



Space Weather

NOAA NATIONAL WEATHER SERVICE

October 2011

What is space weather?

Conditions from sun and space that can influence the performance and reliability of technological systems and can endanger human life or health.

What industries might be impacted by space weather?

- GPS companies
- Companies that use satellites
- Electrical companies
- Aviation
- Other Electronics



Why is forecasting space weather important?



Some of the specific effects of space weather on Earth systems include interference with short wave radio propagation, problems with electric power grids, the decay of satellite orbits, and radiation hazard for satellites and for astronauts during some phases of space missions.

Why is it important to know Sun-Earth effects?

Episodic solar activity has a number of effects that are of interest to us. A radiation dose from energetic particles is an occasional hazard for astronauts and for electronics on satellites. Geomagnetic field disturbances may damage power systems, disrupt communications, degrade high-tech navigation systems, or create the spectacular aurora. The National Weather Service Space Weather Prediction Center provides warnings of these events and continues the solar monitoring that began 400 years ago with Galileo's invention of the telescope.

Have scientists seen a change in space weather intensity?

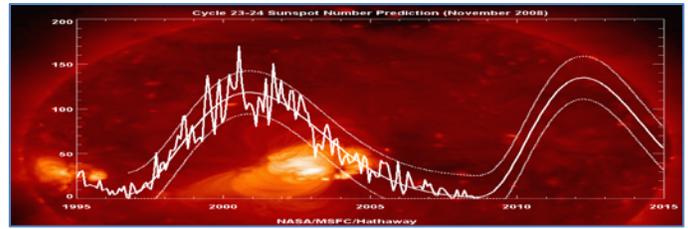
On a short time scale, the intensity of space weather is always changing. Conditions can be mild one minute and stormy the next. On longer time scales, space weather varies with the solar cycle. The solar cycle is an average 11 year cycle where the number of sunspots goes from very few per month, to many, and back to very few. At solar minimum, we might see no sunspots where at solar maximum, we can have 200 sunspots in a month. Solar flares, coronal mass ejections, and solar energetic particles all increase in frequency as we get closer to solar maximum. High speed wind streams are more frequent at solar minimum, thus ensuring that space weather is something to watch for no matter where we are in the solar cycle.

NOAA
National Weather Service
Space Weather Prediction Center

THE NATION'S
 OFFICIAL SOURCE
 OF SPACE WEATHER
 ALERTS AND WARNINGS

Sunspots

Sunspots, dark areas on the solar surface, contain strong magnetic fields that are constantly shifting. A moderate-sized sunspot is about as large as the Earth. Sunspots form and dissipate over periods of days or weeks. They occur when strong magnetic fields emerge through the solar surface and allow the area to cool slightly, from an environment value of 6000°C (10,832°F) down to about 4200°C (7592°F); this area appears as a dark spot in contrast with the Sun. The rotation of these sunspots can be seen on the solar surface; they take about 27 days to make a complete rotation as seen from Earth.

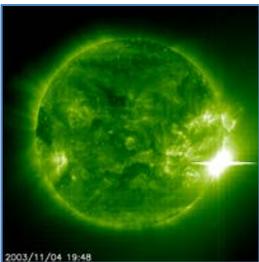


Aurora (Northern Lights)

The solar wind energizes electrons and ions in the magnetosphere. These particles usually enter the Earth's upper atmosphere near the polar regions. When the particles strike the molecules and atoms of the thin, high atmosphere, some of them start to glow in different colors. Aurora begins between 60 and 80 degrees latitude. As a solar wind storm intensifies, the aurora spreads toward the equator.



What is a solar flare?



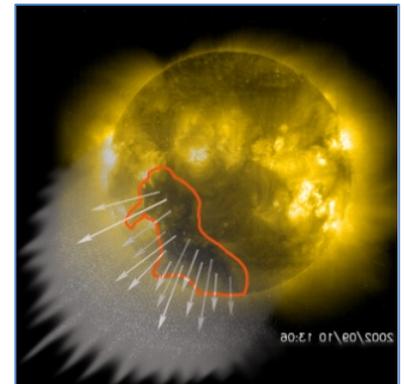
A solar flare is an intense burst of radiation coming from the release of magnetic energy associated with sunspots. We typically see a solar flare by the photons (light) it releases. The primary ways we monitor flares are in x-rays and optical light. Flares are also sites where particles (electrons, protons, and heavier particles) are accelerated.

How are sunspots related to space weather?

The magnetic field in sunspots stores energy that is released in solar flares. As a result, flares usually occur in a cycle that mimics the 11 year sunspot cycle. Sunspots usually occur in simple pairs but at times in complicated arrangements, with many spots and complex shapes. These unusual regions most often produce solar flares. Space weather forecasters use the complexity and shapes of sunspots to make flare forecasts. The more complex the groups of spots, the more likely a flare will occur.

Coronal Holes

Coronal holes are variable solar features that can last for weeks to months. They are large, dark areas when the Sun is viewed in x-ray wavelengths, sometimes as large as a quarter of the Sun's surface. These holes are rooted in large cells of unipolar magnetic fields on the Sun's surface; their field lines extend far out into the solar system. These open field lines allow a continuous outflow of high-speed solar wind. Coronal holes have a long-term cycle, but the cycle doesn't correspond exactly to the sunspot cycle; the holes tend to be most numerous in the years following sunspot maximum. At some stages of the solar cycle, these holes are continuously visible at the solar north and south poles.



On the web:

- Space Weather Prediction Center www.swpc.noaa.gov
- Space Weather FAQ's www.swpc.noaa.gov/info/FAQ.html
- National Weather Service Quad Cities www.weather.gov/quadcities
- National Weather Service www.weather.gov