Australian Government
Bureau of Meteorology

Space weather and the Australian community

A severe space weather event can disrupt electrical currents in power lines, increase radiation in the atmosphere, disrupt communication and navigation systems, damage satellites and pose health risks. Impacts for the Australian community can be serious, and response and mitigation planning is necessary.

Key points

- Severe space weather can significantly disrupt the technology that underpins our energy, transport, communication and financial systems. There can be major flow-on effects for the Australian community.
- Further research and planning are required to build community awareness and resilience to severe space weather.

What causes space weather?

The main driver of space weather is the Sun. Solar activity and the resulting space weather vary day-to-day, seasonally, and over multi-year cycles. Irregular solar activity, including explosive eruptions called solar flares and coronal mass ejections (CMEs), can have a significant impact on the near-Earth space environment.

Major solar flares can be associated with an increase in:

- X-ray and radio emissions, which reach Earth within 8 minutes
- energetic protons, which reach Earth in 20 minutes to 6 hours.

During a CME, billions of tonnes of magnetised solar plasma erupt into space at up to 3,000 km/s, with increased solar wind particles and magnetic field strength typically reaching Earth within half a day to 3 days. If the material is directed towards the Earth, geomagnetic, ionospheric and radiation storms can occur.

Severe space weather can significantly impact the technologies we rely on in different ways and over different time scales.

How does space weather affect the community?

Power networks

Severe space weather can cause key power network infrastructure to fail, and can destabilise the electricity transmission network. This can disrupt the communication, health, financial and transport systems the Australian community relies on.

A severe geomagnetic storm can induce electrical surges in long-distance power lines, causing damage to high-voltage transformers. Power lines at high latitudes are particularly susceptible. The conductivity of the ground nearby can also influence the level of impact.

The impact on power networks can range from short-term outages and restrictions to extended loss of electricity supply due to widespread infrastructure damage.

Example: Severe space weather causes shut down of power grid in Quebec

In Canada in 1989, a severe space weather event caused a complete shut down of Quebec's power grid. The outage affected 6 million people and lasted over 9 hours, before power was eventually restored.

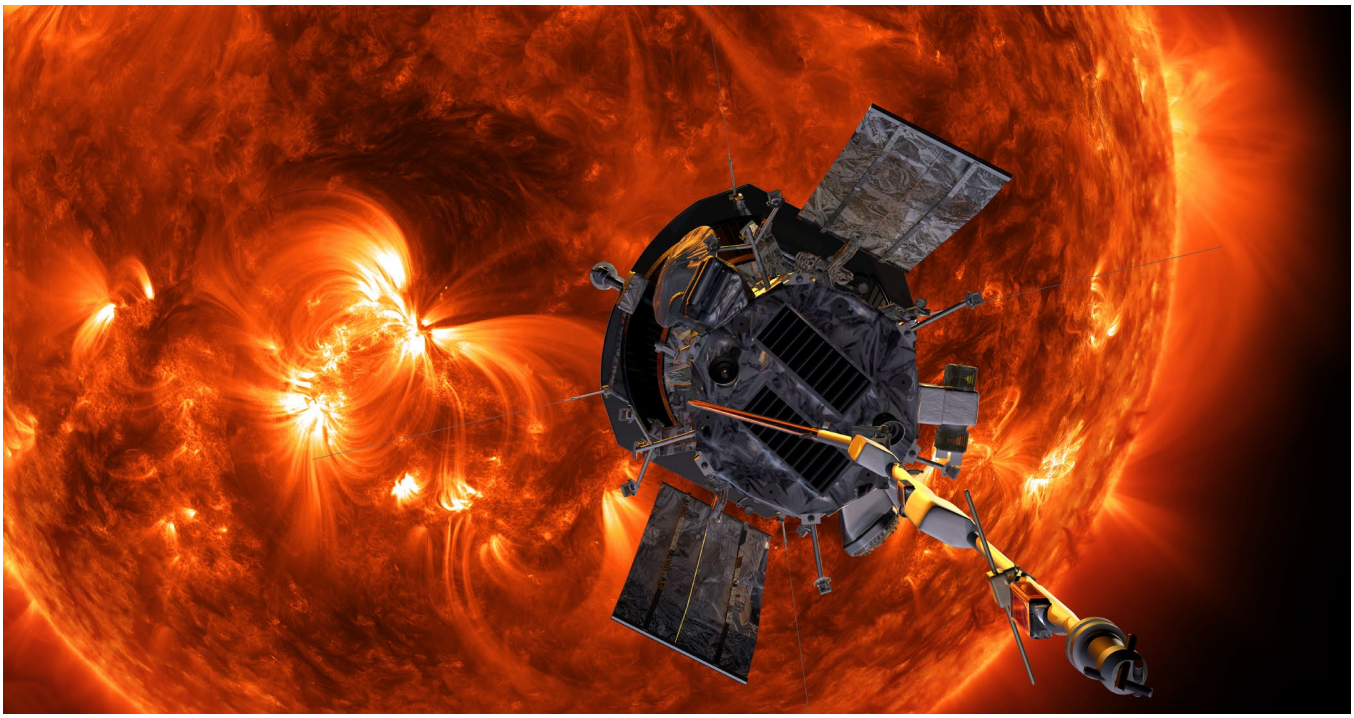
Satellites

Satellite technology underpins many of the communication and navigation services used by the Australian community. Satellites are vulnerable to severe space weather because of their location in the near-Earth space environment, where they can be exposed to damaging radiation. Impacts on the community include poor performance or loss of global positioning system (GPS) navigation and satellite-based communication services.

The main source of damaging radiation is the Sun. However the Earth's own radiation belts, and distant cosmological sources such as black holes, can also disrupt satellites. Radiation can interact with satellite electronic systems causing temporary disruption or permanent damage.

Severe space weather threatens not only the satellites themselves, but also the functions they perform. Radio waves passing between satellites and ground receivers may be interrupted, causing disruption to satellite-based communication and navigation services. This would affect the performance of car navigation computers and smart phones and watches.

Estimates show that during an extreme storm, global navigation satellite system service may be compromised for several days.



Example: Severe space weather causes loss of data and television services in Canada

In 1994 severe space weather caused the failure of two Canadian communications satellites within 9 hours of each other. The failure resulted in disrupted data transmissions across Canada and disconnected data and television services to over 1,600 remote communities for several hours.

Radio communication

HF radio is an important tool used by some members of the community for long-distance communication. It is also used in the aviation, shipping, defence and emergency services sectors.

HF radio uses a layer of the Earth's upper atmosphere called the ionosphere to propagate radio signals over long distances. Space weather can cause variations in the Earth's ionosphere, resulting in decreased performance of HF radio communications.

Aviation

Radiation exposure, disruption to aircraft electronics, and potential loss of communication and navigation systems pose a risk to the safety of air transport for the Australian community.

- During a severe space weather event, levels of harmful radiation increase at high altitudes. The risk of radiation exposure is greater in polar regions. Radiation exposure can have short and long-term health impacts.
- Navigation systems used by aircraft, such as GPS, can become inaccurate or unavailable.
- Radiation can interrupt or damage an aircraft's electronic systems.
- Availability of communication systems such as high frequency (HF), very-high frequency (VHF) and ultrahigh frequency (UHF) radio can be disrupted or lost.

Example: Solar flare activity impacts air-traffic radar for 90 minutes

On 4 November 2015, air traffic control centres in Stockholm and Malmö, Sweden, noticed that radar stations of the Swedish air navigation service provider were not relaying the correct data to air traffic control. This was later attributed to solar flare activity. The interference resulted in a 90-minute impact to radar capability across Swedish airspace.

Resource pipelines

Long steel pipelines that carry essential resources such as natural gas have protection systems that help extend their lifetimes. Geomagnetically induced currents caused by severe space weather can interfere with these protection systems, increasing corrosion and reducing asset lifespan. Space weather can also interfere with routine inspection of pipelines.

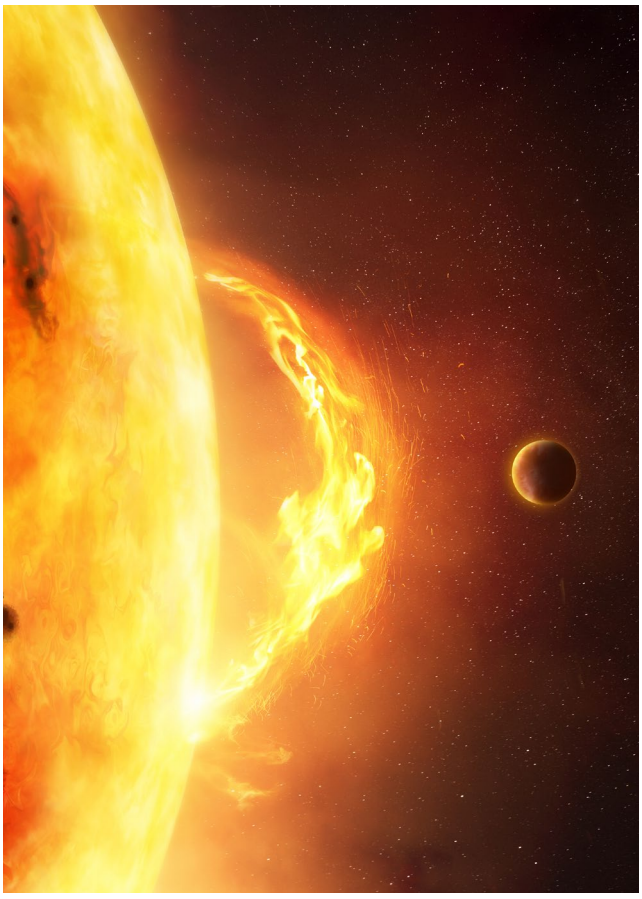
Auroras

Auroras are a visual manifestation of space weather. They routinely occur in the night sky over high-latitude locations such as Antarctica, and even in southern parts of Australia, such as Tasmania. Viewing and photographing auroras is for some a recreational pursuit.

Bright auroras extending to unusually low latitudes may indicate that severe space weather is occurring.

Response to a severe space weather event

Like for any severe weather, it is critical to plan and prepare for severe space weather.



The Bureau provides forecasting and real-time observations of space weather. This gives the opportunity to take protective action and prepare for disruptions. In extreme events we provide a severe space weather warning service.

We work closely with the community to limit their space weather risks, including delivery of:

- space weather forecasts, warnings and alerts
- tailored space weather services for business
- real-time and historical observations
- HF radio advice and planning tools
- space weather education.

Longer-term mitigation measures

Understanding of space weather risks can inform the design and management of communication and infrastructure processes and systems. With targeted research and development, Australia's resilience to the impacts of space weather can be increased. To ensure greater resilience in the community, the Bureau:

- contributes to space weather risk assessments for a comprehensive understanding of the direct and indirect impacts of space weather on the community, along with dependencies across various sectors
- supports the coordination of Australia's response to severe space weather across relevant departments, agencies and industry, informed by appropriate risk assessment findings
- collaborates with industry, government, and academia to develop and improve models and forecast capabilities. This work is validated by industry observations of the impacts of severe space weather events. This information helps industry to mitigate potential impacts of these events and minimise disruption to society.

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