

WEBQUEST

The Big Three: Solar Wind, Flares, and CME's and their impacts on Earth

Solar wind

Visit the following link for an introduction to solar wind. Click on any links within the article to further your understanding.

http://www.windows.ucar.edu/tour/link=/sun/wind_character.html

This plasma of solar material has an extremely low density compared to anything on earth. The average density is 7 protons/cm³!! That's very small. The average earth atmosphere density at sea level is 2.5×10^{19} molecules/cm³ (25,000,000,000,000,000,000) The best vacuum in a scientific laboratory could not duplicate the low density of the solar wind. Yet this near vacuum has an extraordinary effect on the earth's magnetic field. It compresses the magnetic field on the sun side of the earth and stretches the field lines on the dark side of the earth. See this link for an illustration.

http://upload.wikimedia.org/wikipedia/commons/f/f3/Magnetosphere_rendition.jpg

It also carries its own magnetic field (actually, since the solar wind is an extension of the sun, it carries the sun's magnetic field). Most of the solar wind is diverted away from the earth by the earth's magnetic field, but some of the plasma makes its way into the earth's atmosphere through the open magnetic field lines at the poles. This explains the source of the auroras at the polar regions. During high solar activity, the solar wind can increase in velocity and density, deforming the earth's magnetic field even more, and pushing more solar material into the earth's atmosphere.

Much like the winds on earth are driven by the heating of the earth by solar energy, the solar wind is driven by the energy within the sun's corona. Coronal holes play a big part in the formation of the solar wind. Read this brief article on coronal holes at

<http://helios.gsfc.nasa.gov/chole.html>

For a video clip of solar wind animation, visit

http://science.nasa.gov/videofiles/physics_astronomy/Solarwind.mov

Questions:

1. What does the solar wind consist of?
2. How fast is the solar wind moving? How long would it take to travel from New York City to Los Angeles (3900 km)?

3. What state of matter is the solar wind?
4. What are coronal holes? How are they related to the solar wind?
5. The average solar wind velocity is 250 mi/s (that is miles per second, not per hour). Explain why the solar wind at this velocity would not even move a hair on your head if you were out in space.
6. What effect does the solar wind have on the earth's magnetic field?

Solar Flares

Solar flares appear as bright flashes in the chromosphere of the sun. They occur around active magnetic areas on the sun, and produce enough energy to power the US for 20 years at its current rate of consumption.¹ Flares, which are usually followed by coronal mass ejections (CME's), produce radiation across the electromagnetic spectrum as well as a proton storm. This radiation travels to the earth at the speed of light while the protons can travel as fast as a third the speed of light.

Visit the following link for a more detailed introduction to solar flares.

http://en.wikipedia.org/wiki/Solar_flare

For a description of the classification of flares read

<http://www.spaceweather.com/glossary/flareclasses.html>

Questions

1. Where do solar flares take place within the structure of the sun?
2. Is there any correlation between the location of flares and the location of sunspots?
3. How often do solar flares take place?
4. Does the radiation from a flare represent a direct hazard to people on earth? To astronauts on the space station? Explain

¹ *Storms From the Sun* by Michael Carlowicz, Ramon Lopez

Coronal Mass Ejections (CME's)

CME's pose the greatest threat to our everyday life here on earth. These enormous explosions of material in the corona of the sun are responsible for significant inputs of energy into our magnetosphere. How often they occur largely depends on solar activity. During solar minimum, there may be one CME per week, and during solar maximum there may be 2 or 3 a day.

Visit the following link for a more detailed introduction to CME's.

<http://hesperia.gsfc.nasa.gov/sftheory/cme.htm>

As the solar material of a CME streams towards earth, the orientation of its magnetic field is vital. If its magnetic field points northward (the same direction as the Earth's) then the energy of the CME can be diverted by the magnetosphere. But if the CME field is southward, then, like two opposing ends of a magnet, the energy is captured by our magnetosphere.

Visit the following link for an animation of a CME impact on earth's magnetosphere

<http://helios.gsfc.nasa.gov/CME.mpg>

Visit the following link for an explanation of a halo CME.

<http://www.spaceweather.com/glossary/halocmes.html>

Questions

1. How often do CME's occur?
2. What is a "halo" CME?
3. A CME carries with it a magnetic field. How is the orientation of the magnetic field significant?
4. What is a coronagraph?
5. What are the dangers corresponding to a CME hitting the earth?