54442.775	9
6/27	n/a	
6/28	54587.469	3
6/29	54590.7	4
6/30	n/a	

*Highlighted dates represent high k-values

Data for July

Date	B-Field (nT)	k-max
7/1	54589.741	9
7/2	54590.981	3
7/3	54593.15	3
7/4	54590.191	3
7/5	54585.847	9
7/6	54596.568	4
7/7	54597.084	3
7/8	54593.09	3
7/9	54594.078	7
7/10	54591.237	9
7/11	54588.275	9
7/12	54590.608	7
7/13	54583.857	5
7/14	54587.049	5
7/15	54592.765	9

Date	B-Field (nT)	k-max
7/16	54595.521	9
7/17	54598.88	9
7/18	54595.555	3
7/19	54598.88	3
7/20	54595.5	3
7/21	54598.88	4
7/22	54596.394	5
7/23	54598.88	6
7/24	54591.093	5
7/25	54598.88	8
7/26	54596.001	3
7/27	54598.88	3
7/28	54592.302	4
7/29	54598.88	4
7/30	54591.73	9
7/31	54585.112	3

Data for August

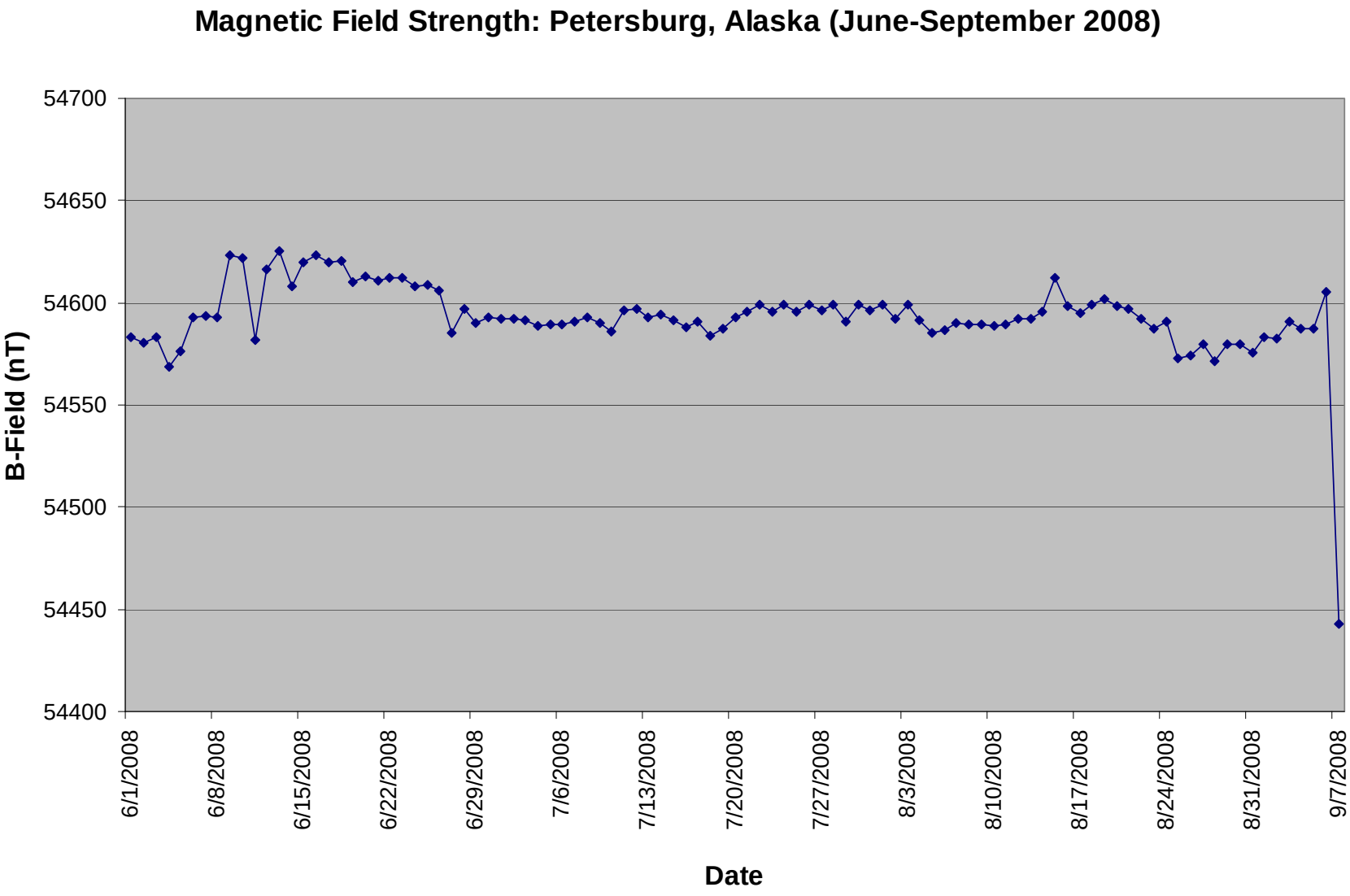
Date	B-Field (nT)	k-max
8/1	54586.844	3
8/2	54590.278	4
8/3	54589.36	3
8/4	54589.188	4
8/5	54588.999	3
8/6	54589.244	9
8/7	54592.316	3
8/8	54592.131	4
8/9	54595.735	6
8/10	54612.385	6
8/11	54598.605	9
8/12	54595.087	9
8/13	54598.855	9
8/14	54602.118	3
8/15	54598.628	3

Date	B-Field (nT)	k-max
8/16	54596.923	4
8/17	54592.18	4
8/18	n/a	
8/19	54585.018	9
8/20	54596.976	3
8/21	54590.125	3
8/22	54592.92	4
8/23	54592.455	3
8/24	54591.913	3
8/25	54591.287	4
8/26	54588.608	3
8/27	54589.646	3
8/28	n/a	
8/29	n/a	
8/30	n/a	
8/31	n/a	

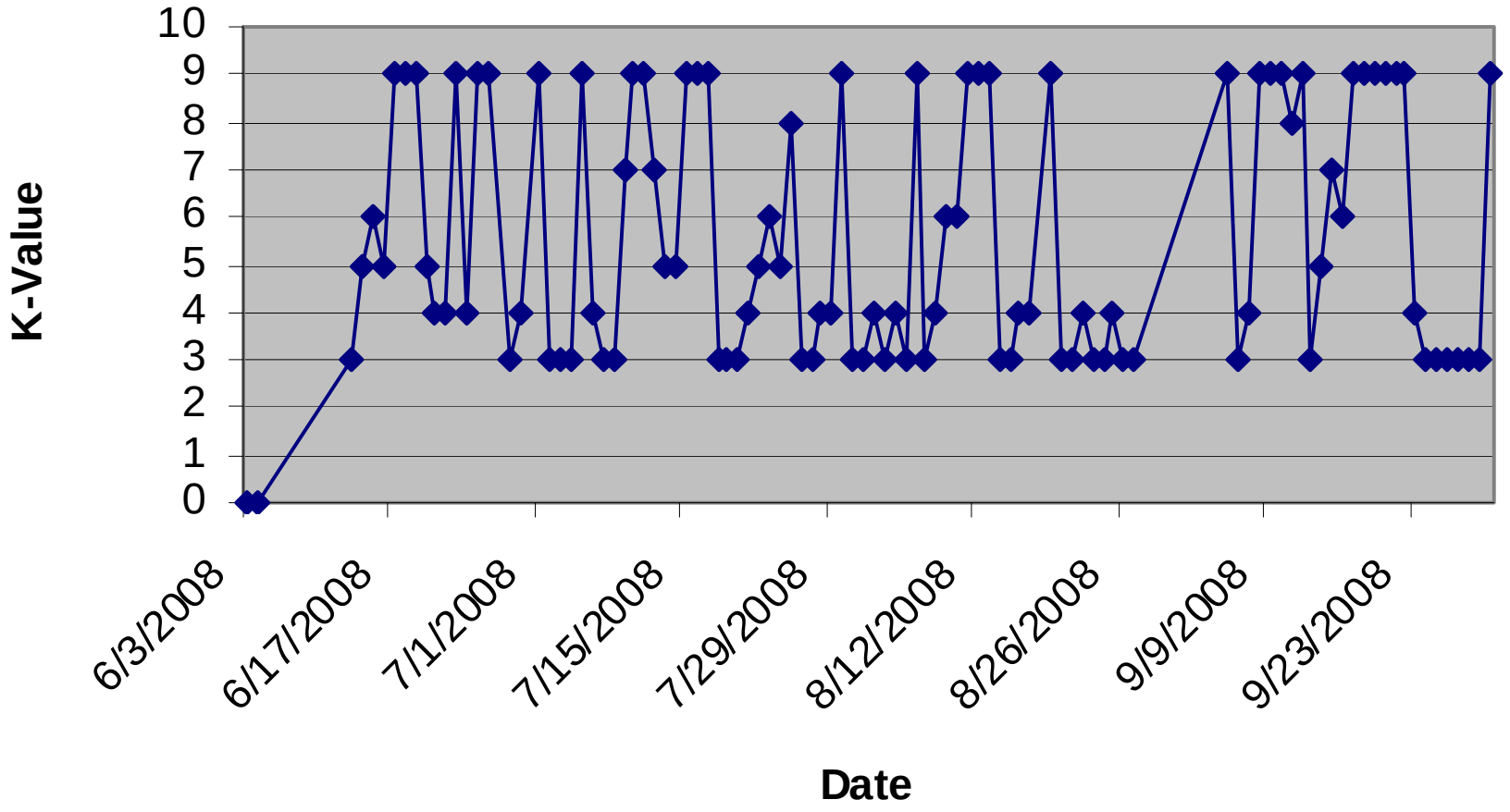
Data for September

Date	B-Field (nT)	k-max
9/1	n/a	
9/2	n/a	
9/3	n/a	
9/4	n/a	
9/5	54582.977	9
9/6	54580.335	3
9/7	54582.996	4
9/8	54568.325	9
9/9	54576.23	9
9/10	54593.104	9
9/11	54593.839	8
9/12	54592.77	9
9/13	54623.426	3
9/14	54621.654	5
9/15	54581.49	7

Date	B-Field (nT)	k-max
9/16	54616.598	6
9/17	54625.436	9
9/18	54607.982	9
9/19	54620.028	9
9/20	54622.969	9
9/21	54619.976	9
9/22	54620.314	9
9/23	54610.198	4
9/24	54613.125	3
9/25	54610.526	3
9/26	54612.05	3
9/27	54612.064	3
9/28	54608.297	3
9/29	54608.607	3
9/30	54605.952	9


Magnetic Field Strength: Petersburg, Alaska (June-September 2008)
B-Field (nT)
54700
54650
54600
54550
54500
54450
54400
6/1/2008
6/8/2008
6/15/2008
6/22/2008
6/29/2008
7/6/2008
7/13/2008
7/20/2008
7/27/2008
8/3/2008
8/10/2008
8/17/2008
8/24/2008
8/31/2008
9/7/2008
Date

K-Values Petersburg, Alaska (June-September 2008)

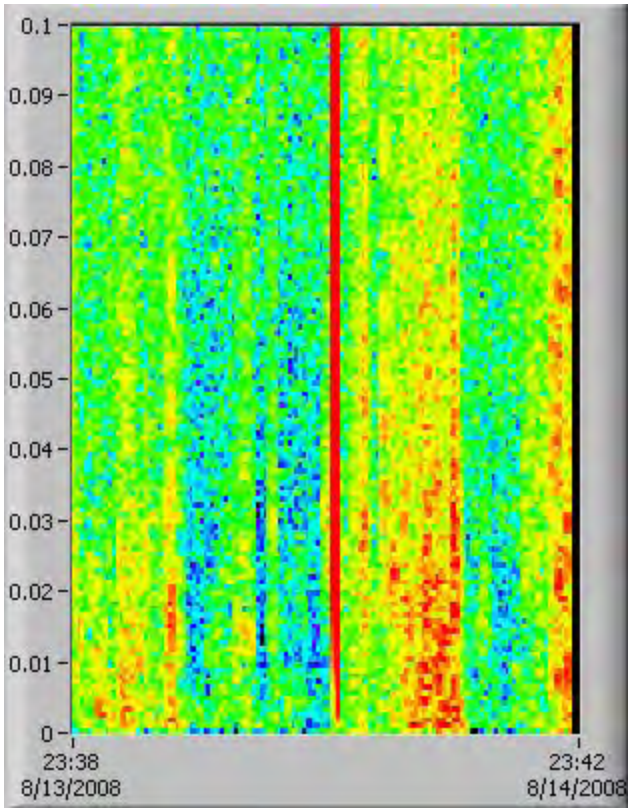


Statistical Analysis

- **“Normal” Day**
  - A normal day is when the k-max is at the average for the month in the particular area.
  - Petersburg, AK: $\mathbf{K_{max}}$ = 5.10 +/- 1.94, **B** = 54,419.08 nT +/- 14.4 nT
- **“Active Day”** would appear to be $\mathbf{K_{max}}$
  - An active day is when k-max is significantly higher than the location;s average.
- The B-field appears to be holding at a constant strength.

Spectrometers

On a Normal Day:

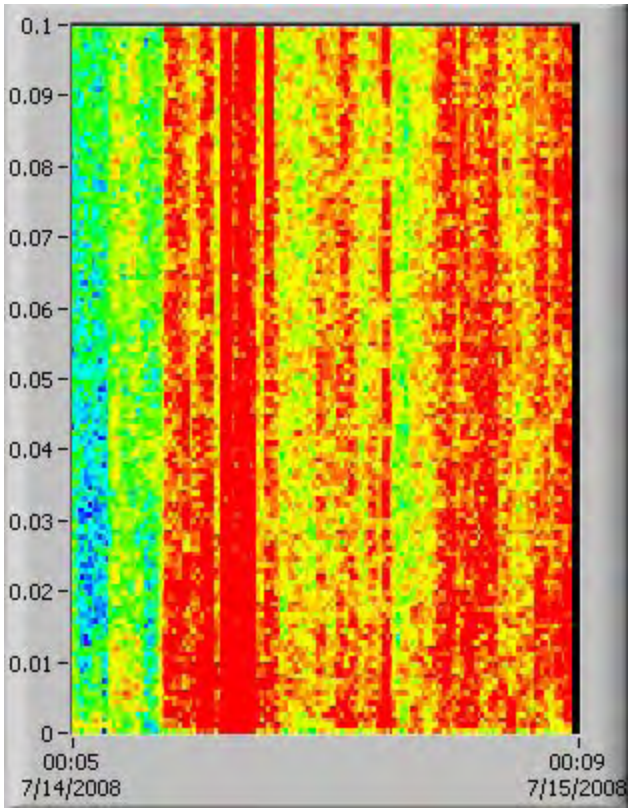


This shows the Spectrometer for August 14, 2008.

On this day, we had a k value of 5, but the rectangular red bar, representing the highest k value, is probably due to human activity because of its unnatural regularity. However, the blue and yellow speckled areas are typical in most spectrometers from Petersburg.

Spectrometers

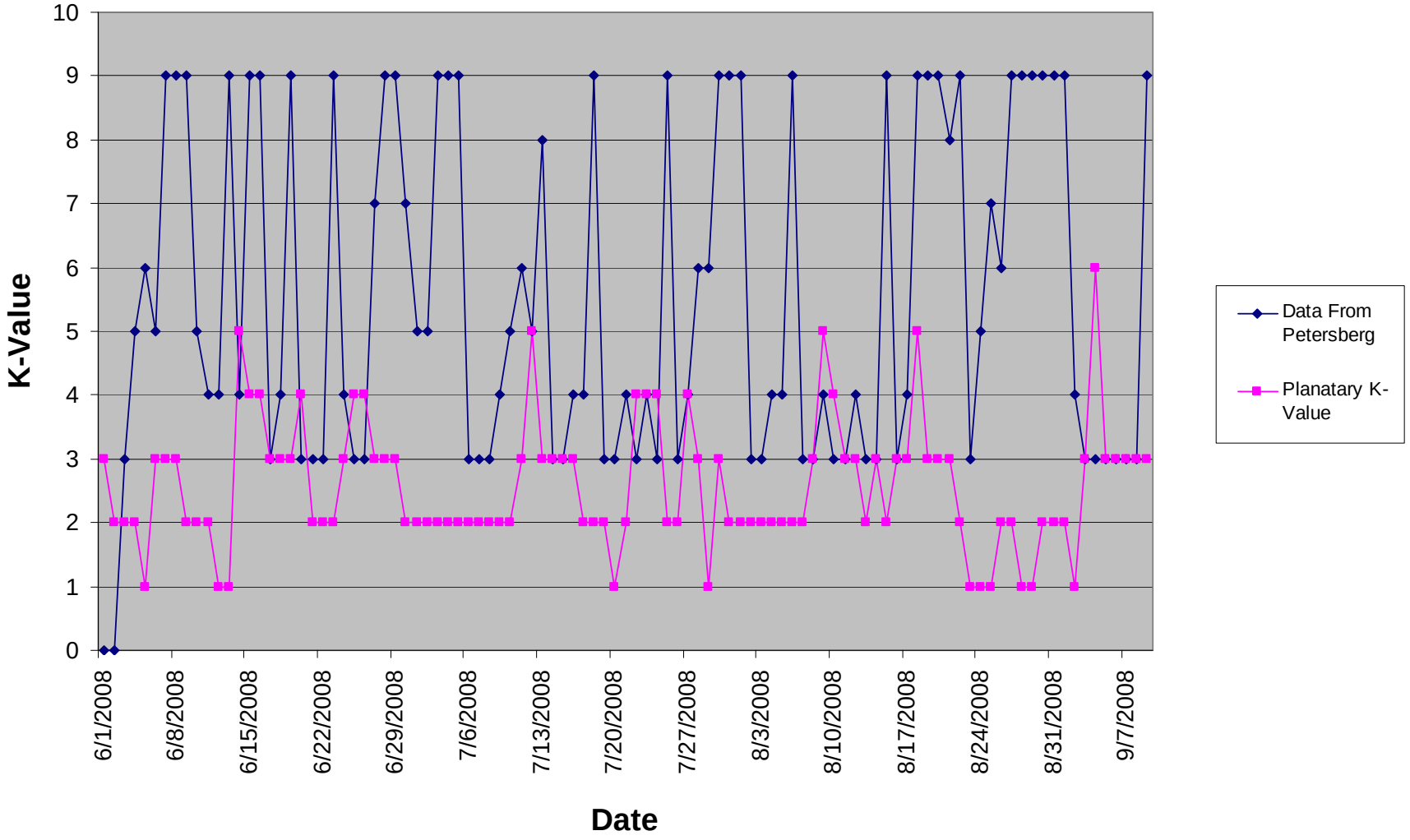
On a High Activity Day:



This shows the Spectrometer for July 14, 2008.

On this day, we had a k value of 9. It is obvious that this magnetic disturbance is due to magnetic storms because of the randomness in the spectrometer indicative of a natural event.

K-Index Comparison with Planetary Data: Petersburg, Alaska (June-September 2008)



K-Index Observations

- The k values for the planetary data are much lower than the data we collected for Petersburg, Alaska.
- This difference is due to the fact that Petersburg is closer to the “real” South Pole, so it receives more noticeable magnetic radiation.
- Although Petersburg receives more radiation than other locations, spikes in our data generally match spikes in the planetary data.

Discussion

- Our data may be inaccurate because it appears as though there are several cases of human errors on the spectrometer graphs.
- Although our data is abnormally high, in an ideal circumstance the data for this location would still be higher compared to the planetary data.

The End