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Transient galactic cosmic ray modulation during solar cycle 24: A comparative study of two prominent Forbush decrease events

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Forbush decrease (FD) events are of great interest for transient galactic cosmic ray modulation study. In this study, we perform statistical analysis of two prominent Forbush events during cycle 24, occurred on 8 March 2012 (Event 1) and 22 June 2015 (Event 2), respectively, utilizing the measurements from the worldwide neutron monitor (NM) network. Despite of their comparable magnitudes, the two Forbush events are distinctly different in terms of evolving GCR energy spectrum and energy dependence of the recovery time. The recovery time of Event 1 is strongly dependent on the median energy, compared to the nearly constant recovery time of Event 2 over the studied energy range. Additionally, while the evolution of the energy spectra during the two FD event exhibit similar variation pattern, the spectrum of Event 2 is very harder, especially at the time of deepest depression. These difference are essentially related to their associated solar wind disturbances. Event 1 is associated with a complicated shock-associated ICME structure of IP/Sheath/MC sequence with large radial extend and limited longitudinal extent (narrow and thick), probably merged from multiple shocks and transient flows. Conversely, Event 2 is accompanied by a relatively simple interplanetary disturbance of IP/Sheath/Ejecta sequence with small radial extend and wide longitudinal departure (wide and thin), possibly evolved from an over expanded CME. Such comparative study may help to clarify the occurrence mechanisms of Forbush events related to different types solar wind structures and provide valuable insight into the transient GCR modulation, especially during the unusual solar cycle 24.