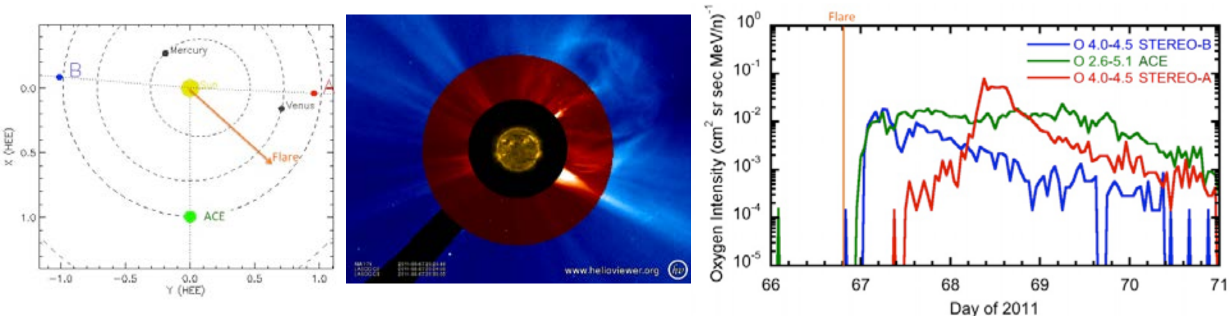
ACE News #152 July 17, 2012
Prompt SEP Onsets from Backside Solar Events



(left) The relative positioning of STEREO-A and –B, ACE, and the flare that occurred on 7 March 2011; (center) The associated CME observed by LASCO; (right) O SEP intensities observed by STEREO/LET and ACE/ULEIS.

It is well known that the time profile of a solar energetic particle (SEP) event depends strongly on the longitudinal location of the observer relative to the solar source, with events from source regions west of the observer being prompt (rising quickly to a peak and decaying exponentially) and those from eastern sources having a more gradual rise and peaking at or after the related interplanetary shock passes the observing spacecraft (Cane et al., 1988). These differences are understood in terms of magnetic connection to the coronal mass ejection (CME)-driven shock that is accelerating the energetic particles. Due to the Parker spiral, spacecraft are well connected to western events when the shock is still close to the Sun and strong, whereas in eastern events the shock must travel a significant distance (weakening along the way) before intercepting field lines that are magnetically connected to the spacecraft.

As this characterization was based primarily on SEP events from source regions on the solar disk as viewed from Earth, it was not clear what to expect from a source on the backside of the Sun. An opportunity to examine this occurred on 7 March 2011 when active region 11164 at W48 produced an M3.7 flare which was accompanied by a fast CME (center panel). The resulting SEP event was observed not only by ACE but also by instruments on STEREO-B (95 deg. east of ACE) and STEREO-A (88 deg. west of ACE; left panel). While the event was a well-connected western event for ACE, it was an eastern (E40) event for STEREO-A and an over the west limb (W143) event for STEREO-B. As expected, the ~3-4 MeV/nuc oxygen intensity at STEREO-A is delayed in its onset and rises more gradually while the ACE intensity is prompt (right panel). Surprisingly, the STEREO-B intensity has similar onset and rise times to that of ACE even though the source was on the backside for this spacecraft. There have been few SEP events observed by all three spacecraft during cycle 24 so far, but the 23 January 2012 event had similar geometry with the source region on the backside for STEREO-B and being western for ACE. The STEREO-B intensities again showed a prompt time profile. Such behavior was also noted recently by Reames et al. (2012) in analysis of the 24 September 1977 event observed by Helios 1, 2, and IMP-8.

These observations potentially resolve a nagging question regarding the 16 August 2001 SEP event. This event had a prompt time profile but no viable source on the disk. A suitable active region had rotated over the solar limb several days prior but was doubted because a backside source was not expected to produce a prompt rise in particle intensity. Such behavior has significant implications for space weather prediction as well. Luckily, with the current positioning of the STEREO spacecraft the solar source can be identified by the remote sensing instruments anywhere on the solar surface (not just the portion facing Earth), enabling more careful studies of SEP events with backside sources as well as aiding in space weather predictions. Multi-spacecraft studies of these events will yield important information regarding acceleration and transport of particles in the corona and interplanetary medium.

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