Magnetotelluric data helps in assessing geophysical risks for power grids

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Geoelectric field and GIC

- Space weather causes variations in ionospheric currents which induce electric fields in the conducting ground
- These fields can drive intense geomagnetically induced currents (GIC) in power grids
- In worst cases they can cause wide blackouts:
  - ➔e.g. Québec (Canada) March 1989, Malmö (Sweden) October 2003

Geoelectric field modeling

- Direct measurements are sparse. Modeling requires:
  - ➔accurate information on the 3-D ground conductivity (e.g. from Magnetotelluric (MT) measurements)
  - ➔dense network of magnetometer measurements (e.g. IMAGE, Fig. 1) to calculate the ionospheric driver

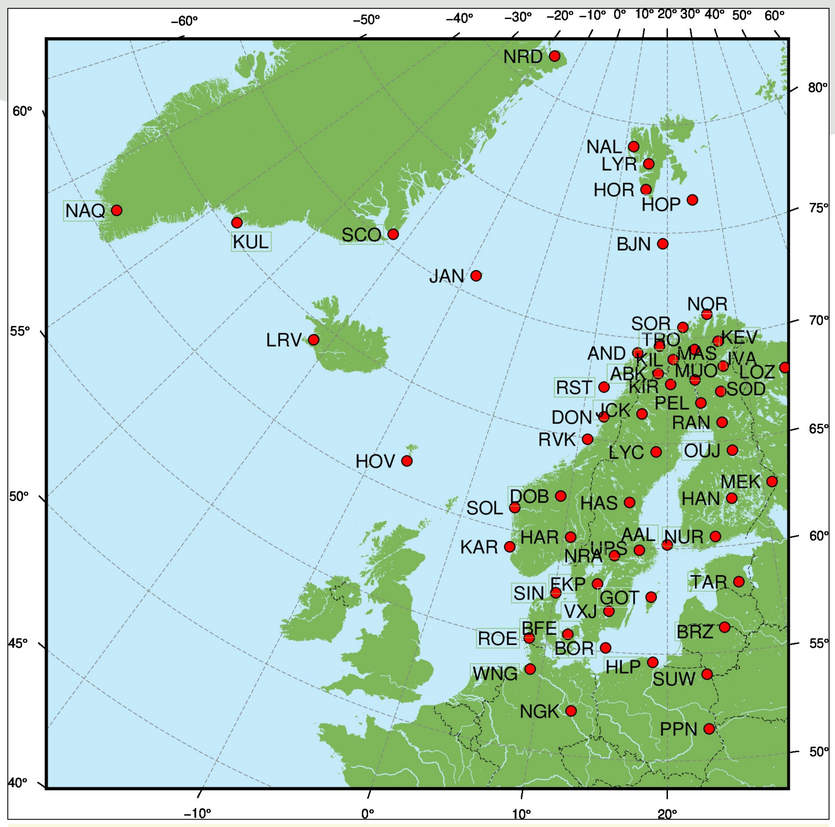

Figure 1. Stations part of the IMAGE (International Monitor for Auroral Geomagnetic Effects) magnetometer network in Feb 2023.

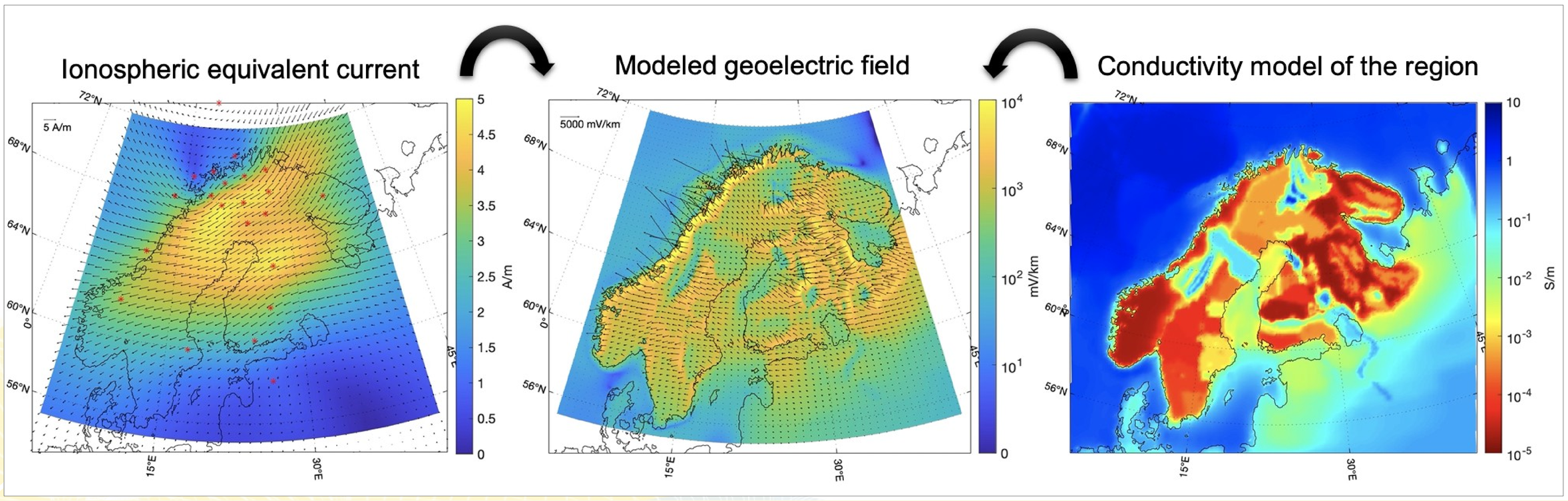

Figure 2. Geoelectric field modeling (center panel) requires an ionospheric source (left panel) and a conductivity model of the region (right panel).

- Kruglyakov, M., and Kuvshinov, A. (2018). Using high-order polynomial basis in 3-D EM forward modeling based on volume integral equation method. Geophys. J. Int., 213 (2), 1387–1401. https://doi.org/10.1093/gji/ggy059.
- Korja, T. et al. (2002) Crustal conductivity in Fennoscandia. https://doi.org/10.1186/BF03353044

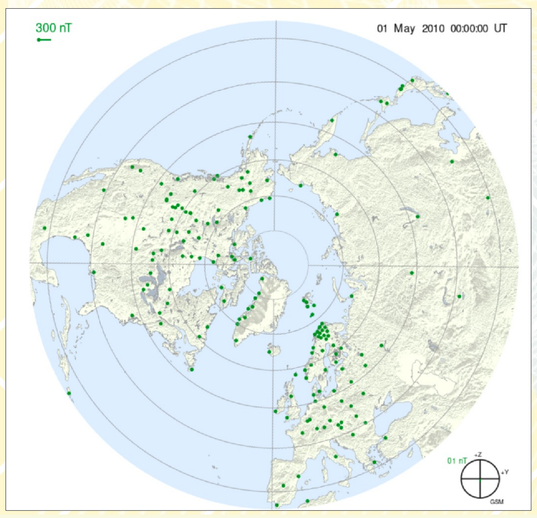

Figure 3. Magnetometer stations that are part of the SuperMAG collaboration (2010).

Data availability, Europe vs. North America

- North Europe has good coverage of MT measurements and FAIR magnetometer data
- North America has a dense array of MT measurements (USArray), but magnetometers are sparse (Fig. 3)
- ➔**Europe: centralized and FAIR access to MT data and ground conductivity models is needed**
- ➔Better preparedness for space weather risks

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