



Solar particle storms: the worst-case scenario

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Sporadic solar eruptive events, such as flares or coronal mass ejections, can lead to bulk acceleration of solar plasma to relativistic energies. This can result in quite rare solar energetic particle events, known also as solar particle storms. About 70 strong and highly energetic solar particle storms (called ground-level enhancements, GLEs) have been recorded by ground-based instrumentations, neutron monitors and ionization chambers. During the last 75 years, at the average rate of ten per solar cycle. The intensity of these events varies by three orders of magnitude, with the strongest observed event taking place as GLE #5 on 23-Feb-1956 with the peak intensity being 5000% above the background caused by galactic cosmic rays. However, the statistical distribution of these events by strength is still limited and does not allow one to assess the worst-case scenario or the strongest possible solar particle storm and the probability of its occurrence. Such assessments can be only made with the help of indirect proxies, viz. cosmogenic radio-isotopes in terrestrial or lunar natural archives, that cover centuries, millennia, up to millions of years. Here we summarize the present-day state of the art, including available data sets and models, and suggest that the recently discovered historical solar particle storm of 775 AD can conservatively serve as a worst-case storm on the time scale of up to a million years. Depending on energy, its intensity was greater by a factor of 3 to 100 than the strongest directly observed events. We also discuss possible terrestrial effects of such an extreme event.