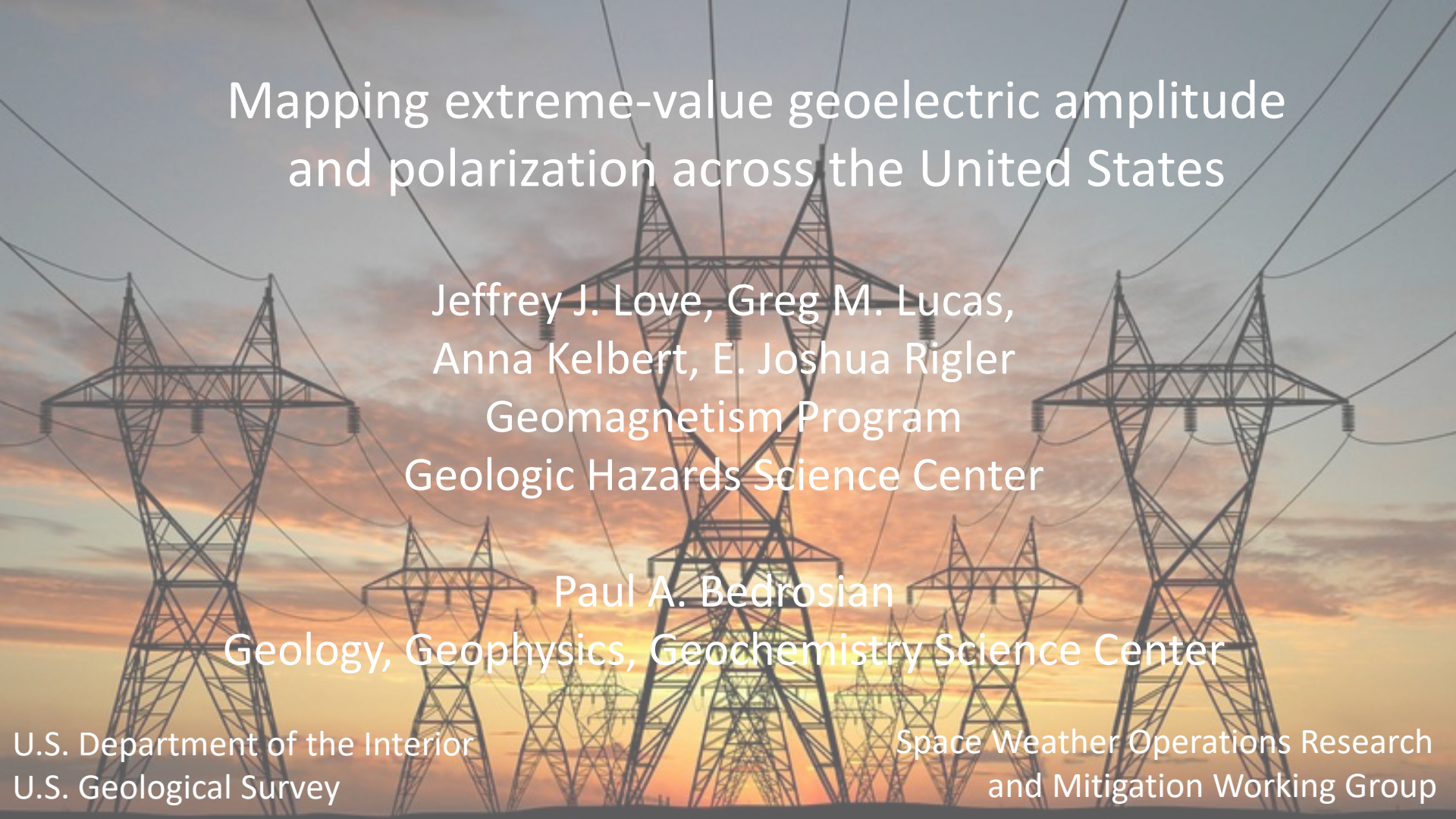


Mapping extreme-value geoelectric amplitude and polarization across the United States

Jeffrey J. Love, Greg M. Lucas,
Anna Kelbert, E. Joshua Rigler
Geomagnetism Program
Geologic Hazards Science Center

Paul A. Bedrosian
Geology, Geophysics, Geochemistry Science Center

U.S. Department of the Interior
U.S. Geological Survey

Space Weather Operations Research
and Mitigation Working Group

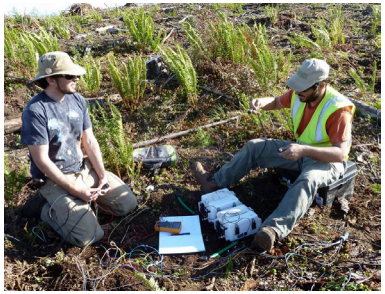
Input signal time series → Convolution through a filter → Output signal time series

Geomagnetic variation →

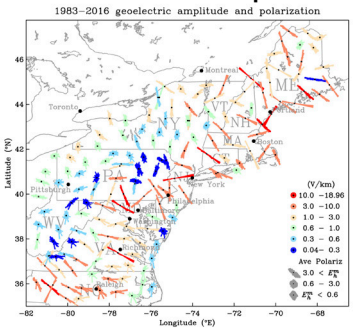
→ Geoelectric field

Geomagnetic variation recoded at observatory

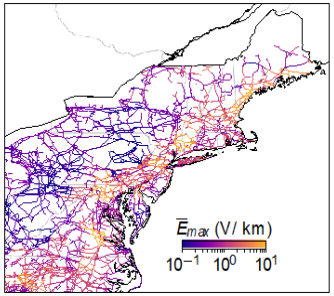
Impedance measured during magnetotelluric survey



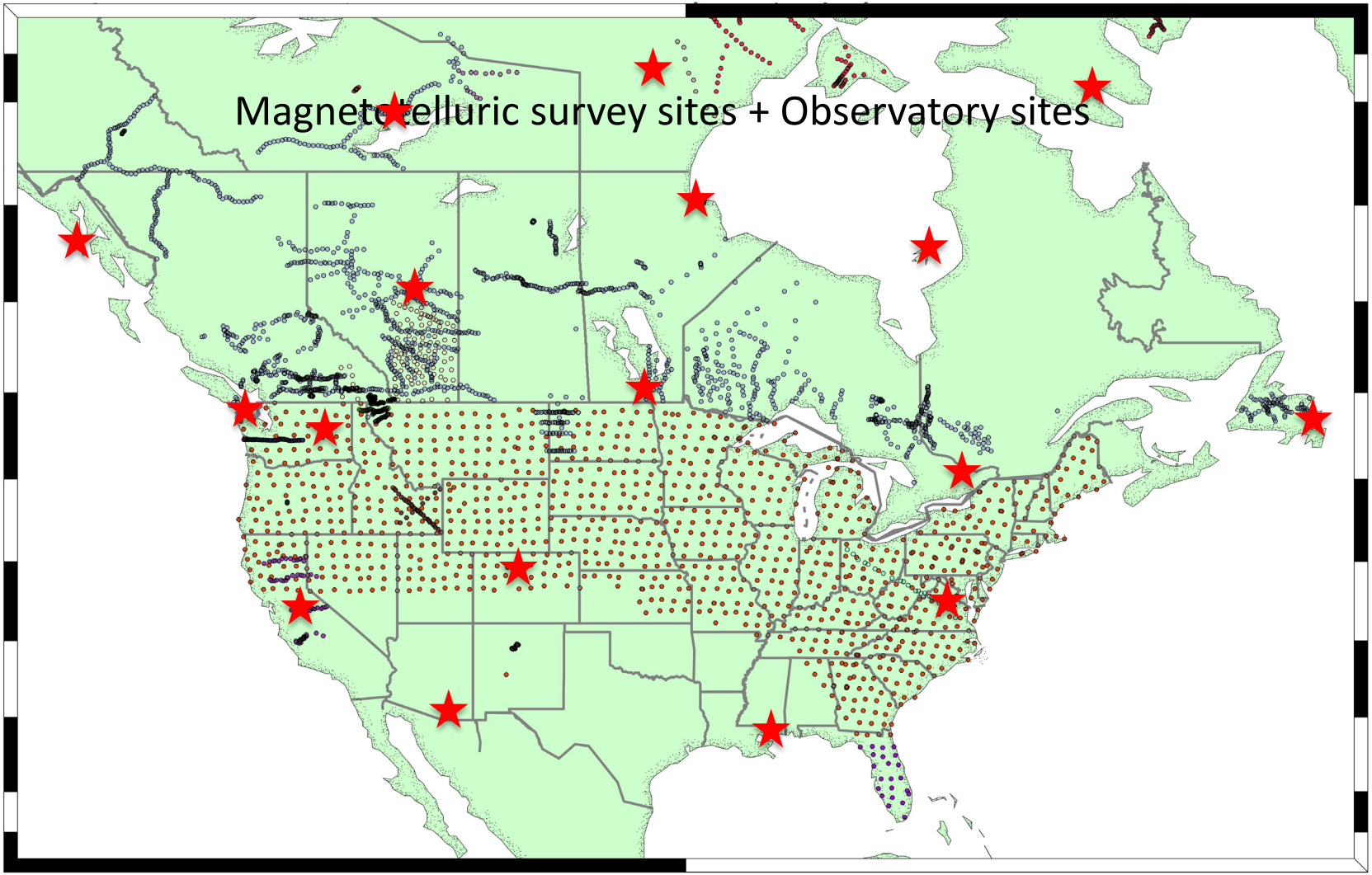
Statistical geoelectric hazard maps

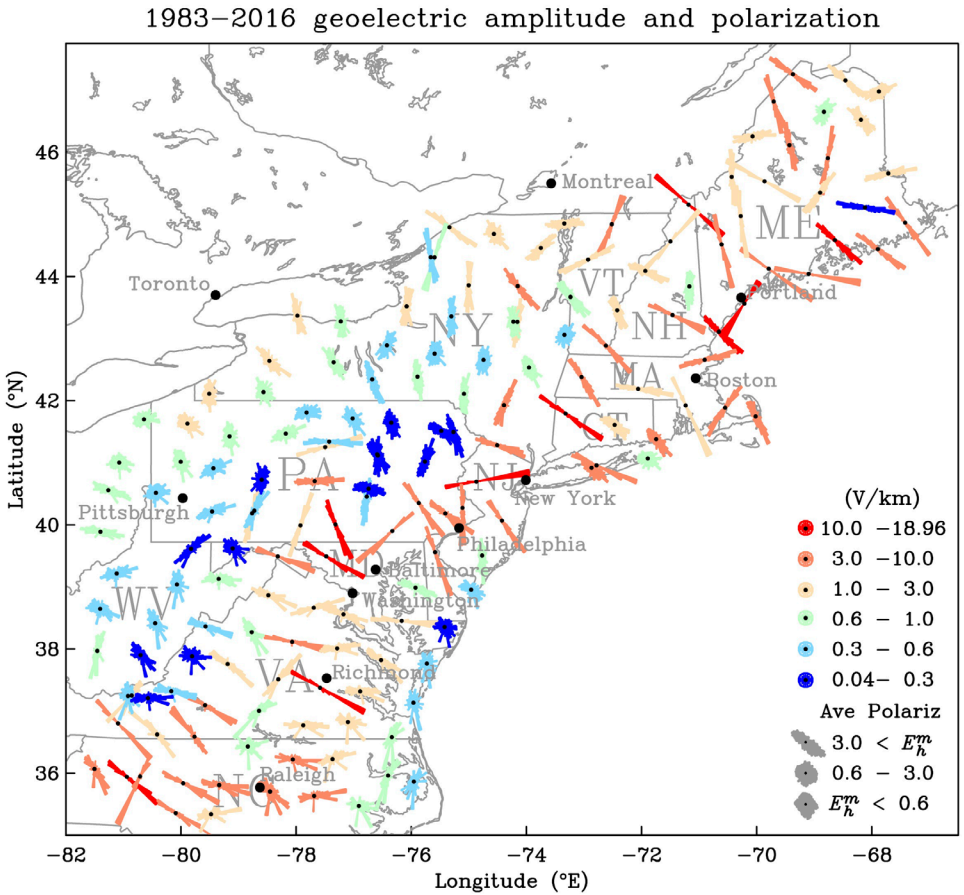


Geoelectric hazards mapped onto power grids



Love, J. J., Rigler, E. J., Pulkkinen, A., Balch, C. C., 2014.
Magnetic storms and induction hazards, Eos, Trans. AGU, 95(48), 445-446, doi10.1002/2014EO480001.


Magnetotelluric survey sites + Observatory sites



Map showing maximum geoelectric field, as a function of azimuthal direction (declination), realized at sites across the NE United States from 1983-2016.

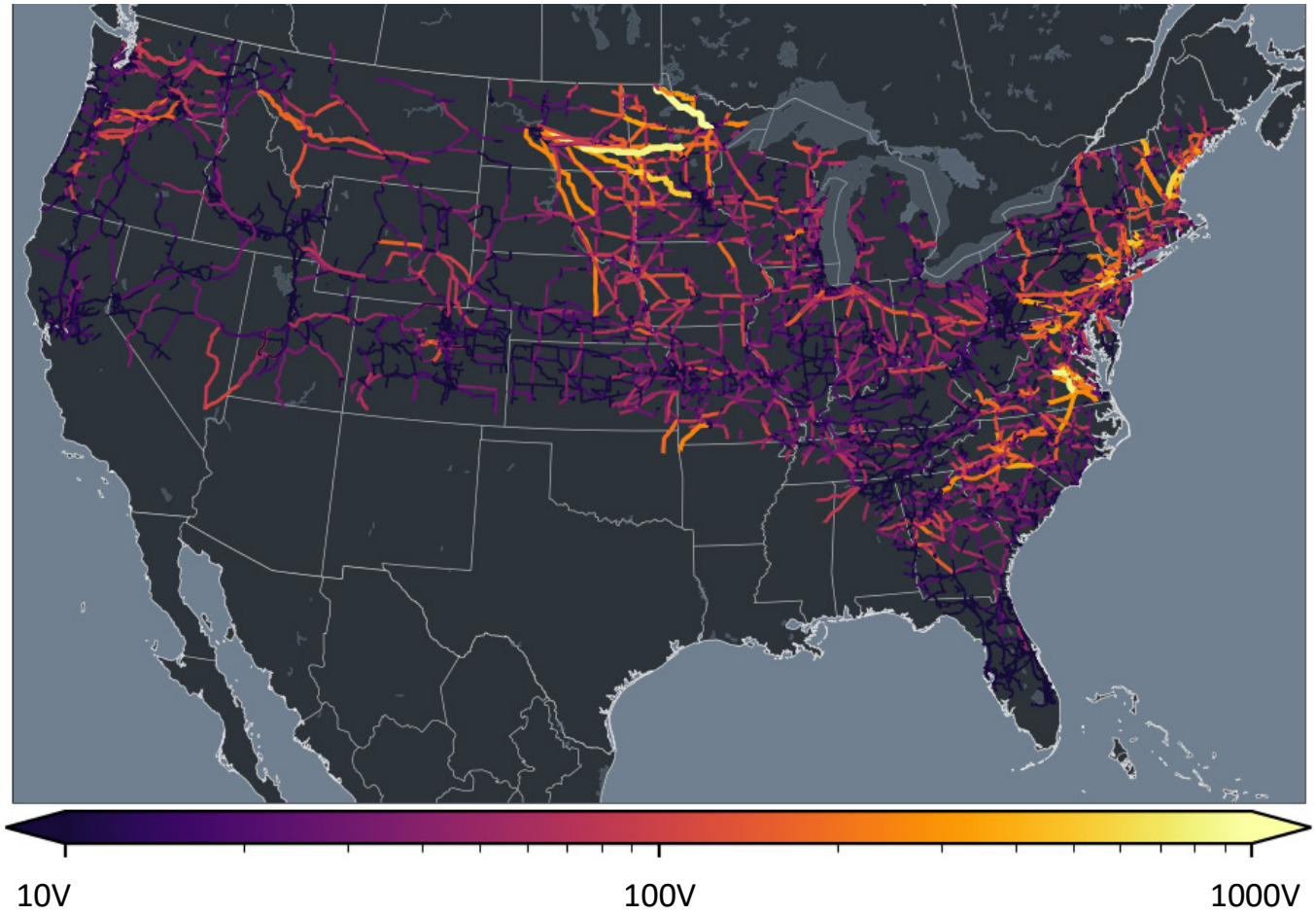
Geoelectric fields tend to be most (least) polarized at locations with high (low) geoelectric hazard.

High amplitude geoelectric fields tend to be polarized in a direction orthogonal to the strike of the Appalachian Mountains.

Results such as these illustrate the importance of solid-Earth conductivity structure (impedance) in estimating geoelectric hazards induced by magnetic storms.

Love, J. J., Lucas, G., Bedrosian, P. A. & Kelbert, A., 2019. Extreme-value geoelectric amplitude and polarization across the Northeast United States, Space Weather, 17(3), 379-395, doi:10.1029/2018SW002068.

100-year voltages on the U.S. power grid



Obtained by integrating geoelectric fields along power lines.

High hazards are notable in the Northern Midwest and in the East, near many major metropolitan centers.

Lucas, G., Love, J. J., Kelbert, A., Bedrosian, P. A. & Rigler, E. J., 2019. 100-year Geoelectric Hazard Analysis for the United States High-Voltage Power Grid, Space Weather, submitted.

Conclusions

- High geoelectric hazards are realized over metamorphic and igneous geological structures. Here the geoelectric fields tend to be highly polarized – the result of three-dimensional Earth structure.
- Low geoelectric hazards are realized over sedimentary basins, these are (sometimes) roughly one-dimensional in structure.
- Magnetotelluric surveys: The MT survey of the continental United States needs to be completed. A regular grid survey is needed in Canada. Some densification is needed in key spots in both US and Canada.
- Magnetic observatories: The United States needs to maintain the observatories that it has. Additional stations are needed in high-hazard areas, especially to support real-time mapping of geoelectric hazards.

Conclusions

- High geoelectric hazards are realized over metamorphic and igneous geological structures. Here the geoelectric fields tend to be highly polarized – the result of three-dimensional Earth structure.
- Low geoelectric hazards are realized over sedimentary basins, these are (sometimes) roughly one-dimensional in structure.
- Magnetotelluric surveys: The MT survey of the continental United States needs to be completed. A regular grid survey is needed in Canada. Some densification is needed in key spots in both US and Canada.
- Magnetic observatories: The United States needs to maintain the observatories that it has. Additional stations are needed in high-hazard areas, especially to support real-time mapping of geoelectric hazards.