Global Measurement of Lightning-associated TLEs from the International Space Station by the EUSO Telescope

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In the last decade lightning-associated transient luminous events (TLEs) were first discovered by the ground-based optical observations. Recently, these events seem to be ubiquitous around the world. Using a technique of a numerical simulation it was reported that TLEs would chemically change the concentration of NOx and HOx in the mesosphere and lower thermosphere, which would be linked with the chemical reactions of Ozone. However, the chemical impact of TLEs on the global atmosphere is not identified since the global occurrence rates and locations of TLEs have not been identified so far. Moreover, the occurrence conditions of TLEs which would be established by gravity waves, injections of cosmic rays (CRs) and micro meteors are not fully understood.

In order to clarify them, we are planning to observe TLEs continuously from International Space Station (ISS) altitude using the Extreme Universe Space Observatory (EUSO) telescope. EUSO is an international and multi-agency mission led by ESA. EUSO observes the night side of the earth to detect fluorescence and Cerenkov emissions from extensive air showers generated by the ultra high energy (over 5*10^19 eV) CRs with a time resolution of 2.5 us and a spatial resolution of 800 m*800 m at the ground surface. EUSO employs an UV (300-400 nm) telescope as a detector with the active diameter of 2.5 m and a FOV of 60 degrees, which will be installed at ISS around 2010. Using this telescope it is also possible to carry out the nadir observation of lightning and lightning-associated TLEs.

Using data sets of global lightning occurrence rates and locations derived from ELF magnetic field waveform data, we estimated possible detection rates of lightning by the EUSO telescope. It is found that the possible detection number of lightning is estimated to be 1.1*10^4 events/day. Furthermore, we estimated a number of photons which are emitted by sprites and reach at the entrance of the telescope. It is found that the photon number is estimated to be 1.4*10^7 ph/event/pix when the optical energy of sprites is supposed to be 10 kJ. These facts imply that EUSO has high potential to detect TLEs with extremely high spatial and temporal resolution.

Since EUSO is originally designed to detect weak UV emission of extensive air showers, it is necessary to change gain level of detector at the focal surface (about 6,000 multi-anode photomultiplier tubes (MAPMT)) when the telescope looks such strong light sources. We are developing a new-type of the MAPMT divider which can automatically change the gain level of MAPMTs. We will show a design of the circuit and discuss the operation mode of the telescope for TLE observations.