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Nowcasting Solar Energetic Particle (SEP) events using Principal Components Analysis (PCA)

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Solar Energetic Particle (SEP) events and their parent solar events (e.g. solar flares - SFs and coronal mass ejections - CMEs) are closely related. A wealth of statistical studies has indicated the dependence of the probability of occurrence of SEP events on the magnitude and the longitude of the SF, as well as the velocity and the width of the CME. However, most studies are limited to two dimensional correlations. In addition, similar coefficients are identified for the pair-wise correlation of the SEP peak intensity to both the SF magnitude and the CME speed. The situation is further complicated by the fact that the solar parameters are not independent. In this work, we perform a principal component analysis (PCA) on a set of six (6) solar variables (i.e. CME width and velocity, logarithm of the SF magnitude, SF longitude, duration and rise time), and we further apply logistic regression to infer the possible prediction of SEP events. In our analysis, we utilize 126 SEP events with complete solar information. Each SEP event is a vector in six dimensions (corresponding to the six solar variables used in this work). PCA transforms the input vectors into a set of orthogonal components. We applied logistic regression with a single categorical predictor, as well as, single or multiple explanatory variables. Furthermore, we validated our findings with the implementation of categorical scores (Probability of Detection - POD, False Alarm Rate - FAR). We present and interpret the obtained scores and we discuss the strengths and weaknesses of the different implementations.

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