



# Space weather: Storms from the Sun

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## Eruptions from the Sun can disrupt technology

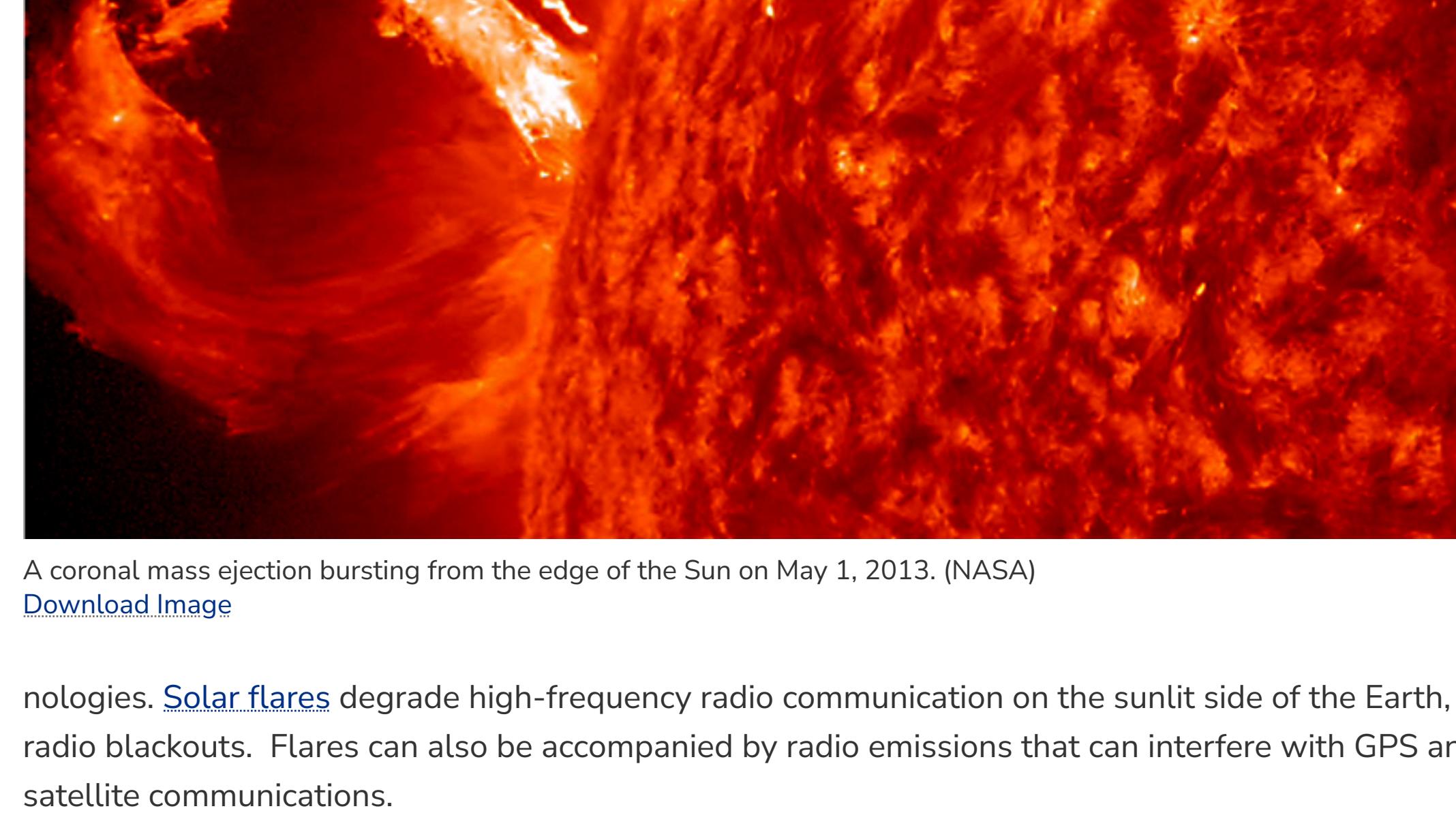
### Preparing for strong space weather

Focus areas: Satellites, Weather Topics: space weather, solar storms

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Our nation's security, economic vitality, and daily functioning depend on the reliable operations of satellites and aircraft, communications networks, navigation systems, and the electric power grid. As these technologies and infrastructures become increasingly interdependent, the world faces greater risks from space weather events.

In 2013, Lloyds of London predicted that the most extreme space weather storms could affect 20-40 million people in the U.S. and cause up to \$2.6 trillion in damages, with recovery taking up to two years.



There are different types of space weather events, and each can affect different technologies.

A coronal mass ejection bursting from the edge of the Sun on May 1, 2013. (NASA)  
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technologies. [Solar flares](#) degrade high-frequency radio communication on the sunlit side of the Earth, causing radio blackouts. Flares can also be accompanied by radio emissions that can interfere with GPS and other satellite communications.

High-energy particles (protons and electrons) released during flares, can penetrate satellite electronics and cause malfunctions. During significant [solar radiation storms](#), airlines may suspend transpolar flights to avoid degraded navigation and communications. International Space Station astronauts may have to take precautions during extreme events.

[Coronal mass ejections](#) (CMEs) are giant blobs of plasma which erupt from the Sun. If they arrive at Earth, they can cause [geomagnetic storms](#). Rare but significant storms can lead to blackouts, such as the 1989 event that plunged Quebec into darkness for nine hours. Most of the time, however, geomagnetic disturbances are much less dramatic and easily dealt with by power grid operators.

Space weather is common, and generally invisible to the average person, except when geomagnetic storms cause beautiful [aurora](#). However, industries affected by space weather have to plan for these events to ensure the reliability of their products and services. Users of space weather information include satellite operators, electric utilities, airlines, oil drilling companies, precision agriculture, and federal agencies.

### Space Weather Impact Examples

- [1859 \(Late August-early September\): The Carrington Event](#), named for astronomer Richard Carrington who observed the solar flare preceding an historic geomagnetic storm. The storm disrupted telegraph communications around the world and produced aurora seen as far south as Hawaii and Central America. ↗
- [1989 \(March\): Quebec plunged into darkness for 9 hours as power grid overwhelmed by geomagnetic storm.](#) ↗
- [2003 \(October\): "Halloween Storms" resulted in a 30 hour outage of the Federal Aviation Administration's Wide Area Augmentation System \(WAAS\), which provides GPS navigation support to aircraft.](#) ↗
- [2005 \(January\): United Airlines diverted 26 flights from polar routes to avoid radio blackout potential.](#) ↗
- [2013 \(March\): Three separate CME arrivals in March resulted in three separate satellite outages lasting from hours to days.](#) ↗

Part 2 of 4

Part 1

What is space weather?

Part 3

Forecasting

