



# SPACE WEATHER

Space weather refers to changes in the space environment and geomagnetic storms resulting from eruptions on the Sun. Space weather ultimately affects human activities and technologies on Earth and in space.

Above: AuroraMAX images of the northern lights above Yellowknife provided courtesy of AuroraMAX. (Canadian Space Agency, Astronomy North, University of Calgary, City of Yellowknife)

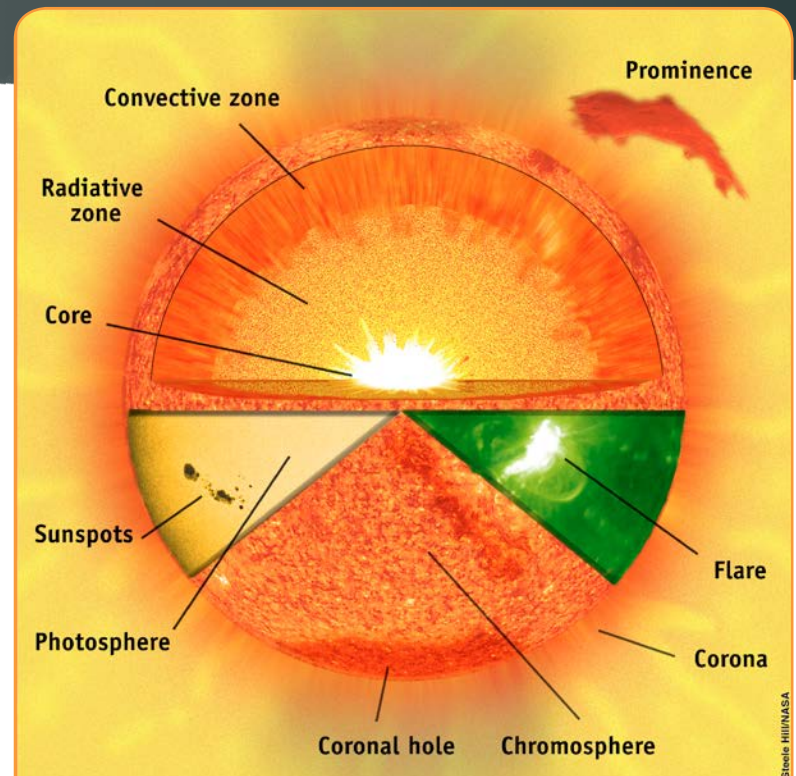
## What causes space weather?

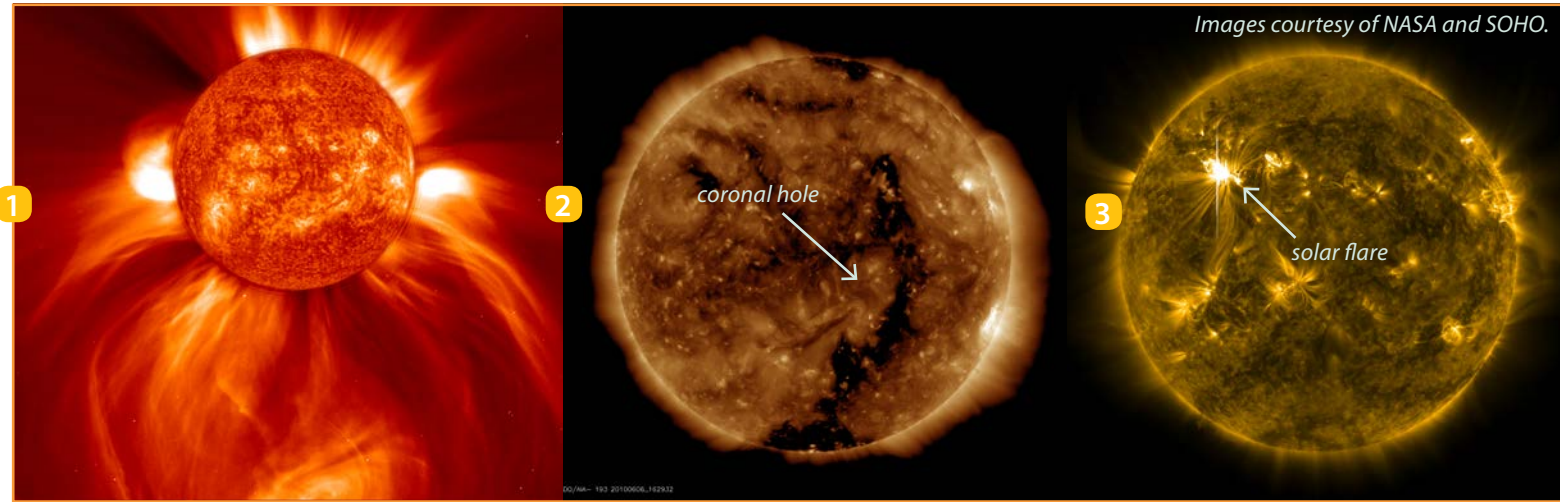
The source of space weather is the Sun. The Sun is a million times larger than Earth and so distant that its light takes eight minutes to reach us. When violent solar phenomena occur, they create space weather effects on Earth, which can pose a hazard for human activities.

## Solar Phenomena

The outermost region of the Sun is called the corona, and it extends millions of kilometres. Temperatures in the corona register in the millions of degrees Celsius.

*The outer visible layer of the Sun, called the photosphere, is constantly bubbling and has very low density, like our atmosphere. (Image courtesy of Solar Heliospheric Observatory – SOHO. SOHO is a project of international cooperation between the U.S. National Aeronautics and Space Administration - NASA - and the European Space Agency - ESA)*





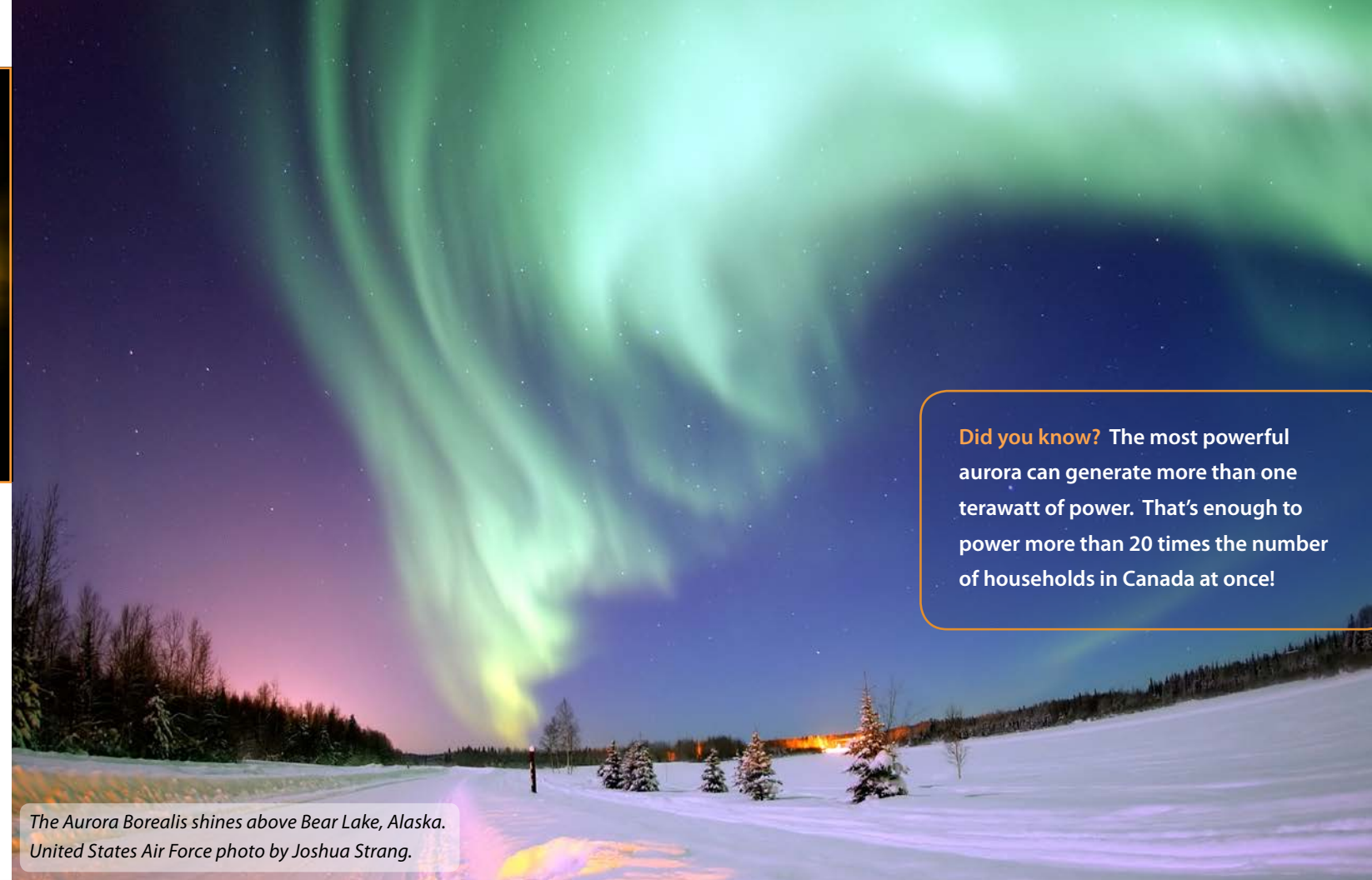
Three kinds of solar phenomena can have major impacts on Earth by disturbing our space environment:

- 1 A coronal mass ejection (CME)** is a large explosion that hurls superheated plasma (electrified gas) into interplanetary space.
- 2 Coronal holes** release high-speed streams of plasma that boost the solar wind.
- 3 A solar flare** is an intense burst of radiation coming from the release of magnetic energy.

CMEs and coronal holes can trigger geomagnetic storms in our magnetosphere (the region surrounding a planet where its magnetic field dominates).

#### What are geomagnetic storms?

A geomagnetic storm refers to disturbances of the Earth's magnetosphere, caused by sudden strong variations in the speed, density, and magnetic properties of the solar wind. The resulting magnetic field variations generate electric currents in long conductors such as power lines and pipelines. The effects of geomagnetic storms range from mild (interference with aeromagnetic surveys) to extreme (electric power grids may experience blackouts or collapse).



**Did you know?** The most powerful aurora can generate more than one terawatt of power. That's enough to power more than 20 times the number of households in Canada at once!

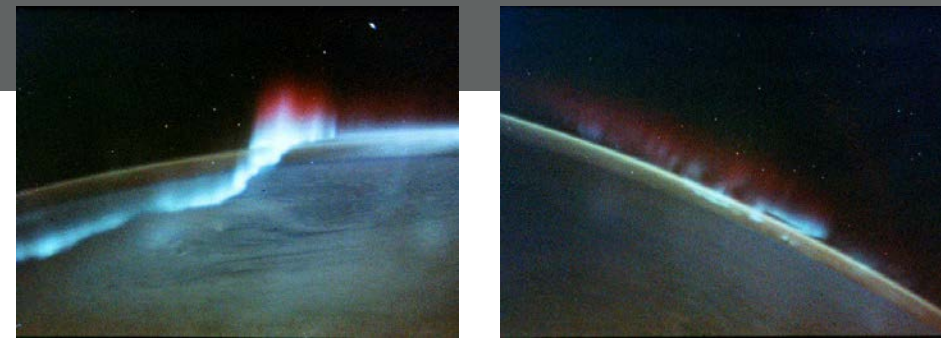
*The Aurora Borealis shines above Bear Lake, Alaska.  
United States Air Force photo by Joshua Strang.*

The Sun releases a continuous stream of charged particles made up of energized electrons and protons. This is called the solar wind, and it travels at speeds of more than 1.5 million km/hour and carries parts of the Sun's magnetic field toward Earth. As the solar wind gets close to our planet, it is deflected by the Earth's magnetic field.

*A look at how space weather affects Earth's magnetic field.  
(Image courtesy of SOHO)*

#### What is the aurora?

Auroras, often called northern lights, are coloured patterns of light seen dancing in the night sky. They are driven by the energy coming from the Sun. When the Sun is active, it often produces mass ejections of charged particles that get trapped by the Earth's magnetic field. Guided by the magnetic field, the particles flow toward the Earth's poles where they collide with nitrogen and oxygen in the upper atmosphere. As a result of this interaction, green, blue, and red light is emitted, producing the aurora borealis and aurora australis.



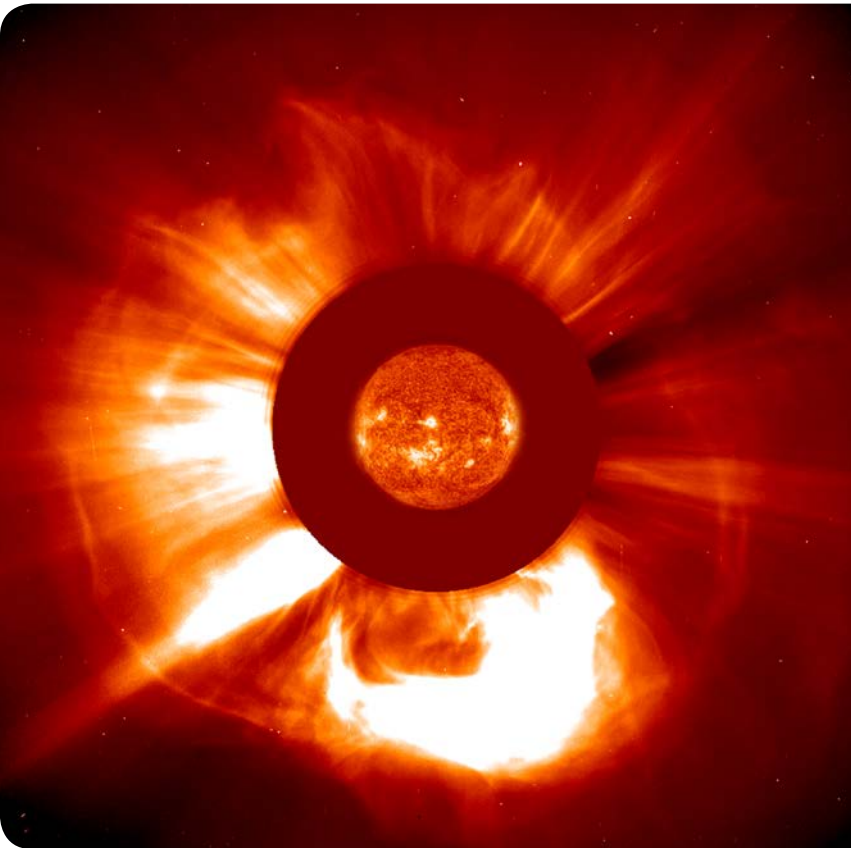
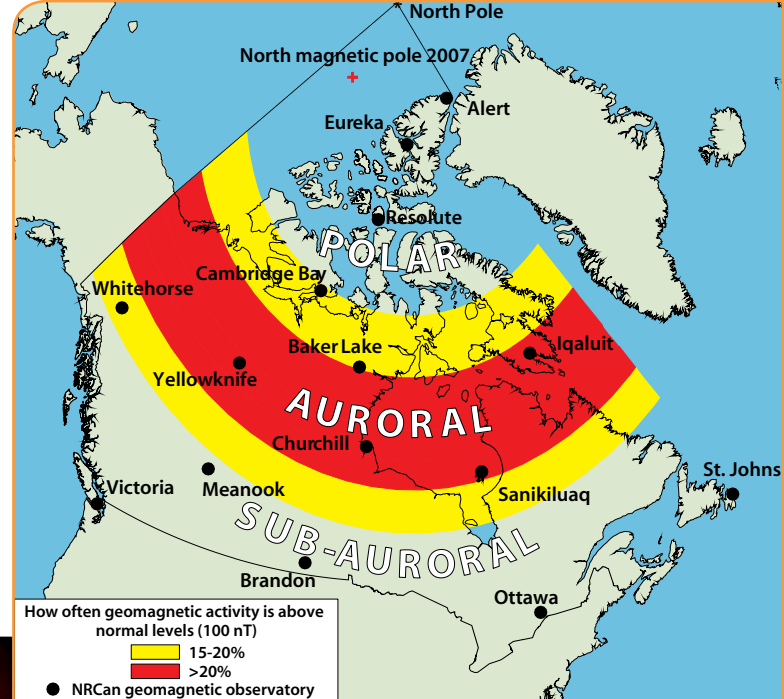
*Images courtesy of NASA : Space Shuttle photo of red tipped aurora arcs over the South Pole.*

### Are there geomagnetic storms in Canada?

Yes. Canada has three zones of geomagnetic activity: the polar cap zone; the auroral zone; and the subauroral zone. The highest geomagnetic activity and greatest disturbances are observed in the auroral zone.

### How active is the Sun?

The Sun follows a regular cycle of activity. Over the last 300 years, the Sun has consistently alternated through periods of maximum and minimum activity on a roughly 11-year cycle. During solar maximum (next one expected in 2013), geomagnetic storms are predicted to be more frequent.



*A massive coronal mass ejection erupted from the surface of the Sun at 9:51 UTC on October 28, 2003. Large Angle and Spectrometric Coronagraph (LASCO), NASA Earth Observatory Collection.*

### Why is space weather important to Canadians?

The Earth's northern magnetic pole is located in the Arctic Ocean near the Canadian Arctic Archipelago. Geomagnetic activity is especially strong in the surrounding auroral zones. Given its close proximity to the north magnetic pole and the auroral zone, Canada is among the countries most affected by space weather.



*Surveying the north magnetic pole.*

You may also want to read "Forecasting Space Weather in Canada" and "Space Weather — Effects on Technology".

Government of Canada work on space weather and geomagnetic storms is undertaken by Natural Resources Canada, Earth Sciences Sector. For more information, please visit the NRCan Space Weather Canada website: [spaceweather.gc.ca](http://spaceweather.gc.ca).

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