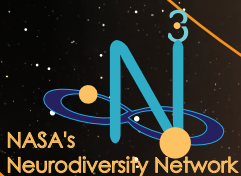


# Solar Science

## N3 Curriculum Student Guide Session 5





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# Session 5: Living With a Star

35 min

## Student Learning Objectives:

- Students will continue to take sunspot observations using their sunspotter to observe the Sun.
- Students will continue to compare their sunspot observations with the Helioviewer to see how NASA satellites observed the sunspots.
- Students will use Helioviewer to investigate solar storm activities during the dates of the Mysterious Events and make observations about solar flares and CME's.
- Students learn about geospace and geomagnetic storms.
- Students will experience Earth's magnetic field with a hands-on demonstration.
- Students will use SpaceWeather.com to investigate space weather conditions during the dates of the Mysterious Events and compare the results to their Helioviewer observations.
- Student will learn about "Living With a Star" and will take notes using TacFacs and DIY TacFacs.
- Students reflect on their knowledge using TacFacs and DIY TacFacs.
- Students will determine likely causes for the Mysterious Events.

## Introduction:

Now you are going to put together everything you learned since the Mysterious Events in Session 1! You have now made several sunspot observations, and utilized the Helioviewer to see how NASA observed the sunspots. You have also learned about magnetic storms on the Sun and that many of the Mysterious Events occurred during times when the Sun is very magnetically active.

You will use Helioviewer again to see if there was solar storm activity during the Mysterious Events. You will have a hands-on demonstration of the magnetic field on Earth. You will expand your knowledge of NASA resources by utilizing SpaceWeather.com and last but not least, you will put everything together and use evidence and reasoning to explain the Mysterious Events.



## 5.1 Sunspot Observing continued:

### Materials:

- Assembled Sunspotter (built in Session 2)
- Sunspot Detector



Assembled Sunspot Detector



*The complete setup photo is showing the white side of the panda board on the front.*

### Instructions:

1. Set up your assembled sunspotter and sunspot detector again, being sure to align them properly like you did in Session 2.
2. Record your observations onto your detector screen like you did previously by making a drawing of how the Sun appears with your sunspot detector. Refer back to Session 2's instructions for a refresher if needed.
3. Save this drawing for the future and keep it with your drawing from Session 2 and Session 3. If you have a hardcopy, make sure they are together. If it is a photo, make sure it is saved in a folder online or on your computer.
4. Open your Google Sheet titled "Sunspot Data".
5. Enter in your sunspot data in the rows immediately below where you left off previously.
6. Answer the following questions on "Worksheet: Sunspot Observations continued".

# 5.1 Worksheet:

## Sunspot Observations continued

Name: \_\_\_\_\_

Do you notice any changes in the Sun's appearance since your last observations?

Have the sunspots you previously observed moved?

Are there any new sunspots?

Have previous sunspots disappeared or changed shape or size?

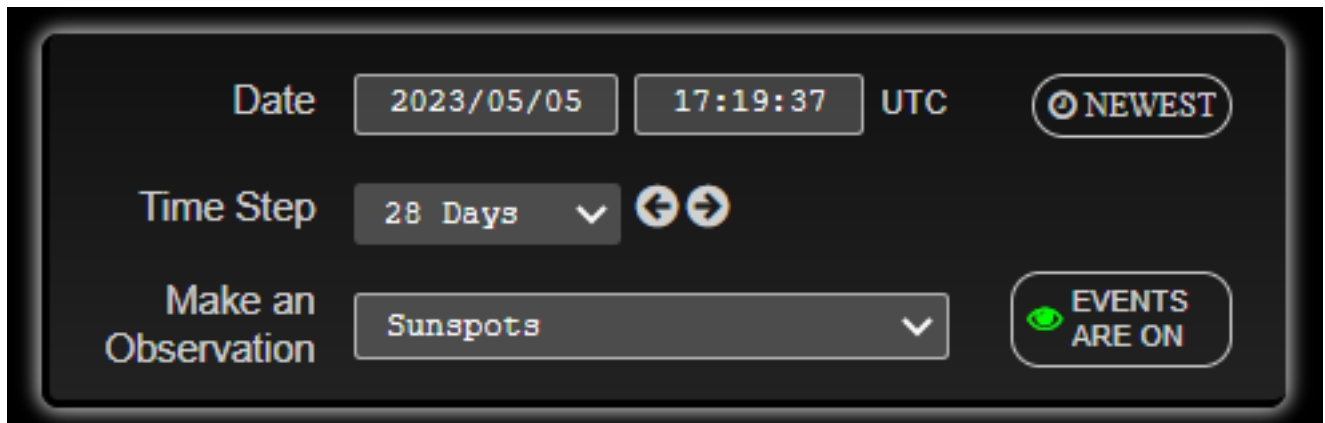
## 5.2 Compare with NASA's Observations continued

### Materials:

- Helioviewer guide:  
[\*buac18-doc-helioviewerguide-handout.pdf\*](#)

### Instructions: How to Use Helioviewer continued:

1. Open the Helioviewer Guide ([here](#)) or read the handout your teacher provided for you.
2. Go to [NASA's Student Helioviewer](#) or type this url into a web browser:  
► <https://student.helioviewer.org>.
3. Notice the controls in the upper left corner of the window. Select the corresponding date for your sunspot observations from the calendar. In the "Make an Observation" drop down menu, select "Sunspots"..



4. Compare the data you've recorded on your sunspot detector and Google Sheet.
  - a. Are there more sunspots than you observed using the sunspotter?
  - b. Do you notice any differences in the sunspot's details (shapes and/or sizes) in the Helioviewer's SDO images?
5. You may need to do Time Zone conversions to find Coordinated Universal Time (UTC). Your teacher may give you an additional exercise for this, or you can use the conversion chart in the Helioviewer Guide, or use Google to convert time to UTC.

## 5.3 Investigate Solar Storm Activity During Mysterious Events

You will use your data table from Session 4.4 to continue making observations on the days Mysterious Events occurred, but now looking for Solar Flares and CME's. Use either your Google Sheet "Data Table 4.4 - Sunspots and Mysteries" or the hardcopy "Worksheet: Mysterious Events Data" and fill out the two columns to the right labeled "Solar Flares" and "CMEs".



*Helioviewer time again!*

### Instructions:

1. Use [Helioviewer](#) once again, this time to investigate solar storm activity during the Mysterious Events.
2. In the "Make An Observation" drop-down menu, choose both options of "Flares and Active Regions" (with events turned on) and "Eruptions and CMEs".
  - For the "Eruptions and CMEs" data make sure to zoom out so you can see the full coronagraph colored blue.
3. Go to the dates of the Mysterious Events and step through the data in intervals of hours.
4. Make note of the strength of solar flares, which are classified as A, B, C, M, and X. Each letter represents a 10x increase in flare energy
  - Note the timing of any flares or CMEs.
5. Add observations of solar flares and CME's for each date of the Mysterious Events. See the example template from Session 4.4 if needed.
  - a. The example template shows details you can record in the column "Solar Flares", however you can record any details that you find interesting or think might be important..
  - b. Same thing goes for the column "CMEs" (feel free to record similar data to what is shown in the example template or anything else you find useful).
6. Next, to the best of your ability, answer the following three questions in the worksheet on p.7 about your observations given the information you've gathered.



# 5.3 Worksheet:

## Mysterious Events Observations - Solar Storm Activity

Name: \_\_\_\_\_

1. Do you have enough data to come to the conclusion that the Sun might have something to do with these events? Explain your reasoning.

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2. What things do these observations have in common?

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3. How can we determine if the Sun's appearance on these dates is normal or unusual?

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## 5.4 Living With a Star Lecture



### Materials:

- TacFacs (premade)
- DIY (blank) TacFacs

### Introduction:

You will now listen to a lecture by your teacher on what it is like ‘living with a star’, or what can be called Space Weather. While you listen, use the materials and instructions below to help you take notes and organize your learning.

### Instructions:

1. Flip to the Orange TacFacs. These have Space Weather facts on them. Each card has a different fact on the back.
2. You may pull them off the ring so you can lay them out and look at them as you listen to the lecture.
3. You may also check the other colors of TacFacs to see if any get mentioned. They are organized in colors by topic.
4. If there is a new fact you heard that you like, you may write it on a DIY (blank) TacFac. Follow the same format by writing the theme on one side, and just a single fact on the other side. Try to use the same or similar color theme to the premade TacFacs color theme.
5. Organize your premade TacFacs and DIY TacFacs (if any) on your desk in a way that makes sense to you.

# 5.4 Worksheet

Name: \_\_\_\_\_

**CLAIM:**

**EVIDENCE:**

**Place TacFac  
Card Here**

**REASONING:**

## 5.5 Investigate Space Weather During the Mysterious Events

### Instructions:

1. Look for articles on the dates of the Mysterious Events by entering the date you want to investigate in the top right corner dropdown menus under the word “Archives”.

### Materials:

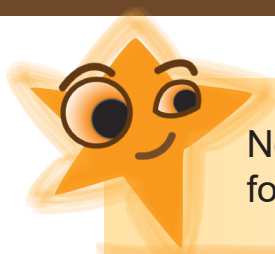
- Space Weather website:  
<https://SpaceWeather.com>



2. Read “What’s Up in Space” for clues as to what was happening on the Sun at the time
  - a. It might give clues to an event that happened a few days before!
  - b. Then you can try reentering dates just before the event to see if you can find something that happened that may have caused the event.
3. Record Space Weather conditions corresponding to each Mysterious Event in the final column of either your Google Sheet “Data Table 4.4 - Sunspots and Mysteries” or the hardcopy “Worksheet: Mysterious Events Data”.
  - For the column “Geomagnetic Storms”, record yes or no depending on whether or not there were any for the date(s) of the event.
4. Compare your findings with your Solar Storm Activity findings from Session 5.4.



## 5.6 Solving the Mysteries



Now it's time to write possible explanations for each of the Mysterious Events!

### Instructions:

1. Discuss as a group each of the events and their ideas for the possible causes.
2. Even with data from Helioviewer and SpaceWeather.com some of the events might still be uncertain:
  - a. Some geomagnetic storms result from fast solar wind gusts that come from coronal holes on the Sun. These holes are not explosive events like flares, prominence eruptions, and CMEs. They are direct magnetic connections from the solar surface into the solar wind. Stronger geomagnetic storms can result if the solar wind magnetic field is aligned with Earth's magnetic field when the storm occurs.
  - b. Ionospheric disturbances can be caused by flows of ionized gas enhanced by radiation from solar flares and directed by weather conditions in the lower atmosphere.



## 5.7 Final Mystery Matching Assessment

### Instructions:

1. Your teacher will provide you with a spreadsheet for you to match the mysterious events we've been studying with their explanations.
2. As you read through the explanations listed in column D on the sheet, sort through your mystery event deck and type in the name of each mystery that you think was caused by the explanation to the cell to the right of it (column E).
3. TacFacs are listed on the left side of the sheet and organized by topic. These are not listed in order of the explanations. It is your job to use these TacFacs to guide your thinking as you pair events with explanations.
4. When you use a TacFac to reach a hypothesis for which event was caused by an explanation, copy and paste that fact to the right of the mystery (columns F-K).
5. You may use more than one TacFac during this thinking process. However, only one mystery will be associated with each explanation.



## 5.8 Conclusion

### Congratulations!

You've solved the mysteries...or have you?

By now, it should be clear that natural phenomena can be very complicated and that some events are the result of a sequence of cascading causes and effects.

Hopefully it is also now clear that the Sun has even more influence on us than simply lighting up our world. Its light provides the energy that drives our lives. But its magnetic field can release energy in stormy fits that can impact our technology, and has other far reaching effects across the Solar System.

Scientists continue to find the Sun's mysteries compelling and perhaps you can join them in the search for more understanding!

