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Poster
Artificial Intelligence (AI) techniques, particularly Machine Learning (ML), have undergone significant growth in heliophysics research in recent years. Various ML models have emerged, some outperforming empirical and physics-based models while significantly reducing computational time. The Artificial Intelligence Modeling Framework for Advancing Heliophysics Research (AHR) project is an initiative aimed at integrating community-wide AI efforts into a unified AI modeling framework, advancing system-of-systems science in Sun-Earth interactions and enhancing the predictability of space weather hazards. This presentation highlights our initial efforts under the AIMFAHR project. We selected data-driven models of the magnetosheath, cusps, auroral precipitation, field-aligned currents (FACs), ionospheric electrodynamics, and thermospheric density as the initial set of AIMFAHR base models. As part of the MLGEM Challenge Storm study, we simulated geomagnetic storms on 4 Jan 2023, 6 May 2023, and 11 May 2024, selected by the Machine Learning-based Geospace Environment Modeling (MLGEM) resource group at the Geospace Environment Modeling (GEM) workshop. The AIMFAHR models reveal the storm responses of various geospace systems from a data-driven respective, including the spatiotemporal variation of the magnetopause reconnection line and its global dayside reconnection rate; cusp motions and the evolution of cusp ion energy dispersions; auroral boundary motions and variation in global auroral spectrums; increases in FACs and ionospheric potentials; and enhanced Joule heating in the upper atmosphere. These initial efforts provide valuable insights for future AIMFAHR activities, including ML model coupling, knowledge transfer between models, uncertainty quantification, and research-to-operation transitions.

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