Classification of Forbush decrease events utilizing machine learning

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The potential existence of two classes of Forbush Decrease (FD) events has already been suggested by the analysis of energetic proton fluence spectra measured at L1 (Savić et al. 2023). We further explore this assumption in the work presented herein.

The most powerful coronal mass ejections, which can lead to Forbush Decreases, often occur during periods of increased solar activity. Coincidentally, such intense phenomena can also result in complex interactions in the heliosphere, where accurate determination of energetic proton fluence may become more difficult. Therefore, in order to increase statistical robustness and reduce uncertainties, we try to expand the classification procedure to include a wider set of various space weather parameters, that are more reliably determined.

The IZMIRAN database of Forbush decreases (IZMIRAN 2021) serves as an online repository, and contains an extensive list of FD events, along with a large number of associated space weather parameters. The idea for the presented analysis is to employ machine learning techniques in an attempt to separate FD events into two assumed classes, using a number of selected parameters from the IZMIRAN database as input variables. We compared the efficiency of different machine learning algorithms using the TMVA package integrated in the ROOT analysis framework (Hocker 2007), and tried to establish the optimal boundary value of FD intensity to be used for separation. The Support Vector machine algorithm (SVM, Cortes 1995) was selected for the analysis based on its overall performance, efficiency and flexibility. Finally, a subset of space weather variables to be used for classification was selected based on their predictive power.

References

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IZMIRAN Space WeatherPrediction Center, 2021
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