

Activity 18 - Student Derived "Kp" index

Teacher's Guide:

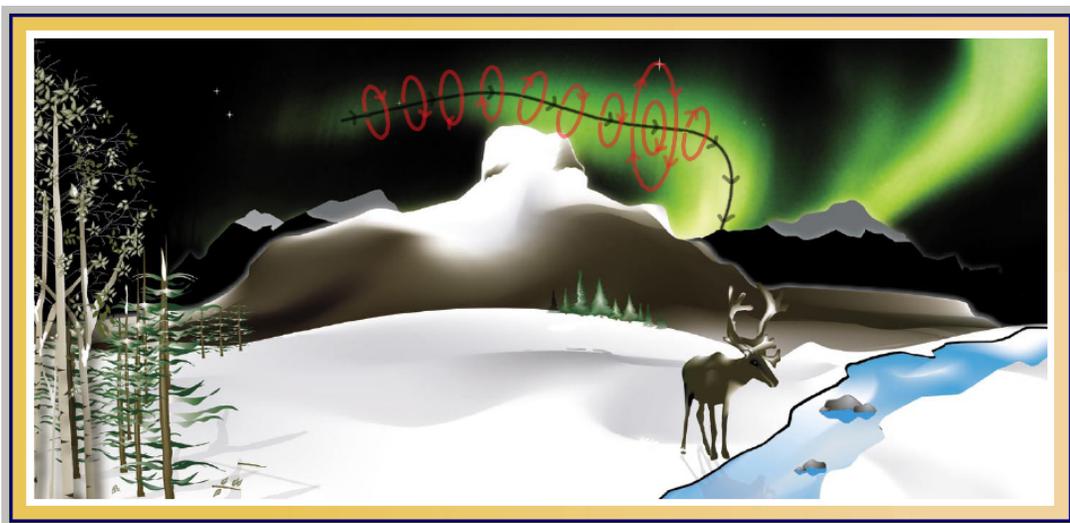
Kp is a relative strength of a magnetic storm determined by the global averages of a large number of magnetometers that are scattered around the North American Continent and Europe. The **Kp-index** is determined by averaging all of the measured K index on a 3 hour or shorter interval. The **K- index** is determined by the average of the A index and then is converted by a table of comparison. The **A- index** is the difference between the maximum and minimum reading for the X component of the magnetometer.

This activity is not designed to replace the actual Kp index but to allow students to take reading from a magnetometer and make a Kp index estimate. Using this estimate you can make a prediction as to whether an aurora display will occur that night.

Student Objectives:

1. **Observing real time data**
2. **Measuring and collecting data**
3. **Analyzing the collected data and make predictions**
4. **Checking with observations to validate the data**

The effects of the aurora current may be seen as the Aurora Borealis. A magnetic storm will disturb all three of the components, but due to the right hand rule the change in the Aurora current will affect mostly the X- component directly. This is illustrated in the figure below where the black line in the aurora indicates the direction of the current and the red circles represent the magnetic field lines around this current. Directly below the aurora, the x-component will be the most affected. To the South and North of the auroral arc, the z-component will be affected.



The A index is determined by the maximum strength of the X component minus the minimum strength of the X component for a three hour time period. ($X_{\max} - X_{\min}$). For our Activity we will determine the Max-Min strength for a 24 hour time period. Thus, in a sense, your reading will be similar to an A index average. Using the following table we can convert the A- index component strength difference directly to a K index.

Table of Conversion for Boulder magnetometer

The K-index is related to the maximum fluctuations of horizontal components observed on a magnetometer relative to a quiet day

Procedure:

Finding the A-index

1 - Print off a days-worth of XYZ data from a THEMIS magnetometer site as close to your school as possible. To do this, visit the THEMIS education data website: http://ds9.ssl.berkeley.edu/themis/classroom_geons_data.html

From here you can either choose real-time data, that means data that is being taken and plotted right now. Or you can choose archived data - data from a previous day. To use the real-time data, find the "Site-Specific GEONS Real-Time Data" and click on the link under "24-hour Plots" for the station closest to your school. A map indicating the location of these magnetometer sites can be found at the bottom of this web page. Three plots will come up. You can click on them to make a larger version and then if you right click (PC), <CTRL>-click (Mac) you can save the images on your computer and print from your computer.

To use the archived data, go to "GEONS Archive Data" and click on "archive data page." Here, you will fill out a form. On the left side of the form, click on the "Day Plot" button. Click on the "Start Date/Time" button and then choose the date you want to look at. Note that the time for a "Day Plot" is not important since all day plots go from 12 midnight UT to 11:59pm UT. On the right side of the form, choose the School town you want and then click on the "XYZ" button. Then click on "Start Mag Search." If data is not available for the date you chose, try another date until you find some data. Once you have selected the XYZ data you want to work with, either print the plot from the web site or save the image to your computer and print from your computer.

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2 - Using a clear metric ruler 15 mm length, place the ruler horizontally across the X-scale of the graph.

3 - Using a sharp pencil select the highest reading of the X component that does not look like a human made signal. To check if it is a human-made signal, compare with neighboring magnetometers to see if other magnetometers have the same signal. If they do, it is most likely NOT a human made signal and it can be used as the highest reading of the X-component scale. Place a horizontal line across the x-component plot that touches this highest reading.

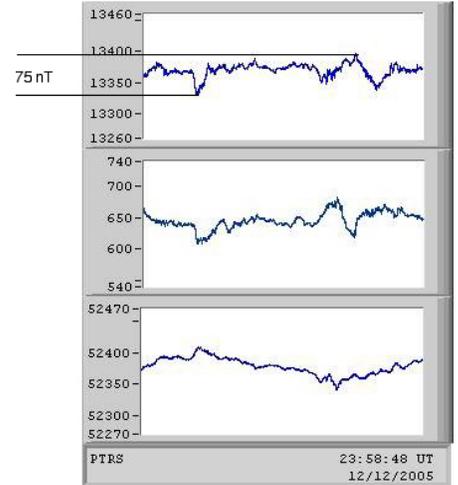
4 - Repeat 3, but for the lowest x-component reading. At this point, your x-component plot will have two horizontal lines, one touching the maximum x-component reading and one touching the minimum x-component reading.

5 - Using the metric ruler, measure the distance between the two horizontal lines. Then use the ruler to determine the scale of mm to nT on your x-component plot (for example 1 mm = 5 nT). Using this scale determine the difference in nT from the maximum x-component reading to the minimum x-component reading in nT. We call this "nT diff." See the plot on this page as an example.

K-Conversion:

6 - Now that you have "nT diff." you can use the conversion table on this page to obtain an approximate K-index value. This is the strength of the magnetic storm on your magnetometer.

7 - Compare this information to the Kp index (http://www.sec.noaa.gov/rt_plots/kp_3d.html) Try to predict the possibility of the people in the town where the magnetometer is located of seeing an aurora display on the night of the data you choose.



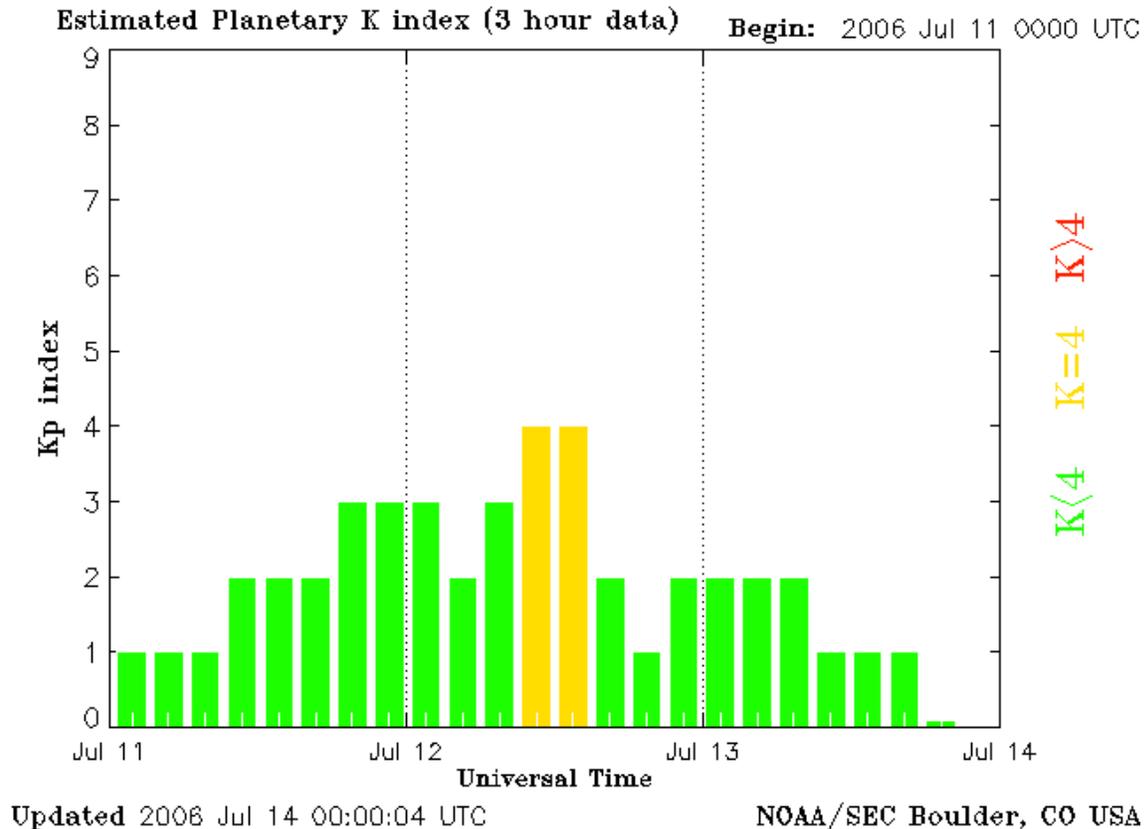
K index	nT diff.
0	0-5
1	5-10
2	10-20
3	20-40
4	40-70
5	70-120
6	120-200
7	200-330
8	330-500
9	>500

Teacher Notes:

This activity can be used in Physical Science classes dealing with magnetism. This is also the place where you can introduce the magnetometer plots and look at them to get an idea of what is going on. The Kp strength and prediction activity can also be conducted with Geology students. First go over the background material in class and then do an activity recording the data when students artificially disturbed the magnetometer with various objects. Students can look at the plots and mentally predict what is happening to the magnetic field. See more teacher notes at the end of this activity.

- 1 - The actual disturbance may have been caused by a local event.
- 2 - If you are in the upper Northern Hemisphere a high Kp storm affects may be below your southern horizon.
- 3 - Not all storms produce Auroras.
- 4 - Daylight Auroras occur but are not visible.
- 5 - The global Kp index determined by three hour interval averages can always be used to authenticate the students data. The real-time plot below is available at

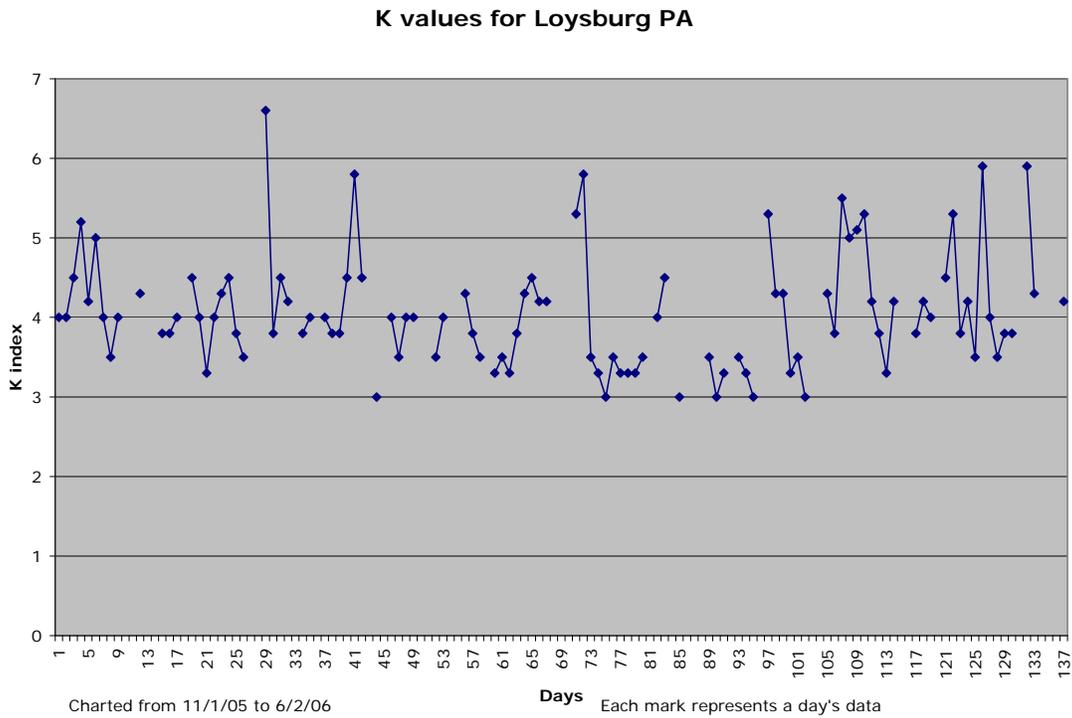
http://www.sec.noaa.gov/rt_plots/kp_3d.html



Activity A:

- 1 - Record the X component difference during the day.
- 2 - Using the table determine the K index.
- 3 - Find your locations Kp index for aurora display.
- 4 - Predict the possibility of staying up for an Aurora Show or going to bed and getting some sleep.

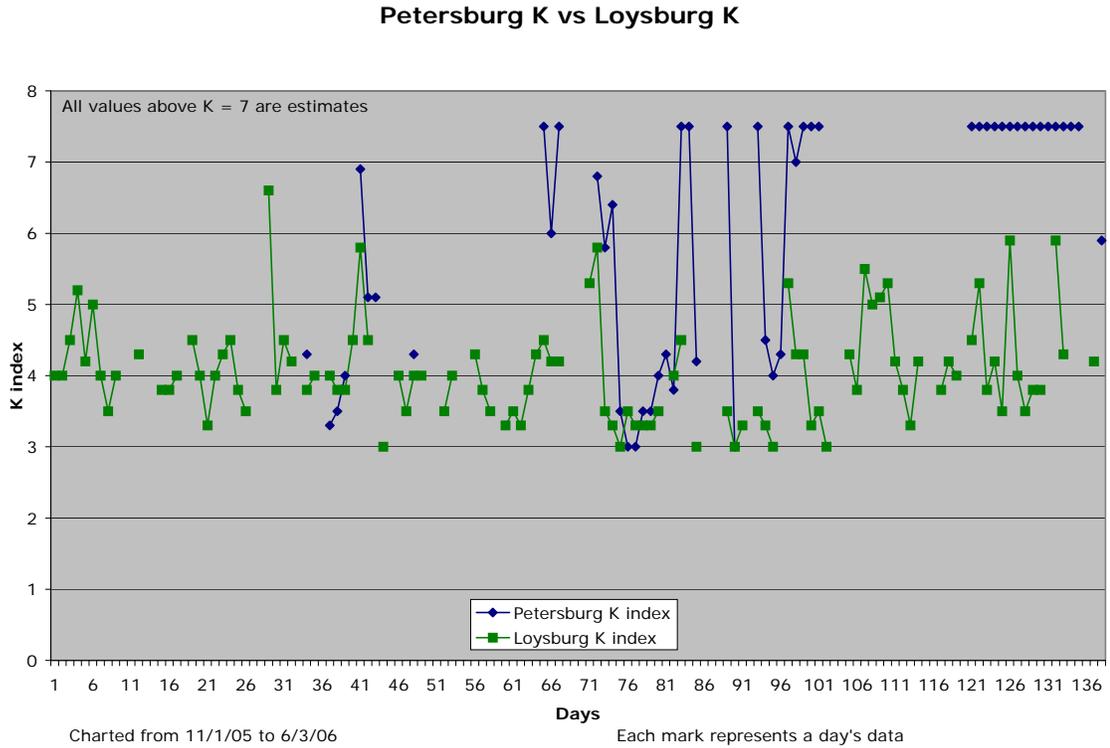
Example below is for Loysburg ,PA.



Activity B:

- 1 - Determine the K index for your school's magnetometer.
- 2 - Determine the K index for another school's magnetometer.
- 3 - Based on comparison you will be able to determine if the activity is the result of a magnetic storm or just a local event.
- 4 - Build a table on excel and using graphic comparison over a longer period will show relationships between your magnetometer and another school's magnetometer.

Example below compares Petersburg with Loysburg data.



Activity C:

Contact other schools in your region. The students would be able to share their data and get other students involved in using the Magnetometer data. Then through collaboration they could decide if it would warrant an Auroral Alert.

Notes to Teachers:

- 1 - The largest measurement you can make on the existing plots is about 200 nT but varies in the displays from school to school, and in time.
- 2 - You need a small (15 cm), clear, metric ruler. So that you can draw a line perpendicular to the left edge of the plot to get an precise measurement line.
- 3 - Print out and three hole punch the X,Y,Z, plots. This allows the students the ability to go back and double check questionable data
- 4 - When you do comparative graph have both the day number and actual date so you can graph the corresponding data together.
- 5 - Microsoft EXCEL treats all data as numbers, not dates, so you need to select the correct days and cut and paste to get a comparative graph.