Next step (NS) geoelectric benchmark, challenges and opportunities for moving forward from Phase 1

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Philosophy:

* This is about getting answers in terms of vector estimates along with sober estimates of uncertainty.
* The results should be well-defined and scientifically valid.
* Work needs to be done on a reasonable time schedule (the project is not open-ended).
* Practical limitations need to be recognized. Not everything is possible, especially when some important data have not been acquired.
* Numerical models, can certainly provide insight of the space environment, but their outputs are not always especially accurate; and the solid Earth is not simple (contrary to some impressions held by space scientists).
* Since each magnetic storm is unique, generalizations are sometimes difficult to make.
* Scenario analyses might be considered in place of a purely statistical approach.

Survey data:

* Need to complete national-scale magnetotelluric (MT) survey across the SW United States according to EarthScope protocols: 70-km station spacing, 10 to 10,000 sec period band.
* Some areas of high hazard, especially in Minnesota and NE United States might need augmented MT surveying.
* Expand MT survey to southern Canada (starting in Quebec and Ontario).
* Consider MT surveys in Mexico.

Magnetic monitoring:

* The US needs to maintain the magnetic observatory stations that it already has.
* Analysis is needed on the relationship between (long, historical) geomagnetic index time series and transient geographically complicated and localized geomagnetic disturbance.
* The spatial scale (geographic scale) of geomagnetic disturbance needs to be investigated, possibly with reconnaissance deployments of closely space magnetometers. Some results might be obtained from analysis of the EarthScope time series (that are input for the impedance tensors).

Analysis methods:

* As an augmentation of the Phase 1 benchmarks, which were focused on 100-year instantaneous geoelectric amplitude, the NS process might consider analysis of characteristic geoelectric waveforms (possibly wavelets of characteristic frequency and duration). This might be a useful step in meeting industry interest in a "100-year timeseries".
* Numerical simulations of theoretical most extreme events might be considered (coupling of space models with realistic models of solid-Earth impedance).
* Results can be summarized as geoelectric fields (or voltages) on power-grid geometry.
* General analysis of extreme intensity geomagnetic storms needs to continue.

Integration:

* We need some benchmark-to-operations-to-benchmark (B2O2B) so that benchmarks are developed with understanding of how they can be/might be used.
* Benchmark results of hazard might be extended to risk analyses.

Long-term benefits

* Some methods developed for extreme-event analysis can be applied for developing real-time monitoring and assessment products.