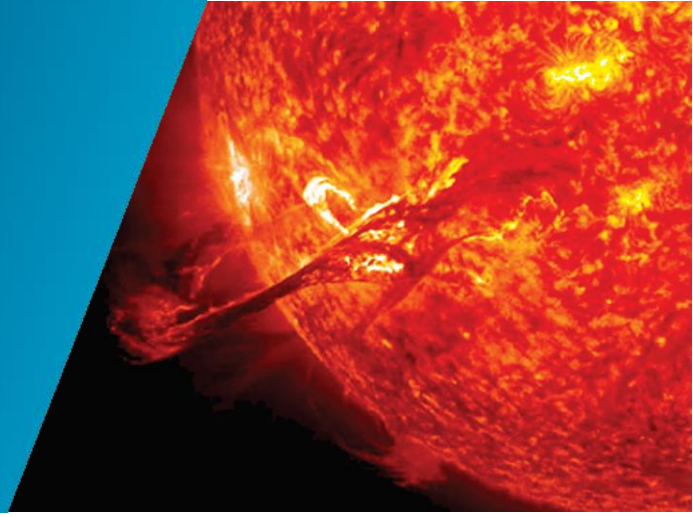
Australian Government
Bureau of Meteorology



What is Space Weather?

Space weather is the effect of the space environment on technology and the near-Earth space environment. The biggest influence on space weather is the Sun.

Space Weather & Technology

Space weather can pose a serious threat to increasingly complex communications and technological systems. The greatest space weather disturbances are usually caused by solar flares and subsequent geomagnetic storms. These can potentially:

- Make global navigation satellite system (GNSS) signals unreliable
- Increase harmful solar radiation, with possible risks to health at aviation altitudes
- Interrupt high frequency radio communications
- Threaten satellite transmissions and instruments, including avionics, and reduce the life of satellites in low earth orbit
- Damage power grids, causing a risk to supply and infrastructure

As reliance on technology grows, so does the potential impact of space weather.

What causes space weather?

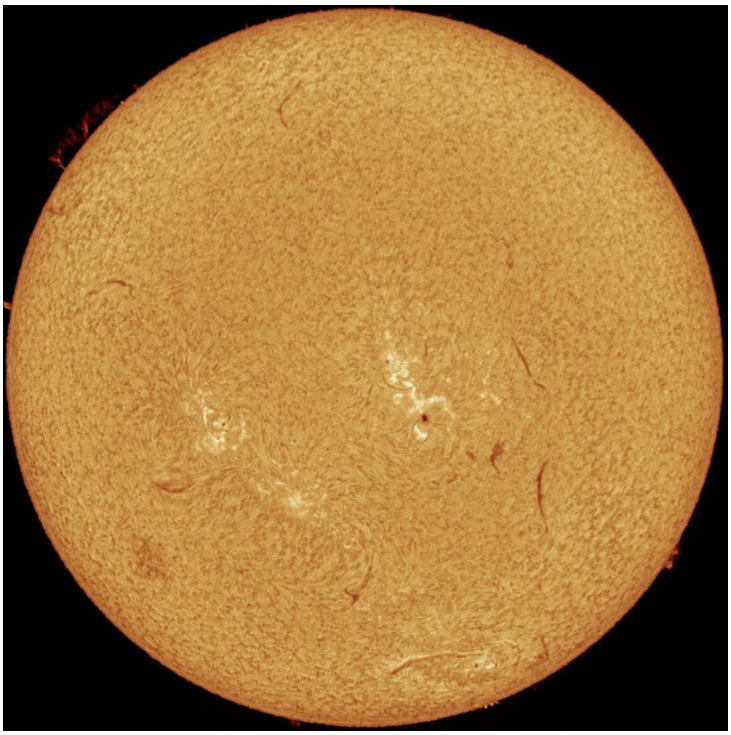
The biggest influence on space weather is the Sun. The Sun's turbulent activity, including explosive eruptions called solar flares and coronal mass ejections, has a significant impact on the near-Earth space environment.

Major solar flare eruptions are associated with an increase in:

- X-ray and radio emissions that reach Earth within eight minutes – sometimes in the ultra-high frequency (UHF) band;
- Energetic protons, reaching the Earth in 30 minutes to 6 hours, and
- An increase in solar wind particles and magnetic field strength, typically reaching Earth within half a day to three days, called a coronal mass ejection.

During a coronal mass ejection, billions of tonnes of magnetised solar matter erupts into space at up to 10 million km/h. If the material is directed towards the Earth, then the event may result in geomagnetic and ionospheric storms.

A geomagnetic storm is a major disturbance in the Earth's magnetic field, while a serious variation in ionospheric conditions is called an ionospheric storm. Both can significantly disrupt technology in the near-Earth space environment.

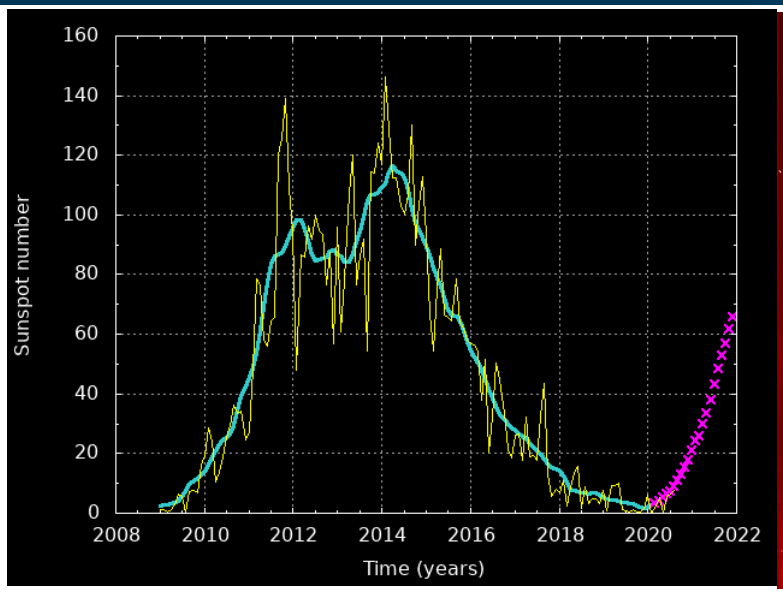


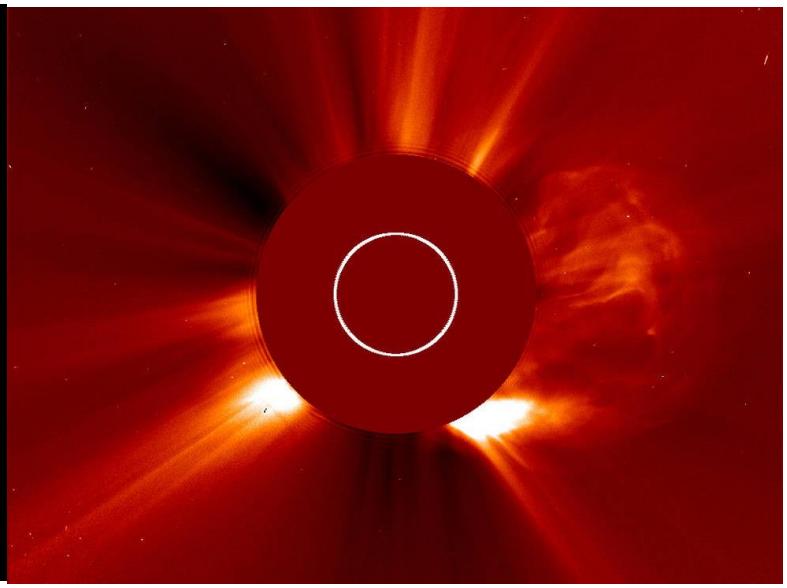
Hydrogen alpha image, 24 October 2015

Impacts on the Space Industry

Severe-to-extreme space weather can threaten various aspects of the space industry, particularly satellites, including:

- surges of electric current capable of disrupting satellites in orbit
- An increase in ions impacting satellites, overwhelming sensors, damaging solar cells, and degrading wiring and other equipment.





Left: Monthly sunspot number (yellow) during the previous solar cycle and predicted monthly sunspot number (magenta) during the beginning of Cycle 25 (Bureau of Meteorology). Right: Solar plasma ejects from the sun, leading to one of the fastest coronal mass ejections ever recorded (Credit: ESA & NASA/SOHO).

- Increased risk of exposure for astronauts to harmful solar radiation
- Changes to orbital dynamics, such as satellite drag, impacting the lifespan of low-Earth orbit satellites

Solar Cycles

The Sun's magnetic field goes through a complete cycle approximately every 11 years, during which the Sun's north and south magnetic poles reverse. This has important implications for solar activity, such as sunspots, solar flares and coronal mass ejections.

The beginning of a solar cycle is a solar minimum – when solar activity is generally low. Over time, activity increases to its maximum roughly halfway through the cycle. This is when sunspots increase in size and number, and solar flares and coronal mass ejections are most likely to affect the near-Earth space environment.

Some solar cycles are much more active than others. The current cycle – known as Cycle 25 – is expected to be similar in strength to Cycle 24 and will likely reach its peak between 2023 and 2026. The Bureau of Meteorology forecasts solar activity for the years ahead, allowing our customers to prepare for the impacts of an increase in solar activity.

Case Study: July 2012 coronal mass ejection

On July 23, 2012, a large coronal mass ejection occurred, projecting massive amounts of solar plasma into space. The eruption missed the Earth, but enveloped NASA's STEREO-A satellite, which measured the eruption as one of the fastest coronal mass ejections ever observed.

A 2013 study estimated that the U.S. would have suffered between $600 billion and $2.6 trillion in damages, mainly to electrical infrastructure, if this coronal mass ejection had been directed towards the Earth. The strength of the eruption was comparable to the famous 1859 Carrington Event, during which telegraph stations around the world were damaged, and which produced aurora displays as far south as the Caribbean.

The 2012 space weather event highlights the risk geomagnetic storms pose to critical infrastructure on Earth and in the near-Earth space environment. Our ability to observe and monitor solar activity is crucial to protecting this infrastructure and ensuring the sustainability of the space industry.

FIND OUT MORE

To find out more about the Bureau of Meteorology's Space Weather Services, please visit http://www.sws.bom.gov.au/