

Teacher's Guide

Solar Activity and Coronal Mass Ejections

Introduction

The Sun constantly emits matter into space in the form of a more or less steady solar wind. From time to time the Sun also ejects individual clouds of gas in an event called a Coronal Mass Ejection or CME. CMEs can cause storms in the environment of the earth that can have harmful impacts on humans working in space, on communication satellites, and many other aspects of our technology dependent society. For this reason, scientists look for many clues to tell when the next one may happen to provide us with an advanced warning.

Objective

Students will construct a graph to compare the sunspot cycle with Coronal Mass Ejections (CMEs).

Procedure

1) Students will use the graphing calculator to create the graphs for the sunspots and the CMEs. Students will graph the sunspots and CMEs on graph paper. **Note:** Using different colors to depict each graph will allow for ease when comparing the two graphs.

2) Students are to compare the two graphs. Location of the maximums, the minimums, and the time frames are the key components. Have students determine if there is a correlation.

3) Discuss the possible relationships that the students locate. Among other things to consider are:

—How well does the CME activity follow sunspot number

—Do the maximums and the minimums happen at about the same time

Some things you will find are:

—CME activity should follow rather closely to the sunspot cycle, but the correlation in exact counts may not be precise. This is probably because CMEs happen in layers of the sun that are much higher above the solar surface than the sunspots.

—The CME curve seems to have a longer, flatter minimum than the sunspot curve and its center is offset from the sunspot minimum by 2-3 years earlier. CME activity may decline to a minimum faster than sunspots after sunspot maximum.

Materials

- Graph paper
- Colored pencils
- Student worksheet

Optional:

- Teacher notes on the graphing calculator.
- Graphing Calculator
Note: TI-83 used in the examples

Key Terminology:

Solar Wind: A flow of matter from the surface of the Sun which passes through interplanetary space.

CMEs: Coronal Mass Ejections, which are sudden ejections of matter from the Sun's outer layers.

Teacher Notes for the Graphing Calculator

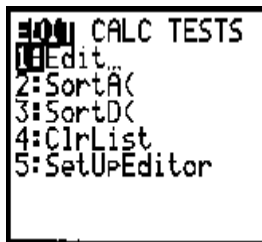
Reminder: Be sure to reset the calculator using the “Teacher Notes for the Graphing Calculator” included in the previous sunspot lesson .

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

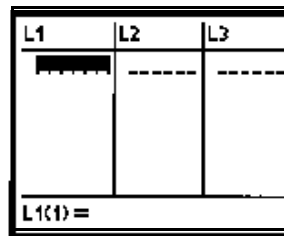
Students will enter the following data:

Year	CMEs	Sunspots	Year	CMEs	Sunspots
1980	12	154	1988	29	98
1981	26	140	1989	38	154
1982	7	116	1990	18	146
1983	8	67	1991	32	144
1984	6	46	1992	23	94
1985	2	18	1993	10	56
1986	4	14	1994	9	30
1987	5	32	1995	13	17

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

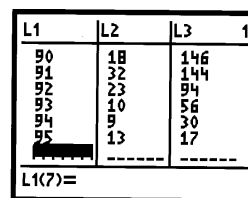
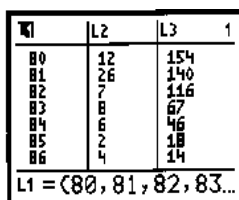


STAT

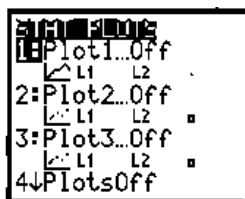


ENTER

This will put you at the window to input the data for the year in List 1, CME number in List 2, and the sunspot number in List 3. Sample screen images are shown on the right:



After the data has been entered into the lists, the stat plots need to be turned on. To turn the plots on, use the following keystrokes:



2ND Y=



ENTER

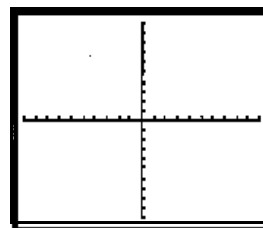
Plot 1 allows the year and CME data to be graphed. Plot 2 allows the year and sunspot number to be graphed.

Note: To change the xlist and the ylist to L1, L2 and L3, use the **2nd 1**, **2nd 2**, and **2nd 3**, commands.



2ND Y= 2

This would be a good time to discuss the appropriate graph for this situation. The explanation given in the sunspot lesson is consistent with this data. The data is continuous and should be displayed as such.



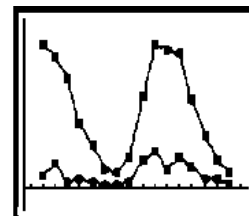
GRAPH

When the students push the graph key, they may not see any data. They may see a graph of four quadrants with a small display of data:

In order to get the correct window, the students need to zoom the screen:

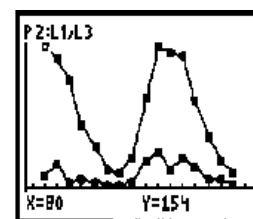
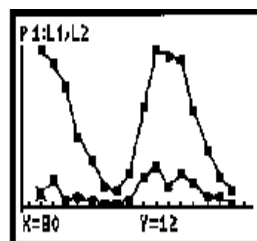


ZOO



9

In order to move along the values and make comparisons, use Trace. Note: The top graph is the number of sunspots and the bottom graph is the number of CMEs.



TRACE

When using the TRACE key, the students are able to see the year displayed in L1, the CMEs in L2, and the sunspot numbers in L3. By using the right and left arrow key, the students can move along a particular graph. To move to the other graph, the up and down arrow keys allow the students to move from one graph to the other.

Name _____

Date _____

