Surface Particle Detectors in Space Weather forecast

A.A.Chilingarian

Cosmic Ray Division, Alikhanyan Physics Insitute, Yerevan, Armenia, chili@aragats.am

Recently several groups report on the development of the alarm system based on the surface particle detector data. Among them are high-latitude neutron monitors network "Spaceship Earth", coordinated by the group from Bartol Research Center; Muon network coordinated by the group from Shinshu University and Athens Neutron Monitor Data Processing Center.
In the presented report, based on the information content of data from particle detectors of Aragats Space Environmental Center (ASEC) we made attempt to review possibility of surface particle detectors in Space Weather forecasts.
Particle monitors located at ASEC at 1000, 2000 and 3200 m altitudes (40˚25′N, 44˚15′E; Vertical cut-off rigidity in 2007: 7.1 GV) detect charged and neutral components of the secondary cosmic rays with different energy thresholds and various angles of incidence. ASEC monitors reliably detect the highest energy CR due to unique geographical location and large underground high energy muon detector.

Forecasting of the Solar Energetic Proton (SEP) events by surface particle detectors is based on the detection of the Ground Level Enhancements (GLE). Unfortunately not all SEPs contain particles energetic enough to produce GLE, therefore, the efficiency of the warnings will not be very high. Nonetheless, we can expect that the major events, (like 1859, 1956, 1972, 1989) with high probability will generate GLEs and surface detectors can provide forewarnings on upcoming abundant SEP particles. With the exception of the event on 20 January, when due to very good magnetic connection of the flare site with earth, all relativistic particles seem to come simultaneously, the enhancements of GeV solar particles detected by surface particle detectors can alert on upcoming severe radiation storm. The alerts from middle and low latitude monitors are even more important compared to high latitude networks, because of lower probability of false alarms. If an enhancement occurs at monitors with large cutoff rigidity it indicates that spectral knee occurs at large enough energy. Enhancements in the ASEC detectors count rates indicate higher solar ion energies, and, consequently hard spectra of the GLE in progress.

The triggers of the Geomagnetic Storms are huge magnetized clouds (Coronal mass ejections – CMEs), emitted by sun and traveling in the Interplanetary Space (IP). This gigantic plasma clouds with "frozen" magnetic field (Interplanetary CMEs, - ICMEs) disturb the Interplanetary Magnetic Field and "modulate "the ambient flux of the Galactic Cosmic rays (GCR). On the way to Earth (15 – 70 hours) the magnetic cloud and shock change GCR intensity and make it anisotropic. The strength of these modulation effects correlate with severity of the geomagnetic storm. Networks of the particle detectors located on Earth surface detect these modulation effects and can predict the upcoming geomagnetic storms hours before the ICME arrival at the magnetometers on ACE and SOHO space stations.

We will demonstrate that simultaneously detection of the charged and neutral components of the secondary cosmic rays made by ASEC monitors enlarged possibilities of physical inference on the solar modulation effects and, therefore, enlarges possibilities of timely and reliable forecasts of dangerous consequences of radiation and geomagnetic storms.