Characteristics of the lightning associated with terrestrial gamma ray flashes observed by the ELF network

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Terrestrial Gamma-ray Flashes (TGFs) is one of the great mysteries in phenomena associated with lightning. TGFs were first discovered by BATSE on CGRO satellite in 1994. RHESSI satellite observed over 170 TGFs per year from 2002 to 2005.

VLF/ELF sferics provides us important information on the lightning generating TGFs. Tohoku University is measuring ELF magnetic field at three sites located globally. From the data, we can estimate the charge moment, location, and polarity of lightning occurring in the world.

There are some studies that indicate the charge moments of the lightning associated with TGFs. But the relation between the magnitudes of lightning and TGFs occurrence frequency is not fully understood.

We checked 141 our ELF waveform at the timing of TGFs recoded by RHESSI in 2004. And found 27 ELF transients generated by lightning. We estimated the charge moments of the 27 lightning. The charge moments of the 27 lightning is 217 Ckm in average. The biggest lightning has 404 Ckm. 26 lightning have positive polarity, 1 lightning has negative polarity.

We also calculate the global occurrence frequency of lightning that have the charge moment less than 400 Ckm. The frequency is 90,000/day. Smith et al. reported that the TGFs occurrence frequency is 50/day if the beamwidth of TGFs is 45 degrees, 5000/day if the beamwidth is 10 degrees. We estimate that the occurrence frequency of TGFs is between 0.05 and 5 % for lightning that have the charge moment less than 400 Ckm.