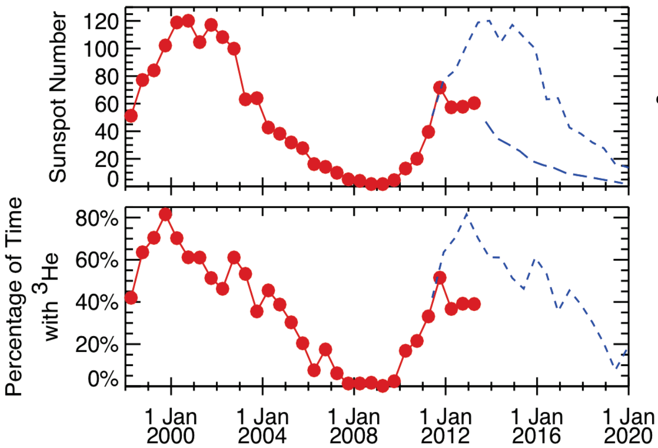
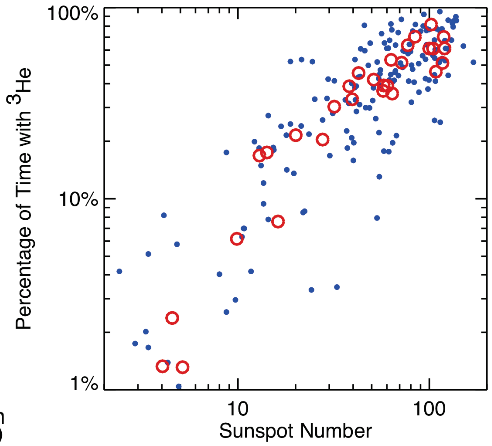
ACE News #162 -- August 6, 2011
Deficit of Suprathermal ^{3}He in Solar Cycle 24





<u>Left hand figure:</u> lower panel: percentage of time with energetic ^{3}He present near 1 AU; upper panel: sunspot number. Red points: 6-month averages of the observations. Short blue dashes: observed time dependence shifted later by 13 years and 2 months. Long blue dashes: recently updated prediction of sunspot numbers through the remainder of cycle 24. <u>Right hand figure</u>: correlation between sunspot number and percentage of time with ^{3}He. Blue points represent individual months; red circles represent 6-month averages.

Using the ULEIS and SIS instruments on ACE we have been monitoring the fraction of time that energetic ^{3}He is detectable near Earth over the past 15+ years. This ion is a nearly unmistakable signature of material accelerated in impulsive solar energetic particle (SEP) events because these events typically produce enhancements of ^{3}He by orders of magnitude over the abundance found in the solar wind where $^{3}He/^{4}He \approx 4 \times 10^{-4}$. Suprathermal ions from impulsive SEP events are known to provide a source of seed particles that can be efficiently accelerated to high energies when coronal mass ejections (CMEs) drive shocks through the solar corona and inner heliosphere.

In 1999 through 2002, near the peak of solar cycle 23, energetic ^{3}He was observed at ACE more than 50% of the time, but the percentage dropped as the solar minimum between cycles 23 and 24 approached, with ^{3}He detectable <2% of the time in 2008-2009. In ACE News #145 (December 5, 2011), we reported the return of energetic ^{3}He in the inner heliosphere during the onset of solar cycle 24. In 2011 the level and rate of increase of the fraction of time with ^{3}He present were consistent with the values observed 13 years and 2 months earlier, shortly after the launch of ACE. By assuming that the variation of ^{3}He in cycle 24 would follow the trend observed in the previous cycle, it was possible to plot an estimate of the fraction of time with observable ^{3}He that could be expected later in cycle 24. According to that estimate, the percentage of time with ^{3}He should have continued to increase, reaching a maximum of ~80% around the beginning of 2013.

However, observations of ^{3}He over the past year and a half have shown a significant deficit in the amount of time that this ion is observable when compared with the shifted time dependence from solar cycle 23. The lower panel of the left-hand figure shows 6-month averages of the percentage of time with ^{3}He present extending from the start of 1998 through mid-2013. The most recent three points indicate that ^{3}He is now present only about the half as frequently as it was observed at the peak of cycle 23. The upper panel shows sunspot number observations with the same averaging as well as this time dependence shifted as was done for the ^{3}He percentage. The deficit in the sunspot number in cycle 24 compared with cycle 23 looks remarkably similar to that seen in the ^{3}He plot. Also shown is a recently updated prediction (www.ips.gov.au/Solar/1/6) of how the sunspot number will vary over the next 6½ years, according to which a steady decline can be expected. If this prediction proves to be correct and if the good correlation we observe between the percentage of time with ^{3}He present and sunspot number (right-hand figure) continues, one should expect the fraction of time that ^{3}He is observable to decrease steadily over the next 6+ years.

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*