Lesson Plan for Solar Wind 50 minute class at Piedmont Middle School

Student Objectives

- Students will know there is an electrified wind coming off the Sun, known as the solar wind
- Students will know that the solar wind is mostly made up of protons and electrons
- Students will map the magnetic influence (field) of a bar magnet inside a box and Earth's magnetic field using a compass
- Students will know there is a magnetic field associated with the solar wind
- Students will discuss how to design a scientific instrument to measure the solar wind magnetic field without measuring the spacecraft's magnetic field

Materials

- Overhead projector
- Computer
- LCD projector
- PowerPoint presentation (or overhead?)
- 210 handouts of Notes on PowerPoint presentation and solar wind paragraph
- masking tape (there?)
- scissors
- large roll of butcher paper.
- 8 Gregoire boxes
- 8 scotch tapes
- 10 bar magnets (cow magnets?)
- 50 golf pencils
- 30 compasses
- big sheet

Student Procedure

1. Work in groups – each table is one group (6 people).
2. Gather butcher paper. Cut 4' of butcher paper roll & tape to table.
3. Tape bar magnet to the inside of the bottom of the box.
4. Tape box to the middle of the paper.
5. Wait quietly for groups to finish.
6. Quietly listen to fellow students while they read about the solar wind (2 sentences per group).
7. Quietly listen to scientists describe the solar wind and find out what the boxes have to do with the solar wind.
8. Watch how to map a magnetic field around a bar magnet (on the overhead projector).
9. Individually map the magnetic field around the box with your own compass. This will determine where you start detecting the magnetic field of the room (solar wind) versus the magnetic field of the box (spacecraft).

11. As a class share what you discussed about your findings and your design.
12. Clean up as you leave: 1) recycle butcher paper, 2) remove tape from bar magnet, 3) return pencils, compasses, bar magnet, and scotch tape to the box.

Presenter Notes:

(10 min) 1-5 above: one presenter can be going through the instructions and the other walking around class passing out hand-outs and helping make instructions happen (help with butcher paper…etc)

(5 min) 6 above: get the class quiet; ask for reading volunteers; have students read

(20 min) 7-8 above: present PowerPoint, questions, and mapping demonstration

(10 min) 9-10 above: walk around and help students map their fields and with discussion

(5 min) 11 above: facilitate discussion

(10 min) 12 above: change of class periods

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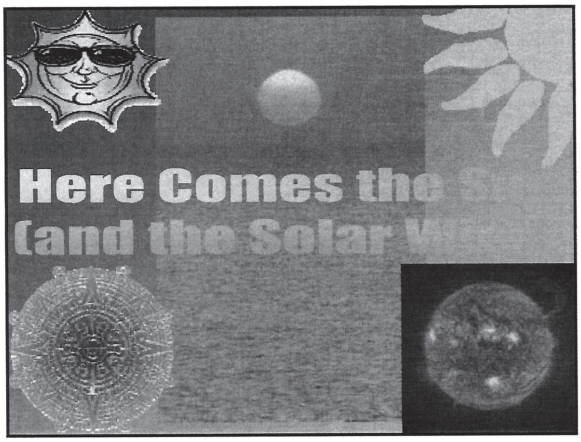
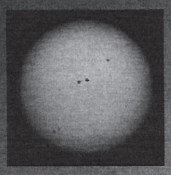
Solar Wind and Interplanetary Magnetic Field

There are many scientists who want to understand more about the Sun. They know that the Sun is a fiery ball of gas that gets so hot that gas flies out from the Sun at very high speeds. Many of the electrons in the Sun's atoms have enough energy to leave the atoms. These new particles are called ions. These ions and electrons are flowing from the Sun and together they are known as the solar wind. The ions and electrons dance in the Sun's magnetic field. Scientists discovered that the solar wind and its magnetic field flow together out past Mercury, past Earth, and continue out past Pluto. Because the magnetic field is threaded throughout the solar system, we call it the interplanetary magnetic field, that is the magnetic field found between (inter) the planets (planetary).



What is the Sun?



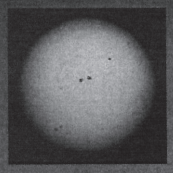
The Sun is a star (but very close to us).

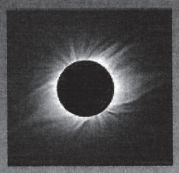
The Sun is giant ball of hot gas.
It is so hot that it makes its own light.

The Sun is 100 times larger than Earth.
Over 1,000,000 Earths could fit inside the Sun!

The Sun is 150 million kilometers (or 90 million miles) from Earth – closer than other stars, but still far away. It takes light 8 minutes to travel that far.

What is the Sun?





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The Sun has a constant wind flowing away from it – the solar wind.

Why? The Sun is so hot, its outer layers cannot be held in place by the Sun's immense gravity – the Sun is constantly losing its atmosphere as it flows away into space (but not much, don't worry).

The solar wind is electrified.

The solar wind is magnetic.

Solar Wind

Solar Wind

The solar wind is electrified.

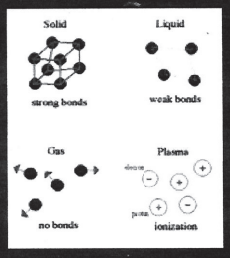
It is made up of ions and electrons – ions have a positive electric charge, electrons have a negative electric charge.

A mixture of ions and electrons is called a plasma.

Plasma: the 4th state of matter
Start with a solid.
Heat it up, and it turns into a liquid.
Heat it up more, and it turns into a gas.
Heat it up even more, the electrons and protons go their separate ways, and it turns into a plasma.

The solar wind is a plasma.

Why? The Sun is hot – it is hot enough to ionize gas and turn it into a plasma.



Solar Wind

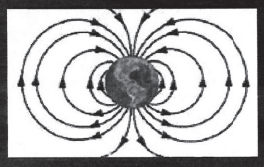
The solar wind is magnetic.

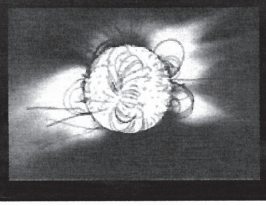
Just like Earth, the Sun has a magnetic field (but the Sun's is much more complex).

Unlike solids, liquids, or gases, plasmas are stuck to magnetic fields (and vice versa).

As plasma flows away from the Sun, the magnetic field is dragged with it.

This magnetic field fills the space between the planets, so it is called the interplanetary magnetic field (or IMF for short).





Solar Wind

How do we know?

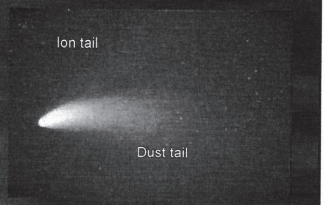
The existence of the solar wind was predicted in 1951 from observing comets.

Comets have two tails.

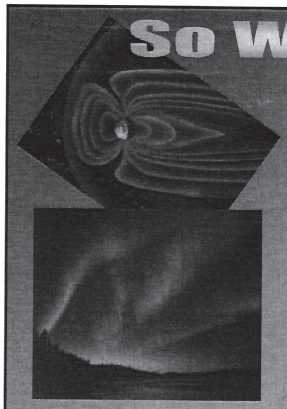
Dust tail: dust from the comet is pushed by sunlight.

Ion tail: ionized gas (plasma) from the comet is pushed by the solar wind and the interplanetary magnetic field.

The solar wind was not measured by satellites until ten years later – 1960.



So What?



What does the solar wind do for you?

The solar wind interacts with Earth's magnetic field forming a magnetosphere

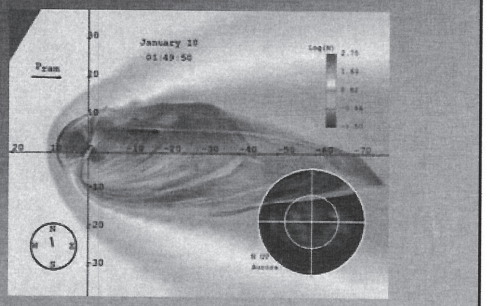
If we could see the magnetosphere (but we can't – magnetic fields are invisible), it would look kind of like a comet with a long tail pointing away from the Sun

The solar wind is not steady, just like Earth winds – sometimes the solar wind is weak; sometimes it is strong

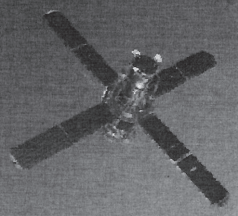
The direction of the IMF is important

The solar wind's interaction with the magnetosphere can produce aurora or northern lights (nice) but can also damage satellites usually protected by the magnetosphere (not so nice)

So What?



Solar Wind



How do we measure the solar wind? With spacecraft!

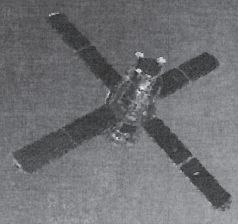
The solar wind plasma is relatively easy to measure – put a scientific instrument on spacecraft and count the ions and electrons as they enter the instrument.

Measuring the IMF is not as easy – spacecraft have magnetic fields, too!

Scientific instruments on spacecraft run on electricity (usually from solar panels). Electricity (or more precisely, electric current) creates magnetic fields.

How do we measure the Sun' magnetic field when the spacecraft's magnetic field is bigger...?

Solar Wind



...You are going to tell us!

The box is your spacecraft.

The magnetic field of the magnet inside the box represents the magnetic field created by the spacecraft.

The magnetic field in the room represents the solar wind's magnetic field, the IMF.

Map the magnetic field around ycur box

Where are you measuring the box's magnetic field? Where are you measuring the room's magnetic feld?

How do you know?

How could you design a scientific instrument to measure the IMF?