**Global Earth Magnetic Field Modeling and Forecasting with Spherical Harmonics Decomposition**

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**PROBLEM SETTING**

**Motivation**  
*Geoeffectiveness* characterizes impact of solar storms on terrestrial systems, defined on a global scale through “geomagnetic indices” that give an indication of activity. Driven by geomagnetic field perturbations, measured by ground magnetometers on Earth’s surface.

**Challenge**  
Disturbances starting from the Sun reprocessed by Earth’s magnetosphere reach the ground: (1) Single spatial point measurement of the solar wind a proxy for the 3D solar wind structure. (2) Perturbations on the ground sampled sparsely by magnetometers. (3) Need to *connect the dots* from the solar wind to the global impact of Earth.

**Contributions**  
1. Spherical Harmonics based, compressed sensing technique to recover global maps of the geomagnetic perturbation from sparse measurements. Improve of temporal cadence by >10x.

**Data**  
2. MHD simulation (OpenGGCM) for same dates

**Method**  
LASSO regression on Spherical Harmonics to obtain sparse representation of global $\Delta B$.  
- **Hyperparameters**: Max no. of modes and LASSO penalty $\alpha$.  
- Parameter sweeps to minimize L1 error and maximize coefficient of determination (R2) using least possible number of modes.  
- Find the “knee” of performance enhancement.

**REFERENCES**


https://sites.google.com/view/geoeffectivenet/