Teacher's Guide

Satellite Glitches and Cosmic Rays

Introduction

Electronic problems with orbiting satellites are more frequent when the environment has been bombarded with energetic particles called cosmic rays. These high energy, charged particles impact sensitive electronic circuits and causes 'glitches', which can alter the operation of a satellite in an unpredictable manner. This activit shows the correlation between cosmic ray hits and the electronic errors in the NASA TDRS-1 communication satellite which is used for keeping in touch with the Space Shuttle crew while in space.

Objective

Students will construct a graph from a data table. Students will look for correlations and patterns between the frequency of cosmic rays and glitches.

Procedure

1) Arrange the students into four groups.

2) Give each group a data table for an assigned year.

3) Students will create a double line graph with the months on the horizontal axis. Using two different colored pencils, plot the glitches and the cosmic ray counts.

4) Permit time for the students to analyze the graphs and look for a correlation.

5) Have the groups combine the graphs into a single graph in the proper time order from 1987 to 1990 to detect any long-term trends.

6) Provide each group with a transparency. Have each group prepare a presentation of their findings.They should note an correlation or discrepancy that the have found.

7) Have a prepared transparency of the four tables and graphs, and the combined four-year graph. Provide a concluding summary using the class results. Possible student conclusions include that when the cosmic ray hits are high, glitches are more common. There is a correlation between the two sets of data. Was there a year where there was a particularly high number of both, and did that relate to a solar storm event, sunspot number increase, or coronal mass ejection

Materials

—Table of cosmic ra counts and TDRS-1 glitches.

—Graph paper

Extra Credit:

If you compare the cosmic ray hits against the sunspot cycle, you will note that when the solar cycle is near maximum, the number of cosmic ray hits is lowest. This is because cosmic rays come from interstellar space and not the sun. When the sunspot activity is highest, the sun's magnetic field is much stronger out near the Earth, and this helps to shield us from cosmic rays. When solar activity is lowest, the sun's magnetic field is weaker near the Earth and so the cosmic rays have an easier time reaching the Earth and affecting our satellites.

Conclusion:

Students should have correlated the data for the electronic glitches with the cosmic ray hits to the satellite. From the real data in the tables, the students have plotted, analyzed and have drawn a conclusion.

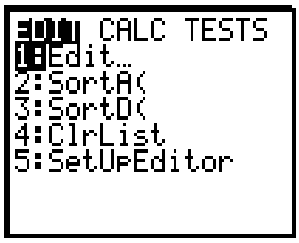
TEACHER NOTES FOR THE TI-83 GRAPHING CALCULATOR

Reminder: Be sure to reset the calculator using "Teacher Notes for the Graphing Calculator" included in the previous sunspot lesson.

The commands for the graphing calculator are given in bold print.

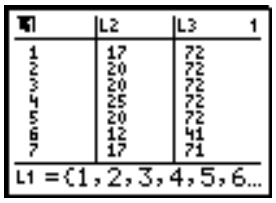
Students will enter the data for the years into list one, the data for the glitches in list two, and the cosmic ray hits (Cr hits) in list three. NOTE: Be sure to list the years as the numbers 1 through 48.

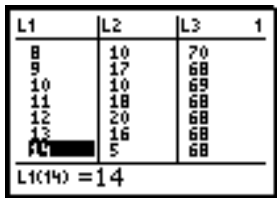
Entering the data into the list will consist of the following keystrokes:

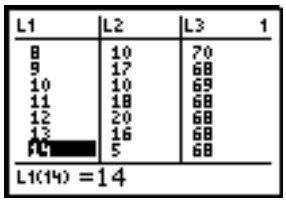


STAT ENTER

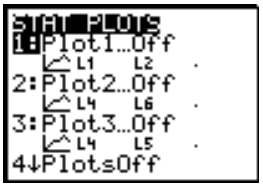
This will put you at the window to input the data for the year into your selected lists. Sample screen images are shown below.







The next step is to turn on the appropriate graph and to use the correct lists. Since the data is in List 1, List 2, and List 3, those are the ones that we shall select. To turn the plots on, use the following keystrokes:

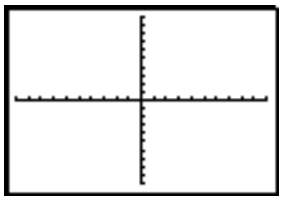


2ND Y= ENTER

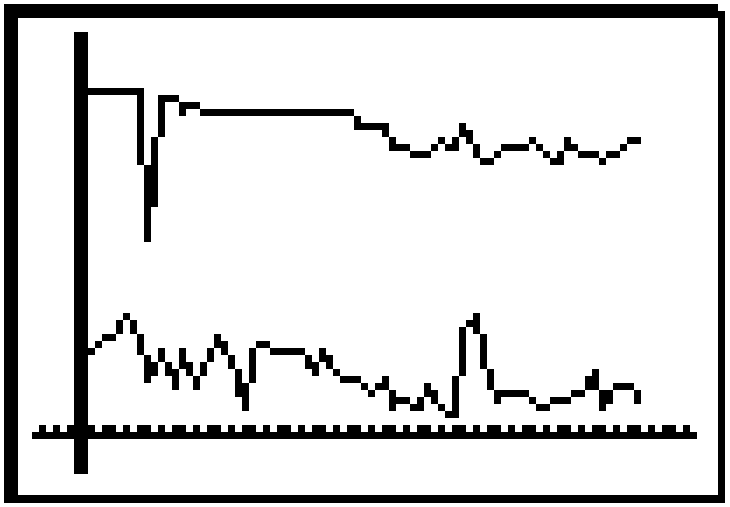
To turn the plot on, make sure that the cursor is blinking over the **ON** and push **ENTER**. Next arrow down and over to select the second graph. Once the cursor is flashing over it, push **ENTER**. Arrow down to the X list and push **2ND 1**, arrow down to the Y list and push **2ND 2**. To turn on the second plot, **2ND Y= ENTER**. Arrow down and select 2. Again, make sure that the cursor is flashing over the **ON** and push **ENTER**. Then arrow down and over to the second graph, and **ENTER**. Arrow down to the X list and push **2ND 1**, and arrow down to the Y list and push **2ND 3**.

The correct windows are displayed below.

The next step is to graph the data. When the students push the graph key, they may or may not see a part of the graph. If the calculator was reset prior to the beginning of the lesson, the students would see the following blank display. It is necessary to adjust the viewing window using **ZOOM 9**. The window display for the zoom is shown below.



In order to move along the graphs and to display the values, push **TRACE**. The up and down arrow keys allow movement between the two graphs, and the right and left arrow keys allow movement along a particular graph.The appropriate graph display will appear as follows:



Students will probably say that there is no relationship evident between these two graphs, and they are right.There is a correlation between these two, it is just not evident with the small sampling of data that is presented. The overall slopes are similar in that there is a downward slant to both. Students need to be aware that in the scientific world, answers are not always readily apparent and that there may be a need to explore a relationship further. However, students can draw conclusions based on the given data.The discussion can also focus on the need to possibly scale one set of data to see if this allows for more concise results, or to collect more data to analyze.

Name _____ Date_____

1987

Month	Glitches	CR Hits
Januar	17	72
February	20	72
March	20	72
April	25	72
May	20	72
June	12	71
July	17	71
August	10	70
September	17	68
October	10	69
November	18	68
December	20	68

1988

Month	Glitches	CR Hits
Januar	16	68
February	5	68
March	17	67
April	19	68
May	18	67
June	17	67
July	17	67
August	13	67
September	18	67
October	13	67
November	12	67
December	12	65

1989

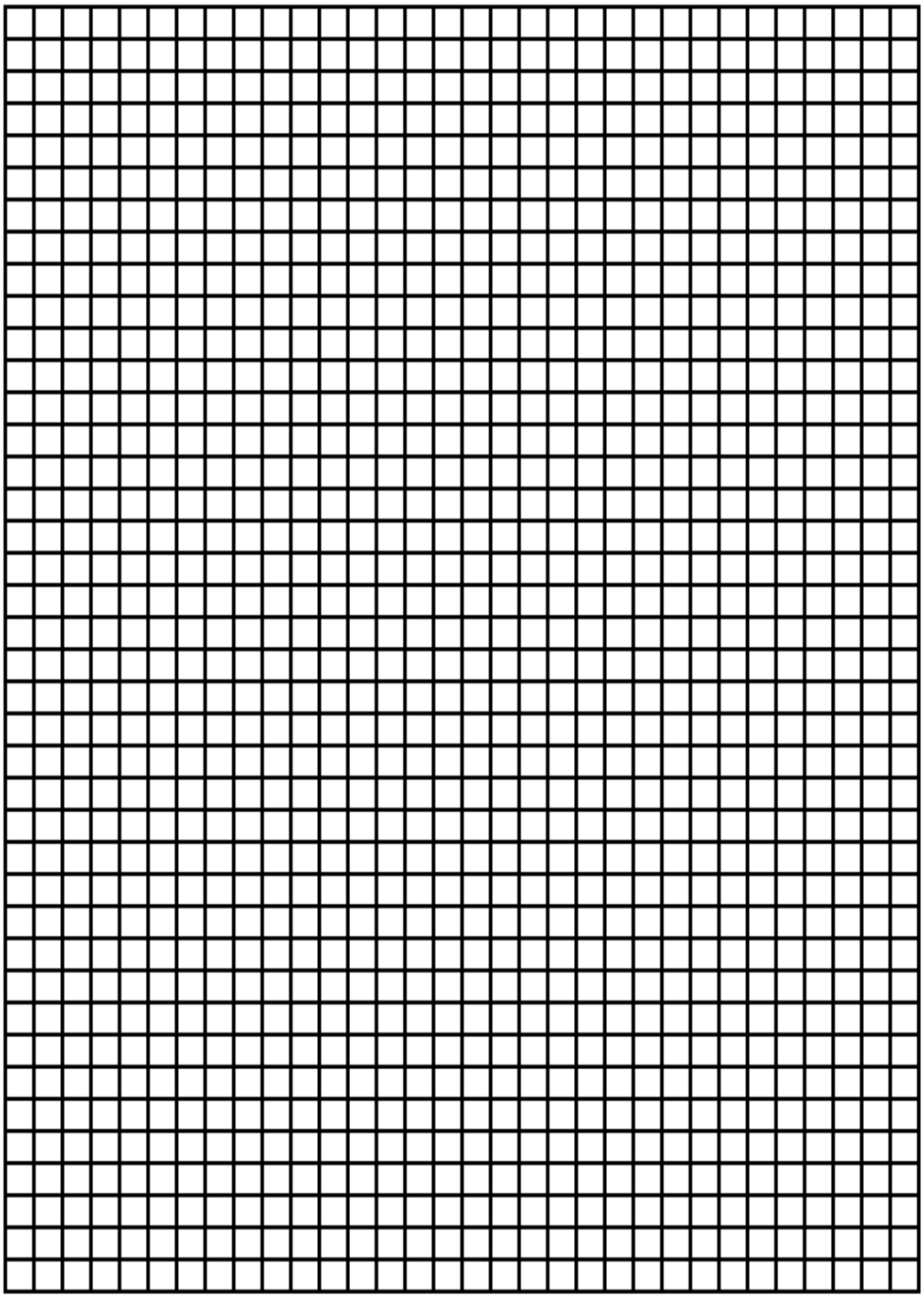
Month	Glitches	CR Hits
Januar	9	64
February	12	64
March	5	60
April	7	60
May	5	59
June	10	59
July	6	62
August	4	60
September	22	65
October	25	58
November	10	57
December	7	59

1990

Month	Glitches	CR Hits
Januar	8	60
February	9	60
March	7	61
April	6	58
May	7	57
June	7	61
July	9	58
August	13	58
September	5	57
October	10	58
November	10	61
December	7	62

Name _____

Date_____



Name _____

Date_____