

Space Weather Science and Research Advances from the Heliophysics Science Community

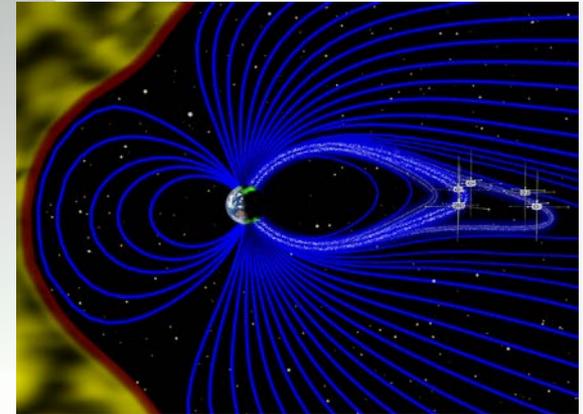
In [a paper](#) using data from [NASA's Heliophysics THEMIS mission](#), scientists were able to map the variations in magnetic field lines out in the [magnetosphere](#) to auroral movements in the sky over Canada and to geomagnetic disturbances down on the ground for the first time. Scientists used all-sky cameras on the ground to image the brightening and dimming of the aurora while simultaneously using magnetic sensors to collect ground-based observations of the electrical currents during the geomagnetic [substorm](#). Until this event, the five THEMIS probes had never been positioned in the right place above the network of ground-based sensors to collect data during a substorm. This allowed scientists to coordinate data showing how geomagnetic disturbances in our magnetosphere connect down to the ground.

Scientists have hypothesized that oscillating magnetic field lines guide the aurora. These observations supported this hypothesis as scientists found that [the aurora moved in harmony with the vibrating field line](#). The magnetic field lines oscillated in a roughly six-minute cycle, or period, and the aurora brightened and dimmed at the same pace.

Earlier this month, Heliophysics Director, Steven Clarke, was interviewed by local [News Channel 4 in Detroit](#) on how solar and geomagnetic storms have impacted and can impact Earth. Clarke referenced [a 1989 event in Quebec, Canada](#) where significant power loss was observed due to a large solar storm. From the moment Quebec's power grid was impacted by the geomagnetic disturbances driven by the solar storm to full blackout conditions for the entire province was about 2 minutes. The blackout which occurred in March and lasted for 12 hours, leaving people stranded underground on subways, closing schools and airports, and leaving homes without heat.

The United States was also affected by this event, with over 200 power grid problems erupting as a result of the solar storm hitting our power lines. In space, some satellites tumbled out of control for several hours, including NASA's TDRS-1 communication satellite, which recorded over 250 anomalies as high-energy particles penetrated the satellite's sensitive electronics.

Space weather events like the Quebec event will happen again. The international Heliophysics science community is working to incorporate what we are learning about the physics of space weather into models and tools that could be used to predict geomagnetic activity. Earlier this month, researchers with the USGS and NASA published the first ever ["geolectric hazard" map](#) for large parts of the United States. Traditionally, only local recommendations were available for making power grids safe or providing short-term predictions. This new map is focused on the area in the country scientists believe will be the most vulnerable during a large solar storm event: the northern edge of the Midwest and in particular, Minnesota and Wisconsin. These areas are more susceptible due to the geography of Earth's magnetic field and the composition of the Earth's crust in this part of the country, where the sediment is a mix of sedimentary and igneous rock. This geological composition creates strong conditions for electrical conductivity. This new map and the important advances the Heliophysics science community is making in space weather research and technology are helping us prepare for our next big solar storm – which could happen at any time.



This is an artist's rendition of the five Themis probes collecting data in Earth's magnetosphere seen in the right-hand side of the image. Credits: Emmanuel Masongsong/UCLA EPSS/NASA