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Statistical analysis of extreme values for geomagnetic and geoelectric field variations for Canada

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Disturbances of the geomagnetic field produced by space weather events cause variable geoelectric fields at Earth's surface which drive electric currents in power systems, resulting in hazardous impacts on electric power transmission. In extreme cases, as during the magnetic storm in March 13, 1989, this can result in burnt-out transformers and power blackouts.

To make assessment of geomagnetic and geoelectric activity in Canada during extreme space weather events, extreme value statistical analysis has been applied to more than 40 years of magnetic data from the Canadian geomagnetic observatories network. This network has archived digital data recordings for observatories located in sub-auroral, auroral, and polar zones. Extreme value analysis was applied to hourly ranges of geomagnetic variations as an index of geomagnetic activity and to hourly maximum of rate-of-change of geomagnetic field.

To estimate extreme geoelectric fields, the minute geomagnetic data were used together with Earth conductivity models for different Canadian locations to calculate geoelectric fields. The extreme value statistical analysis was applied to hourly maximum values of the horizontal geoelectric field.

This assessment provided extreme values of geomagnetic and geoelectric activity which are expected to happen once per 50 years and once per 100 years. The results of this analysis are designed to be used to assess the geomagnetic hazard to power systems and help the power industry mitigate risks from extreme space weather events.