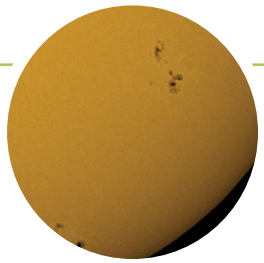
Historical Sunspot Activity: Finding Patterns

A Carolina Essentials™ Activity



Overview

When studying the Sun, students are often told that there is an 11-year sunspot cycle and that the cycle of maximum and minimum number of sunspots can affect our weather here on Earth. Scientists have been studying sunspots, their location, groupings, and motion for hundreds of years. At the same time every day, astronomers in Belgium still map the number and location of sunspots by hand to help forecast solar weather.

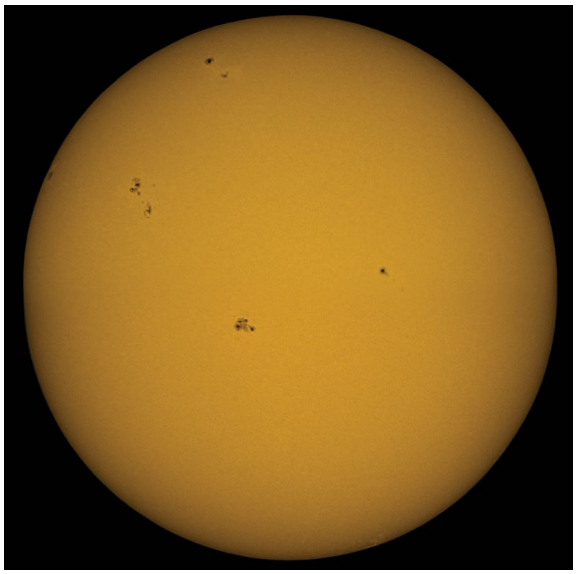
In this activity, students use historical data from SILSO, the Royal Observatory of Belgium, to plot the monthly average of sunspots over a 30-year period. From the plot, students determine if a cycle exists, and if one does, the length of the cycle.

The data set is large and can be broken up into sections for individual students or groups of students if graphing by hand. The entire plot can be constructed from each group's part. The procedure is simple, but the data visualization is a powerful tool for establishing the sunspot cycle pattern.

Earth and Space Science
Grades: 9–12

Phenomenon

Look at the photo of the sun disk. Circle the individual and group sunspots. How might the disk appear in 3 days?



Essential Question

How does the sunspot cycle contribute to a model explaining the release of energy by the Sun?

Activity Objectives

1. Use monthly sunspot averages to determine if a sunspot cycle exists.
2. If a sunspot cycle exists, determine the length of the cycle.

Next Generation Science Standards* (NGSS)

PE HS-ESS1-1. Develop a model based on evidence to illustrate the life span of the Sun and the role of nuclear fusion in the Sun's core to release energy in the form of radiation.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models • Develop a model based on evidence to illustrate the relationships between systems or between components of a system.	**ESS1.A: The Universe and Its Stars** • The star called the Sun is changing and will burn out over a lifespan of approximately 10 billion years.	**Scale, Proportion, and Quantity** • The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

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TIME REQUIREMENTS

PREP	ACTIVITY
15 min	30-45 min

Teacher Prep: 15 min
Student Activity: 30-45 min, depending on graphing technique selected

SAFETY REQUIREMENTS

No PPE is required for the activity.

MATERIALS (PER GROUP)

Sunspot data table
Graph paper or graphing computer program
Colored pencils

RESOURCES

Sunspots and Solar Flares
Solar Synoptic Map
SOHO Mission Data
SILSO Sunspot Data

HELPFUL LINKS

Basics of Graphs and Charts
The Composition and Age of Stars
Investigating and Building Refractor Telescopes Kit
Galaxy Cards
Night Sky Planisphere, 30–40 Degrees North

REFERENCE KITS

Stellar Origin of the Elements

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Teacher Preparation and Disposal

Print or download the student activity sheets and the sunspot data table. Divide the data table into group segments if desired. No disposal of materials.

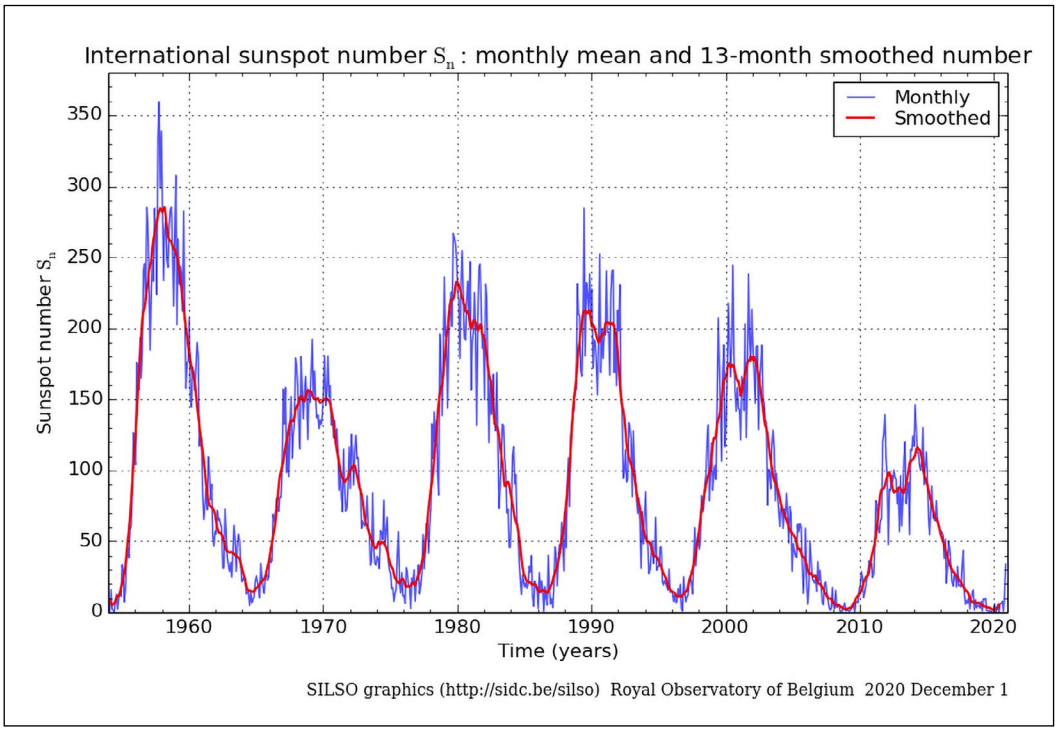
Student Procedure

1. Your teacher will assign you a section of the data table or the entire data table to graph.
2. Decide as a class the scale that should be used for the x-axis and y-axis.
3. Graph the data assigned.
4. Mark the maximum points on the plot with a colored vertical line.
5. Using a different color, mark the minimum points on the plot with a vertical line.
6. If you were assigned a section of the data table, join your section of the graph (or plot) to the others in chronological order to make a complete plot.

Teacher Preparation and Tips

To save time, segment the data table if students are graphing by hand. Then, tape all the individual graphs together to make one large plot. Students can take a gallery walk to check maximums and minimums.

Monthly and Smoothed Sunspot Number



SILSO Graphic, Royal Observatory of Belgium, Brussels

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Data and Observations

See data sheet: Average Monthly Sunspot Activity 1995–2019 (PDF).

Analysis and Discussion

1. In the space below, construct a data table with the date of every maximum and minimum for the 30-year period.

   Students answers may vary slightly in the month selected. Stress the importance to your students of reading the graph and the maximum and minimum points they selected in the procedure.

2. Calculate the time in years and months between maximums and minimums.

   The time should be between 5 and 6 years, half of the sunspot cycle.

3. Calculate the time in years and months between every 2 maximums.

   The time should be about 11 years, a full sunspot cycle.

4. Average the lengths of time between every 2 maximums shown on the full plot.

   The average time should be about 11 years.

5. Explain whether a sunspot cycle exists using the data above.

   A sunspot cycle of about 11 years exists. There is a regular pattern of maximum sunspot activity and minimum sunspot activity.

6. Explain how the presence of a sunspot cycle models the Sun's production of energy.

   The Sun's core produces energy through nuclear fusion. The heat or thermal energy produced by fusion is large enough that the surface of the Sun is about 5,800 K. Heat moves from the core, where fusion is taking place, to the surface by convection currents, keeping the surface hot enough to be in the plasma state where there is an abundance of charged particles.

   Magnetic fields are associated with convection of the hot plasma, and in places a strong magnetic field can cause cooling of around 2,000 K. These cooler places are visible as the darker spots we call sunspots. Therefore, sunspots model the transfer of heat from the core to the photosphere, and their movement over time indicates the motion of magnetic fields.

TEACHER NOTES