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On the occurrence of proton events from the standpoint of X-ray flare

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Radiation dose to astronauts by solar energetic particle (SEP) events is one of the serious concerns for ISS operation. Total dose during large solar flares is expected several tens times as high as that during no flare, which is estimated at about 1 mSv/day. Operational SEP alert is required for radiation dose control for astronauts. For routine operation of alert and forecast, we need simple criterions or guidelines for duty forecasters.

We analyzed X-ray flux and proton intensity data observed by GOES satellite in the 22nd and 23rd solar cycle to seek useful criterions or guidelines for SEP alert operation. Solar flare scale is specified by peak X-ray flux in current space weather forecast operation. However, integrated X-ray flux must be better indicator than peak X-ray flux because integrated X-ray flux relates to a total energy released by a flare. In this study, we use integrated X-ray flux as an indicator for flare scale.

We found that, for proton events larger than 10 PFU (proton flux unit), there is a threshold of the product of flare duration by peak X-ray flux. The threshold of about 20 ergs/cm^2 should be a proxy of total soft X-ray energy released by a flare. For example, proton event does not occur if flare duration is less than 30 minutes for M1.0 class flare or 3 minutes for X1.0 class flare. This threshold is confirmed also for data set in the cycle 22.

Our result should be useful as a criterion for daily operational proton alert and forecast to evaluate a risk of solar proton events in near future. The criterion will be tested in daily forecast operation at the space weather forecast center in CRL.