The Global Muon Detector Network -GMDN and the space situational awareness

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Space weather forecasting is a very important tool for the space situational awareness to the space objects, the space environment and related threats and risks for manned and non-manned spacecrafts. The global network of ground based multi-directional detectors (GMDN) can be considered as one example of an important emerging Space Situational Awareness program around the world, since its requirements needs global technical, scientific and logistic collab-oration between several countries in different continents. ICMEs accompanied by a strong shock often forms a high-energy galactic cosmic rays (GCRs) depleted region behind the shock known as a Forbush decrease. The ICME arrival also causes a systematic variation in the GCR streaming (i.e. the directional anisotropy of intensity). The magnitude of the streaming is small (about 1 % or less), but its variation is relevant. Some particles from this suppressed density region traveling with about the speed of light leak into the upstream region, much faster than the approaching shock, creating the possibility of being observed at the earth, by a global net-work of ground based multi-directional detectors (GMDN), as precursory loss-cone anisotropy. Loss-cones are typically visible 4-8 hours ahead of shock arrival for shocks associated with ma-jor geomagnetic storms. A multi-directional muon detector for detection of GCR was installed in 2001, through an international cooperation between Brazil, Japan and USA, and has been in operation since then at the Southern Space Observatory -SSO/CRS/INPE -MCT, (29.4° S, 53.8° W, 480m a.s.l), Sao Martinho da Serra, RS, in southern Brazil. The detector's capability and sensitivity were upgraded in 2005. The observations conducted by this detector are used for forecasting the arrival of the geomagnetic storm and their interplanetary coronal mass ejec-tion (ICME) drivers in the near-earth geospace. The detector measures high-energy GCRs by detecting secondary muons produced from the hadronic interactions of primary GCRs (mostly protons) with atmospheric nuclei. Since muons have a relatively long life-time (about 2.2 mi-croseconds at rest) and can reach the detector at ground level preserving the incident direction of primary particles, the detector can measure the GCRs intensity in various directions with a multidirectional detector at a single location, such as in Brazil. The Brazilian muon detector (MD), at SSO, is a part of the GMDN, an international collaboration consisting of 10 insti-tutions from 6 countries, with real time data generated by the GMDN, which was developed at Shinshu University, Japan. With the expectation of the approval by European Commission of the NESTEC (NExt generation Space TEChnology) Project, the GMDN may be upgrade in 2010 including new muon detectors in Bremen, Germany and in Hermanus, South Africa. Therefore the ICMEs traveling in the interplanetary space and reaching the Earth -cause re-duction in cosmic ray counts at the Earth by one to ten percent, and can be detected sometimes as much as ten hours before their arrival at Earth -with the GMDN, thus permitting accurate and reliable Space Weather forecasting and for the space situational awareness.

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