Anisotropic cosmic ray decrease in September 12, 2017 observed with Global Muon Detector Network

Y. Hayashi[1], C. Kato[1], R. Kataoka[2,3], M. Kozai[4], A. Kadokura[2,3,4], S. Miyake[5], K. Murase[3], and K. Munakata[1]

[1]*Department of Physics, Shinshu University, Matshumoto, Nagano 390-8621, Japan*

[2]*National Institute of Polar Research, Tachikawa, Tokyo 190-8518, Japan*

[3]*Department of Polar Sience, Scool of Multidisciplinary Science, The Graduate University for Advanced Studies, SOKENDAI, Tachikawa, Tokyo 190-8518, Japan*

[4]*Polar Environment Data Science Center, Joint Support-Center for Data Science Reasearch Organization of Information and Systems, Tachikawa, Tokyo 190-8518, Japan*

[5]*Department of Industrial Engineering, National Institute of Technology (KOSEN), Ibaraki College, Hitachinaka, Ibaraki 312-8508, Japan*

We analyze the galactic cosmic-ray (GCR) observed with ground-based muon detectors. The GCR intensity transiently changes related to solar activities, such as the interplanetary coronal mass ejections (ICMEs). The arrival of ICMEs causes spatio-temporal variations of GCR intensity. Therefore, the analysis of fluctuating GCR provides us with information about the near-Earth GCR environment and the ICME arrivals. The variations of GCR intensity consist of two different components, density and anisotropy. Only a single detector cannot separate the density and anisotropy, while a global network enables us to do it. In other words, we are observing GCR flux using the Earth as a large single detector. This network is called the Global Muon Detector Network (GMDN), which consists of four multidirectional ground-based muon detectors in Japan, Australia, Kuwait, and Brazil. The previous studies using the data of GMDN include the papers by Munakata et al. (2022), Kihara et al. (2021), and Rockenbach et al. (2014). Figure 1 shows the asymptotic viewing directions of GMDN. In addition, we installed a pair of an NM64 neutron monitor and a muon detector at the Syowa Station, Antarctic, and started simultaneous measurements with both detectors in 2018. The Syowa neutron monitor and muon detector measure GCR with different energies coming from similar asymptotic directions. Combining these data, both GMDN data and Syowa data, we investigate the energy dependence of time variations of GCR intensity. Data from Syowa will play a key role to connect neutron monitors and muon detectors. In September 2017, one of the largest solar flares occurred and the associated ICMEs arrived at the Earth. We analyze the data of GMDN and separated the density and anisotropy. As a result, we identified a decrease of GCR density and the increase of anisotropy >2 days after the ICME passage, which is different from standard Forbush decrease events. We observed both the first- and second-order anisotropies corresponding to the uni- and bi-directional GCR flows, respectively. In this talk we report the progress of further analysis of this particular GCR decrease event.

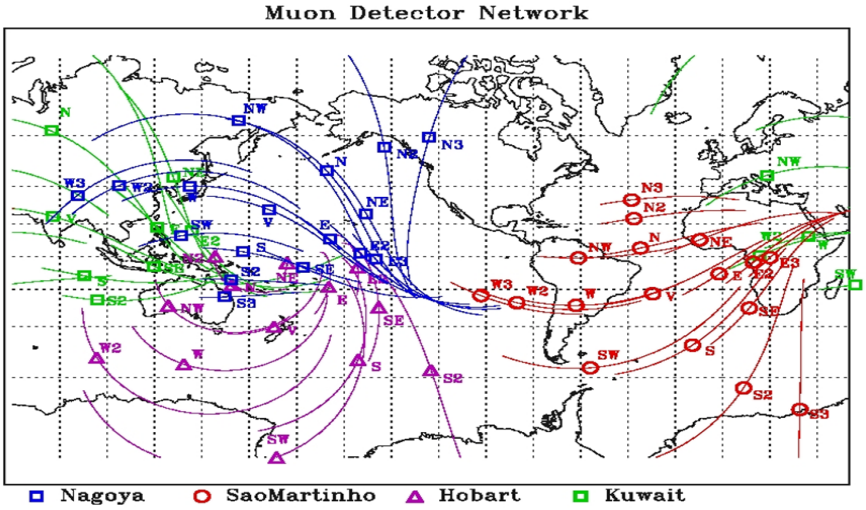

Figure 1. Asymptonic viewing directions of GMDN.

References

Munakata, K., et al. 2022, http://arxiv.org/abs/2209.05743 APJ 2022 *inpress.*

Kihara, W., et al. 2020, Space Weather, 19, issue 3.

Rockenbach, M., et al. 2014, Space Sci. Rev., 182, 1.