Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PEM029-06 Room:203 Time:May 24 15:30-15:45

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

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

Solar flares are observed by using electromagnetic radiations. Hard X-ray, radio and line gamma-ray observations give information of accelerated electrons and ions, respectively. High energy particles which reached to the Earth and penetrated to ground are observed by neutron monitors. We can predict energy spectrum of high energy particles penetrating to the Earth's atmosphere, by comparing 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 - the flare producing 'seed' particles that enter to the CME-driven shocks and then they are re-accelerated there. However detailed acceleration mechanisms are still not understood that 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 present two topics regarding solar flares, for the sake of the prediction of radiation dose in the Earth's atmosphere. The first is the population of accelerated particles in solar flares, and the second is the prediction of the energy spectrum of high energy particles (especially solar neutrons) in the Earth's atmosphere during the GLE event.

Keywords: solar flare, particle acceleration