The Role of GLEs in Space Weather

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Ground level enhancements (GLEs), i.e. the sudden increases in the count rates of ground-based cosmic ray detectors (e.g. neutron monitors), are the manifestation of short-time energetic solar particle radiation near Earth. With a variety of direct and indirect effects on geospace, humans, industry, and economy, relativistic solar particle events are at the same time one of the main but also one of the most uncertain factors in the space weather domain. In all space weather scenarios cosmic ray measurements are included as an additional forecasting tool, as a monitoring instrument, and as a key provider of input parameters for modeling. Major applications are the protection of aircrew and astronauts from the effects of enhanced particle radiation, but further applications, e.g. meteorological and climatic influences, are possible. On the basis of selected examples (e.g. January 20, 2005) and from a statistical perspective, the paper reviews selected characteristics of high-energy solar particle events such as the peak flux, the event integrated $>$10 MeV total proton fluence, the spectrum and anisotropy, as well as the rate of occurrence. Advanced analysis and modeling techniques are illustrated, and the role of cosmic ray measurements and GLE analysis, e.g. based on observations with the worldwide network of neutron monitors, is evaluated in view of real-time monitoring, forecasting, and post-event analysis of the interplanetary radiation environments.