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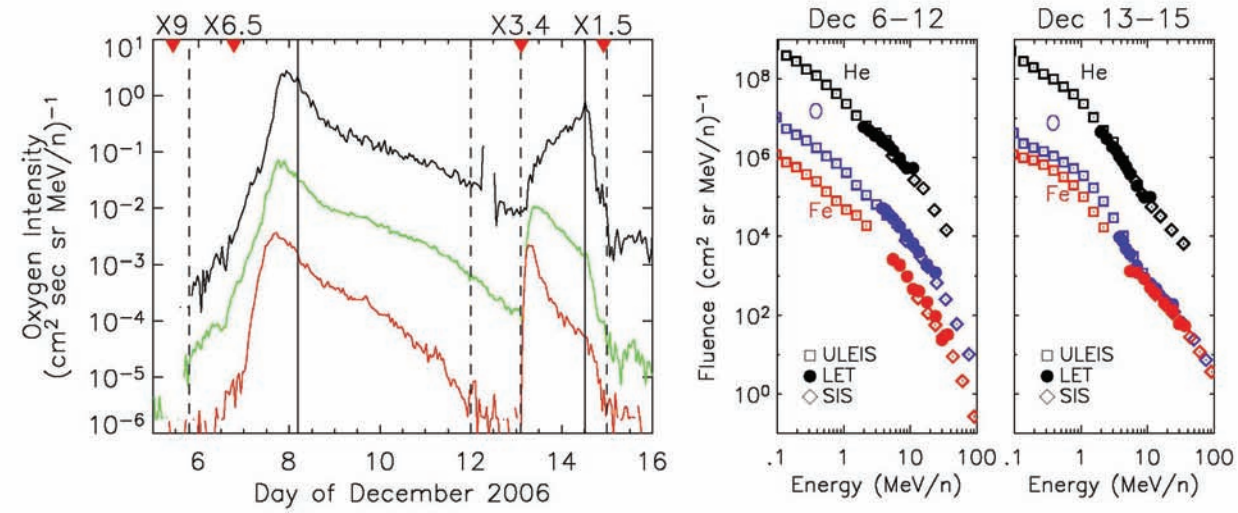
STEREO Joins ACE to Witness the Last (?) Large SEP events of Cycle 23



On the evening of 25 October 2006 NASA's twin STEREO spacecraft roared into the sky, powered by a Delta-II rocket launched from Cape Canaveral. Each STEREO spacecraft includes a suite of four solar energetic particle (SEP) sensors (as part of the IMPACT investigation) that measure the composition and energy spectra of SEP ions with $1 \leq Z \leq 28$ from ~0.05 to ~100 MeV/nucleon. One of the sensors, the Low Energy Telescope (LET), was developed by Caltech, Goddard, and JPL and designed to measure SEP composition from ~3 to 30 MeV/nucleon. LET is designed to identify the nuclear charge (Z) of sixteen separate species on-board, and sort up to ~1000 particles/s into Z versus energy/nucleon matrices which are read out once each minute.

The STEREO SEP sensors were first powered up in mid-November and were still being commissioned in early December when the Sun, which had been approaching solar-minimum conditions, suddenly let loose with an X9 solar flare from longitude E71. The source of this flare was giant sunspot 930 which had just rotated onto the solar disk. Several hours later the ACE/SIS real time proton intensities began to rise indicating the start of an SEP event. A subsequent X6.5 flare (at E57) apparently added to the SEP population, which peaked in intensity at the end of December 7th. During the decay of the event, the sunspot rotated west and at W23 released another X-class flare (X3.4) and fast coronal mass ejection (CME), which initiated another large SEP event. The time history of these SEP events is illustrated above with hourly oxygen intensities as measured at ~3 MeV/nucleon by LET and at ~11 and 30 MeV/nucleon by SIS (from top to bottom in left plot). The times of the X-class flares are given by red, inverted triangles at the top and interplanetary shock passages are indicated by the solid vertical lines. The dashed lines indicate the time periods used to calculate event-integrated ion spectra for the two SEP events.

The two plots to the right show the spectra for He, O, and Fe obtained during the two SEP events. Plotted are the combined data from ULEIS and SIS on ACE and LET on the STEREO Behind spacecraft. It is clear that the LET results (based entirely on the on-board analysis) are in excellent agreement with the more mature ground-based analysis of ULEIS and SIS. Further refinements in the operational configuration of LET will provide additional improvements. The LET data nicely bridge the gap between the ULEIS and SIS measurements for elements heavier than O, allowing composition to be studied over 3 orders of magnitude in energy. Although abundance ratios are not shown, it is clear from the relative amplitudes of the O and Fe spectra that the SEP event on Dec 13th was significantly more Fe-rich than its counterpart from the east (on Dec 6th) and that the Fe-richness appears to increase with increasing energy. The excellent agreement between SIS/ULEIS and LET while the spacecraft are close together enables apparent differences in future observations to be interpreted in a physically meaningful way as the spacecraft drift apart. In addition, it will be possible to correlate multipoint SEP and other *in situ* data from STEREO and ACE with STEREO images of the corona and of CMEs.

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