EGU22-4842
https://doi.org/10.5194/egusphere-egu22-4842
EGU General Assembly 2022

Predicting the Bz magnetic field component from upstream in situ observations of coronal mass ejections using machine learning

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Predicting the Bz magnetic field embedded in interplanetary coronal mass ejections (ICMEs), also called the Bz problem, is a core challenge in space weather research and prediction. We tackle this problem with a new approach by taking upstream in situ measurements of the ICME sheath region and the first few hours of the magnetic obstacle to predict the downstream Bz component. To do so, we trained a machine learning algorithm on 348 ICMEs (extracted from the open source ICMECATv2.0 catalog) observed by the Wind, STEREO-A, and STEREO-B satellites to predict the minimum value of Bz. The predictive tool was built to mimic a real-time scenario, where the ICMEs sweep over the spacecraft, which allows us to continually provide updates and improved predictions of Bz as time passes and more of the CME structure is observed. The final model, which is based on random forests, can predict the minimum value of Bz with a reasonable level of agreement compared to observations. In this presentation, we will discuss the main challenges we face in using a data-driven machine learning application to solve the Bz problem, and outline the lessons learned and future strategies for predicting and potentially mitigating the effects of ICMEs arriving at Earth.