Dependence of Solar Proton Events on Flare Peak Flux, Longitude, and Impulsive Time

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In this study we have examined the occurrence probability of solar proton events and their peak fluxes depending three flare parameters (X-ray peak flux, longitude, and impulsive time). For this we used NOAA solar energetic particle (SEP) events from 1976 to 2006, and their associated X-ray flare data. As a result, we selected 166 proton events that were associated with major flares; 85 events associated with X-class flares and 81 events associated with M-class flares. Especially the occurrence probability strongly depends on three parameters as follows. (1) We found that about only 3.5% (1.9% for M-class and 21.3% for X-class) of the flares are associated with the proton events. (2) It is also found that this fraction strongly depends on longitude; for example, the fraction for 30°W < L ≤ 90°W is about three times larger than that for 30°E < L ≤90°E. (3) We also note that the occurrence probability of solar proton events associated with long duration (≥0.3 hours) flares is about 2 (X-class flare) to 7 (M-class flare) times larger than that with short duration (<0.3 hours) flares. (4) The largest difference is found between eastern short duration M-class flare group (0.3%) and western long duration X-class flare group (46.5%). In addition, the relationship between X-ray flare peak flux and proton peak flux as well as its correlation coefficient are strongly dependent on longitude and impulsive time.