



A new definition of GLE and sub-GLE events as necessitated by new high-altitude polar neutron monitors

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The "official" list (<http://gle.oulu.fi>) of ground-level enhancements (GLE) of the count rate of a neutron monitor (NM), caused by solar energetic particles, plays an important role in solar and solar-terrestrial studies. The list is based on the classical GLE definition, which assumes that the event should be registered by at least two differently located NMs regardless to their atmospheric and geomagnetic cutoff properties. Until 2015 there was only one long-operating NM at a high-altitude polar site with the reduced total cutoff (SOPO/B at the Amundsen-Scott station, South Pole, Antarctica, elevation 2835 m asl), and Vostok NM (Vostok station, 3500 m) operating 1963-1969. Accordingly, most of the registered GLEs included data from at least one NM near the sea level. However, another high-altitude polar NM (DOMC/B) had been installed in 2015 at Concordia station (Dome C, Antarctica, elevation 3233 m asl) and is in continuous operation since then. As a result, this pair of exceptionally sensitive instruments (SOPO/B and DOMC/B) can formally register a GLE from a relatively weak SEP event below the full atmospheric cutoff, which would have not been detected at any other NM station and, accordingly, not accepted as a GLE before 2015. This would potentially distort the homogeneity of the present GLE list by more frequent detections due to the enhanced sensitivity of the global NM network.

In order to maintain the homogeneity, we propose to modify the presently used GLE as follows: " A GLE event is registered when there are near-time coincident and statistically significant enhancements of the count rates of at least two differently located neutron monitors, including at least one neutron monitor near sea level and a corresponding enhancement in the proton flux measured by a space-borne instrument(s)." We also propose to classify SEP events under the full atmospheric cutoff, which are seen only in data of high-altitude polar NMs, as sub-GLEs. We note that this definition does not affect the present list of GLEs.