

Module 3: How does the Sun affect the Earth?

Activity B: Space Weather

Overview

The Solar Dynamics Observatory (SDO) was launched on February 11, 2010 from Cape Canaveral, Florida. It is the first mission to be launched in NASA's Living With a Star Program, which is designed for research in the causes of solar activity and its impacts on Earth. SDO studies how solar activity is created, how it affects Space Weather, and how it influences life on Earth and the technology we increasingly rely upon. Space Weather can interfere with our power grids, communication and navigation systems on Earth and harm astronauts and satellites in space. If scientists can learn how to predict when Space Weather events are going to occur, it could help us prevent or lessen the negative effects solar storms have on our technology.

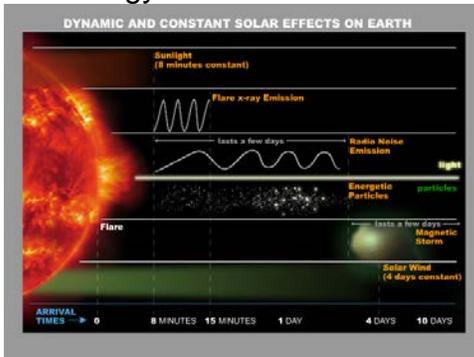


Image: NASA

Camilla Corona is SDO's mascot and your team will assist Camilla in forecasting upcoming Space Weather using current, real-time data and images provided by SDO. Predicting Space Weather is a fairly new science and much is still being learned about how to analyze data from the Sun to accurately forecast Space Weather events. Give it a try, and see how closely your team's ability to predict Space Weather matches actual Space Weather reports!

Teacher Overview

The focus of Module 3B is to provide an authentic opportunity for students to apply real-time SDO data to make realistic forecasts of upcoming Space Weather and then verify the accuracy of their predictions based upon actual Space Weather reports.

The Solar Dynamics Observatory (SDO) was launched on February 11, 2010 from Cape Canaveral, Florida. It is the first mission to be launched as part of NASA's Living With a Star Program, which is designed to understand the causes of solar activity and its impacts on Earth. SDO studies how solar activity is created, how it affects Space Weather, and how it influences life on Earth and our technological systems. Space Weather can interfere with power grids, communication and navigation systems, and harm astronauts and satellites in space. If scientists can learn how to accurately predict when Space Weather events are going to occur and which ones have potential to affect Earth, it could help prevent or lessen problems associated with solar storms.

Predicting Space Weather is a relatively new science and much is still being learned about the process. This activity allows students to forecast Space Weather events just as scientists do; they will be accessing and analyzing the same real-time SDO data scientists use.



Team Goal

Your team’s goal is to use real-time, online SDO data to forecast upcoming Space Weather conditions and predict the chance of solar storms that may impact Earth.

Materials

- Pencil
- Colored pencils
- Ruler
- 1 piece of legal-size paper or poster paper
- Computer with Internet access
- “The Camilla Space Weather Project” website
- “SDO Solar Storm Prediction” printed data sheet
- “Space Weather Forecast Submission Form” (online)

Engage & Explore!

1. BUILD Knowledge:

Causes of Space Weather

What is Space Weather? Space Weather refers to conditions and processes occurring in space that have the potential to affect Earth, its atmosphere, and our technology. Space Weather is caused by coronal mass ejections (CMEs) and solar flares releasing huge amounts of energy and particles from the Sun, which are carried through space by the solar wind. These massive amounts of solar radiation and particles can cause disruptions in the Earth's magnetic field that affect technology on Earth and in Earth’s near-space region.

Objectives

Students will be able to:

- Analyze real-time solar activity data taken by Solar Dynamics Observatory (SDO) instruments
- Identify sunspots, active regions, and other solar features on SDO images
- Predict the probability of a Space Weather event using SDO data

Essential Vocabulary

- Active region
- Coronal mass ejection (CME)
- Magnetogram
- Intensitygram
- Space Weather
- Sunspot
- Solar Dynamics Observatory (SDO)
- SDO instruments: AIA, HMI, EVE

Module Lesson

Time: 1 block period/2 class periods (can be extended multiple days)

Materials: per team

- Pencil
- Colored pencils
- Ruler
- 1 piece of legal-size paper or poster paper
- Computer with Internet access
- “The Camilla Space Weather Project” website
- “Space Weather Forecast Submission Form” (online)
- “SDO Solar Storm Prediction” data sheet

Teacher Prep:

- Bookmark [“The Camilla Space Weather Project”](#) homepage & the [“Space Weather Forecast Submission Form”](#) on the computer(s)
- Make copies of “SDO Solar Storm Prediction” data sheet
- Refer to the [Camilla Space Weather Classroom Page](#) for additional information



Space Weather Impacts on Earth

Energy and radiation from the Sun can:

- Create power outages and blackouts if they cause surges in power grids.
- Disrupt our navigation systems (i.e. aircraft, GPS).
- Interfere with communication systems on Earth (i.e. cell phones, ATMs).
- Cause colorful auroras often seen in the polar latitudes (Aurora Borealis in the Northern Hemisphere and Aurora Australis in the Southern Hemisphere).
- Harm astronauts in space (high-energy radiation exposure to x-rays and gamma rays).
- Damage sensitive electronics on orbiting spacecraft (i.e. satellites, space telescopes).

As a team, watch these NOVA and NOAA videos to learn more about the causes and effects of Space Weather:

[Solar Wind and Storms Video](#)

[The Threat to Earth Video](#)

[NOAA Space Weather Videos](#)

Now, navigate to “The Camilla Space Weather Project” homepage to learn more about Space Weather and how SDO is playing a role in predicting solar storms:

[The Camilla Space Weather Project](#)

Student Engage/Explore Activity

1. BUILD Knowledge:

Causes of Space Weather

What is Space Weather? Student teams learn about the two primary causes of Space Weather - coronal mass ejections (CMEs) and solar flares, which eject energy and particles from the Sun and are carried by the solar wind through the Solar System. These processes cause disruptions in the Earth's magnetic field, which can impact Earth's near-space region and Earth's surface.

Space Weather Impacts on Earth - energy and radiation from the Sun can:

- Create power outages and blackouts if they cause surges in power grids.
- Disrupt our navigation systems (i.e. aircraft, GPS).
- Interfere with communication systems on Earth (i.e. cell phones, ATMs)
- Cause colorful auroras, often seen in the polar latitudes (Aurora Borealis in the Northern Hemisphere and Aurora Australis in the Southern Hemisphere).
- Harm astronauts in space (high-energy radiation exposure to x-rays and gamma rays).
- Damage sensitive electronics on orbiting spacecraft (i.e. satellites, space telescopes).

Teams watch the two NOVA Sun Lab videos and NOAA Space Weather Prediction Center videos to gain an understanding of the causes of solar storms and threats to Earth from Space Weather:

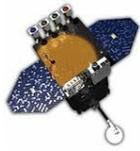
[Solar Wind and Storms Video](#)

[The Threat to Earth Video](#)

[NOAA Space Weather Videos](#)

Next, teams navigate to “The Camilla Space Weather Project” homepage to learn more about Space Weather and how SDO is playing a role in forecasting it:

[The Camilla Space Weather Project](#)



2. APPLY Learning:

Space Weather Concept Map

Next, with your student-scientist team, review the following two NOAA Space Weather Prediction Center resources (scroll down to the “Space Weather Information” section) and create a concept map to illustrate the causes and effects of Space Weather. This concept map is another artifact for your Module 4 SDO Exploration Museum 3-D Solar Exhibit.

[NOAA Space Weather Poster & Booklet](#)

Student Engage & Explore Activity (cont.)

2. APPLY Learning:

Space Weather Concept Map

Next, student teams review the NOAA double-sided poster and booklet about Space Weather to help create their own concept map of the causes and impacts of Space Weather. The concept map is included as an artifact in teams’ Module 4 SDO Exploration Museum 3-D Solar Exhibit.

[NOAA Space Weather Poster & Booklet](#)

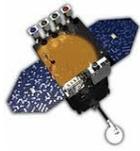


3. DEMONSTRATE Ability:

SDO Solar Storm Prediction

From “The Camilla Space Weather Project” website homepage, click on the “Forecast” tab and complete the online “Space Weather Forecast Submission Form”. Also, fill out the “SDO Solar Storm Prediction” data sheet to keep a written documentation of your team’s forecast to use in your Module 4 Living Museum & 3-D Solar Exhibit. Your team will use real-time SDO data to identify and analyze solar features to predict the chance that a Space Weather event will occur in the next 24 hours. Your team’s Space Weather forecast and results will also be included in the Module 4 SDO Exploration Museum 3-D Solar Exhibit.

[The Camilla Space Weather Forecast](#)



3. DEMONSTRATE Ability:

SDO Space Weather Forecast

Using "The Camilla Space Weather Project" online "Space Weather Forecast Submission Form", student teams identify and analyze solar features to predict the chance that a Space Weather event will occur within the next 24 hours. As they complete the online form, teams also document their responses in writing on the "SDO Solar Storm Prediction" data sheet, which will serve as an artifact for SDO Module 4. In Part A, student teams will use an intensitygram image to locate sunspots and learn how sunspot positions on the Sun are important in Space Weather prediction. In Part B, teams will examine a magnetogram image to analyze the position and intensity of magnetic fields on the Sun. In Part C, teams will use an AIA image to identify solar active regions and learn how these relate to Space Weather events. In Part D, teams will interpret EVE data from a line graph that shows changes in the brightness of the Sun over time. In Part E, teams will analyze LASCO data to identify coronal mass ejections (CMEs) and determine if they are heading towards Earth. In Part F, teams will then determine the probability of a Space Weather event occurring within the next 24 hours, based on their findings from Parts A-E. Teams' Space Weather forecast and results will be part of their Module 4 SDO Exploration Museum 3-D Solar Exhibit.

[The Camilla Space Weather Forecast](#)

SDO Project Suite Student Guide

Names: _____ Date: _____

Module 3B: SDO Solar Storm Prediction Data Sheet

Space Weather Forecast Submission Form
 Answer the following questions in Part A through Part F to determine the current solar activity level of the Sun. By using current SDO data, your team will predict if the environment on the Sun is active enough to produce space weather, just as solar scientists do. Use the online information buttons (i) and video clips to help you along the way.

Over the next week, check back to the "The Camilla Space Weather Project" homepage and read the "Space Weather News" section for information on current Space Weather conditions and determine how accurate your team's solar storm prediction was!

Click on the link to make your team's space weather prediction online and fill out this form to keep a written record of your team's Space Weather forecast (this form will be part of your team's SDO Module 4 artifacts).
[Camilla Space Weather Forecast Submission Form](#)

Part A
 In Part A, your team will use an intensitygram image to locate sunspots and learn how sunspot positions on the Sun are important in space weather prediction.

Use the HMI Intensitygram to answer questions 1 - 5
[See instructional video for part A](#)

1. Are there any sunspots?
 Yes: No:

2. How many sunspots are there?

3. Are the sunspots grouped in clusters?
 Yes: No:

4. Where are the sunspots located compared to the sun's equator? Use the hands of a clock and North/South to describe position (i.e. 10 o'clock north)

CIRES Education Outreach http://ires.colorado.edu/education/outreach/index.html





Fantastic forecasting, the outlook is sunny with the chance of a solar storm!

Differentiation/Extension

- Student teams review the following resources to guide them in creating their own version of SDO Camilla Space Weather Project informational flip cards or a pamphlet that explains how SDO is being used to predict Space Weather events on the Sun that can impact Earth:
[Space Weather Flip Cards](#)
[Storm Signals Flip Cards](#)
[NOAA Space Weather - Storms from the Sun Booklet](#)
- [NASA Solar Math](#)
Grade Level 3-5, p. 25
Grade Level 6-8, p. 40
Grade Level 9-12, p. 65

Internet Resources

[NOAA Space Weather Prediction Center](#)
[NOVA Sun Lab: Space Weather Online Activity](#)
[NOVA Labs: Earth's Magnetic Shield](#)
[NOVA Sun Lab: Solar Cycle & Storm Prediction Practice](#)
[NASA Space Weather Media Viewer: Videos "The Sun #5"](#)
[NASA Space Weather Media Viewer: Visualizations "Solar Flare" and "Coronal Mass Ejection"](#)
[Space Weather Center](#)
[Solar Effects](#)
[Space Weather FAQs](#)
[Space Weather Lesson PowerPoint](#)
[Storm Signals Flip Chart](#) & [Storm Signals Collection Sheet](#)
[Nat Geo Our Active Sun](#)
[Nat Geo Unlocking the Secrets of Space Weather Video](#)
[Sun|Trek Solar Storms](#)
[Sun|Trek Solar Winds](#)
[Stanford Solar Center Space Weather](#)