Enhanced gamma-ray dose-rate associated with winter thunderstorm activities and the effect of cosmic-rays muons

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Gamma ray dose-rate increases associated with winter thunderstorm activities have been observed in the coastal areas facing the Sea of Japan. In order to investigate the generation of energetic photons which originate in thunderstorm electric fields, we have calculated the behavior of energetic particles in such electric fields with the Monte Carlo method. In the calculation of MeV electrons emitted in the atmospheric air, the electron and photon fluxes have increased greatly in the region where the field strength exceeded 280P(z) kV/m, and the photon energy spectrum showed a large increase in the energy region of several MeV. We have also carried out the Monte Carlo calculation of the cosmic-ray muons and associated particle transport in the thunderstorm electric fields. It has been confirmed that the electron and photon fluxes are incredibly increased in the strong electric field simulated thunderclouds, while the muon flux does not fluctuated significantly. From these results, it is seemed that the energetic electrons induced by cosmic ray muons are a key role of the enhanced electron and photon fluxes in thunderstorm electric fields. These results indicate that the production of secondary electrons plays an important role in the intensive ionization of the air, and as a result a significant growth of electric conductivity in thunderstorm electric fields.