

Observations of high-energy electrons and gamma rays from winter thunderclouds

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We have continued our GROWTH (Gamma-Ray Observation of Winter Thunderclouds) experiment from December in 2006, in order to investigate high-energy radiation phenomena from winter thunderclouds along the Japan Sea [H.Tsuchiya, T.Enoto et al.,2007, PRL][Is a thundercloud natural particle accelerator ?, The Astronomical Herald,2008][T.Enoto, ICRC, 2007]. We installed two observing systems at Kashiwasaki-Kariwa nuclear power plant in 2007 December. These instruments were manufactured by Tokyo University and RIKEN, using inorganic scintillators, plastic scintillators, and environmental sensors (light, sound and electric field).

We have already detected two gamma-ray events from winter thunderclouds. These events have $\sim 36, 72$ seconds duration times, with photon index of gamma-ray spectra at ~ 1.1 and ~ 1.3 , and extending up to nearly 10 MeV. Strong low pressure systems developed above the Japan Sea during these period, and MeV electrons can be produced by a mechanism of relativistic runaway electron acceleration in a strong electric field in the thunderclouds. So, these detected events are interpreted as a bremsstrahlung X-rays emitted by the relativistic electrons in the dense atmosphere. There results were already reported at the past JGU conferences in 2007 and 2008.

Here we report a newly detected burst at 14:48 JST on 2008 December 23 (During this period, thunderclouds activity occurred above Kashiwasaki). It is interesting that this burst event had much shorter duration time (nearly 400 ms) of inorganic scintillators (NaI, CsI, BGO) than past two burst events. In addition, the spike increase of plastic scintillators were recorded at the onset of the burst with less than 50 ms duration. This means that our instruments detected electrons, which may be accelerated in the thunderclouds activity, because plastic scintillators are more sensitive to particles than photons. At this presentation, we report other three events detected during this winter on December 25, January 13 and 25.