Space Weather Prediction Center

The Space Weather Prediction Center (SWPC), headquartered in Boulder, is part of the National Weather Service and is the nation's official source of space weather alerts, watches and warnings. SWPC's Space Weather Forecast Office (SWFO) coordinates services jointly with the U.S. Air Force space weather group located at Offutt AFB, Omaha, Neb.

Space weather begins with solar eruptions; the effects can travel across the 93 million miles between the sun and our planet and can impact Earth systems, such as communications, navigation, spacecraft operations, aviation and electric power. The SWFO provides forecasts and warnings of solar activity and the changes such activity can bring to Earth and its magnetic cloak as well as electronic interference. People in government and the private sector who are responsible for preparing and protecting affected systems use SWPC forecasts.

To provide real-time monitoring of the space environment, solar forecasters analyze information from a variety of sources, including telescopes on the ground and satellites pointed at the sun or the environment between the sun and Earth.

Like our weather on Earth, space weather can follow a pattern of events through the storming process. Space-weather forecasts evolve similarly, from announcing activity on the sun to describing what's expected to happen on Earth.

Starting with an analysis of sunspots, forecasters assess the size and magnetic complexity of sunspot groups. Like meteorologists monitoring a deep low-pressure

center, forecasters monitor these sunspot groups to get an idea of the strength, complexity and potential of the storm site. Forecasters will estimate the probability of these areas producing a solar flare – a sudden eruption of energy in the solar atmosphere. When a solar flare occurs, it produces a burst of electromagnetic radiation traveling at the speed of light. This radiation can cause significant ionization in the ionosphere and upper atmosphere. This can cause interference in high frequency (HF) radio communications signals that airlines use - referred to as Radio Blackouts.

A solar flare may also signal an acceleration of solar energetic particles, mostly protons and electrons, contained in the eruption as both the flare and coronal mass ejection (CME). A CME can also occur independently from a flare. These energetic protons typically arrive 1-12 hours after the eruption is detected on the sun. These storms are referred to as Solar Radiation Storms. Satellite operations can experience memory device problems, noise on imaging systems, star-tracker orientation problems and damage to solar panels. NASA monitors radiation hazards for the biological effects on astronauts in space. Airlines also respond to solar radiation storms by rerouting flights away from the poles, or in some cases, lowering altitude.

One to four days after the solar eruption, a cloud of solar material and magnetic field associated with the CME reaches Earth. This creates a Geomagnetic Storm. During a geomagnetic storm, changes to the solar plasma in solar wind interact with (and can add energy to) Earth's magnetic field. The resulting disturbance (magnetic storm) affects (heats) the upper atmosphere and enhances currents already present in Earth's magnetic field. A visual affect from these storms is the beautiful aurora (the interaction of high-energy particles striking Earth's upper atmosphere). Geomagnetic storms may result in electric power grids experiencing problems with voltage control; transformers may experience damage, and some grid systems may experience complete collapse or blackouts. Upper atmospheric changes affect satellite operations and navigation, and can cause GPS signal errors.

The NOAA Space Weather Scales were introduced as a way to communicate to the general public the current and future space weather conditions and their possible effects on people and systems. The scales describe the environmental disturbances for three event types: Geomagnetic Storms, Solar Radiation Storms, and solar flare Radio Blackouts. The scales have numbered levels, analogous to hurricanes, tornadoes, and earthquakes that convey severity. The Fujita scale (F0-F5) is used to measure the severity of a tornado, for example.