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Longitudinal Dependence of Peak Intensities in Solar Energetic Particle Events

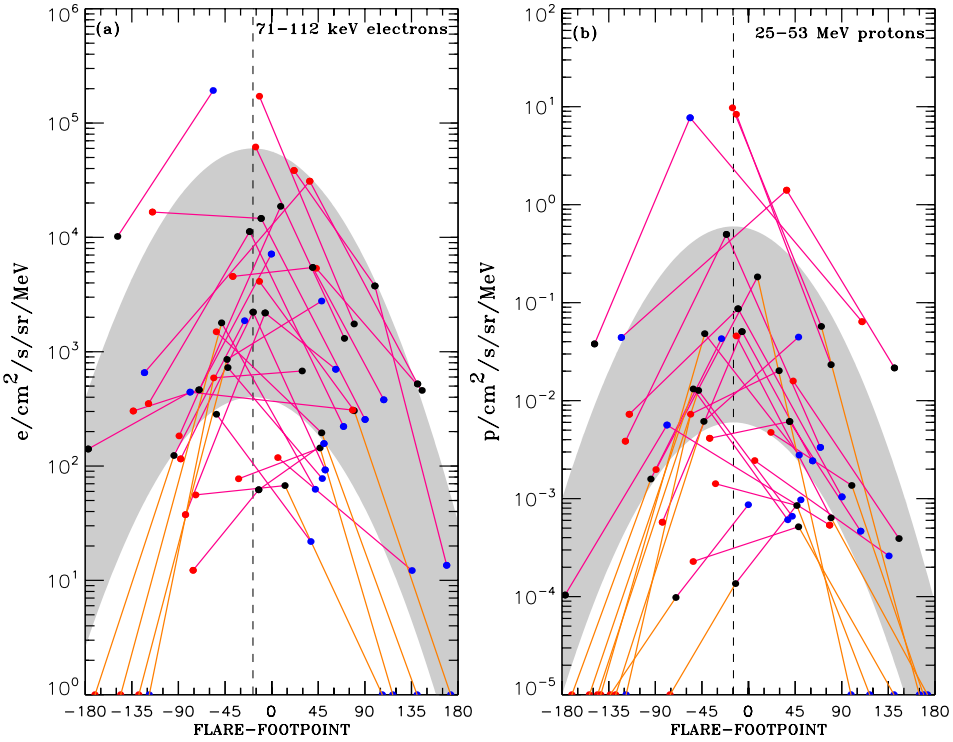

Figure 1: Longitudinal distribution of (a) 71-112 keV electron and (b) 25-53 MeV proton peak intensities. Black symbols indicate SEP events measured near Earth by ACE (left) and SoHO (right). Red and blue symbols indicate events measured by STEREO-A, STEREO-B, respectively. Events for which no intensity increase was observed are plotted at the bottom horizontal axes. Magenta lines connect events observed simultaneously by two or three spacecraft with intensity enhancements. Orange lines connect those events for which no intensity enhancement was observed. The gray area follows the functional form $j \sim \exp[-(\Phi-\Phi_0)^2/2\sigma^2]$. See text for best-fit parameter values.

The current fleet of spacecraft distributed throughout the inner heliosphere allows the study of solar energetic particle (SEP) events during the rising phase of solar cycle 24 from multiple vantage points (see ACE News #139). Simultaneous observations of SEP events by ACE, SoHO and the two STEREO spacecraft allow us to estimate the longitudinal dependence of peak SEP intensities. We selected 26 SEP events observed during the 3-year period 2009-2011 for which (1) a 25-53 MeV proton intensity enhancement was detected; (2) a 71-112 keV electron intensity enhancement was observed by at least two spacecraft; and (3) a solar origin (i.e. solar flare and/or filament eruption) has been confidently identified.

Figure 1 shows (a) the 72-112 keV electron and (b) the 25-53 MeV proton peak intensity observed in these events by ACE or SoHO (black dots), STEREO-A (red circles) and STEREO-B (blue circles). Horizontal axes show the longitude difference between the parent solar event and the footpoint of the nominal magnetic field line connecting each spacecraft with the Sun (assuming a Parker spiral with a 400 km/s solar wind speed). The magenta lines connect events simultaneously observed by two or three spacecraft. The orange lines connect events observed by three spacecraft, but in which one of the spacecraft did not detect any particle increase (artificially plotted in the low horizontal axes of the Figure).

We use the functional form $j = j_0\exp[-(\Phi-\Phi_0)^2/2\sigma^2]$ to describe the longitudinal distribution of peak intensities. By combining three pairs of spacecraft for events observed by three spacecraft and one pair for events observed by two spacecraft (i.e. using only those events connected by magenta lines in the Figure) we obtain Φ_0=-18°±5°and σ=51°±2° for 71-112 keV electrons and Φ_0=-14°±4°and σ=46°±2°for 25-53 MeV protons. These values are directly comparable to previous studies performed with Helios and IMP-8 data from solar cycle 21 that obtained Φ_0~-11°±3°and σ~36°±2°for 27-37 MeV protons (Lario et al., 2006; ApJ 653, 1531-1544).

As solar cycle 24 progresses we expect a large number of SEP events that will increase the statistical significance of the results of the study.

This item was contributed by David Lario and Edmond C. Roelof of the Johns Hopkins University Applied Physics Laboratory. Address questions and comments to david.lario@jhuapl.edu An archive of earlier ACE News items can be found at http://www.srl.caltech.edu/ACE/ACENews_Archives.html