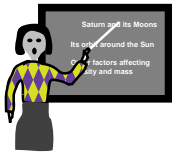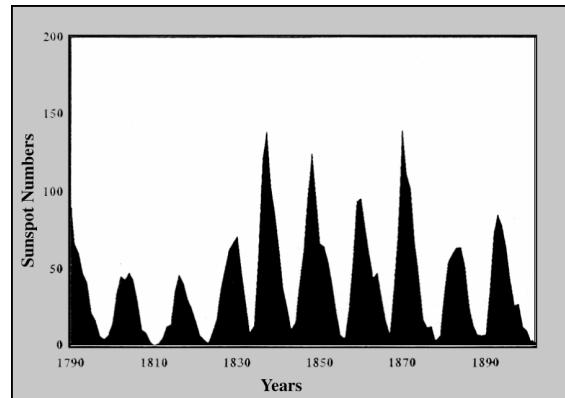# ACTIVITY 2:
SUNSPOT NUMBER VARIATIONS

Guide to Teachers

Goal: Students learn about sunspot variations and the solar cycle, and are able to predict future solar minimums and maximums.


This activity focuses on one feature of the Sun seen in the last activity, sunspots, and examines their variation over times much greater than a solar rotation (about 25 days). It functions as an EXPLORE phase in Solarscapes.

MATERIALS NEEDED

- One copy of the student activity information and worksheet (included)
- Table of yearly sunspot numbers (Charts #1 and #2, included)
- A photocopy of the student activity, preferably one copy per student. Provide the worksheet first, then the rest of the text once students have discussed their initial ideas
- Three sheets of graph paper per group of 3 students
- Colored pencils
- Ruler
- Scissors
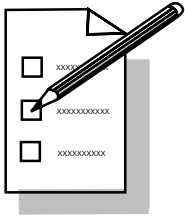
Procedure:

DISCUSS: Students discuss what they know about sunspots and their variations. This allows them to revisit some material from Activity 1. Many may know that the number of sunspots changes over time, or even that the number changes in a regular cycle. Students then report a few ideas from their groups, facilitated by the teacher.

EXPLORE: Provide students with activity materials and text. Students work in groups of three. They begin by reading about sunspots and their relationship to Earth. Each student prepares a graph using the procedure in the student worksheet. They plot the number of sunspots for each year using Charts #1 and #2, join their graphs and observe the resulting pattern. The teacher should assist students who are having difficulties producing a correct graph of the data to ensure that all students who wish to produce a correct graph do so.

> *NOTE: Since they will be taping these graphs together, make certain that all three students in each group use the same scale for both the time in years (x-axis) and sunspot numbers (y-axis).*

REFLECT: At this point, the teacher should call on several students to report their observations. After discussing the observations, tell them that the pattern they see is called the **Solar Cycle**. Solar cycles have been numbered beginning with the minimum that occurred about 1755. A cycle includes an increase and the following decrease in sunspot numbers. Cycle number 22 peaked in 1990. The next two sunspot cycles are numbered 23 and 24. Students are to number the cycles on their graphs. Point out to students that during the Maunder Minimum (from 1645 to 1715), the solar cycle almost disappeared as no sunspots were seen. The link between climate (long-term variations in the weather) and sunspots may have something to do with the maximum number of sunspots in a cycle, but scientists do not completely understand the connection.

APPLY: Students use their graphs to answer various questions and predict aspects of the next sunspot cycle.

Options for modifying this activity:

As it is written, the activity for plotting sunspot numbers takes a class of 30 students, who meet in 45 minute periods, about three or four days to complete. To reduce the amount of time that you spend on the activity to about two days, you might try the following suggestions

- Have the students only plot every other point.

- Assign students to finish plotting the data as homework.

- For smaller classes (fifteen or less) and for an activity that gets students out of their seats and moving about, you might try the following procedure:

Use butcher paper long enough to graph the accompanying data (perhaps cover one wall of a classroom).

1. Prepare the butcher paper in advance by drawing the horizontal axis along the bottom and labeling it "Time in Years." Number from 1700 to present. Draw a vertical axis on the left hand side of the butcher paper and label it "Sunspot Numbers." Number from 1 to 200. Write a title.

2. Cut out the individual dates or series of dates for individual students to graph.

3. Have students graph the sunspot numbers that you have prepared. (This is most exciting when students have sunspot numbers that are not sequentially, but randomly dated so that they must move around to find the dates on the horizontal axis.) When all of the points are plotted, have several students connect the data points.

4. Ask students to observe the resulting pattern, answer the questions that accompany this activity, then draw their prediction for the next two sunspot cycles on the graph using a dashed ------ line.

Explore More: To add an interdisciplinary or a personal touch, ask students to mark historical events or dates of personal interest such as birthdays.

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Scoring Rubric for Activity 2: Sunspot Number Variations

Student Name: _____

Individual Assessment (goal met if student achieves a "3")

Task(s)	0	1	2	3	4
Answering questions and making predictions	Student did not participate or answer questions.	Student answers questions, but is unable to explain the answers.	Student answers questions, includes reasonable explanation for those answers, but does not provide a reasonable prediction for sunspot cycle numbers 23 and 24 or a reasonable explanation for the answer.	Student answers questions, includes a reasonable explanation for those answers, but does not provide a reasonable prediction for sunspot cycle numbers 23 and 24.	Student does all of the things in "3," but also includes very innovative answers for question 6.

Group Assessment (goal met if group achieves a "2")

Task(s)	0	1	2	3	4
Producing a graph of sunspot numbers and making predictions	Group does not produce a graph.	Group produces a graph that does not contain reasonable predictions for the sunspot cycle numbers 23 and 24.	Group produces a graph that does contain reasonable predictions for the sunspot cycle numbers 23 and 24.		

SUGGESTED USE: Make one copy per student; there is also room for you to add your own task and scoring criteria.

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