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Characterization of X-ray and Type III radio bursts during solar cycle 24 for short-term warning of solar energetic particle events

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The empirical model developed by Laurenza et al. (2009), based on data from 1995 to 2005, can provide short-term warnings of solar energetic proton (SEP) events that meet or exceed the Space Weather Prediction Center threshold of J ($\geq 10MeV$) = 10 p cm^{-2} s^{-1} sr^{-1}, within 10 minutes after the maximum of the associated soft X-ray flare. The $\geq$ M2 X-ray and type III bursts occurred in the period 2006 - 2014 were used to compute the parameters of the model, i.e. the time-integrated soft X-ray intensity and time-integrated intensity of type III radio emission at about 1 MHz. The probability distribution functions associated with both parameters were derived. It was found that both the occurrence and the fluence of X-ray bursts is noticeably reduced in solar cycle 24 (35% and 30%, respectively, compared to solar cycle 23). The radio fluence of type III bursts associated to the considered X-ray events was lower of about 30% as well. Moreover, in order to test the accuracy of the model, the probability of detection (POD) and the False Alarm Rate (FAR) were evaluated by using the new database. The obtained verification measures show a good performance of the model: POD= 59% and FAR= 30%, which are, respectively, comparable and even lower with respect to those obtained from the datset on which the model was developed. Moreover, the performance is very high when major SEP events, having a peak flux $\geq$ 100 pfu, are considered (POD=79%, FAR=5%), i. e., for the most hazardous Space Weather conditions. Finally, the median warning time (as computed by Nunez (2011)) was estimated to be of about 11 h, highly exceeding that obtained through other competing techniques.

References

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