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Particle acceleration in solar flares and propagation of high energy particles to the Earth (II)

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Large amount of particles can be accelerated to relativistic energy in association with solar flares, and sometimes these penetrate to the Earth's atmosphere. These particles are observed by ground-based detectors (e.g., neutron monitor). Such phenomena are called Ground Level Enhancements (GLEs).

Solar flares are observed by detecting their electromagnetic radiations. Hard X-ray, and radio and line gamma-ray observations give information of accelerated electrons and ions, respectively. High energy particles which reach the Earth and penetrate to the ground are observed by neutron monitors. We can predict the energy spectrum of high energy particles penetrating the Earth's atmosphere by comparing neutron monitor measurements with electromagnetic radiations. This is beneficial for the quantitative prediction of radiation dose.

There are two possible candidates for high energy particle production: the solar flare itself; and/or the CME-driven shocks, where by the flare-produced "seed" particles are re-accelerated by the CME-driven shocks. However, detailed acceleration mechanisms are still not understood, and should be modeled. For predicting the energy spectrum of energetic particles at the Earth, it is important to understand quantitatively the population of accelerated particles during the flare.

In this paper, we discuss the population of accelerated particles produced in solar flares, and the prediction of the energy spectrum of high energy particles (especially solar neutrons) in the Earth's atmosphere during GLE events. We also inspect an M8.7-class flare of 23 Jan 2011 using solar data; this event was the source region of a large SEP event.

Keywords: solar flare, particle acceleration