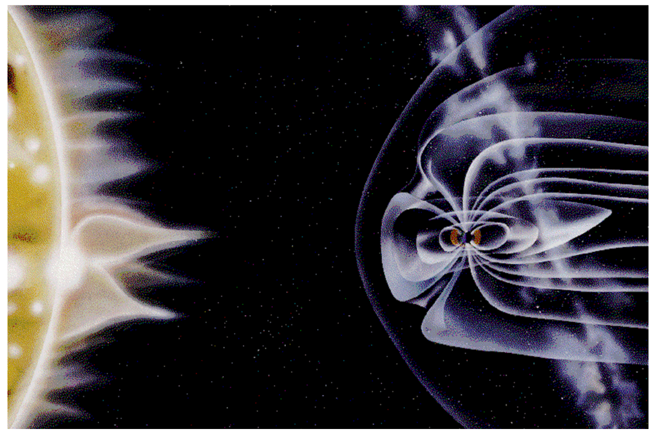
A Profile of Space Weather

Space weather describes the conditions in space that affect Earth and its technological systems. Space weather is a consequence of the behavior of the Sun, the nature of Earth's magnetic field and atmosphere, and our location in the solar system. The active elements of space weather are particles, electromagnetic energy, and magnetic field, rather than the more commonly known weather contributors of water, temperature, and air. The Space Weather Prediction Center (SWPC) forecasts space weather to assist users in avoiding or mitigating severe space weather. Most disruptions caused by space weather storms affect technology, With the rising sophistication of our technologies, and the number of people that rely on this technology, vulnerability to space weather events has increased dramatically.



Geomagnetic Storms

Induced Currents in the atmosphere and on the ground

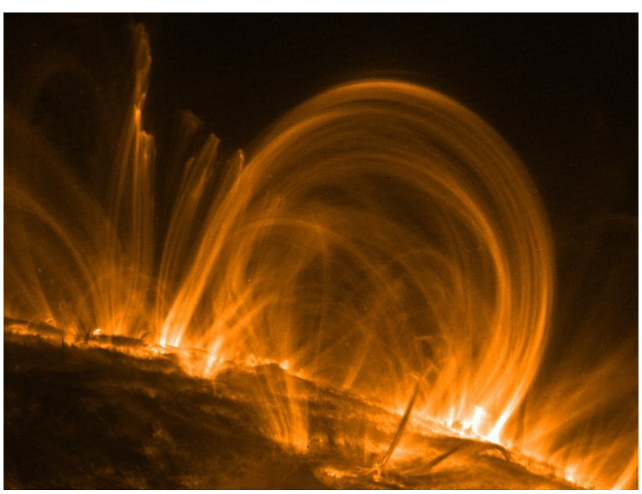
- Electric Power Grid systems suffer (black-outs)
- Pipelines carrying oil, for instance, can be damaged by the high currents.

Electric Charges in Space

- Satellites may encounter problems with the on-board components and electronic systems.

Geomagnetic disruption in the upper atmosphere

- HF (high frequency) radio interference
- Satellite navigation (like GPS receivers) may be degraded
- Satellites can slow and even change orbit.
- The Aurora can be seen in high latitudes



Solar Radiation Storms

Hazard to Humans

- High radiation hazard to astronauts
- Less threathening, but can effect high-flying aircraft at high latitudes

Damage to Satellites

- High-energy particles can render satellites useless (either temporarily or permanently)

Impact on Communications

- HF communications as well as Low Frequency Navigation Signals are susceptible to radiation storms. HF communication at high latitudes is often impossible for several days during radiation storms

Space Weather Prediction Center

The Space Weather Prediction Center (SWPC) Forecast Center is jointly operated by NOAA and the U.S. Air Force and is the national and world warning center for disturbances that can affect people and equipment working in the space environment.

SWPC provides observations and issues forecasts on space weather conditions on NOAA Space Weather Scales.

Information courtesy of Space Weather Prediction Center with additional information available at: http://www.swpc.noaa.gov/

Aurora

The Aurora Borealis (Northern Lights) and Aurora Australis (Southern Lights) are the result of electrons colliding with the upper reaches of Earth's atmosphere. (Protons cause faint and diffuse aurora, usually not easily visible to the human eye.) The electrons are energized through acceleration processes in the downwind tail (night side) of the magnetosphere and at lower altitudes along auroral field lines. The accelerated electrons follow the magnetic field of Earth down to the Polar Regions where they collide with oxygen and nitrogen atoms and molecules in Earth's upper atmosphere. In these collisions, the electrons transfer their energy to the atmosphere thus exciting the atoms and molecules to higher energy states. When they relax back down to lower energy states, they release their energy in the form of light. This is similar to how a neon light works. The aurora typically forms 80 to 500 km above Earth's surface.

Earth's magnetic field guides the electrons such that the aurora forms two ovals approximately centered at the magnetic poles. During major geomagnetic storms these ovals expand away from the poles such that aurora can be seen over most of the United States. Aurora comes in several different shapes. Often the auroral forms are made of many tall rays that look much like a curtain made of folds of cloth. During the evening, these rays can form arcs that stretch from horizon to horizon. Late in the evening, near midnight, the arcs often begin to twist and sway, just as if a wind were blowing on the curtains of light. At some point, the arcs may expand to fill the whole sky, moving rapidly and becoming very bright. This is the peak of what is called an auroral substorm.

Then in the early morning the auroral forms can take on a more cloud-like appearance. These diffuse patches often blink on and off repeatedly for hours, then they disappear as the sun rises in the east. The best place to observe the aurora is under an oval shaped region between the north and south latitudes of about 60 and 75 degrees. At these polar latitudes, the aurora can be observed more than half of the nights of a given year.

When space weather activity increases and more frequent and larger storms and substorms occur, the aurora extends equatorward. During large events, the aurora can be observed as far south as the US, Europe, and Asia. During very large events, the aurora can be observed even farther from the poles. (Of course, to observe the aurora, the skies must be clear and free of clouds. It must also be dark so during the summer months at auroral latitudes, the midnight sun prevents auroral observations.

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