ABSTRACT

The Regents Physics-Honors classes of Pittsford Mendon High School analyzed relationships between measurable muon variables. The kp index and muon rate were collected from University of Rochester data from November 2004 and data from January 2005. The resulting data was analyzed by the three Regents Physics-Honors classes. Mendon data was compared to data from both the National Oceanic and Atmospheric Administration (NOAA).

Data from January 20, 2005: an X-7.1 solar flare produced a dramatic increase in the University of Rochester Cosmic Ray Muon Detector rate within minutes of the flare and roughly coinciding with the detection of the X ray pulse by the NOAA GOES-12 satellite. This was detected by neutron monitors in Moscow and Thule, Greenland, as well. This event is an example of a cosmic ray ground level enhancement, or GLE.

GLEs are sharp increases in the ground-level cosmic ray count to at least 10 percent above background, associated with solar protons of energies greater than 500 MeV. GLEs are relatively rare, occurring only a few times each solar cycle. When they occur, GLEs begin a few minutes after flare maximum and last for a few tens of minutes to hours. Intense particle fluxes at lower energies can be expected to follow this initial burst of relativistic particles. GLEs are detected by neutron monitors, e.g., the monitor at Thule, Greenland. What seems particularly unusual is the fact that this was detected at approximately 2:00 AM standard Rochester time, which would seem to be an unlikely time for a particle shower of solar origin. The ensuing Forbush decrease is clearly evident in the graph above, beginning approximately 34 hours after the flare, and lasting for about 29 hours.

Analysis of the data not related to this event revealed anti-correlations between muon rate Kp index.

Kp Index-Muon Rate: Anticorrelation

The Kp Index measures disturbances in the earth’s magnetic field from ground level. The index is a semi-logarithmic scale divided in measurements from 0-9 based on fluctuations in three-hour intervals. K disturbances arise from solar particle radiation that is derived from an influx of cosmic rays. An anti-correlation exists between the muon rate and Kp index. When charged particles, such as the muon, move through a magnetic field, they lose more energy and are more likely to decay before reaching the ground. Therefore, the detector picks up less muons because they have decayed into smaller particles.

Pressure-Corrected Muon Rate and Kp Index vs. Time