Measurement of high-energy radiations in association with winter thunderclouds at the Sea of Japan

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Observations of high-energy radiations, which extend to around 3 MeV, from natural and rocket-triggering thunders have been reported by various past experiments, especially based on monitoring posts located around nuclear power plants. However, it has been still unknown how such high-energy radiations are emitted from the lightning. This is because that almost of the past experiments does not

have enough timing resolutions and cover energies greater than 3 MeV. Therefore, we start observations at Kashiwazaki-Kariwa nuclear power plant located at the Sea of Japan, with optical, sound and electric field monitors as well as instruments to detect x- and gamma rays, aiming to elucidate the mechanism to emit high-energy radiations from thunderclouds and that of the underlying particle acceleration.

Installed at the Kashiwazaki-Kariwa nuclear power plant on 2006 December, our measurement system has been successfully operated. The system is divided into two major parts. One part has a wide energy range from from 50 keV to 80 MeV, consisting of spherical NaI/CsI scintillators with a diameter of 3 inch, plastic ones and an electric filed meter. The equipped scintillators measure omnidirectional radiations. Another part are composed of NaI/BGO scintillators, plastic ones and environment monitors to measure optical flushes and acoustic sound produced by lightning. The cylindrical NaI scintillator, with a dimension of 3 inch X 3 inch, is capable of observing radiations from 50 keV to 3 MeV with a high energy resolution of around 0.7 keV and a timing resolution of 10 usec. In addition, it is surrounded by the well-type BGO scintillator and the plastic scintillator plate to reject radiations which are not derived from thunderclouds and lightning. Thus the NaI scintillator can effectively detect photons related with thunderclouds and/or lightning. Using the system constituted by two major parts, we have made a complementary observation.

In addition to characteristics and abilities of our system, we show results of observations obtained in winter season and discuss how the high energy emissions are produced and the underlying particles are accelerated up to MeV energies in a thundercloud and/or lightning.