

## Multiscale Geoeffectiveness Forecasting using SHEATH and DAGGER

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### Oral

To safeguard critical infrastructure against space weather hazards such as geomagnetically induced currents, we need to develop operational forecasting tools. These tools need to (i) be computationally fast and inexpensive, (ii) resolve signatures over a range of length and time scales, and (iii) be actionable - including forecast uncertainties and an appropriate lead time to enable informed decision making. To address this need for a lightweight, multiscale, ground magnetic perturbation forecasting tool, the Deep leArninG Geomagnetic pErtuRbation (DAGGER) pipeline was created in 2020 during the Frontier Development Lab (FDL) research sprint. The core of the pipeline leverages spherical harmonic basis functions to forecast magnetic perturbations at both global and local scales.

This year, The FDL-X program has focused on elevating DAGGER's technical readiness and integrating it across other FDL forecasting and data product modules. We present two components of this workflow: SHEATH and DAGGER++. SHEATH is a solar wind forecaster which ingests full-disc SDO ML v2 data to forecast solar wind and IMF properties at L1, while DAGGER++ is an upgrade on the original DAGGER model. SHEATH increases the forecast horizon of the entire pipeline to several days, while DAGGER++ provides high-fidelity forecasts by incorporating magnetosphere-ionosphere contextual data. The whole pipeline now quantifies uncertainty in forecasts and enables DAGGER to facilitate real-time deployment and integration with Sun-side and Earth-side modules.

This work has been enabled by FDL-X ([fdlxhelio.org](http://fdlxhelio.org)); a derivative of Frontier Development Lab (FDL.ai); as a public/private partnership between NASA, Trillium Technologies, and commercial AI partners Google Cloud and Nvidia.

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