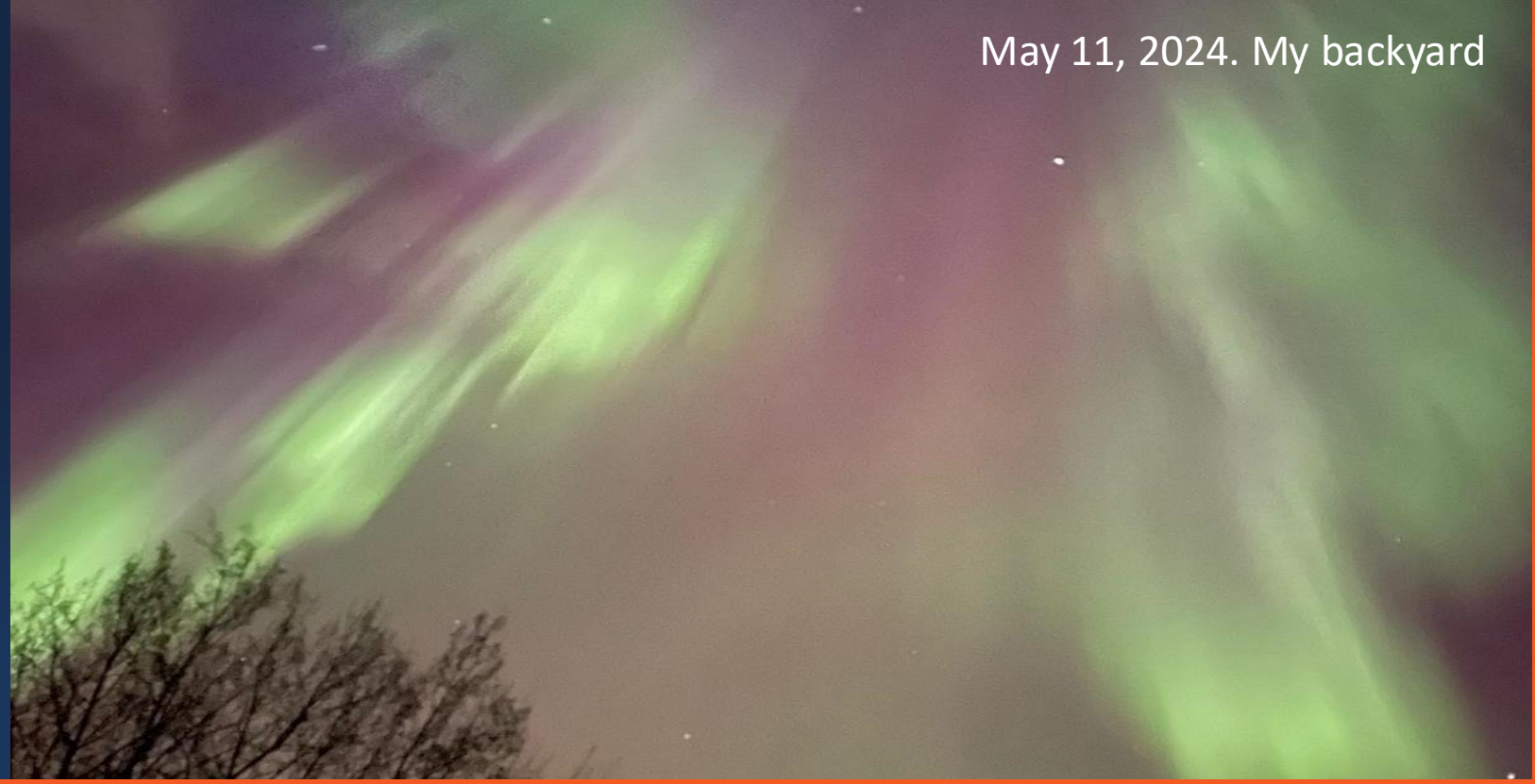

Geophysics for space weather hazards in Canada

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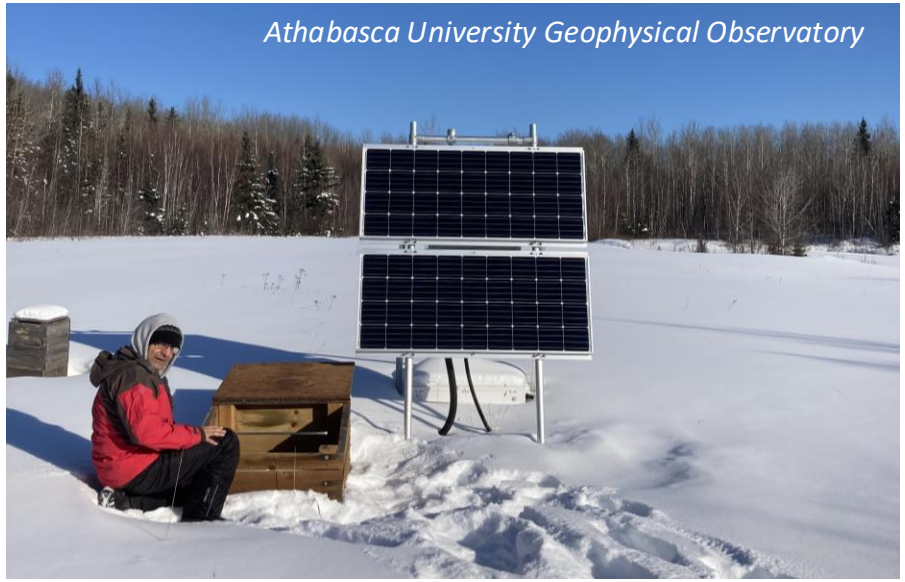
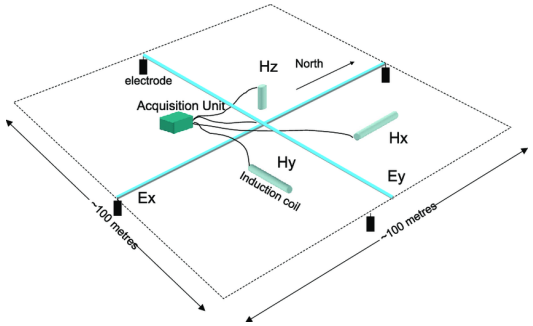
[1]Centre for Science, Faculty of Science and Technology, Athabasca University

Geophysics for Geological Applications

- Fieldwork to collect geoelectric and geomagnetic data
- Data tell you where conductors and resistors are underground
- Method known as “magnetotellurics” (MT)

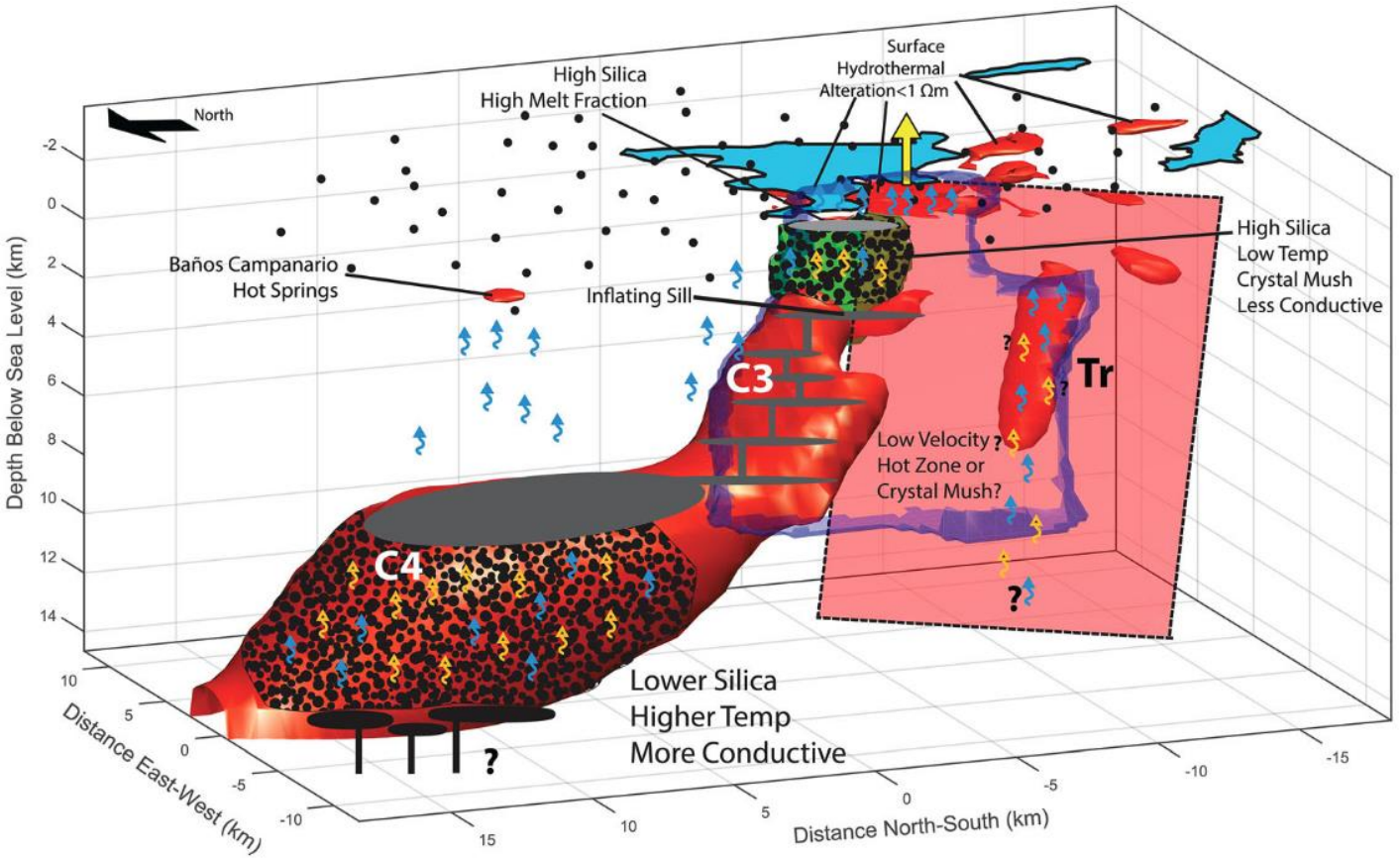


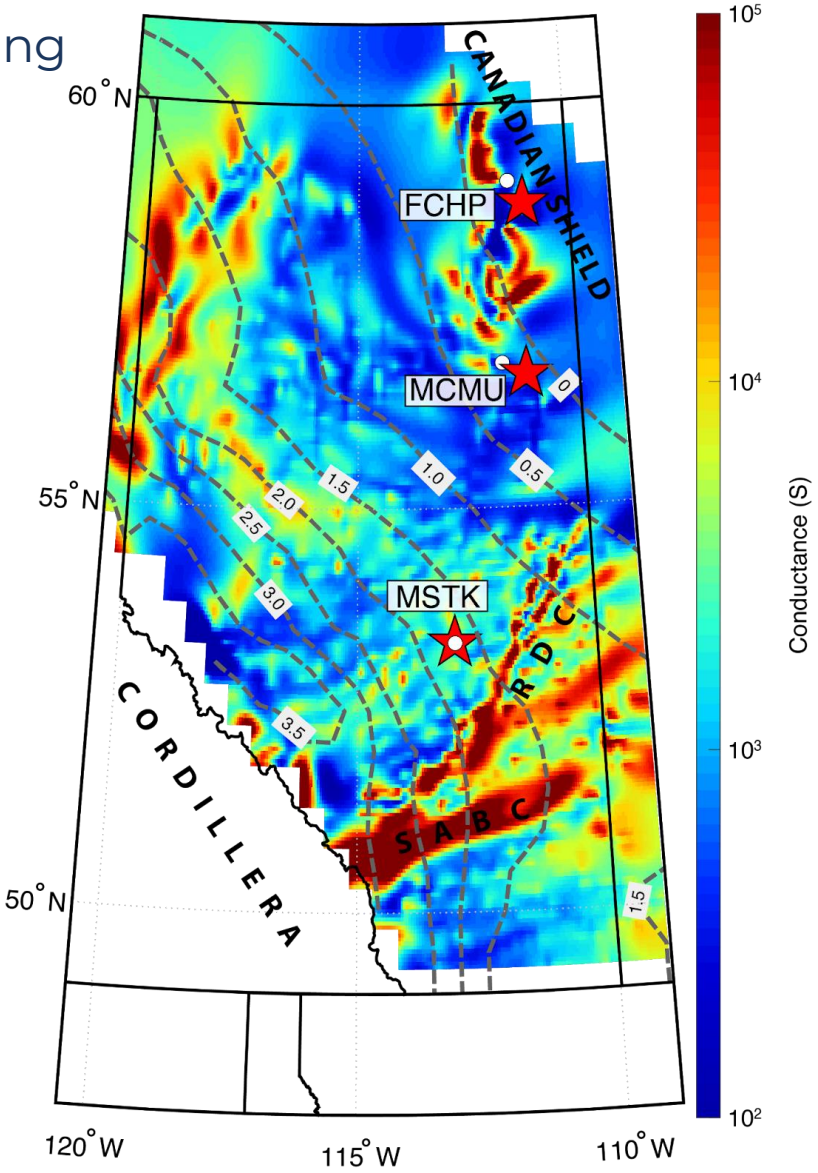


Hobbs & Jones (2020)

Geophysics for Geological Applications

- Electromagnetic geophysical modelling using cluster computing
- Determine 3-D ground conductivity for mining exploration, volcano hazards, geothermal exploration





Background: Space Weather

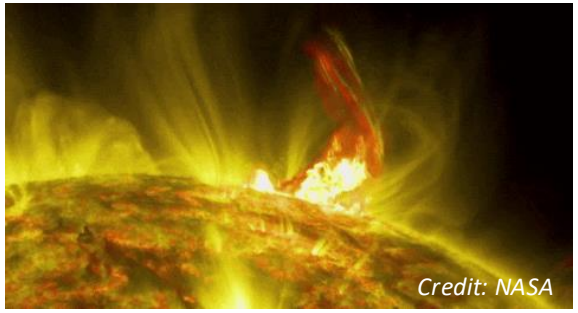
Energy Input → **GMD** → **Geoelectric Fields** → **GIC**

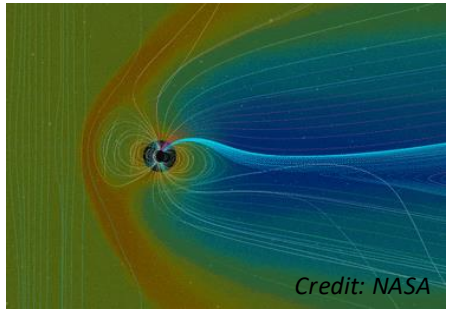
e.g. Coronal Mass Ejections
Where: Sun
Who: Heliophysics

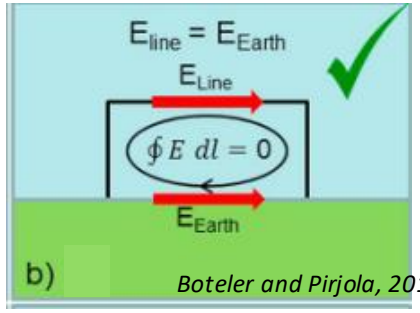
Geomagnetic Disturbance
Where: Near Earth
Who: Space Physics

The Induction
Where: Earth
Who: Geophysics

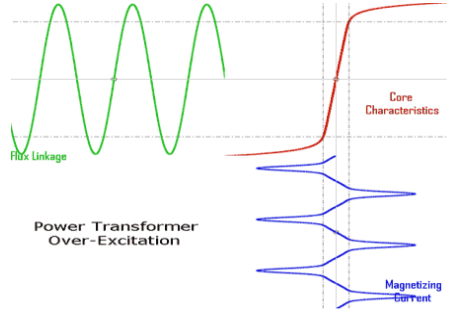
Geomagnetically-Induced Currents
Where: Power Networks
Who: Electrical Engineering







Boteler and Pirjola, 2017



Background: Space Weather

- March 1989: Hydro-Québec outage
  - 6 million people without electricity for 9 hours
  - ~$15 million in damages

- Carrington Event of 1859
  - Largest known geomagnetic storm
  - Telegraph network disruptions
  - Estimates that similar event could cost $billions today


MONEY

The Gazette

MONTREAL TUESDAY MARCH 14 1989 FINAL 50¢

Canada bans fresh fruit and vegetables from Chile

Hydro blames sun for power failure

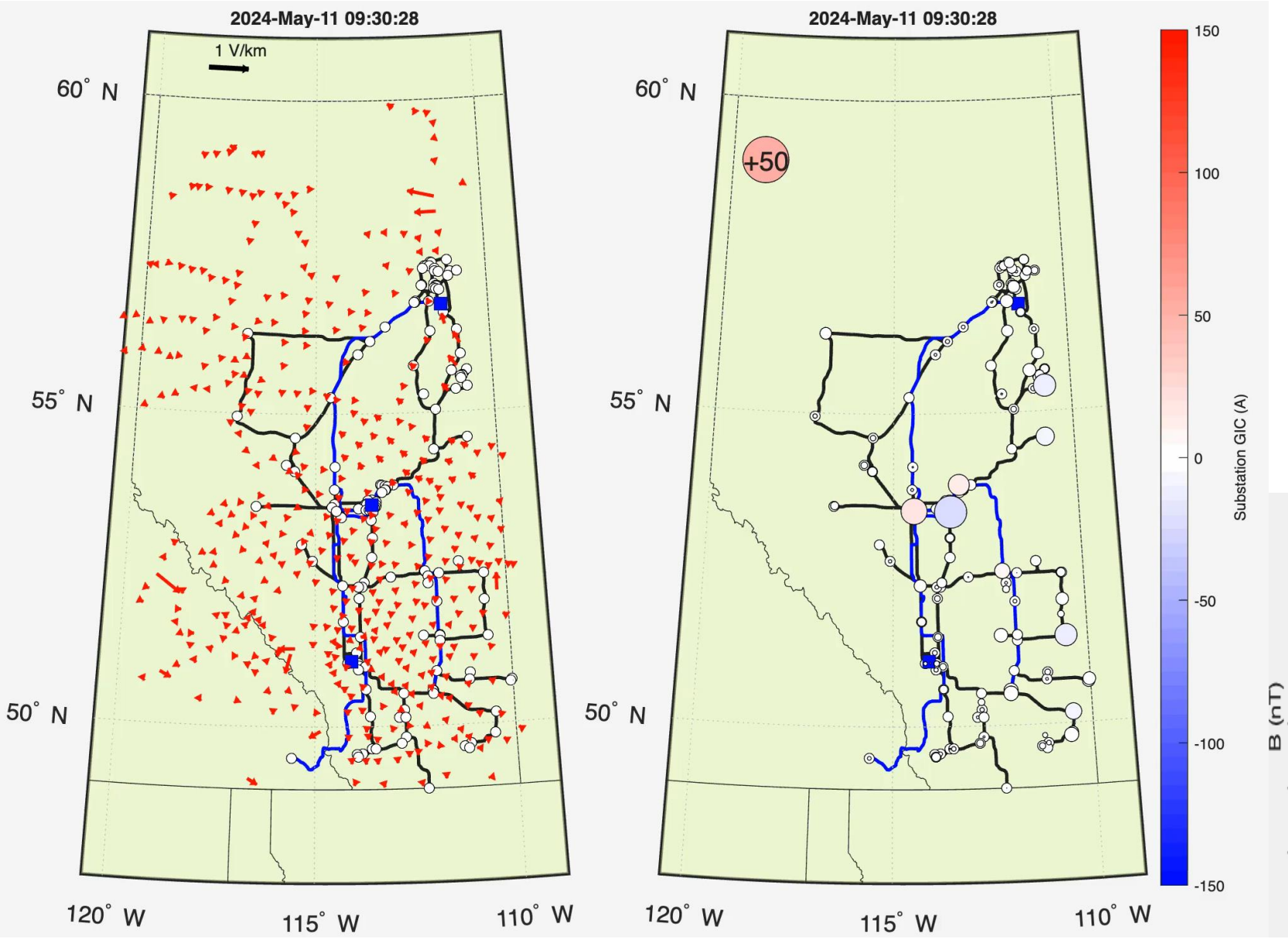
It says solar storm overloaded system

QUEBEC

We're sorry for the delay

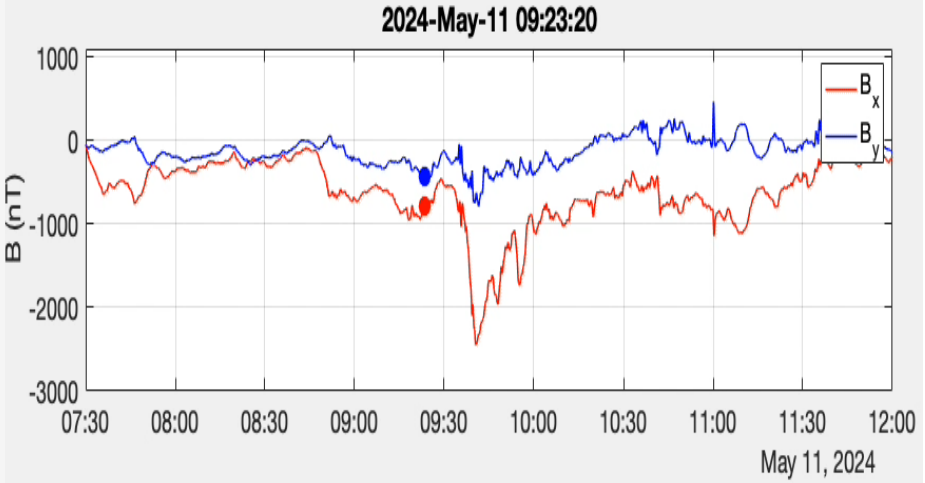
Montreal Gazette, March 14, 1989

May 10-12, 2024



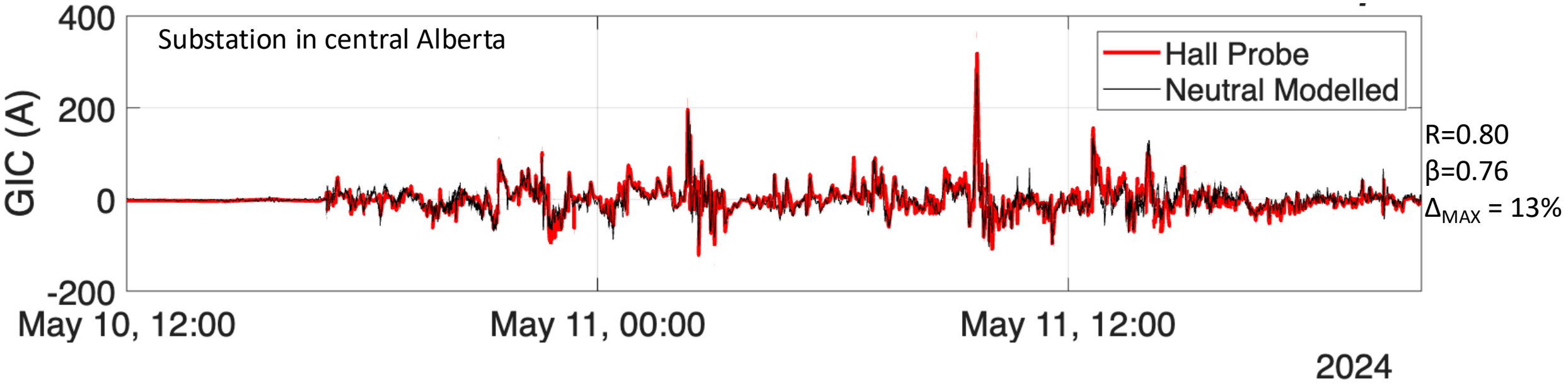
- Physics-based model requires:
  - Magnetic observatory data
  - Geophysical data for ground conductance
  - Power network parameters

- Results:
  - Geoelectric field
  - GICs



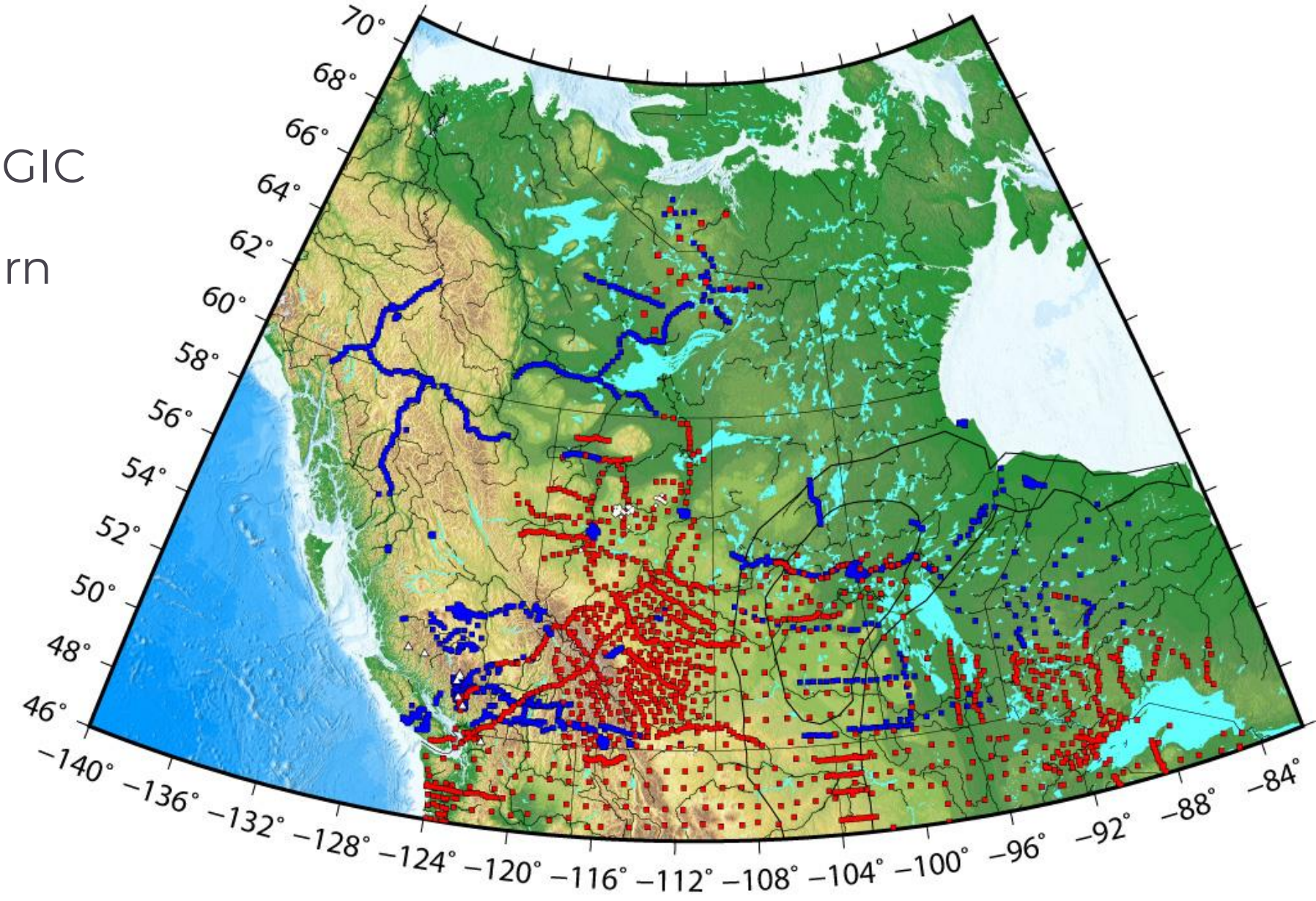
May 10-12, 2024

~50 A/phase in each transformer



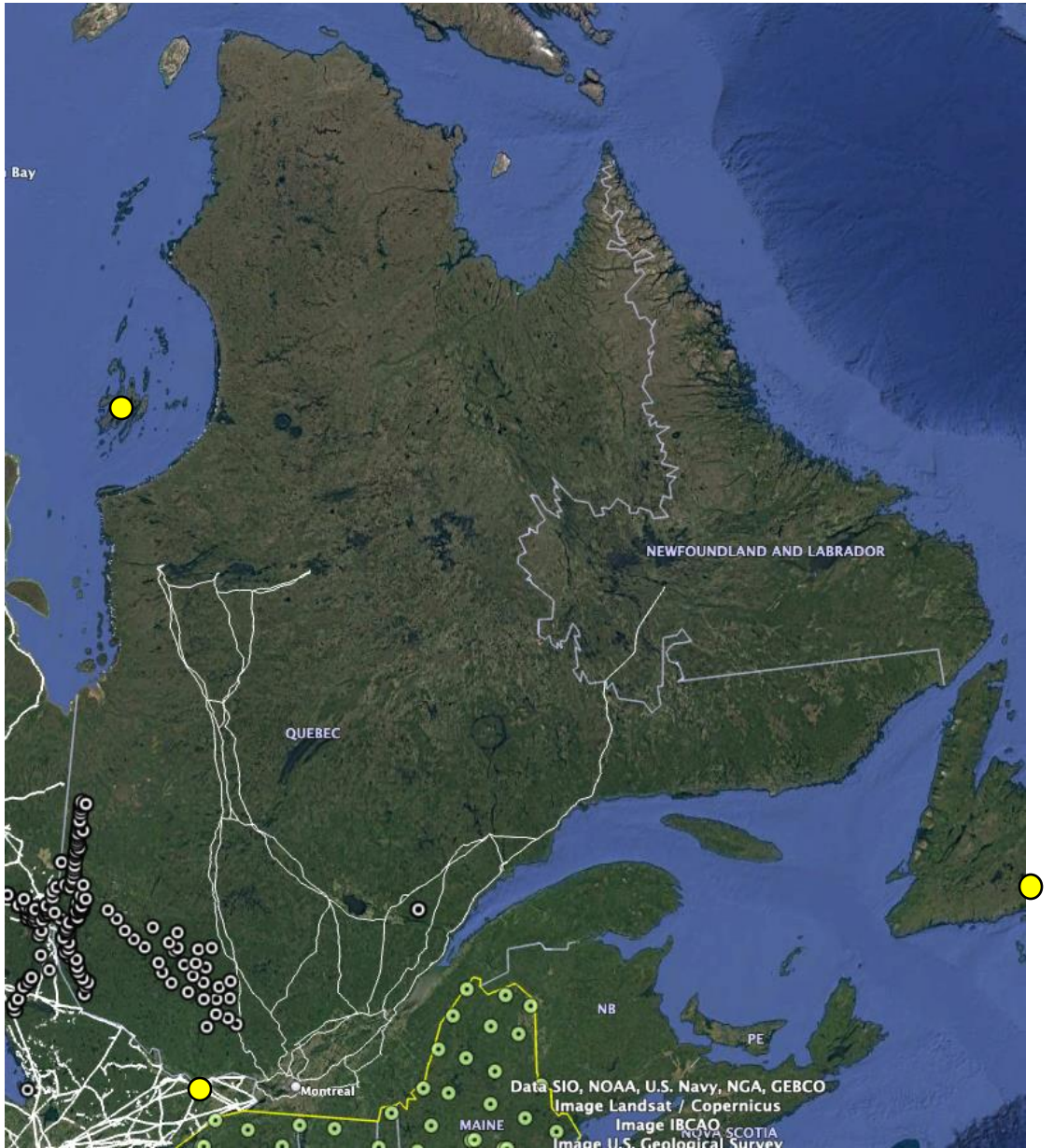
Future Projects

- Western Canada
- Geoelectric field and GIC estimates for hazard analysis across western Canada
- Space weather and geological interest



Future Projects

- Quebec
- Most infamous GIC impact
- No regional geophysical data at all
- Power industry and geology interest
- Geophysical field work
- Geophysical 3-D inverse modelling (cluster computing)



Future Projects

- TBs of geoelectric field measurements
- Better geoelectric field models using physics-based and ML models
- Ionospheric source modelling (FDTD methods)
- Ionospheric current estimation (PCA)
- Geoelectric field estimates based on upstream solar wind
- Benchmark models with measurements