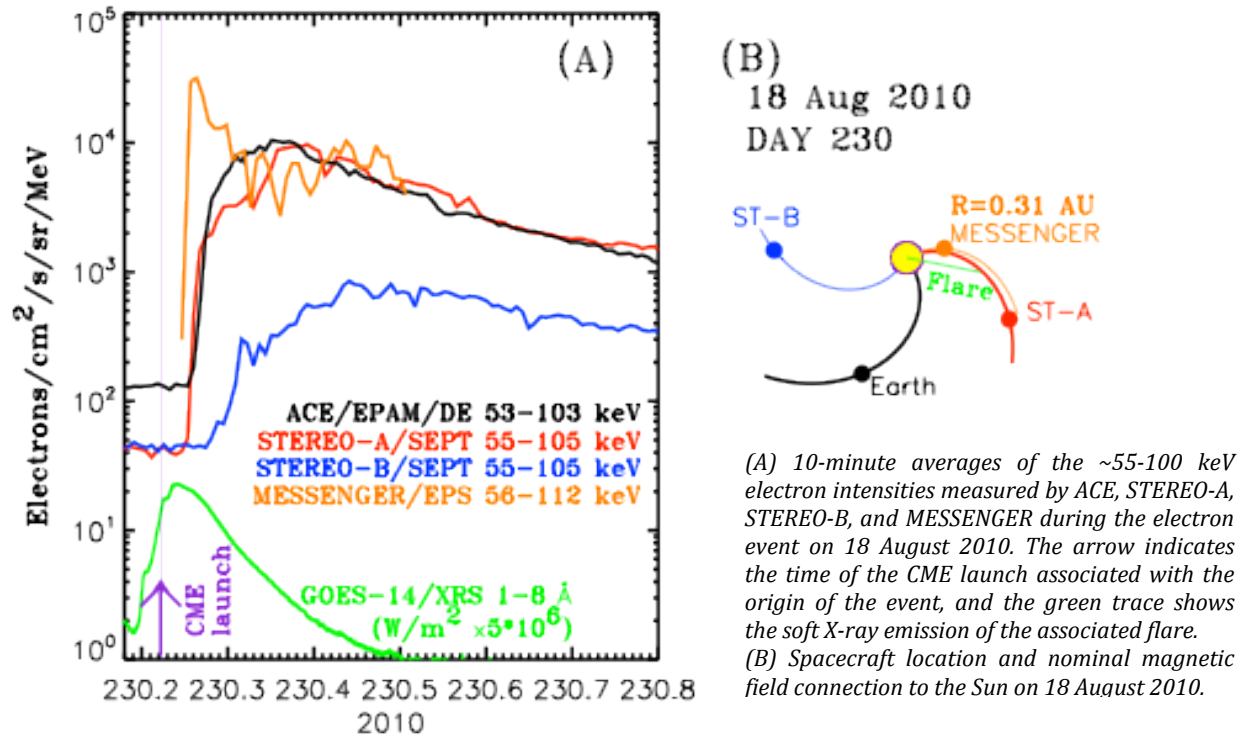


Multi-spacecraft Observations of an Energetic Electron Event from 0.3 to 1.0 AU: ACE, MESSENGER, and STEREO A/B



One of the first solar energetic particle (SEP) events of Solar Cycle 24 was detected simultaneously by STEREO-A, STEREO-B, ACE and MESSENGER beginning at $\sim 05:45$ UTC on 18 August 2010 (day of year 230). Figure (A) shows 10-minute averages of the ~ 55 -100 keV electron intensities averaged over all directions observed by the listed instruments on the four spacecraft. Pre-event background intensities have been subtracted from the MESSENGER Energetic Particle Spectrometer (EPS) intensity profiles (because EPS has a much smaller instrument geometric factor than the other three), and an empirically-derived normalization factor of 1.3 has been applied to the STEREO data. Figure (B) gives the locations of the spacecraft on the plane of the ecliptic as seen from the north ecliptic pole, along with the nominal Parker spiral interplanetary magnetic field lines (for solar wind speed $V_{\text{sw}} = 400 \text{ km s}^{-1}$) connecting each spacecraft to the Sun. The magnetic field coronal footpoints of STEREO-A and ACE were approximately equidistant ($\pm 40^\circ$) from the flare site, but MESSENGER ($R = 0.31 \text{ AU}$) and STEREO-A ($R = 1.0 \text{ AU}$) were essentially on the same nominal field line. At the other extreme, the footpoint of STEREO-B was about 110° east of the flare site. The active region (AR11099) associated with the origin of this electron event produced a gradual class C4.5 X-ray flare (1-8 Å profile shown in Figure A with maximum at 05:48 UTC) from just beyond the west limb of the Sun ($\sim W100^\circ$ central meridian longitude as seen from Earth; indicated by the green line in Figure B). A fast (1471 km/s) coronal mass ejection (CME) was launched at $\sim 05:20$ UTC (as extrapolated from SOHO/LASCO observations). As expected, the onset of the SEP event was first seen by MESSENGER, later at ACE and STEREO-A, and with a considerable delay (~ 70 min) still later at STEREO-B. Both STEREO-A and ACE showed similar intensities during the decay phase of the event. Although MESSENGER intensity was initially higher than the others, they all became comparable within 2 hours. This pattern suggests that an energetic electron "reservoir" was sampled by these three spacecraft over $\sim 80^\circ$ of longitude and that the intensity gradient along a magnetic field line was negligible during the decay of the event.

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