# *Space Weather Action Center*

*EDUCATOR'S INSTRUCTIONAL GUIDE (Version 4)*

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# Program Overview

## Summary:

Imagine being able to monitor the progress of an entire solar storm from the time it erupts from our sun and eventually sweeps past our small planet effecting enormous changes in our magnetic field. With the Space Weather Action Center (SWAC) program and a few minutes each day your students will be able to do just that! By following the basic steps in this guide you will soon be on your way to accessing and analyzing NASAs online satellite and observatory data. All of this can be done from the comfort of your very own classroom-based Space Weather Action Center. Also in this guide you will find a variety of recommendations that will help you to successfully install your SWAC while keeping potential limitations on classroom space and technological in mind.

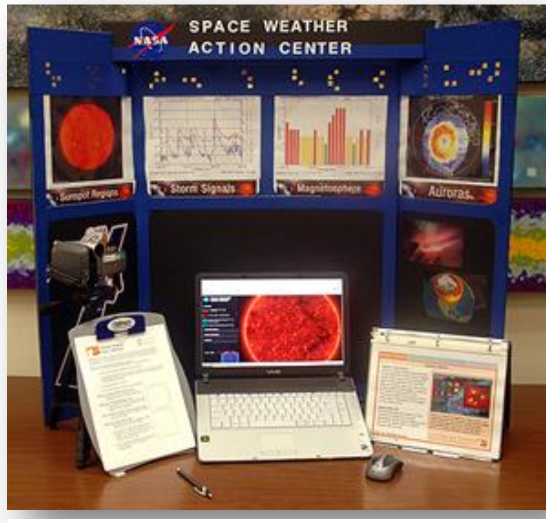


**Figure 1: Sample SWAC Display Board**

Once you have created your SWAC your class will be ready to move into the second cross-disciplinary phase of the program: creating real SWAC news reports! We've made this phase easy by providing your students with a sample script! All they have to do is fill in the missing pieces based on the data collected in their student journals.


**Figure 2: Sample SWAC Report**

Now it's lights, camera, action! You are finally ready to turn your script into a multimedia broadcast complete with current NASA data and dazzling graphics! If your school isn't equipped with a broadcasting studio, don't worry! We've suggested several very inexpensive methods by which you and your class can produce professional looking Space Weather Action Reports.

This program addresses student outcomes in 4 areas of national science standards and also integrates the use of reading, writing, math, and technology standards in a seam-less multi-curricular approach. Research shows that, "*more teachers nationwide are using video as an instructional tool. Video assignments motivate students to go beyond what is expected of them. Plus, the cost of digital video cameras and editing software keeps dropping, while the ease of use increases.*" (eSchool News http://www.eschoolnews.com/ )

## Student Learning Components:

**Research:** Students master an understanding of Sun-Earth Connection Science

**Communicating Science:** Students share their research through oral presentation

**Communicating Science:** Students demonstrate their own mastery of the content through selection of images and data to enhance a news report

**Ownership:** Students construct a personalized Space Weather Action Center

**Analytic interpretation:** Students collect and analyze data using flip chart instructions and data collection sheets

**Higher Level Thinking:** Students summarize the data and predict auroral events

## Modalities for Learning:

**Auditory:** This learner does best by listening and responds to verbal instructions. They solve problems by talking them out.

**Visual:** This learner does best through demonstrations and descriptions. They often make lists or drawings to develop solutions. They have well developed imaginations.

**Tactile:** This learner does well with projects or demonstrations. They like hands-on. They need to take notes when learning something new.

**Kinesthetic:** This learner does best when they are actively involved. They learn best by doing and often have problems sitting still and lose much of what is said or read.

## Overarching Concept:

The SWAC program is extremely flexible and can be quickly modified to fit the needs of any number of students. These included activities have been carefully designed to follow the sequence of events that occur during typical Solar Storm and are therefore comprised of the following four main sections: Sunspot Regions, Storm Signals, Magnetosphere, Auroras. Student analysis of the data associated with each of these sections will contribute to a deeper understanding of the overarching concept:

**How can we predict solar storms to protect satellites, power grids, and astronauts?**

### Sub Concepts:

**Predict which sunspots may be a source of solar storms.**
The **Sunspot Regions** section allows students to collect data to answer the question, “Do sunspot regions exist today that could be a source of solar storms?"

**Discover when solar storms occur and predict which ones will affect Earth.**
The **Storm Signals** section allows students to collect data to answer the question, "Have storm signals been recorded today due to a flare or CME that could affect Earth?"

**Measure disturbances to Earth's magnetic field and predict auroras.**
The **Magnetosphere** section allows students to collect data to answer the question, "Has there been a measurable disturbance in the Earth’s magnetic field?"

**Know when to watch for auroras.**
The **Auroras** section allows students to collect data to answer the question, "Have auroras been seen within the last 24 hours due to a solar storm?"

## Resources:

http://sunearthday.nasa.gov/swac
This website contains all information needed to participate in the Space Weather Action Center Program

http://spaceweather3.com/
The space weather website offers daily news and information about the Sun-Earth environment.

http://science.nasa.gov/about-us/email-updates/
Science@NASA offers daily updates in English and Spanish. You may also choose to sign up for updates on upcoming solar storms, sunspots, solar wind, auroras.

# 5E Learning Cycle Lesson Plan

This 5E lesson asks students to use inquiry skills by exhibiting *what they know* and *what they can do* with their knowledge in a real time dimension. Students will construct knowledge and assign meaning to what they have learned and experienced.

## Instructional Objectives:

The activities in this guide are designed:

- To prepare and teach your students how to quickly and efficiently monitor the progress of an entire solar storm from the time it erupts from the sun and eventually sweeps past our small planet effecting enormous changes in our magnetic field. To be able to accomplish this, students must be able to:
    - Predict which sunspots may be a source of solar storms.
    - Discover when solar storms occur and predict which ones will affect Earth.
    - Measure disturbances to Earth's magnetic field and predict auroras.
    - Know when to watch for auroras.

- To be very flexible to take into account the wide variability of the users. Some educators might use these activities as a “stand alone” unit, while others might find that the Space Weather Action Centers provide a fabulous on-going activity for their students throughout the school year.

- To get students and teachers started in this exciting field, and offer multiple opportunities for further exploration when desired.

After students have collected and analyzed the data in each center, they will be ready to explore the data from the other links and resources that are readily available in the Space Weather Resources ***‘Additional Data’*** section of the website.

## Standards Connections:

***Transfer of Energy:***

- The sun is a major source of energy for changes on the earth's surface. The sun loses energy by emitting light.
- A tiny fraction of that light reaches the earth, transferring energy from the sun to the earth.
- The sun's energy arrives as light with a range of wavelengths, consisting of visible light, infrared, and ultraviolet radiation.

***Earth in the Solar System:***

- The Earth is the third planet from the sun in a system that includes the moon, the sun, eight other planets and their moons, and smaller objects, such as asteroids and comets.

- The sun, an average star, is the central and largest body in the solar system.
- Most objects in the solar system are in regular and predictable motion. Those motions explain such phenomena as the day, the year, phases of the moon, and eclipses.

***Nature of Science:***

- Scientists formulate and test their explanations of nature using observation, experiments, and theoretical and mathematical models.
- Although all scientific ideas are tentative and subject to change and improvement in principle, for most major ideas in science, there is much experimental and observational confirmation. Those ideas are not likely to change greatly in the future. Scientists do and have changed their ideas about nature when they encounter new experimental evidence that does not match their existing explanations.

***History of Science:***

- Many individuals have contributed to the traditions of science. Studying some of these individuals provides further understanding of scientific inquiry, science as a human endeavor, the nature of science, and the relationships between science and society.

***Mathematics Standards (NCTM):***

- Develop an understanding of large numbers and recognize and appropriately use exponential, scientific, and calculator notation.
- Represent, analyze, and generalize a variety of patterns with tables, graphs, words, and, when possible, symbolic rules.

***Technology:***

- Students use technology to locate, evaluate, and collect information from a variety of sources.

# Preparing for the Lesson:

## General Classroom Requirements:

***Classroom Space Requirements:***
It is recommended that a secure area of a classroom or a separate room be established exclusively for the Space Weather Action Center program. The purpose is to minimize the impact on the rest of the classroom space that is utilized for teaching.

***Computer/Internet Station Requirements:***
At least one (1) Internet capable desktop or laptop computer should be available. This computer will be used to access all four data access points for the Space Weather Action Center.

***Additional Considerations:***
If technology in the classroom is limited and dedicated access to a technology/computer room is via a teacher's computer, teachers can print daily data and have students develop weekly line or bar graphs in their journals.

## Time:

| | |
|---|---|
| Engage Activity: | 30 minutes |
| Explore Activity: | 45 minutes |
| Explain Activity(s): | 45 minutes |
| Elaborate Activity: | 90 minutes (Initial Startup Assemble) |
| | 15 minutes (per day): Data Collection (Retrieval and Recording) |
| | 15 minutes (per week): Writing SWAC News Report |
| Evaluate Activity(s): | 20 minutes |

An additional 10 to 15 minutes may be needed for students to communicate their results to the rest of the class when needed.

If time permits, students can expand this activity by creating regular "Space Weather Action Center Newscasts! To learn more about this option, see "Extension 2".

## Vocabulary:

Full vocabulary list is located at the end of this document.

## Content Background:

The Sun is an average variable star. The energy from the Sun is responsible for life on Earth, and conditions on Earth including climate, seasons, and weather. Abrupt changes on the Sun cause flares and coronal mass ejections that blast brief but powerful "solar storms" into space.

Once thought to be unchanging, the Sun is now known to vary constantly. Changes in the activity of the Sun occur in eleven-year cycles. Sunspots can appear and disappear over days or weeks. Flares and large ejections of mass (coronal mass ejections) occur in time spans of minutes to hours. The energy of the Sun constantly blows out a 'solar wind' of electrified particles that is the extended atmosphere of the Sun.

Earth is surrounded by a magnetic field (magnetosphere) that protects us from the worst effects of solar storms. However, solar storms can cause fluctuations in the magnetosphere called magnetic storms. Magnetic storms have disabled satellites and burned out transformers shutting down power grids. These storms also can endanger astronauts, and contribute to more intense auroras that can be seen closer to the equator than is usual.

## Sun Facts:

- The Sun is a medium size star
- The Sun's atmosphere stretches beyond Pluto, called the heliosphere
- The core of the Sun is hot- 15 million degrees, creating a process called fusion where hydrogen atoms are fused together to create helium (a process that has not been duplicated on earth).
- 1 million Earth's can fit on the surface of the Sun
- 109 Earth's can be placed side by side to cover the diameter of the Sun
- The Sun is 5 billion years old
- The Sun rotates
- Planets in our solar System revolve around the Sun

# The Lesson:

## Engage:

*In this section the teacher creates interest, generates curiosity, raises questions and elicits responses that uncover what the students know or think about the topic. The students first encounter and identify the instructional task. They make connections between past and present learning experiences, lay the organizational ground work for the activities ahead and stimulate their involvement in the anticipation of these activities.*

*In this activity students will address, "What we know about the Sun", "What we wonder about the Sun", and "What we learned about the Sun".*

### Time: 30 Minutes

### Materials:

_____ Drawing Supplies (paper, pencils, markers, etc.)
_____ "Blackout" Video Clips from Sun-Earth Day website

### The Activity: Space Weather Pre-assessment

To get started, ask all of the students to draw a picture of the Sun. Encourage them to include as many labeled parts as they can recall. Reassure them that there drawings will not be graded.

Doing a "K-W-L" chart is a great way to have students begin a new project: a chart that lists columns for "What We Know", "What We Want to Know", and "What We Learned". This strategy helps students focus on and share what they already know about a subject. You, as the teacher, will become aware of the general knowledge basis that different students possess, and will be alerted to possible misconceptions that your students may have about particular topics.

One student can act as recorder and can compile a KWL chart for the class using the topics, "***What We Know about the Sun***", "***What We Wonder about the Sun***" and "***What We Learned about the Sun***". Ask the students to complete the last section, "***What We Learned about the Sun***" after they finish this entire SWAC lesson.

As a way to introduce "Space Weather and Solar Storms" content, you may wish to download the "**Blackout"** video clips from the Sun-Earth Day website at: http://sunearthday.nasa.gov/2009/multimedia/video.php .

## Explore:

*In this section the students have the opportunity to get directly involved with the content and materials. Involving themselves in these activities they develop a grounding of experience with the content. As they work together in teams, students build a base of common experience which assists them in the process of sharing and communicating. The teacher encourages the students to work together with minimum supervision, observes and listens to the students, asks probing questions to redirect the students' investigations when necessary. The teacher provides time for students to work through problems, and acts as a facilitator.*

*In this activity students will discover the basics of the Sun through a guided content exploration of the Space Weather Media Viewer:*
http://sunearth.gsfc.nasa.gov/spaceweather

## Time: 45 Minutes

## Materials:

____ "***Understanding the Sun***" Questionnaire (below)

## The Activity: Understanding the Sun

Divide the class into the following 4 teams:

***Team 1 – Sunspot Regions***
***Team 2 – Storm Signals***
***Team 3 – Magnetosphere***
***Team 4 – Auroras***

Provide each team with the "***Understanding the Sun Questionnaire"*** (below) and access to the "***Space Weather Media Viewer"*** at:
http://sunearth.gsfc.nasa.gov/spaceweather .

Each team will use the Space Weather Media Viewer to answer the corresponding set of questions from the questionnaire. (The questions are grouped together for a team approach.) When possible encourage teams to save imagery and/or videos that can be downloaded from the Viewer.

**NAME:_____________________ DATE:________________**

# Understanding the Sun Questionnaire

## Team 1 - Sunspot Regions

1. Draw and label the interior and layers of the Sun.
2. How does the structure of the Sun form an active Sun?
3. What is a sunspot?
4. What is a solar cycle?
5. What is a solar flare/Coronal Mass Ejection (CME)?

## Team 2 - Storm Signals

1. Why are radio waves important when monitoring a solar storm?
2. What wave lengths reach the surface of the Earth?
3. How long does it take radio waves to reach Earth?
4. How can we monitor radio waves from the Sun?

## Team 3 - Magnetosphere

1. What is a magnetosphere?
2. Why is our magnetosphere considered a protective shield against solar storms?
3. Why is this system necessary for life on Earth?
4. How big is our magnetosphere?
5. How does the magnetosphere act like a magnet?
6. If the magnetosphere were visible what would it look like?

## Team 4 - Auroras

1. Why do scientists agree that an aurora verifies a solar storm?
2. What can an aurora tell us about the Sun-Earth system?
3. What is the connection between auroras and the solar wind?
4. Why are auroras different colors?

## Explain:

*In this section the student begins to put the abstract experience through which she/he has gone /into a communicable form. Language provides motivation for sequencing events into a logical format. Communication occurs between peers, the facilitator, or within the learner himself. Working in groups, learners support each other's understanding as they articulate their observations, ideas, questions and hypotheses. The teacher encourages the students to explain concepts and definitions, asks for justification (evidence) and clarification from students, formally provides definitions, explanations, and new labels, and uses students' previous experiences as the basis for explaining new concepts.*

*In this activity student teams will share information gained from the previous activity, "Understanding the Sun Questionnaire", with the rest of the class.*

### Time: 45 Minutes

### Materials:

____ Answers from the "***Understanding the Sun Questionnaire"***
____ (Optional) Printouts of imagery from the Space Weather Media Viewer

### The Activity: Sharing New Knowledge

Using the answers obtained in the 'Explore' activity, each team will develop a report about their specific area of research. Each team will then share their expertise about the Sun and Space Weather with the class. Encourage students to ask questions following each report.

In the next section called, "Elaborate", the students will create SWAC display boards that artistically demonstrate their newly gained knowledge: one per team or one per class. The display boards will be used as backdrops behind each computer being used for SWAC data access.

## Elaborate:

*In this section the students expand on the concepts they have learned, make connections to other related concepts, and apply their understandings to the world around them. The teacher expects the students to use formal labels, definitions, and explanations provided previously, and encourages the students to apply or extend the concepts and skills in new situations. The teacher reminds students of the existing evidence and data and asks:*

- *What do you already know?*
- *Why do you think . . .*

*In this activity students design, assemble and use an 'easy to make' learning center called a Space Weather Action Centers (SWAC) .These centers provide a focused environment where students can monitor and report the progress of a solar storm.*

### Time (Initial Assembly): 90 Minutes

| | |
|---|---|
| *25 minutes:* | *Instructional Flip Chart Assembly* |
| *20 minutes:* | *Data Collection Clipboards or Notebook Assembly* |
| *45 minutes* | *SWAC Display Board or bulletin Board Assembly* |

### Time (Ongoing Data Collection): 30 minutes

| | |
|---|---|
| *15 minutes (per day):* | *Data Collection (Retrieval and Recording)* |
| *15 minutes (per week):* | *Writing SWAC News Report* |

### Materials:

*All required pdf files can be downloaded and printed from the GETTING STARTED section of the SWAC website at http://sunearthday.nasa.gov/swac*

*Flip Charts:*

____ One (1) 3- ring binder
____ Fifteen (20) pocket protectors
____ Sunspot Regions Flip Chart (pdf - 228K) ( 12 pages )
____ Storm Signals Flip Chart (pdf - 142K) ( 7 pages )
____ Magnetosphere Flip Chart (pdf - 246K) ( 8 pages )
____ Aurora Flip Chart (pdf - 788K) ( 7 pages )
____ Instructional Flip Chart Guide (pdf – 500K) (20 pages )

*Data Collection Sheets:*

____ Four (4) clipboards
____ Four (4) composition books or notebooks
____ Four (4) pencils
____ Sunspot Regions Data Collection Sheet (pdf- 27K) (1 page )
____ Storm Signals Data Collection Sheet (pdf - 19K) ( 1 page )
____ Magnetosphere Data Collection Sheet (pdf - 31K) ( 1 page )
____ Auroras Data Collection Sheet (pdf - 27K) ( 1 page )

*SWAC Science Display Board:*

____ Science Display Board (Black is preferred)
____ Styrofoam ball (3-6 in. diameter)
____ Clip board with plastic sleeves
____ Packet of Pipe Cleaners (red, blue, green, yellow, purple)
____ Glue Stick or Spray Glue to stick paper signs to science display board
____ Pencil
____ Heavy Duty or Industrial Strength Velcro
____ Scissors
____ General Group Supplies (enough for Science Board decorations)
____ Paint and brushes (Blue, green, yellow, red, orange, black)
____ Paper clips
____ Magic Markers (assorted colors)
____ Yarn (assorted colors)
____ (Optional) Printouts from the Space Weather Media Viewer

## The Activity: Making Your Space Weather Action Center

Depending on familiarity with the subject matter, many educators may feel overwhelmed by the large amount of available NASA data, or feel that there isn't enough time to incorporate a meaningful experience into the existing classroom structure or curriculum. The Space Weather Action Center is specifically designed to address these concerns by introducing space weather concepts through the use of a familiar and very common classroom teaching strategy; the construction of a classroom-based "learning center". These "learning centers" are generally placed in easily accessible sections of classrooms offering students a separate space to visit topics of interest or to reinforce selected skills. As an additional part of the learning experience, students are encouraged to design action centers with readily available art supplies and downloadable NASA imagery. This artistic approach instills a sense of student ownership and establishes NASA as a visual point of interest in the classroom environment.

As part of the SWAC setup, each center includes one computer with internet access to current and archived NASA data. Student flip charts offer 'Step by Step' instructions needed to quickly retrieve and transfer data to specified data collection sheets. Additional directions are provided to help your students transform all of the newly acquired information into regularly scheduled news reports. Ultimately these brief reports can be presented through variety of accessible media including inexpensive video editing software and/or already existing school-based broadcast studios.

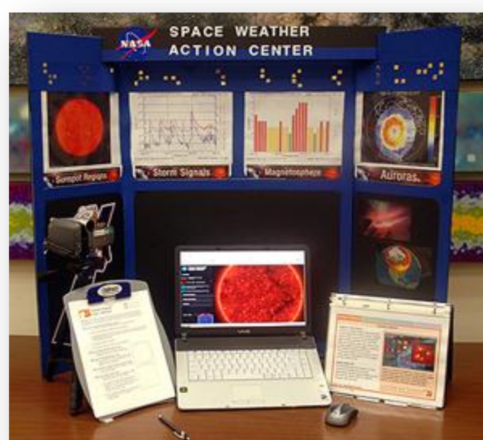


**Figure 3: Sample SWAC Learning Center**

A sample Space Weather video report can be viewed on the SWAC website at: http://sunearthday.nasa.gov/swac/ .

**Each SWAC contains the following elements:**

1. Computer (Internet Access Required)
2. Instructional Flip Charts (Assembly Required)
3. Data Collection Clipboards or Notebooks (Assembly Required)
4. SWAC Display Board or Bulletin Board (Assembly Required)

### Instructional Flip Charts (Assembly Required):

Each of the SWAC flip charts has been carefully designed to enable students easily move through the sequence of events that occur during typical Solar Storm (see Overarching Concept) and are therefore comprised of the following four main sections: Sunspot Regions, Storm Signals, Magnetosphere, Auroras. Each set of flip chart cards also includes 'easy to follow' **INSTRUCTION CARDS** and **INFORMATION CARDS**.

> **INSTRUCTION CARDS** contain every step necessary to obtain, analyze and record all required online data.
>
> **INFORMATION CARDS** contain a variety of sample images and helpful tips when interpreting and analyzing the data.

The flip charts may be downloaded and printed on a single 8x11 sheet of paper. Assemble your flip chart by inserting 2 flip chart sheets (back to back) into plastic sleeves. Place the plastic sleeves in a loose-leaf notebook; turning the notebook in a horizontal direction with the binding at the top.

A smaller flip chart can be assembled by reducing the printout sizes: 2 or 4 to a sheet depending on the size you prefer. Cut out and fasten the smaller flip chart sheets together. We suggest that you laminate or insert each sheet into a plastic sleeve for continued use.

**Figure 4: Sample Flip Chart**

**Instructional Flip Chart Guide:**
The Flip Chart guide provides a snapshot of all four student flip charts: Sunspot Regions, Storm Signals, Magnetosphere, Aurora. Each section contains a brief overview, helpful tips and questions from the student Data Collection Sheets. The student flip charts and data collection sheets can be downloaded from the SWAC website at: http://sunearthday.nasa.gov/swac/gettingstarted/download.php .

## Data Collection Clipboards or Notebooks (Assembly Required):

The data collection sheets follow the same sequence and color coding as the flip charts: Sunspot Regions (orange), Storm Signals (green), Magnetosphere (Blue), Auroras (Purple). With the data collection sheets students can quickly record and analyze the necessary sets of data. The comprehension question at the bottom of each data sheet provides an opportunity for students to summarize the data and make a prediction for verification over the next several days.

There are a variety of ways to keep the recorded data organized for quick review. A few options are listed below:

**Option 1: SWAC Clipboards**

Clipboards provide a stable writing surface as students as they collect data from their Space Weather Action Center. A clipboard, pencil, and a copy of the corresponding "data collection" sheet should accompany the station.

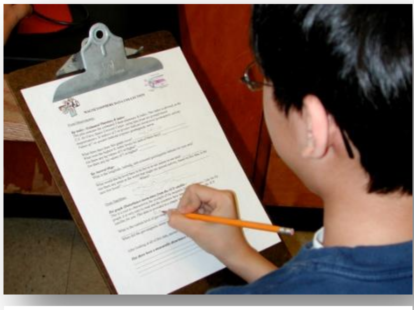

**Figure 5: Sample SWAC Clipboard**

**Option 2: SWAC Notebooks**

To eliminate the need for multiple copies of data collection sheets, download and print one set. Glue each data collection sheet to the inside cover of a separate notebook. When completed there will be four separate Data Collection Notebooks, one for each section of SWAC. Students can then refer to the inside cover of their notebooks for their standard set of questions., each new page of the SWAC notebooks can be dated and numbered accordingly as new data is collected.

**Data Collection Tips:**

- SWAC Data collection is based on a 7 day – weekly cycle. Student teams will use SWAC clipboards or notebooks to document space weather data at their SWAC learning center.
- Daily data collection is recommended if the curriculum time allows or a minimum of 2 to 3 times a week.
- If journaling is not done on a daily basis, students will need to review the space weather data from previous days to stay current.

## SWAC Display Board or Bulletin Board (Assembly Required):

The development of your SWAC display board or bulletin board is determined by how much involvement and time you want to spend. However, the creation of a SWAC display provides ownership and an opportunity for all students to be involved and interested in their learning. Completed display boards are often used as a backdrop for the learning center and are placed behind computers being used to access SWAC data (see Figure 1: Sample SWAC Display Board). Additional graphics for the displays can be downloaded from the SWAC website and the Space Weather Media Viewer.

**SWAC Display Options:**

**Option 1 - Single Classroom SWAC Display Board**

In this model students work together to create one display board that includes components from all four areas of SWAC. With available art supplies students are given artistic freedom to design a display board that exemplifies key components of space weather. Below are a few design ideas that your students could use when designing their display boards:

- Use the entire surface of your display board to create an artistic rendition of a solar storm in progress.
- Divide your display board into the 4 main components of SWAC: Sunspotters, Storm Signals, Magnetosphere, Auroras.
- Create and include drawings of your own space weather discoveries
- Using Styrofoam balls, paints and pipe cleaners, create and include 3 dimensional models of various space weather related objects: Sun, Earth, magnetosphere, aurora, satellites, etc.

**Option 2 - Four Separate SWAC Display Boards**

In this model students work together in 4 groups to create science display boards for each individual section of SWAC: Sunspotters, Storm Signals, Magnetosphere, Auroras. Often these display boards are placed throughout the class if room permits or are simply interchanged as is necessary.

**Option 3 – Classroom Bulletin Board Display**

The teams can work together to design a large bulletin board display featuring the dynamic Sun and a solar storm affecting the Earth's magnetosphere. The bulletin board can be divided into 4 sections for the 4 sections of SWAC or a student rendition of a solar storm may be the center piece for your SWAC in your classroom.

## Using Your New SWAC Learning Center:

With your new Space Weather Action Center assembled, it's time to assign students to one of the following 5 subject area groups:

- Sunspot Regions (1-5 students)
- Storm Signals (1-5 students)
- Magnetosphere (1-5 students)
- Auroras (1-5 students)
- Broadcasting (1-5 students)

The recommended maximum student group size is 5 or <. Four students in each group will act as Data Miners while one student from each group will act as a data analyst. The students in each group can share or rotate data collection responsibilities for their given subject area.

The data miners will be responsible for collecting and recording all information needed on the downloadable data collection sheet specific to their assigned subject area. The data analyst in each group will monitor student data sheets, summarize information and fill in the required information on the space weather script. After all groups have filled in the required information on the script template, it can then be given to the Broadcast Team who will develop and present the information as a comprehensive space weather news report. (see "Extension 2")

***Recommendation - Group Rotation:***

You might want to let students circulate through each section of SWAC by rotating the groups through on a weekly basis. This allows students to learn about the four sections of SWAC, continue to collect and analyze data, make first-hand observations about how the data changes over time and gain experience in broadcasting. By sharing and graphing the data over a month-long period, they can look for patterns or trends in the data and develop a thorough understanding of the targeted concepts.

***Recommendation - Small Group:***

Small groups of 2-4 students can rotate and share data collection responsibilities. However, the entire group can take part in the optional reporting out and/or broadcasting component.

## Color Coding:

We have divided all of the Space Weather Action Center resources into four 'color-coded' categories: Sunspot Regions (orange), Storm Signals (green), Magnetosphere (blue) and Aurora (purple). The same color code scheme is used in the flipchart, the data collection sheets and on the Live Data and Tutorials webpage. You can always know which section you're in with one quick glance!

## Evaluate:

*This is an on-going diagnostic process that allows the teacher to determine if the learner has attained understanding of concepts and knowledge. Evaluation and assessment can occur at all points along the continuum of the instructional process. The assessment as a Space Weather Report will show the improvement of the data analysis as well as a student's ability to communicate the science.*

## Time: 20 Minutes

## Materials:

____ Space Weather Action Center Script Template (see below)

## The Activity: Making a Space Weather Script

Encourage students to write their own Space Weather Reports and present them as Space Weather Broadcasts. To help them get started, we have included this basic script template. Updates for each section of the script can be taken from the SWAC Data Collection Sheets. Remind students to include images when possible.

**Good evening this is _______________ bringing you a Space Weather Report for (month, day, year).**

**Do sunspot regions exist today that could be a source of solar storms?** (Refer to data recorded on your "Sunspot Regions Data Collection" sheet.)

**Have signals been recorded today due to a flare or CME that could affect Earth?** (Refer to data recorded on your "Storm Signals Data Collection" sheet.)

**Has there been a measurable disturbance in the Earth's magnetic field?** (Refer to data recorded on your "Magnetosphere Data Collection" sheet.)

**Have auroras been seen within the last 24 hours due to a solar storm?** (Refer to data recorded on your "Magnetosphere Data Collection" sheet.)

**We will continue to keep you informed of any breaking developments. I'm ______________ bringing you today's Space Weather Action Center report.**

**Thanks for watching!**

## Extension 1:  Additional Data

The SWAC website is an extremely robust learning tool complete with step-by-step tutorials on how to interpret live or 'near real time' heliophysics data from 10 missions and 36 instruments.  Once student have mastered analyzing the data recommended in the Space Weather Action Center Flip Charts, they can move into more advanced data found on the SWAC website in the section called, "Space Weather Data". Additional Data and online tutorials are provided.

## Extension 2:  SWAC Multimedia News Reports

As part of the SWAC approach students are encouraged to transform their SWAC reports into real regularly scheduled news reports. These news reports can be presented through variety of accessible media including inexpensive video editing software and/or already existing school-based broadcast studios. The SWAC website includes sample scripts, video clips, sample reports, teacher guides, downloadable graphics, etc.

These additions will be necessary if you decide to utilize video broadcasting or movie editing software.

- One (1) additional Internet capable computer and desk
- One (1) Webcam or camcorder
- One (1) wall area for use of a 5 by 6 foot green screen or backdrop

**Audio/Video Recording Software:** There are a variety of software options available including: SONY Vegas Movie Studio, Adobe's Visual Communicator 3 (VC3), CCTV, iMovie, Audacity, Garage Band, etc.

A sample Space Weather video report can be viewed on the SWAC website at: http://sunearthday.nasa.gov/swac .

# Vocabulary

**Atmospheric Drag**
Collisions with air particles that slowly act to circularize the orbit and slow down a spacecraft causing it to drop to lower altitudes. A satellite, orbiting around the Earth, would continue to orbit forever if gravity were the only force acting on it. However, satellites below 2000 kilometers are actually travelling through the Earth's atmosphere.

**Astrophysics**
The part of astronomy that deals principally with the physics of stars, stellar systems, and interstellar material

**Aurora**
Light radiated by ions and atoms in the Earth's upper atmosphere, mostly in polar regions, the result of bombardment by energetic electrically charged particles from the magnetosphere
a. Aurora Australis – North Pole
b. Aurora Borealis – South Pole

**Chromosphere**
A reddish layer in the Sun's atmosphere, the transition between the photosphere and the corona

**Core**
The central, energy-producing region of the Sun where it's energy is produced by the fusion of hydrogen nuclei into hydrogen nuclei

**Corona**
The outermost layer of the Sun's atmosphere, visible to the eye during a total solar eclipse; it can also be observed through special filters and best of all, by X-ray cameras aboard satellites. The corona is very hot, up to 1-1.5 million degrees centigrade, and is the source of the solar wind.

**Coronal Mass Ejections (CME)**
A huge cloud of hot plasma, occasionally expelled from the Sun. It may accelerate ions and electrons and may travel through interplanetary space as far as the Earth's orbit and beyond it, often proceeded by a shock front. When the shock reaches Earth, a magnetic storm may result.

**Convection Zone**
The region of the Sun between the Radiative Zone and the Photosphere where energy from the solar interior is transported outwards by the convective motion of the solar gases.

**Electron**
A lightweight particle, carrying a negative electric charge and found in all atoms. Electrons can be energized or even torn from atoms by light and by collisions, and they are responsible for many electric phenomena in solid matter and in plasmas.

**Flares**
A rapid outburst on the Sun, usually in the vicinity of active sunspots. A sudden brightening (only rarely seen without special filters, isolating the red light of hydrogen) may be followed by the signatures of particle acceleration to high energies--x-rays, radio noise and often, a bit later, the arrival of high-energy ions from the Sun.

**Geographic Latitude**
The angular distance of a point north or south of the equator of a body as measured by a hypothetical observer at the center of a body.

**Geographic Longitude**
The angular distance around the equator of a body from a zero point to the place on the equator nearest a particular point as measured by a hypothetical observer at the center of a body.

**Heliosphere**
"Helios" is the ancient Greek word for the "sun". The Heliosphere is the entire region of space influenced by the sun and its magnetic field (called the IMF). The magnetic field of the sun (the IMF) is enormous and is carried throughout space by the solar wind. The solar wind and the IMF push back the Interstellar magnetic field of interstellar space. This creates a bubble or cavity, and the sun and planets are inside this bubble.

**Interplanetary Space**
Interplanetary space, or the space between the planets, is not empty but is filled with the solar wind, and the Interplanetary Magnetic Field (IMF), as well as cosmic rays, and dust. Another name for interplanetary space is the Heliosphere, because the space between the planets is the total space which is under the influence of the sun.

**Interstellar Space**
The space between the stars

**Ionosphere**
The highest region of the Earth's atmosphere containing free electrons and ions

**Speed of Light**
The speed at which electromagnetic radiation propagates in a vacuum; it is defined as 299 792 458 m/s (186,000 miles/second). Einstein's Theory of Relativity implies that nothing can go faster than the speed of light.

**Magnetic Field**
A region in which magnetic forces can be observed.

**Magnetic Poles**
Either of two limited regions in a magnet at which the magnet's field is most intense. The two regions have opposing polarities, which we label "north" and "south", after the two poles on the Earth.

**Magnetic Storm**
A large-scale disturbance of the magnetosphere, often initiated by the arrival of a plasma cloud originating at the Sun. A magnetic storm is marked by the injection of an appreciable number of ions from the tail regions of the magnetosphere into] the near-Earth magnetosphere, a process accompanied by increased auroral displays. The injected particles cause a worldwide drop in the equatorial magnetic field, taking perhaps 12 hours to reach its greatest intensity, followed by a more gradual recovery.

**Magnetosphere**
The region of space in which the magnetic field of an object (e.g., a star or planet) dominates the radiation pressure of the stellar wind to which it is exposed

**Near-Earth Space**
A region of space surrounding Earth interior to the orbits of the geosynchronous satellites (approximately 40,000 km from the surface).

**Nuclear Fusion**
The process of releasing energy by combining hydrogen atoms to form helium, or more generally, to combine light nuclei into heavier ones. Nuclear fusion appears to be the source of the energy of the Sun and of stars.

**Photon**
The smallest (quantum) unit of light/electromagnetic energy. Photons are generally regarded as particles with zero mass and no electric charge.

**Photosphere**
The layer of the Sun from which all visible light reaches us. The Sun is too hot to have a solid surface and the photosphere consists of plasma at about 5500 degrees centigrade.

**Plasma**
A low-density gas in which the individual atoms are ionized (and therefore charged), even though the total number of positive and negative charges is equal, maintaining an overall electrical neutrality.

**Proton**
A particle with a positive charge commonly found in the nucleus of atoms

**Radiation**
Energy radiated in the form of waves (light) or particles (photons)

**Radiative Zone**
The region of the Sun between the Core and the Convective Zone where energy from the Core is transported outwards towards the surface by electromagnetic radiation (mostly gamma rays and X rays) rather than by convection

**Radio Waves**
Electromagnetic waves of relatively low frequency

**Satellite**
A body that revolves around a larger body. For example, the moon is a satellite of the earth.

**Solar Cycle - (or Sunspot Cycle)**
An irregular cycle, averaging about 11 years in length, during which the number of sunspots (and of their associated outbursts) rises and then drops again. Like the sunspots, the cycle is probably magnetic in nature, and the polar magnetic field of the Sun also reverses each solar cycle.

**Solar Flare**
Violent eruptions of gas on the Sun's surface

**Solar Maximum**
The month(s) during the solar cycle when the 12-month mean of monthly average sunspot numbers reaches a maximum. The most recent solar maximum occurred in July 1989.

**Solar Minimum**
The month(s) during the solar cycle when the 12-month mean of monthly average sunspot numbers reaches a minimum. The most recent minimum occurred in September 1986.

**Solar Wind**
A fast outflow of hot gas in all directions from the upper atmosphere of the Sun ("solar corona"), which is too hot to allow the Sun's gravity to hold on to its gas. Its composition matches that of the Sun's atmosphere (mostly hydrogen) and its typical velocity is 400 km/sec, covering the distance from Sun to Earth in 4-5 days.

**Space Weather**
A collection of processes and events often driven by solar activity, which can effect interplanetary space and the near-Earth environment

**Star**
A celestial object that produces energy from nuclear fusion reactions occurring in its core

**Sunspot**
An intensely magnetic area on the Sun's visible face. For unclear reasons, it is slightly cooler than the surrounding photosphere (perhaps because the magnetic field somehow interferes with the outflow of solar heat in that region) and therefore appears a bit darker. Sunspots tend to be associated with violent solar outbursts of various kinds.

**Ultraviolet Light**
Electromagnetic radiation at wavelengths shorter than the violet end of visible light; the atmosphere of the Earth effectively blocks the transmission of most ultraviolet light.

**Van Allen Radiation Belts**
A collection of high-energy particles (mostly protons and electrons) trapped within the Earth's magnetic field which form a doughnut-like cloud in its equatorial plane

**X rays**
Electromagnetic waves of short wavelength, capable of penetrating some thickness of matter. Medical x-rays are produced by letting a stream of fast electrons come to a sudden stop at a metal plate; it is believed that X-rays emitted by the Sun or stars also come from fast electrons.

**Vocabulary Acknowledgments:**
Many of the above definitions were provided by the following websites:

*1. Stargazers to Starships: Author and curator: David P. Stern,*
*URL:* http://www-spof.gsfc.nasa.gov/stargaze/Sintro.htm#q35

*2. Imagine the Universe! : Project Leader: Dr. Jim Lochner,*
*URL:* http://imagine.gsfc.nasa.gov/index.html

*3. Windows to the Universe: University Corporation for Atmospheric Research (UCAR)*
*URL:* http://www.windows.ucar.edu/

The **Space Weather Action Center** is a product brought to you by the **Sun-Earth Day Team.** *http://sunearthday.nasa.gov*

For more information contact: *Elaine Lewis* or *Troy Cline*.