Solar Activity and Energy

Introduction:

Why is the surface of the Sun so stormy? Most of the activity we see on the sun is caused by magnetic fields getting tangled-up and pulled into complex shapes. Enormous amounts of energy can be release when magnetic fields "un-kink". The students will use various activities to model the magnetic fields around the sun. The students will see how changes in this magnetic field cause phenomena like coronal mass ejections, filaments, sunspots, and magnetic loops on the sun. Students will use photographs of coronal mass ejections and magnetic loops to determine the speed of this phenomenon.

Materials:

String - precut into 2 foot lengths

Students

Balloons

Glitter

Photographs of phenomena on the sun Images can be found at SOHO Satellite site's gallery

http://sohowww.nascom.nasa.gov/gallery/bestofsoho/

or TRACE Satellite site's gallery

http://vestige.lmsal.com/TRACE/Public/Gallery/Images/

Objectives:

- The students will use a model to demonstrate the restructuring of the magnetic fields on the sun's surface.
- The students will use a model to demonstrate how magnetic field restructuring can cause phenomena like coronal mass ejection, filaments, sunspots, and magnetic loops.
- The students will use photographs of the sun's surface to determine the speed of the phenomena.

Key Terms:

Coronal Mass Ejection – a blast of particles from the sun that occurs when the magnetic forces on the sun restructure and break.

Magnetic Loop – eruptions of the plasma of the sun that occur when the magnetic fields are twisted.

Solar Prominence- An arch-like filament of gas that extends high up from the surface and looks like a horseshoe.

Sunspots – a cooler area of the sun's plasma that occurs when there is a concentration of the sun's magnetic field lines.

Filament- small eruption on the sun's surface that occurs when the magnetic field is twisted.

Procedure:

- In this activity the students will use string as a model for the magnetic fields on the surface of the sun. They will see how these magnetic fields undergo restructuring over time. Have the students pair up and form a line across the room, all facing the same way. Give each pair of students a piece of the precut string, with each person holding an end. Every other pair should tie the ends of their string to both of their neighbor's and then step away from the line. The remaining students should hold on to the longer strands of string. Now, have every other remaining pair attach tie their ends to both of their neighbors and step away. Continue to repeat the activity until there are just a few students left holding the string. Do the students think that the resulting magnetic fields are going to be stronger or weaker? Do the students think the resulting magnetic fields will take up the same amount of area on the sun? Have the students discuss the changes in the magnetic field and record observations in their learning logs.

- In this activity the students will become the sun's magnetic field. The students should gather randomly in an open space in the classroom with about an arm's length between them. Each student will become an active part of the magnetic field, their left arm will have north polarity and their right arm will have south polarity. Use Post-it notes with N or S on them, or of different colors, to provide a visual aid for younger students. When the students are ready they should raise their arms to the side. You will be asking them to "attract" or "repel" to the other student's poles that are the closest. The students should not move their feet, but simply become the magnetic force with their arms. For example, if two same "poles" were closest together, the students' arms would move away from each. If two different "poles" were closest together, the students' arms would attach to each other at the wrists. Both of the student's "poles" can be attached to different "poles". Have the students look at what student configurations were formed.

The following list is meant to be a guideline to describe to the students what the student configurations could model.

- If a circular group of about eight students formed, they could be considered a candidate for Coronal Mass Ejection. A CME is formed when the magnetic field has been stretched and breaks away from the sun's surface.

- If a loop of about five students formed, they could be considered a candidate for a Magnetic Loop. A Magnetic Loop stretches away from the sun's surface, but remains attached at its ends. These might represent solar prominences.

- If a string of about three students formed, they could be considered a candidate for a Filament. A Filament is a short magnetic cloud that sticks out from the sun's surface.

- If a group of two students form a closed figure, they could be considered a candidate for a sunspot. A sunspot is an area on the sun's surface where the magnetic field is more concentrated, and can cause solar flares to form.

You can repeat the activity as many times as you would like, the students will make many new configurations with each repetition. Stress to the students that these new magnetic field configurations occur repeatedly on the surface of the sun. Scientists are just now studying these configurations to see if there are patterns in where they occur, how often they occur and the ramifications of the occurrences.

- To demonstrate the force of a CME, place some glitter in a balloon. Begin to blow up the balloon, reminding the students to observe the stretching of the balloon. The outside of the balloon models the magnetic forces of the sun that are being stretched. When the balloon is fully stretched, move it away from your face and pop it. This demonstration shows the students that the magnetic field on the sun will break away when it becomes stretched too far. The glitter represents the charged plasma that shoots away from the sun's surface when the magnetic fields break up.
- Discuss the students' observations and update the K-W-L chart with the new information.

Conclusions:

The students will gain an understanding of how the restructuring of the magnetic field of the sun can cause a variety of seemingly unrelated shapes and phenomena. Scientists have been able to learn more about the sun's surface as new information is received from satellites that have been launched in recent years.

Extensions:

Grades 1-6

- Students could make a flipbook of a phenomenon of the sun as it moves. Included in the workbook are some photographs of CMEs and magnetic loops to help the students visualize what they look like. Give each student 10 sheets of 3 x 3 inch paper (a post- it – pad works well for this). The students should draw the sequence of the phenomenon one step at a time on each piece of paper. When all the steps are drawn, the papers should be placed in order and stapled together at one edge. The student holds the stapled edge in one hand and "flips" the other pages to make the image move.

Grades 4 - 6

- Students will look at photographs of a CME and of a magnetic loop and determine the speed using the formula below.

$$\text{Speed of Motion} = \frac{\text{Distance Traveled by the Feature}}{\text{Time of Travel}}$$

This series of four images taken with the NASA, SOHO satellite shows a giant cloud of gas, called a Coronal Mass Ejection, leaving the Sun on April 7, 1997. The time between the first frame (upper left) and the last frame (lower right) is about two hours. The diameter of the circle at the center is equal to the Sun's diameter. Use the Sun's size as a scale to measure how far the cloud traveled in each frame, and from the 30-minute interval between frames, estimate how fast the cloud was traveling.