



SPACE WEATHER – EFFECTS ON TECHNOLOGY

*Energetic particles crashing into the Earth's magnetic field.
(Image courtesy of the US National Aeronautics and Space Administration - NASA)*

Space weather refers to the conditions and processes occurring in space which have the potential to affect the near Earth environment. Space weather processes can include changes in the interplanetary magnetic field, coronal mass ejections from the Sun, and disturbances in Earth's magnetic field. The effects of space weather can range from damage to satellites to disruption of power grids on Earth.

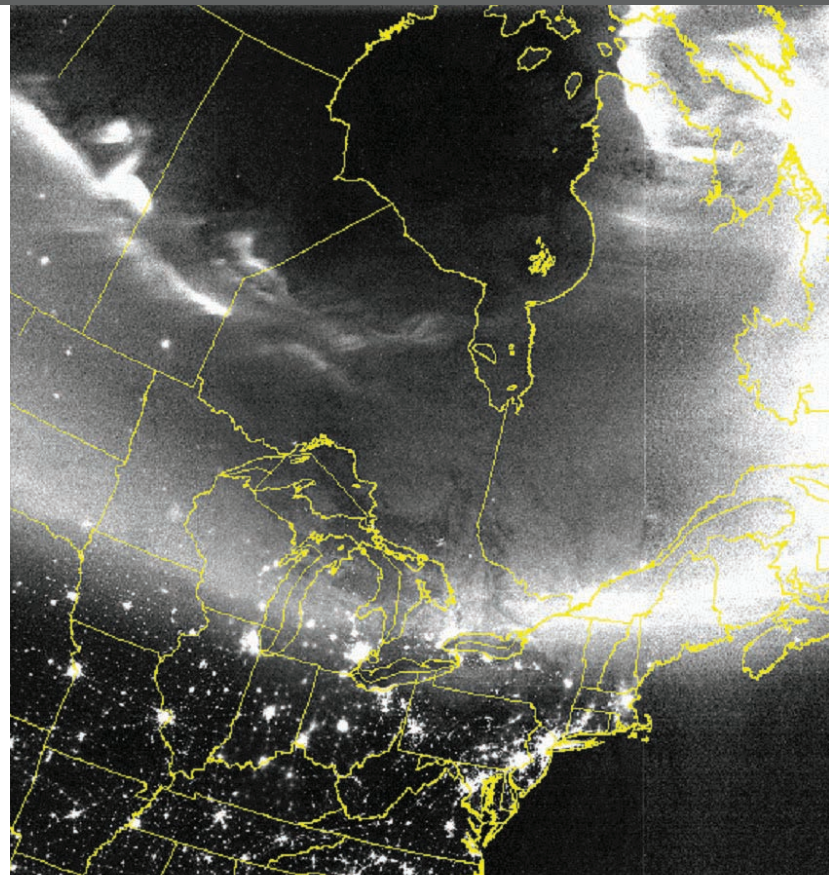
What causes a geomagnetic storm?

An explosion of activity on the Sun causes charged particles to be released, which can eventually result in disturbances in the magnitude and direction of the Earth's magnetic field. Geomagnetic storms can last hours or days, and they can directly affect operations that rely on the Earth's magnetic field, such as magnetic surveys done by mineral exploration companies, compass use for navigation, and directional drilling for oil and gas.

Why are geomagnetic storms a problem?

Geomagnetic storms can cause unexpected electric currents in long conductors like power lines. The effect of geomagnetic storms on power systems is illustrated by the Hydro-Quebec blackout in 1989. In 90 seconds, the entire Hydro-Quebec power grid collapsed. The blackout left over six million people in Quebec and northeast United States without power for nine hours.

United States Air Force satellite image showing the aurora over the Great Lakes. Such large magnetic disturbances pose a threat to infrastructure.



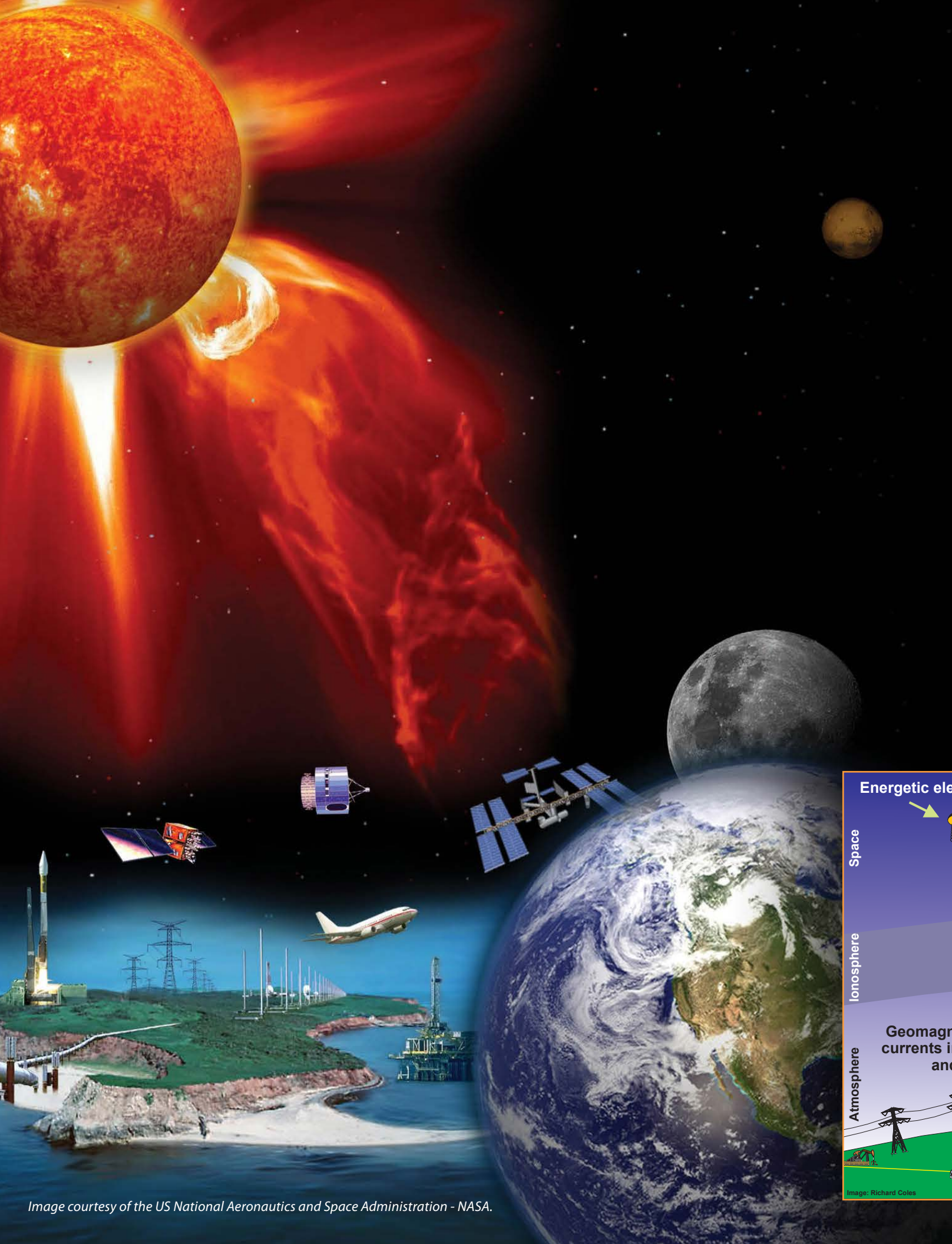


Image courtesy of the US National Aeronautics and Space Administration - NASA.

What happened during the Hydro-Quebec blackout?

A geomagnetic storm generated electrical currents in the Hydro-Quebec power lines, causing protective devices to take sections of the grid off-line. This tripped other protective devices and, in a quick succession of events, the entire system went down.



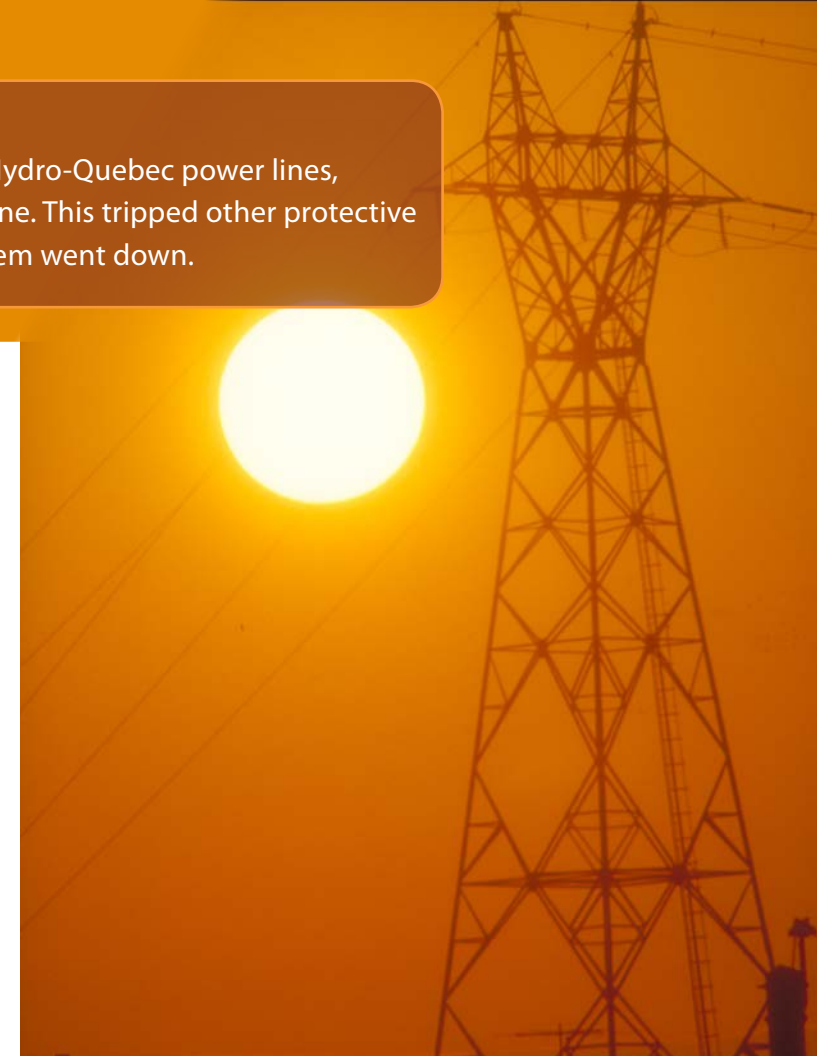
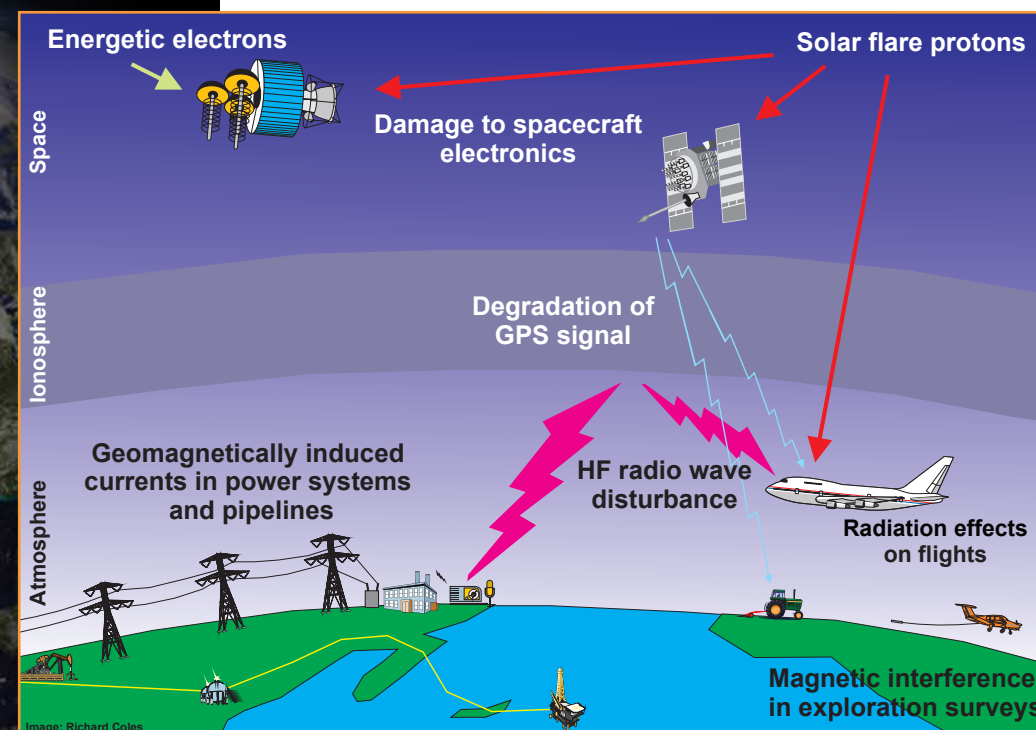
Measuring current in a buried pipeline.

Protecting power systems

Natural Resources Canada conducts specific research related to power systems. Power utility companies use this research to continually improve their operating procedures so that the impact of geomagnetic disturbances on power grids is minimized. Power companies can also use space weather forecasts from Natural Resources Canada to closely monitor geomagnetic storms.

Space weather effects on pipelines

Pipelines are another type of long conductor affected by electrical currents produced by geomagnetic storms. Pipelines are coated and fitted with corrosion protection devices that keep the pipeline in a safe voltage range so that corrosion is prevented or at least minimized. A geomagnetic storm will boost voltages on the pipeline and compromise operation of corrosion protection devices. The effect on the pipeline is cumulative and can significantly shorten its lifespan. Monitoring of the pipeline and the performance of the protective devices helps to reduce the risk of corrosion leading to a leak and environmental damage.



Impacts on polar flights

Streams of energetic particles produced during a geomagnetic storm enter the ionosphere (the upper part of the atmosphere made up of ions and electrons) around the magnetic poles and ionize molecules to form electrons and positive ions. The increased number of electrons at lower altitudes causes the ionosphere to absorb, instead of reflect, radio signals near the poles — so radio signals are weak. Radio communications in the Arctic can be disrupted from days to weeks at a time, causing aircraft flying over the North Pole to have limited radio contact. Airlines use forecasts and monitoring of geomagnetic storms to determine whether their pilots should take alternate routes during these events.

Image courtesy of
NASA.



Did you know?

**There are more than
8,000 flights per year
over the North Pole.**

**Impacts on satellites and
GPS navigation**

Disturbances in the ionosphere can also decrease the precision of locations determined by Global Positioning Systems (GPS) used for navigation in ships, aircraft, and vehicles.

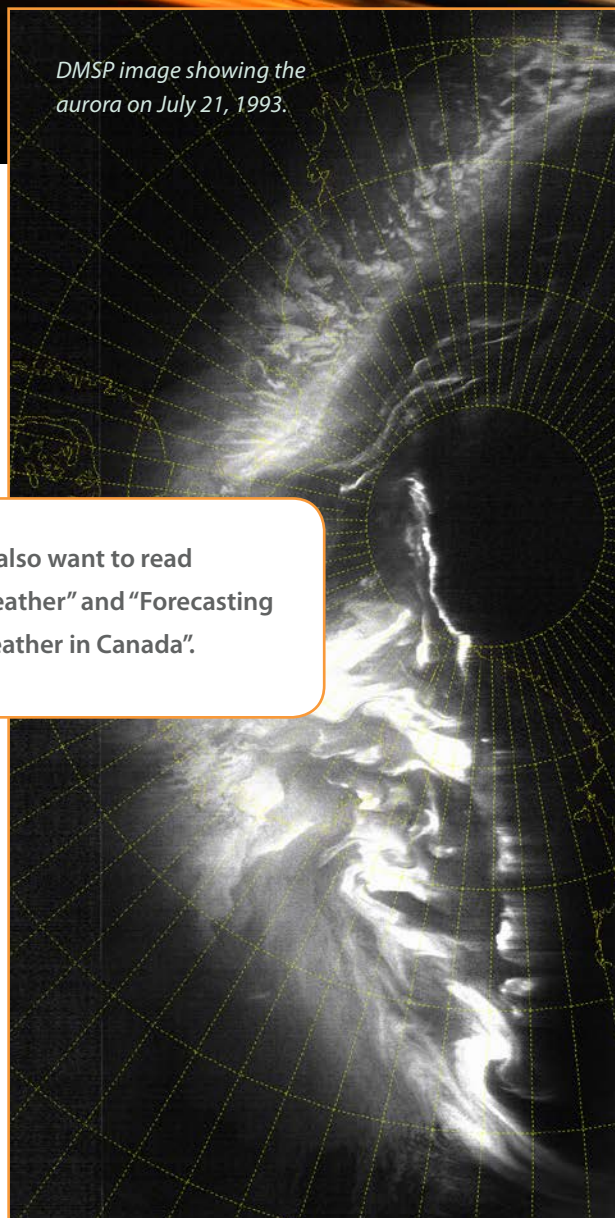
Satellites are particularly sensitive to space weather effects and may experience radiation damage, memory upsets, or phantom commands. One example is a space weather disturbance on January 20, 1994, that caused the failure of the Anik E1 and E2 satellites, Canada's main communications satellites. The failure caused loss of cable television service, failed transmission between media outlets, and a loss of telephone service in northern Canada.

What can we do?

Space weather forecasts from Natural Resources Canada provide crucial information for anyone who might be impacted by geomagnetic storms. Pipeline, power, and communication companies can prepare their systems to be more robust and resilient to the effects of space weather. Directional drilling, cadastral surveying, and magnetic surveying companies can monitor geomagnetic activity and forecasts, suspend operations if needed, and plan operations accordingly. Individuals can prepare themselves for the inconvenience of a power outage or communication breakdown by having an emergency plan and kit prepared. The Public Safety Canada website (getprepared.ca) ***Is Your Family Prepared?*** has excellent advice on what to include in an emergency plan and an emergency kit, both of which can be put to good use in any natural disaster or emergency.

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.

DMSP image showing the
aurora on July 21, 1993.



**You may also want to read
"Space Weather" and "Forecasting
Space Weather in Canada".**

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