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SPARTAI —AI-based forecasting pipeline for energetic electrions in the Earth's radiation belts

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Highly energetic electrons (at the MeV level) in the vicinity of the Earth's radiation belts pose significant risks on satellites through single event effects and long-term radiation damage, in GEO, MEO, and LEO orbits. Accurate forecasting of electron fluxes in this environment is essential for risk mitigation and spacecraft operations. Over the past few decades, several physics-based models have been developed to forecast radiation belt conditions. Here, we develop an AI-based forecasting pipeline for MeV-level electron fluxes a few days in advance using NOAA's space weather instruments and NASA-NOAA's Geostationary Operational Environmental Satellites (GOES). We tested and benchmarked several architectures of machine learning and neural network architectures (e.g., CNN, LSTM, and Transformers), as well as several combinations of these to address data sparsity while optimising performance. Our preliminary results are rather promising, with an R2 score over 80 % for all L-shells (McIlwain L-parameter). Using data covering for at least one complete solar cycle, we will present our findings during extreme events. We will also consider European-based and the ESA's space weather data for model training and for the development of the future operational forecasting pipeline. This work is a prototype product demonstration co-developed by Inria for Augura Space, a deep tech startup that delivers AI-powered space weather intelligence.

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