

X-band radar and disdrometer observations of winter thunderclouds emitting gamma rays

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Strong electric fields in thunderclouds accelerate electrons to relativistic energy even in a dense atmosphere, and bremsstrahlung gamma rays are observed as gamma-ray glows by radiation monitors on aircraft and on the ground. Since gamma rays are absorbed by the atmosphere, it is difficult to observe gamma rays emitted from summer thunderclouds at sea-level, but gamma-ray glows during winter thunderstorms in the Hokuriku region can be observed on the ground because they develop at low altitudes. We are conducting the GROWTH experiments in Ishikawa and Niigata prefectures to observe high-energy atmospheric phenomena such as gamma-ray glows. During the three seasons from 2016 to 2018, a radiation monitor installed at Kanazawa University registered a total of 11 gamma-ray glows. In each case, it was confirmed by the X-band radar operated by the Ministry of Land, Infrastructure, Transport and Tourism that a thundercloud with strong echoes exceeding 35 dBZ developed at an altitude of 2 km or more (-10 degrees or less) passed over the detector. Also a disdrometer installed at the site detected graupel precipitation during the gamma-ray glows. Therefore, it is considered that the developed thundercloud accompanied by hail contributes to the occurrence of gamma-ray glows.

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