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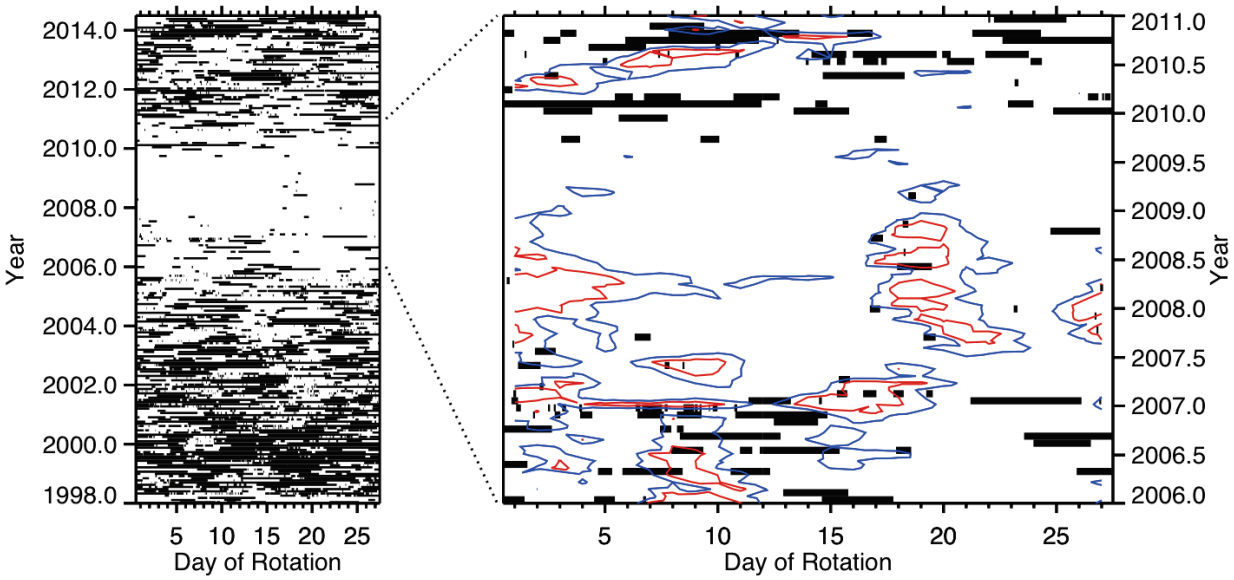
^{3}He-rich SEP Events and Stream Interaction Regions at Solar Minimum



Left panel: times when SEP ^{3}He was detected near 1 AU shown as black bars on a plot of solar rotation number (ordinate) versus day of rotation (abscissa). Right panel: expanded version covering the years around solar minimum and adding contours indicating measured solar wind speeds of 500 km/s (blue) and 600 km/s (red).

The study of the occurrence of ^{3}He-rich solar energetic particle (SEP) events at ACE has been an ongoing effort using data from the ULEIS and SIS instruments (see ACE News #162 and #145). During the extremely quiet solar minimum period of 2007 through 2009 these events were observed only a few percent of the time. The left hand figure indicates the times when SEP ^{3}He was observed as bars on a plot of solar rotation number (ordinate, labeled with the time of occurrence) versus day within the 27-day rotation (abscissa). This plot format helps locate features that recur at the same phase of several solar rotations. A clustering of ^{3}He-rich periods around day ~18±1 stands out distinctly during the solar minimum years.

It has been noted by several authors going as far back as Zwickl et al. (1978) that there is a tendency for impulsive SEP events to occur near transitions from slow to fast solar wind. This phenomenon has been addressed in a number of works using ACE data, including Kocharov et al. (2008) and Bučík et al. (2014). Wang et al. (2006) suggested that this is due to the origin of these events near coronal holes whose open field lines permit particles accelerated in association with jets to escape into the interplanetary medium. These same coronal holes are well known as sources of fast solar wind.

The right-hand panel shows an expanded view of the solar-minimum portion of the left-hand plot with contours added to indicate times when the solar wind speed measured with ACE/SWEPAM was 500 km/s (blue) and 600 km/s (red). The solar-minimum ^{3}He-rich periods have a clear tendency to occur close to stream interaction regions where the solar wind speed increases rather abruptly. According to the explanation put forward by Kocharov and collaborators, the compression region that occurs as fast solar wind catches up with slower wind acts as a partial magnetic trap that can retain accelerated particles longer than unstructured solar wind and, in addition, the compression can partially compensate for the normal solar wind expansion that would cause emerging particles to be adiabatically decelerated. In this framework one may be able to understand the organization of the solar-minimum ^{3}He-rich SEP events as being due to solar wind conditions that enhance the intensities of events that would otherwise be too low to be detected. At times when the Sun is more active, the high rate of occurrence of ^{3}He-rich events makes it difficult to determine whether the same mechanism is playing a significant role. However, future statistical studies may be able to determine whether ^{3}He-rich events have systematically higher intensities when they occur just ahead of a transition from slow to fast solar wind.

This item was contributed by Mark Wiedenbeck *(JPL/Caltech) and Glenn Mason (APL). Address questions and comments to mark.e.wiedenbeck@jpl.nasa.gov.* *For an* archive *of earlier ACE News* items *please see: http://www.srl.caltech.edu/ACE/ACENews/ACENews_Archives.html*