A Particular ICME Event in August 2018 Observed with the Ground Based Muon Detectors and Neutron Monitors

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We demonstrate that global observations of high-energy cosmic-rays contribute to understanding the unique characteristic of a large-scale magnetic flux rope (MFR) causing a magnetic storm in August 2018. Following a weak interplanetary shock on 25 August 2018, a MFR caused an unexpectedly large geomagnetic storm (real-time Dst index minimum = -174 nT on 26 August 2018). It is likely that this event became geoeffective because the MFR was accompanied by the corotating interaction region and compressed by high-speed solar wind following the MFR. Firstly, we analyzed muon detector (MD) data, and a forbush decrease was observed in cosmic-ray data inside the MFR as expected, furthermore a significant cosmic-ray density increase exceeding the unmodulated level before the shock was also observed near the trailing edge of the MFR. In addition, we analyzed 11 neutron monitor (NM) data for this event in the same way, and we found that cosmic-ray density increase was observed by NMs. This unique cosmic-ray density increase can be interpreted in terms of the adiabatic heating of cosmic-rays inside the trailing edge of the MFR, as the observed corotating interaction region is expected to prevent a free expansion of the MFR and results in the compression near the trailing edge. While a variation of cosmic-ray density was consistent with result of MD data, a variation of cosmic-ray anisotropy was different from the result of MD data. In order to fully understand the energy dependence of those variations, we need to analyze the NM and MD data combined. Syowa Station, which has both MD and NM in operation at the same location observing the same direction simultaneously, enables us to mutually calibrate the responses of MD and NM to primary cosmic-rays. We report such an initial analysis, using the unique data from the Syowa Station.

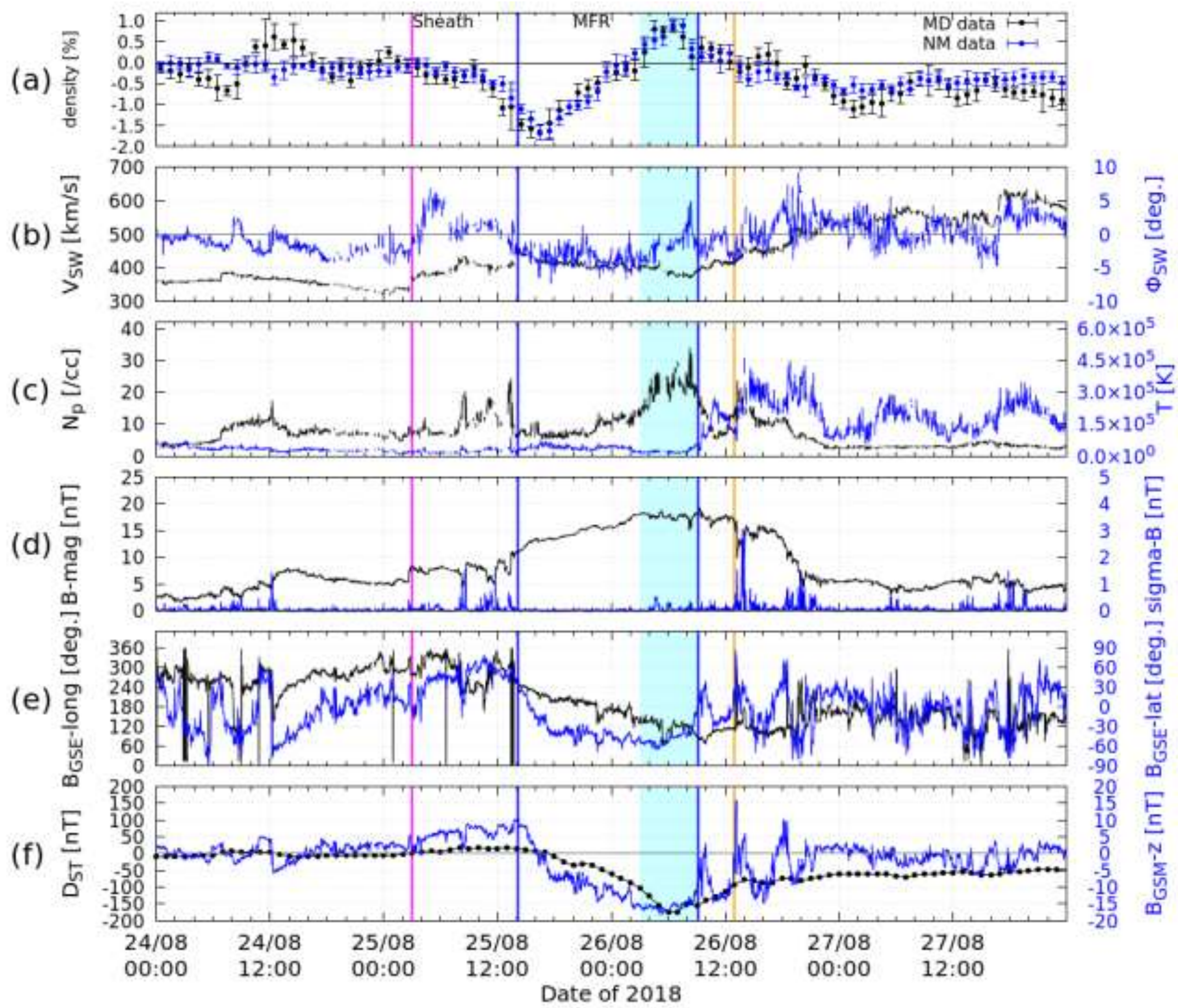

Figure 1: Cosmic-ray density, solar wind parameters by the *Wind* and D_{ST} index for 24-27 August, 2018. From top to bottom; (a) cosmic-ray density by MD data (black) and cosmic-ray density by NM data (blue), (b) magnitude of solar wind velocity (black) and "flow angle of solar wind", (c) proton density (black) and temperature (blue), (d) IMF magnitude (black) and its fluctuation (blue), (e) GSE-longitude (black) and latitude (blue) of IMF orientation, (f) GSM-z component of IMF (blue) and hourly value of the D_{ST} index (black). The pink vertical line indicates the timing of IP-shock identified in the solar wind data at 03:00 UT on 25 August, while a pair of blue vertical lines delimit the MFR period reported by *Chen et al*. (2019). The blue shaded area indicates six hours between 03:00 UT and 09:00 UT on 26 August when an increase is observed in the cosmic-ray density. The orange vertical line indicates the second stream interface at 13:00 UT on 26 August. As indicated at the top of the figure, we define the "MFR period" delimited by a pair of blue vertical lines and the "sheath period" between the pink and the first blue vertical lines.

References

Chen, C., Y. D. Liu, R. Wang, X. Zhao, H. Hu, and B. Zhu (2019), Characteris tics of a Gradual Filament Eruption and Subsequent CME Propagation in Relation to a Strong Geomagnetic Storm, **Astrophys. J., 884, 90**, doi:10.3847/1538- 585 4357/ab3f36.