

## Space Weather

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### Abstract

The magnetic field of the Earth is influenced by the electromagnetic environment of the solar system. The disturbed interplanetary environment changes the conditions of the natural electromagnetic environment of our planet and affects normal operation of space and ground technological infrastructures, such as power grids and pipelines. This map shows the areas of Canada where ground infrastructure is most affected by space weather.

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Space weather phenomena have a variety of disruptive and damaging effects on technology. Energetic particles thrown out from the Sun interact with the Earth's magnetic field producing magnetic disturbances and increased ionization in the ionosphere, 100 to 1000 kilometres above the Earth.

The magnetic disturbances directly affect operations that use the magnetic field, such as magnetic surveys, directional drilling, or compass use. Magnetic disturbances also generate natural electric (telluric) currents in long conductors such as power lines and pipelines causing power system outages or excessive pipeline corrosion. Magnetic disturbances also affect satellite and radio communications.

### Geomagnetic Activity

Geomagnetic activity can be described by the sizes of the disturbances in the Earth magnetic field and how often they occur. Geomagnetic activity depends on the geographic location of the observing point. It is defined by the geometry of the Earth's geomagnetic field and its interaction with both the charged particles produced by the Sun and the solar/interplanetary magnetic field fluctuations. Canadian territory covers three zones of geomagnetic activity: the polar cap (north of Cambridge Bay), the auroral zone (between Cambridge Bay and Meanook) and the subauroral zone (south of Meanook). The highest geomagnetic activity is observed in the auroral zone.

Normal geomagnetic activity is below 100 nanoTeslas and, in the middle of the sub-auroral zone (such as at Ottawa), occurs 99.5 percent of the year. In the middle of the auroral zone (such as at Yellowknife), the normal level of geomagnetic activity occurs only 75 percent of the year.

## Telluric Activity

The geomagnetically induced currents that directly affect vulnerable infrastructure are driven by the geoelectric (telluric) field. Therefore, the most important task in space weather hazard mapping is to identify the areas with different levels of telluric activity. On the map, telluric activity is defined as the annual percentage of the time when variations in the activity is above the normal level of 20 milliVolts per kilometre. Elevated telluric activity occurs for a quarter of the year in the auroral zone, whereas it varies from 15 percent (4.5 times per month) down to just a few percent (1 occurrence per two months) in the Prairies. It is interesting to note that most of the big cities in Canada, and therefore much of the infrastructure, are in the least tellurically active zone (less than 10 percent).

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## Definitions of underlined terms

**nanoTesla:** Unit of measure of the magnetic flux density

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## Map Sources

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Seismology and Geomagnetism, Geological Survey of Canada, 2006.

## References

Boteler, D.H 2001. Assessment of geomagnetic hazard to Canadian power systems. J. Natural Hazards, 23, 101-120, 2001

Boteler, D.H. 2003. Geomagnetic hazards to conducting networks. J. Natural Hazards, 28, Issue 2-3, 537-561, March 2003

Daglis, I. A. (ed.) 2001. Space Storms and Space Weather Hazards. Kluwer Academic Publishers, The Netherlands, 2001

Fernberg, P.A., Trichtchenko, L., Boteler, D.H., McKee, L. 2007. Telluric hazard assessment for northern pipelines. Paper No 07654, Proc. NACE CORROSION/2007, March 2007

Lilensten, J , J. Bornandel 2006. Space Weather, Environment and Societies. Springer, The Netherlands, 2006

Song, P., H.J.Singer and G.L.Siscoe (eds.) 2001. Space Weather. Geophysical Monograph, AGU, Washington, 2001

## **Related Web sites (1999 – 2009)**

### **Federal Government**

Natural Resources Canada. Geomagnetism  
<http://gsc.nrcan.gc.ca/geomag/>

Natural Resources Canada. Space Weather Canada  
<http://www.spaceweather.gc.ca/>

Public Safety Canada. Family Preparedness  
<http://www.getprepared.gc.ca/index-eng.aspx>

This site has comprehensive information on what the risks are, what you can do to get ready and how to respond in an emergency.

### **Other**

Hydro-Québec. Electricity in nature  
<http://www.hydroquebec.com/learning/quest-ceque/nature/tempetes.html>

