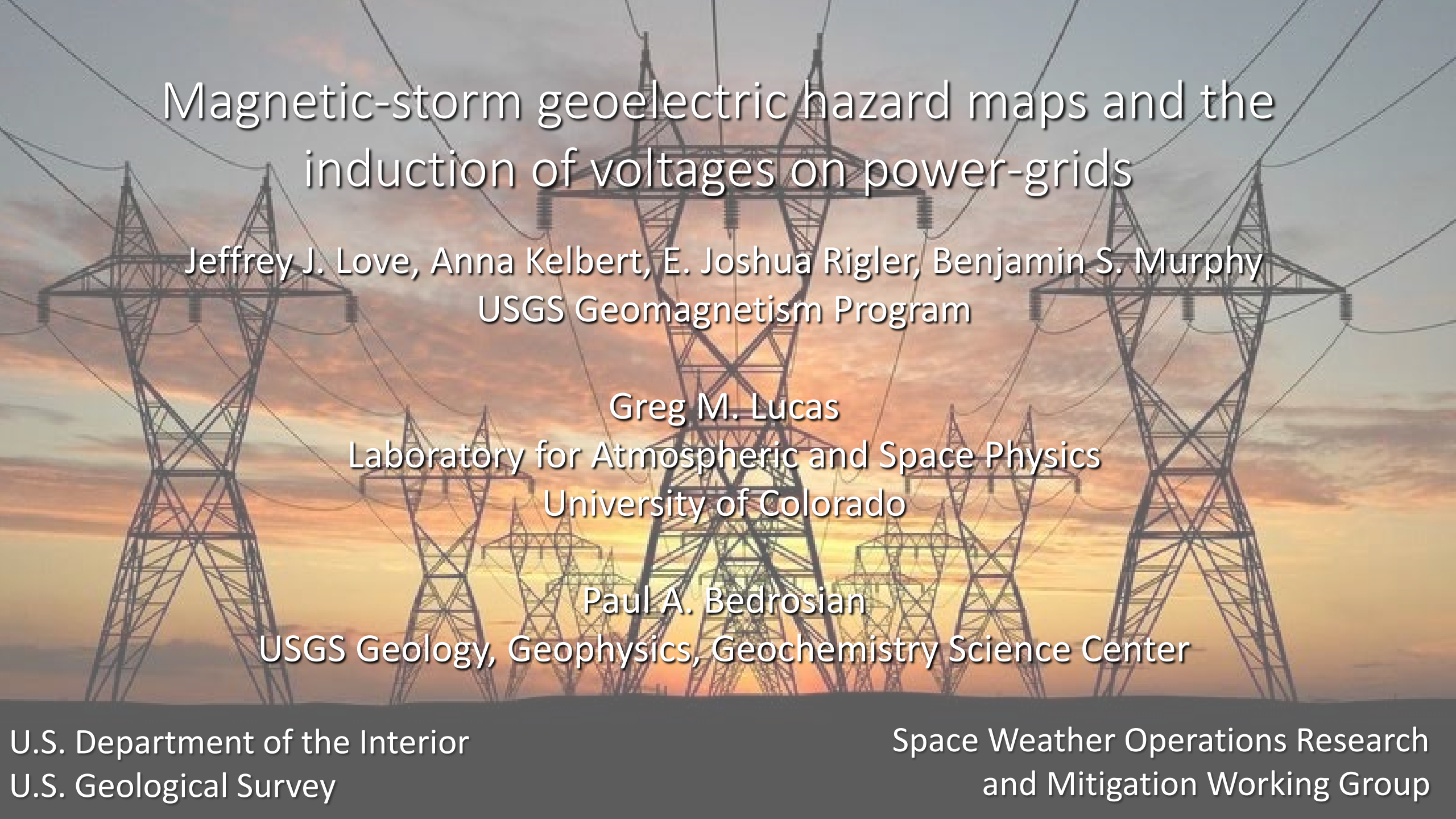


Magnetic-storm geoelectric hazard maps and the induction of voltages on power-grids

Jeffrey J. Love, Anna Kelbert, E. Joshua Rigler, Benjamin S. Murphy
USGS Geomagnetism Program

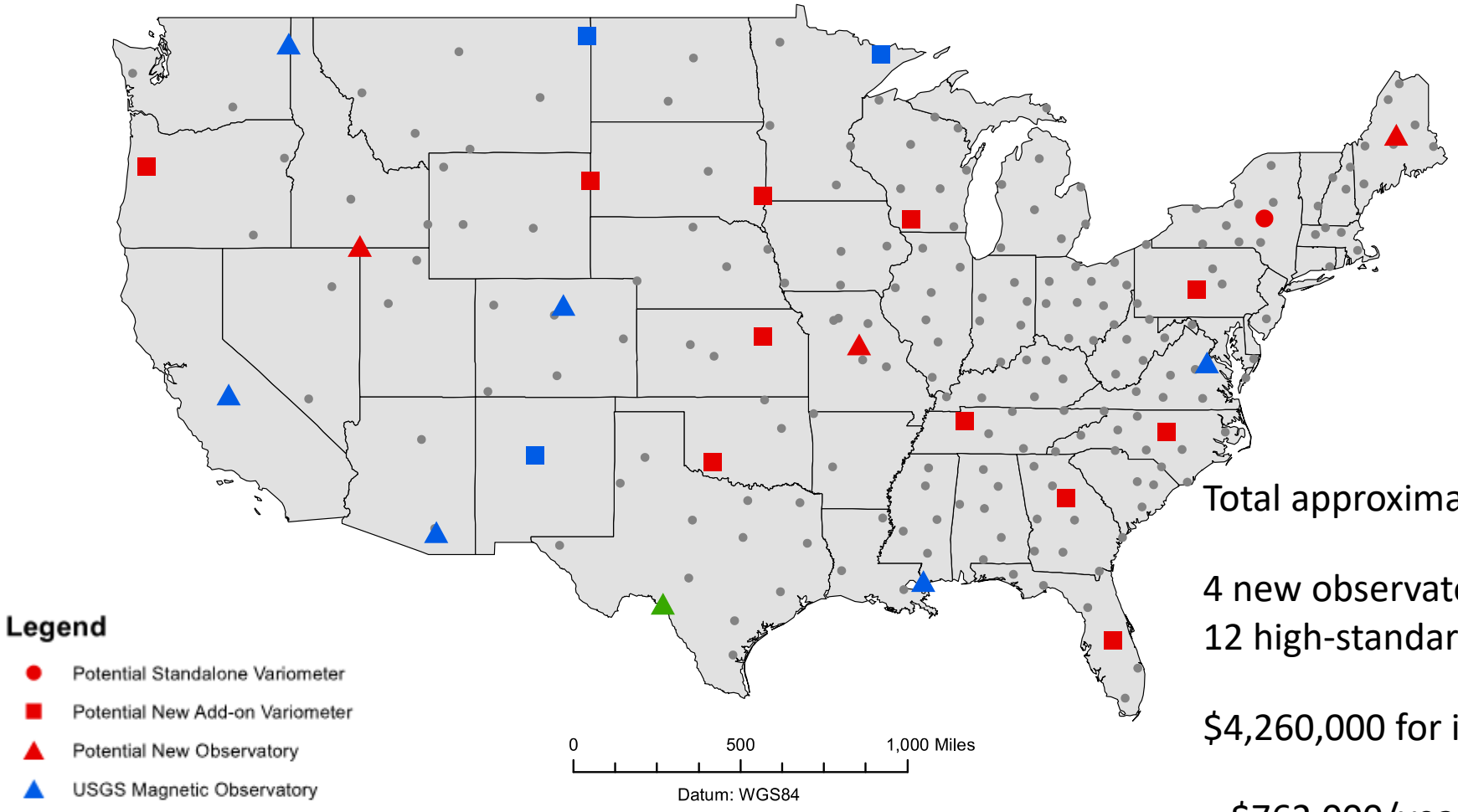
Greg M. Lucas
Laboratory for Atmospheric and Space Physics
University of Colorado

Paul A. Bedrosian
USGS Geology, Geophysics, Geochemistry Science Center

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

Space Weather Operations Research
and Mitigation Working Group

Possible Future CONUS Geomagnetic Monitoring



Total approximate cost for

4 new observatories and
12 high-standard variometer stations:

$4,260,000 for installation of all stations

$762,000/year for operation of all stations

Contact: Krissy Lewis klewis@usgs.gov

CONUS MT Survey Completion

Executive Order 13865 (signed March 26, 2019):

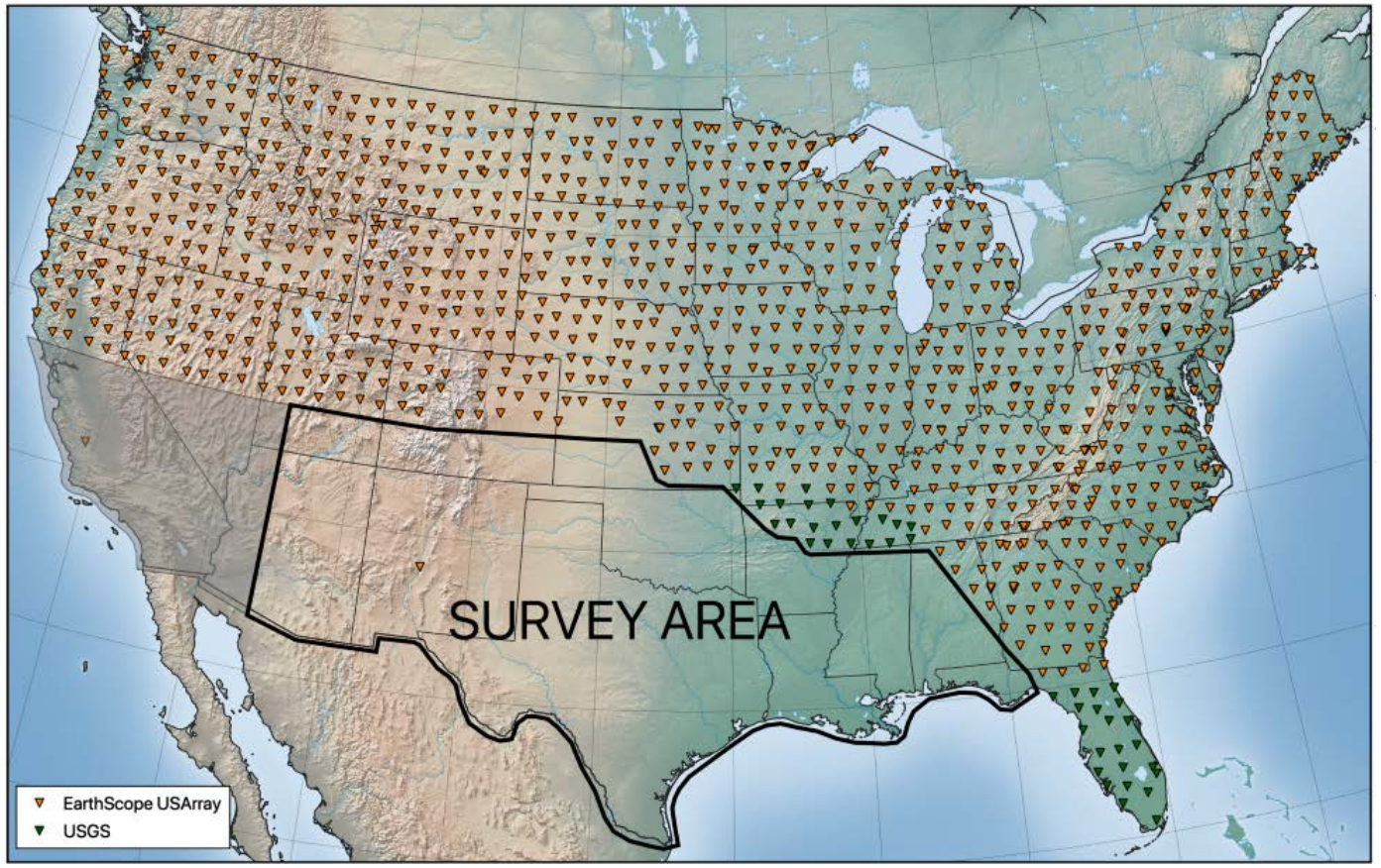
"Within 4 years of the date of this order, the Secretary of the Interior shall complete a magnetotelluric survey of the contiguous United States to help critical infrastructure owners and operators conduct EMP vulnerability assessments."

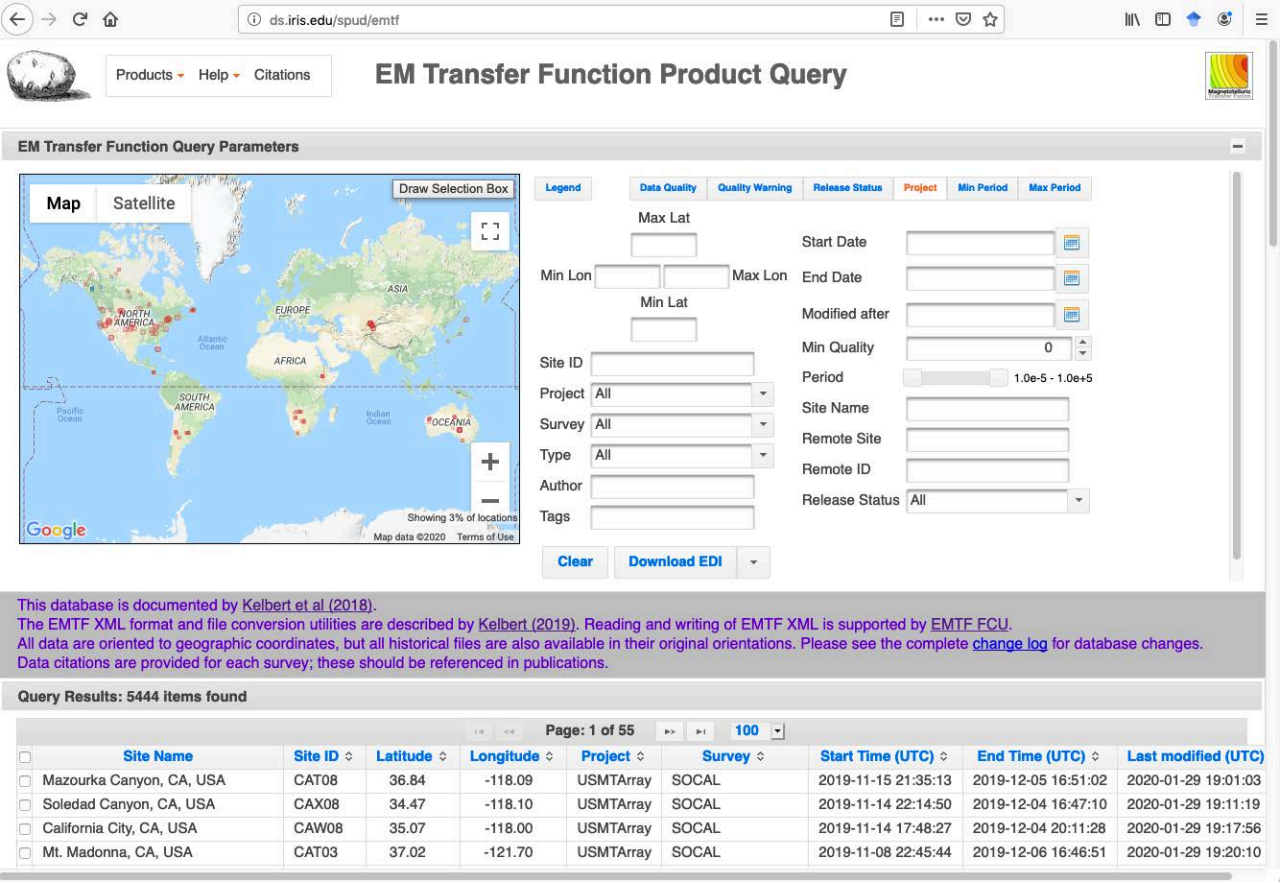
FY20 Geomagnetism Program appropriation:

$4,000,000 for Geomagnetism including $1,726,000 for the magnetotelluric survey as well as funding to maintain operation of existing observatories.

FY21 Geomagnetism Program proposed appropriation:

Continue operating magnetic observatories, continue magnetotelluric survey, continue developing geoelectric hazard maps.





http://ds.iris.edu/spud/emtf

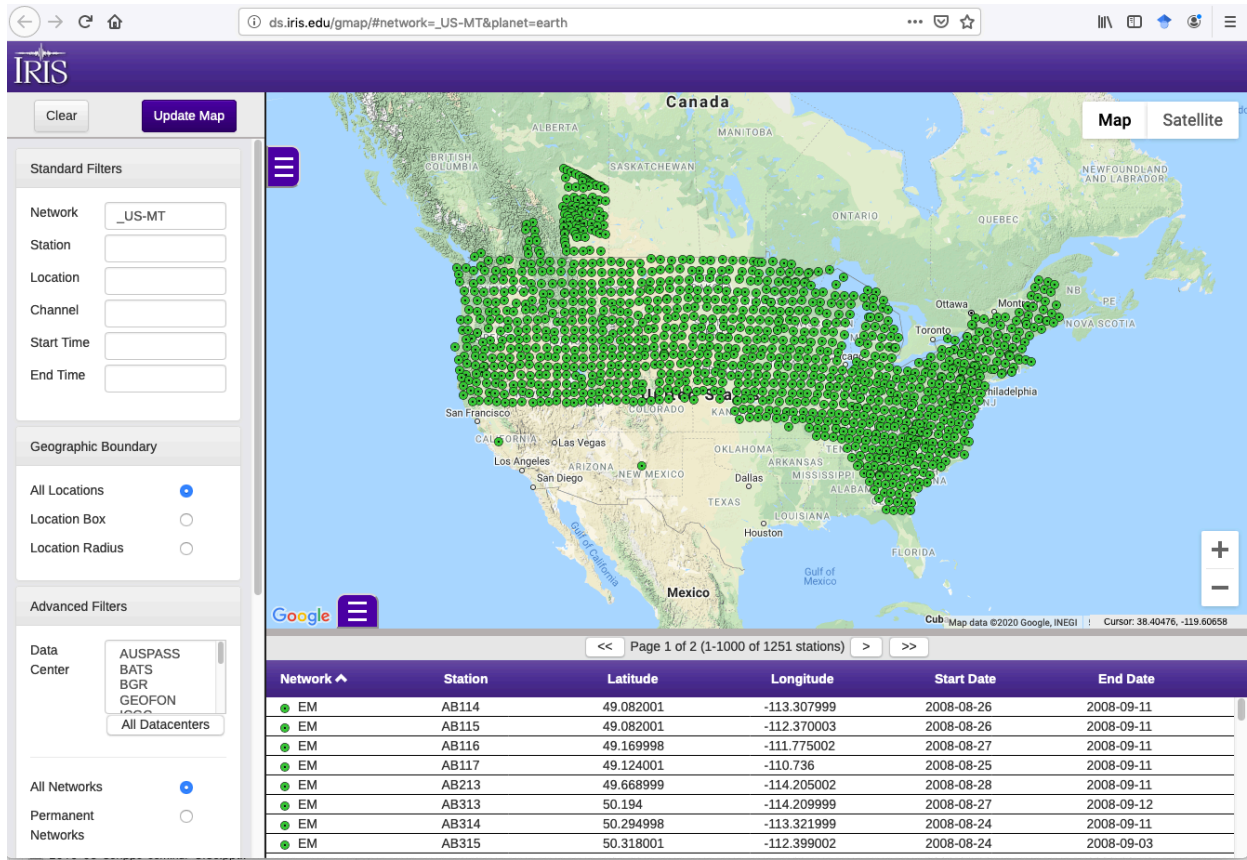
MT Impedance Archiving:

- mature
- format conversion software available
- maintained by USGS

MT Time Series Archiving:

- archaic procedures
- new data format development
- new tools in development at USGS

http://ds.iris.edu/gmap/#network=_US-MT



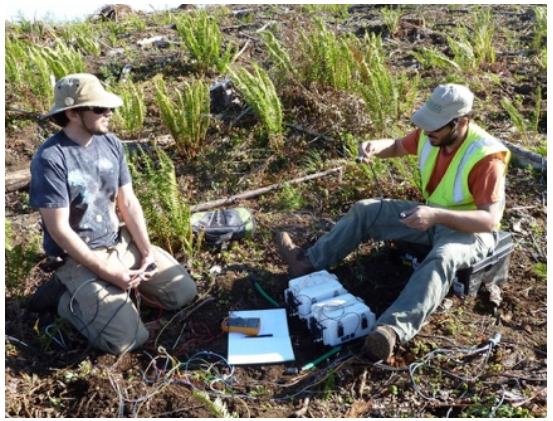
Input signal time series → Convolution through a filter → Output signal time series

Geomagnetic variation →

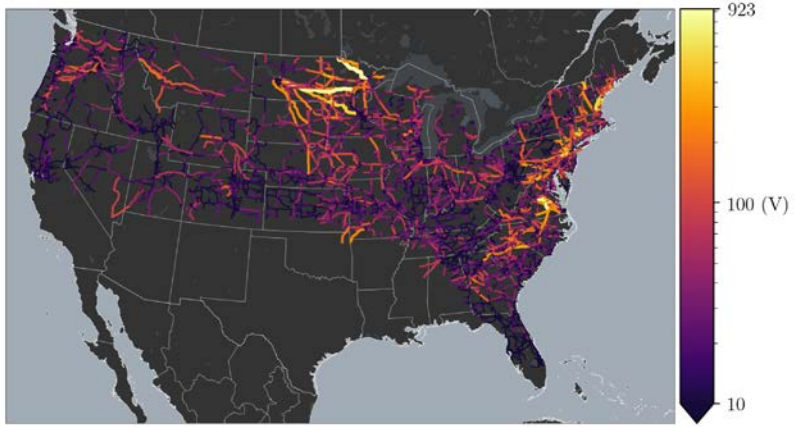
→ Geoelectric field

Geomagnetic variation recoded at observatory

Impedance measured during magnetotelluric survey



Geoelectric hazards mapped onto power grids



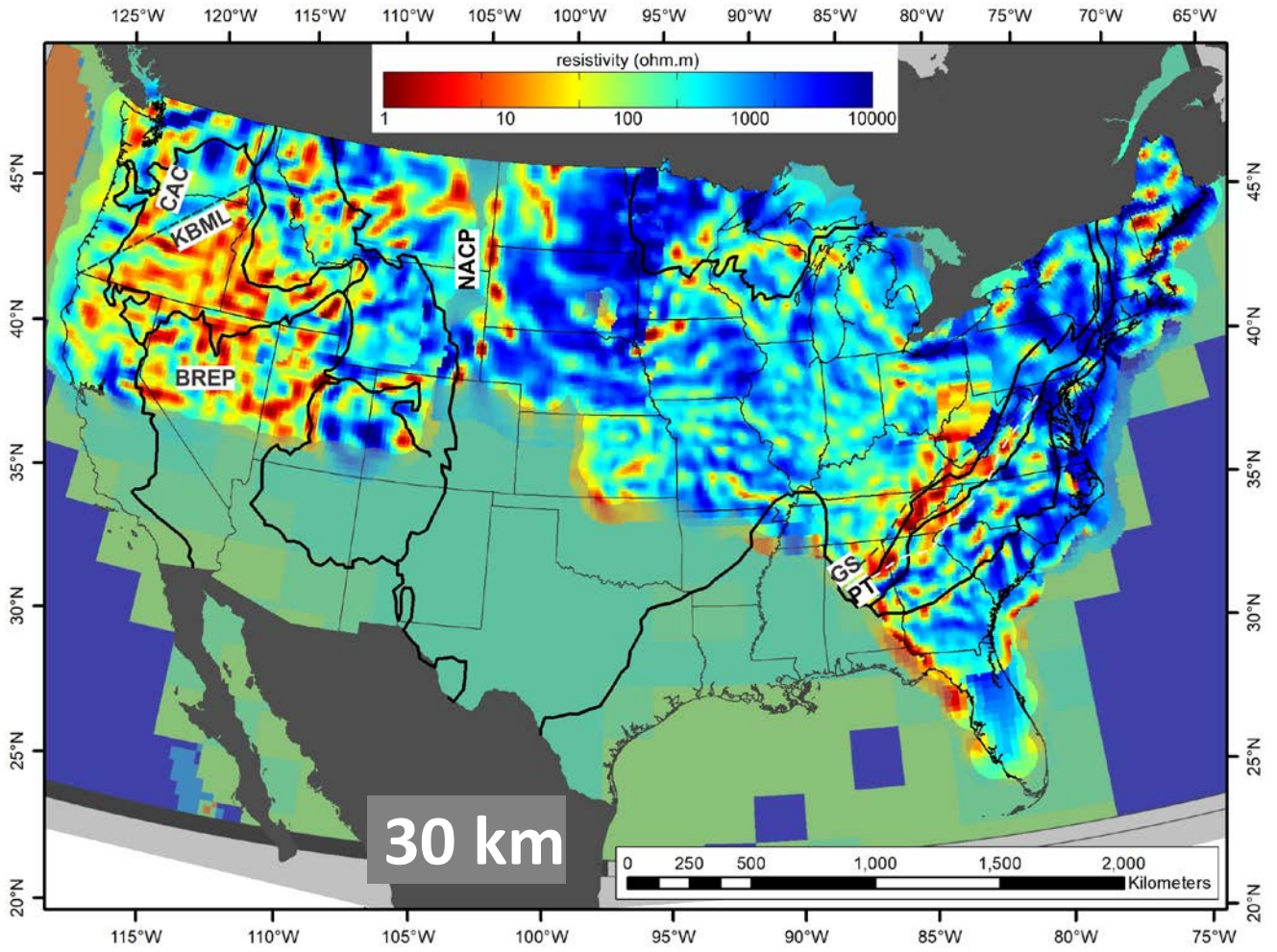
USGS science for a changing world · NASA · NOAA · NSF · earthscope · OSU Oregon State University · CU LASP Laboratory for Atmospheric and Space Physics University of Colorado Boulder

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.

3D conductivity model of CONUS based on magnetotelluric data

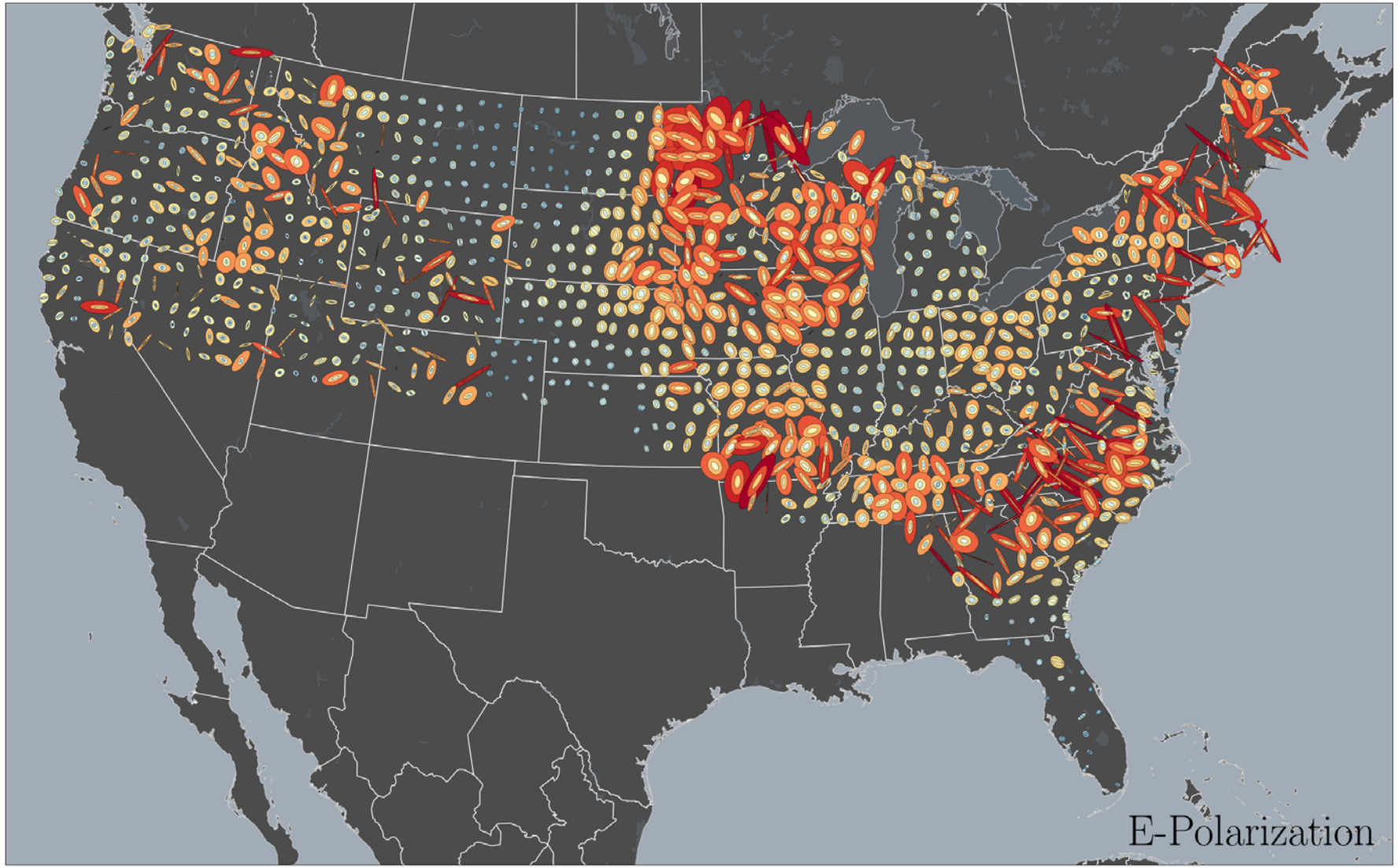
Compilation of existing 3D electrical conductivity models in contiguous U.S. (CONUS) constrained by USArray MT and other MT and magnetometer data from near-surface to approx. 900 km. Improvements are work in progress. Note the 4 orders of magnitude variation.

Working with NOAA SWPC to develop of version of real-time geoelectric field map based on empirical impedances and/or 3D conductivity model.



Kelbert, A., Bedrosian, P. A., and Murphy, B. S., 2019, The first 3D conductivity model of the contiguous United States: Reflections on geologic structure and application to induction hazards, in Geomagnetically Induced Currents from the Sun to the Power Grid, edited by J. L. Gannon, Z. Xu, and A. Swidinski, Geophysical Monograph 244, pp. 127-151, American Geophysical Union, Washington, D.C., doi:10.1002/9781119434412.ch8.

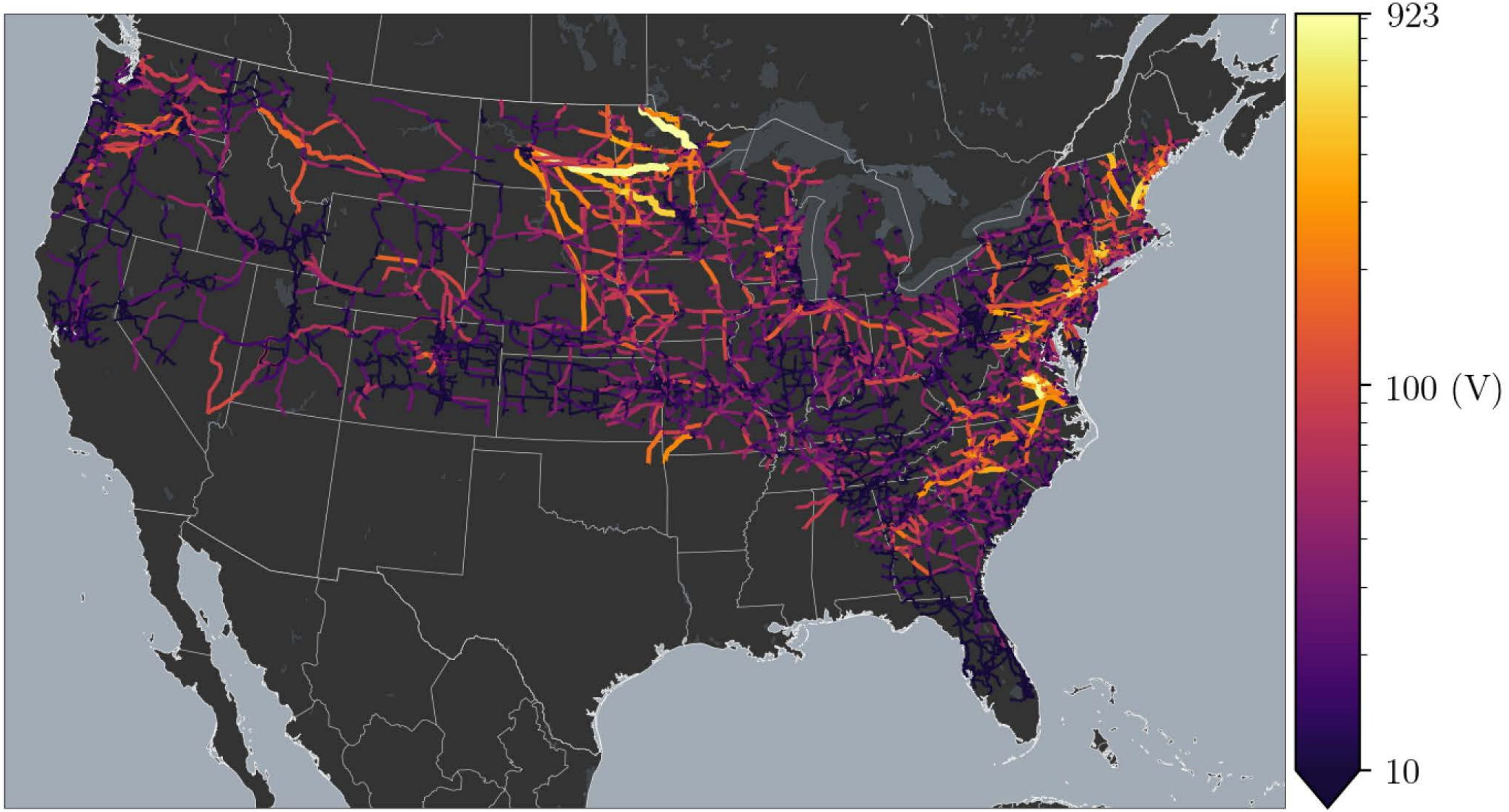
National impedance mapping project



10^{-1} 10^{0} 10^{1} 10^{2}

mv/km/nT

100-year maximum voltages on national power grid (1-min duration)



Lucas, G. M., Love, J. J., Kelbert, A., Bedrosian, P. A., and Rigler, E. J., 2020, 100-year geoelectric hazard analysis for the United States, Space Weather, 18(2), e2019SW002329, doi:10.1002/2019SW002329.