



A Space Place Project:
Solar Cycles Online – Student
Pack

Exploring our nearest star

Observing sunspots offer us a great way to learn some interesting facts about the closest star to the Earth, our Sun.

This interactive project will use yearly sunspot data over a period of 25 years and recent images from a space based telescope. This will allow you to create and analyse the annual number of sunspots as well as investigating how they form, move, change and disappear. At the conclusion of the project you will also be able to estimate how long the Sun takes to rotate at different latitudes (moving from East to West) and the effect of solar activity on our planet.

The Sun, like all stars, produces energy through nuclear fusion at the core. In this process energy is released through heat and light and is eventually lost from the Sun's surface. This energy is what lights our days, drives our weather and allows life on Earth to exist.

Sunspots have been observed for hundreds of years and they have given us valuable insights into the Sun's activity and its long term cycles. Sunspots are cooler regions on the Sun's surface, they appear as dark areas as they are about 2000°C cooler than the normal surface temperature (approximately 5500°C). These can range in size from a few thousand to tens of thousands of kilometres wide.

The Sun is moving towards its current peak of activity over the next year, after which there will be a gradual decline in sunspot numbers. With the large number of sunspots now visible, it is a good opportunity to track the changing number, position and shape of sunspots on our nearest star.

About this project...

Firstly, you will use data from 1983 – 2008, to plot the annual number of sunspots visible on the Sun's surface. You will then use this data to calculate the period of the sunspot cycle.

Secondly, you will map the daily position of sunspots on the surface of the Sun. Today we can safely use the internet to monitor the daily activity of our star, not only in visible light but through many different wavelengths of the spectrum. This project uses images in visible light but we have included images at different wavelengths for reference and extension work.

Project resources required:

- An Excel or similar computer program to enter, record and understand data. You will need to know how to enter data and to create graphs. This activity could also be done without a computer.
- Sunspot numbers for the last 25 years from annual sunspot data provided.
- Full daily Sun images from www.spaceweather.com
- A mapping grid to plot their position (best printed on a transparency sheet).
- As an extra resource, you may like to use Solar or Eclipse shades to view the Sun. This should never be done with the naked eye or with sunglasses.
- A calculator to work out your results.

The sunspot data comes from the Zurich Sunspot Number, an organisation in Switzerland which carefully counts and records the number of sunspots seen annually.

Let's get started!

You may want to do all these activities in pairs or individually.

Your teacher will issue each pair or individual with a list of annual sunspot numbers.

- Enter the annual sunspot numbers into a spread sheet.
- Using the 'line chart' function create a line graph showing the changing number of sunspots over this period.
- You may want to think about a suitable scale to the graph and which type of graph would be best to use.
- Make sure you label the axis correctly. This will help in understanding and analysing the graph later on.

Mapping sunspots

Your teacher will give each pair or individual a transparent mapping grid. You will need to download and print the daily Sun image from the spaceweather.com website.

On the first day, choose 2 or 3 sunspots that are initially towards the left hand side. Draw on your printed grid exactly where the sunspots are, and note the date, sunspot shape and size. It may be useful to number each sunspot. Write down its position in terms of latitude and longitude (for example, spot 1 appears at 15 latitude and -60 longitude, Spot 2 appears at 30 latitude and -15 longitude). Latitude runs North to South, longitude runs East to West.

The next day follow the same process on the same grid but mark the new position of the same sunspots. Over the next 10 – 20 days continue to record the position of the original sunspots. Date each sunspot. You may want to use the table on the following page to show the movements of the sunspots.

Review your data frequently to make sure that the numbers match the drawings.

You should now be able to work out how many degrees of longitude your sunspot moved each day.

Analysing your results...

First, look at the sunspot graph:

- How many cycles can you see on your graph?
- What is the maximum number of sunspots recorded over this time? What is the minimum?
- What is the difference between the highest sunspot number and the lowest? Did these occur in the same cycle?
- What is the period between the two peaks (maxima) and two troughs (minima)?
- Explain the patterns. Are the cycles the same or different?
- Predict what the next cycle may look like.

Now look at your sunspot table:

- Did all of the sunspots move the same average amount?
- How long would it take each sunspot to do one rotation?
- Do sunspots always move in the same direction? Explain your idea.
- Why do you think that the sunspots move at different speeds?
- Did the sunspots change shape or size and if so how?
- How long would it take for each sunspot to rotate 360 degrees?
- Predict where your sunspots will be in 1 day/ 5 days/ a week.
- Explain the movement of your sunspots in latitude and longitude. Are there any patterns that you notice?

Research questions....

You may want to extend your knowledge of sunspots by researching these questions:

- **What causes sunspots?**
- **Do other stars have sunspots and sunspot cycles?**
- **What effect could the solar cycle have on Earth?**
- **Was there any connection with sunspot activity and aurora geomagnetic storms during your observation period? How and where could you find out?**
- **Are there any trends in sunspot cycles?**
- **Why are sunspots important?**