

## **Monte Carlo Simulation for the Source of Transient Energetic Radiation During Winter Thunderstorm**

Energetic Radiation from Thunderstorms and Lightning

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Intensive and transient energetic radiations associated with winter thunderstorm activities were detected around the west coast of Sea of Japan. We identified the source location of the transient energetic radiation, lasting for several minutes, through the observations of radiation, atmospheric electric field, and meteorological radar echoes. Our identification indicated that the transient energetic radiation was emitted from a downward hemispherical surface with regardless of lightning discharge, the bottom of which was about 300 m above sea level. This may occurs due to the generation of bremsstrahlung photons caused by electric fields inside the thunderstorm, because the energy of the observed radiation exceeds that of the radiation emitted from natural nuclides. In order to verify this speculation, we calculate the behavior of secondary cosmic ray electrons and photons in intensive electric fields by Monte Carlo technique. The photon flux largely increases just under the thundercloud if we assume that the electric field around the downward hemispherical surface is - 400 kV/m, and the photon energy spectrum shows a large increase in the energy region of several MeV. When the calculated energy spectrum emitted from the thunderstorm is consistent with the observed results, the large electric field around - 400 kV/m is required around the bottom of the thundercloud.