Geophysical Research Abstracts
Vol. 17, EGU2015-5141, 2015
EGU General Assembly 2015

Near-Earth Cosmic Ray Decreases Associated with Remote Coronal Mass Ejection

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Galactic cosmic ray (GCR) flux is modulated by both particle drift patterns and solar wind structures on a range of time scales. Over solar cycles, GCR flux varies as a function of the total open solar magnetic flux and the latitudinal extent of the heliospheric current sheet. Over time-scales of hours, drops of a few percent in near-Earth GCR flux (Forbush decreases, FDs) are well known to be associated with the near-Earth passage of solar wind structures resulting from corotating interaction regions (CIRs) and transient coronal mass ejections (CMEs). We present four FDs seen at ground-based neutron monitors which cannot be immediately associated with significant structures in the local solar wind. Similarly, there are significant near-Earth structures which do not produce any corresponding GCR variation. Three of the FDs are shown to be during the STEREO era, enabling in-situ and remote observations from three well-separated heliospheric locations. Extremely large CMEs passed the STEREO-A spacecraft, which was behind the West limb of the Sun, approximately 2-3 days before each near-Earth FD. Solar wind simulations suggest that the CMEs combined with pre-existing CIRs, enhancing the pre-existing barriers to GCR propagation. These events are compared to the well-documented extreme event of July 2012 as a good comparison. Our observations provide strong evidence for the modulation of GCR flux by remote solar wind structures and a potential to detect these remote structures using neutron monitor data.