Solar particle events detected on board ISS

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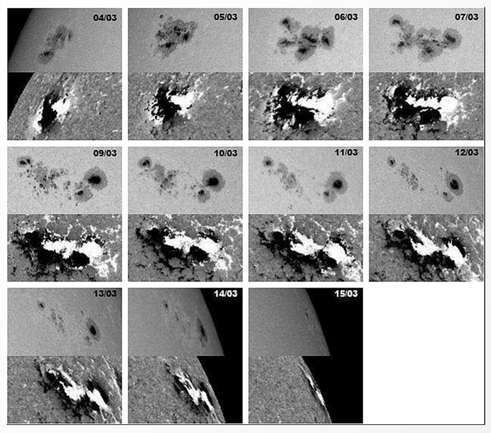
Abstract: Solar activity poses substantial risk for astronauts of the International Space Station (ISS) both on board and during extravehicular activity. We present in this work a parallel analysis of the ALTEA-ISS on board data and of the solar flares on the 7th of March 2012 produced by NOAA AR11429, described in the framework of space weather. The ALTEA (Anomalous Long Term Effects on Astronauts) experiment mounted on the ISS is an active detector composed of six silicon telescopes and is able to follow the dynamics of the radiation flux. During its operation in 2012 a number of flux peaks were detected in correspondence with solar events.

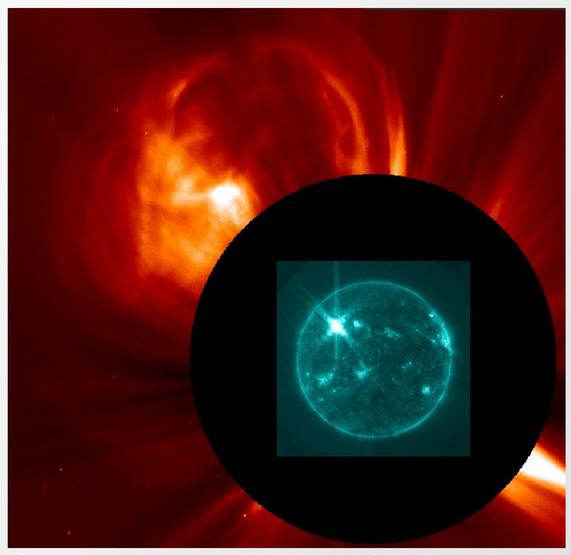
7th March 2012 solar event

The source of the flares was NOAA AR 11429. This region was located at N17E16 on the Sun. Its classification according to the Hale system was βγδ/βδ. AR 11429 flared repeatedly between the 5th and the 7th of March 2012. Of these flares, the one we are comparing with the ALTEA records, was an X class flare (X5.4) and occurred at 00:02UT on the 7th. It produced a full-halo CME whose speed was recorded at 2300 km/s. Proton flux measured by GOES soon increased starting from the 7th.



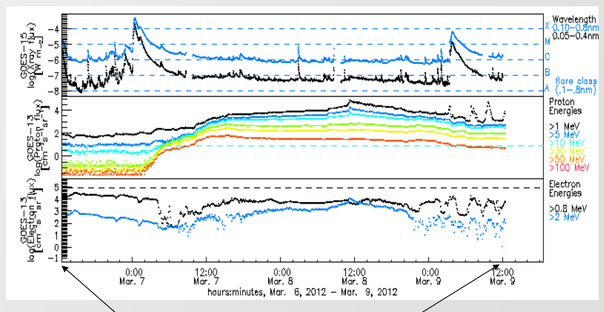
AR 11429 white-light images taken at the Astronomical Observatory of King Saud University (AOKSU) with corresponding SDO/HMI magnetograms; the evolution of the region is tracked through 11 days

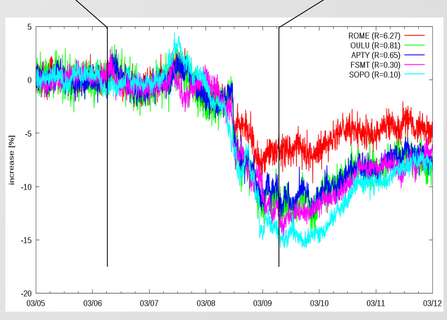
(Abouazza Elmhamdi, A.S. Kordi, H.A. Al-Trabulsy, M. El-Nawawy, A.A. Ibrahim, N. Ben Nessib, M.A. Abdel-Sabour, Z.A. Al-Mostafa, Observations and analysis of NOAA AR 11429 at KSU-Astronomical Observatory, New Astronomy 23-24 (2013) 73–81)



Superimposition of SOHO/LASCO C2 and AIA 131 showing the CME and the X5.4 flare

(courtesy of SDO-NASA, SOHO-ESA/NASA, http://helioviewer.org)





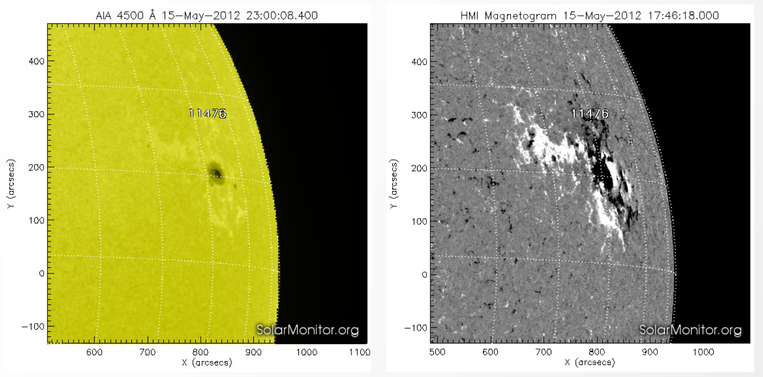
Upper panel:
GOES plots for X-ray, proton and electron fluxes around the event of March 7th

Lower panel:
the Forbush decrease as recorded by a number of ground based neutron monitor

(courtesy of NMDB, http://www.nmdb.eu)

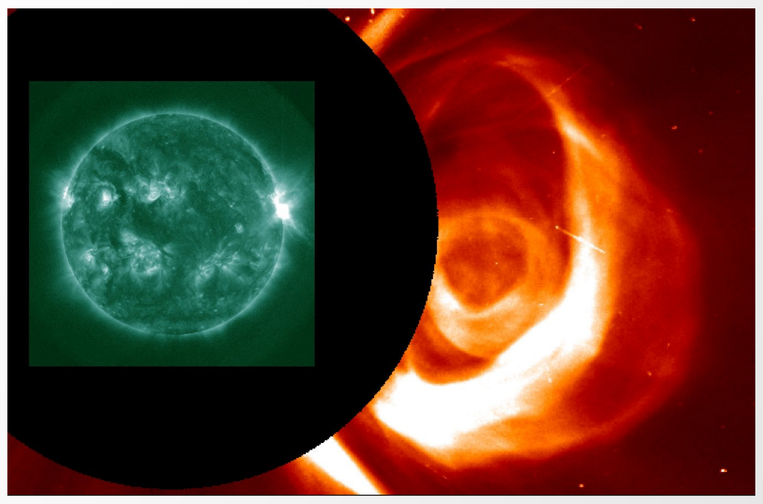
17th May 2012 event

The source was NOAA AR 11476, located at the time at N11W76, on the western limb. It was classified at the time of flaring as a Hale β/β, that is, double bipolar region. The region produced an M5.1 class flare at 01:30UT on the 17th, the CME lift-off occurred between 20 and 30 minutes later. Proton flux measured by GOES registered a peak intensity of 150 pfu.



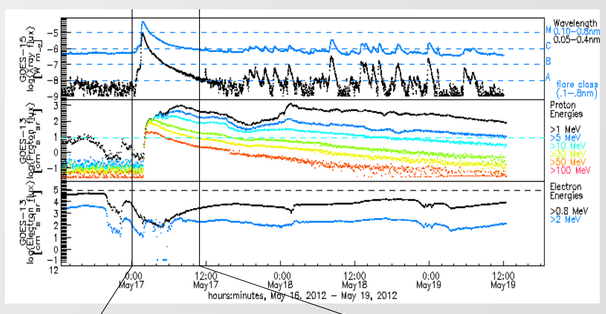
AR 11476: left 4500A image (AIA/SDO), right magnetogram (HMI/SDO)

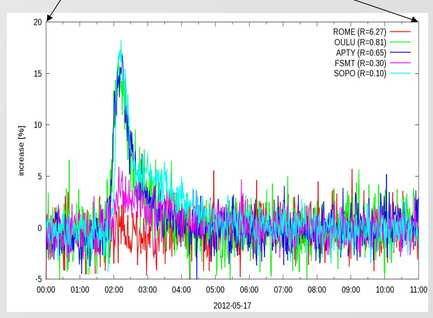
(courtesy:http://solarmonitor.org)



Superimposition of SOHO-LASCO C2 and AIA 131 showing the CME and the X5.4 flare

(courtesy of SDO-NASA, SOHO-ESA/NASA, http://helioviewer.org)





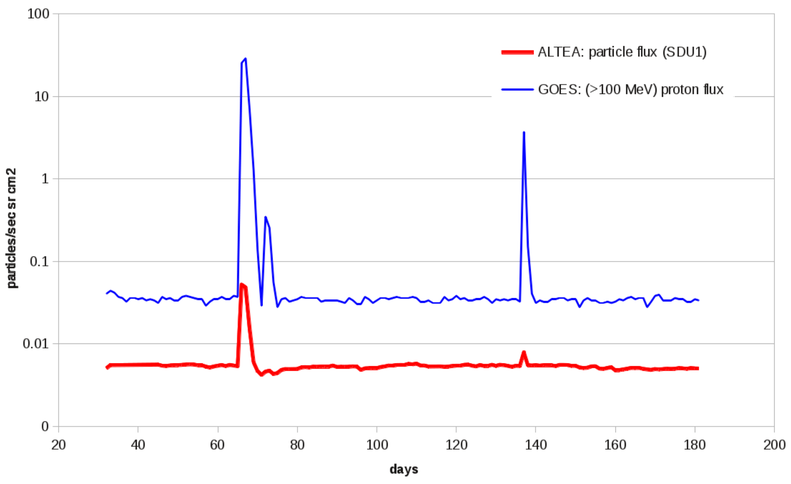
Upper panel:
GOES plots for X-ray, proton and electron fluxes around the event of May 17th

Lower panel:
the GLE71 as recorded by a number of ground based neutron monitor

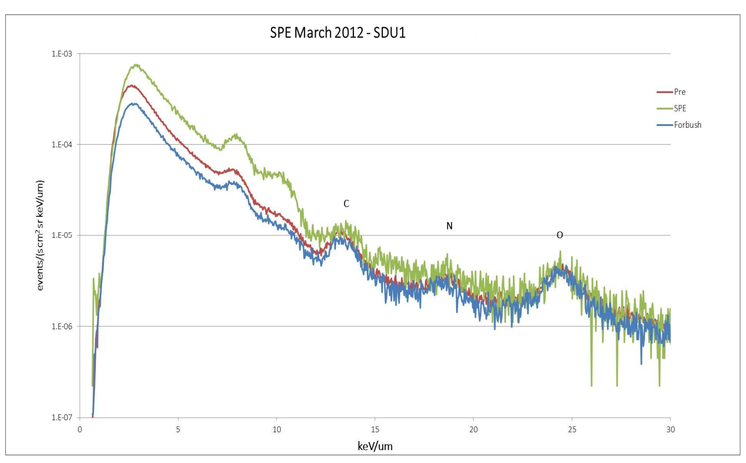
(courtesy of NMDB, http://www.nmdb.eu)

ALTEA: Anomalous Long Term Effects on Astronauts

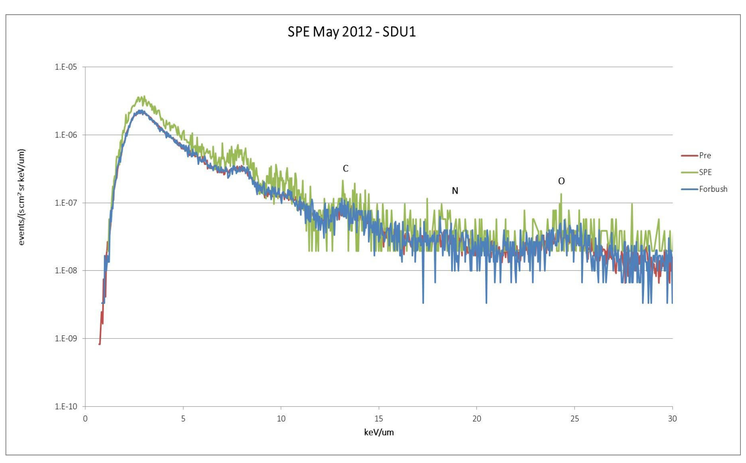
The ALTEA-space particle detection system, called SDS (Silicon Detector System), includes six identical particle telescopes (SDU, Silicon Detector Units) arranged either on a helmet-shaped structure or on an adaptable mounting system. Each SDU is able to determine the energy loss and the trajectory of the penetrating cosmic rays and has a geometrical factor of 230 cm^2 sr. The energy resolution of the detector ranges from a threshold of 2.9±0.2 keV/μm up to 800 keV/μm (linear energy transfer (LET) in Si), corresponding to ions between Li and Fe with a small energy interval for protons and He.
On board the ISS since July 2006, the ALTEA telescope was operative non continuously since August 2006 in different configurations, positions and orientations inside the USLab and Columbus module of the ISS. From September 2010 ALTEA SDUs were mounted on the adaptable support system, in a 3D configuration, for Survey (ALTEA-shield/Survey, part of an ESA sponsored experiment). In the new setup the SDUs were coupled to form silicon telescopes with twelve planes with each detecting couple pointing in a different X-Y-Z space direction.



February 1st to June 30th ALTEA SDU1 (red) and GOES 13 (blue) fluxes showing March 7th and May 17th events. Both the datasets are daily averaged.



Energy loss distributions as acquired by the ALTEA detector in the two events. The highest peak on the leftmost part of each plot encloses the contribution of the lightest ions (Z<5). The peak positions of relativistic Carbon, Nitrogen and Oxygen ions are shown. The period named "Pre" includes data collected in about the previous months (Feb 2nd to Mar 6th and Apr 20th to May 16th) while "Forbush" plot shows data collected between 12th and 19th March, and 19th and 26th May. The particle events give rise to an enhancement of low Z contribution in the spectrum with respect to the quiet Sun condition. The restoring of the solar quiet conditions is followed by a lowering in the particle flux due to the corresponding Forbush decrease: strong in the former event, almost negligible in the latter one.



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