Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

AEM012-P03 Room: Convention Hall Time: May 27 17:15-18:45

The relationship between sprite luminosity and charge moment based on ISUAL and ELF measurements

Hiroshi Nakajo[1*], Yukihiro Takahashi[1], Hiromi Kase[2], Toru Adachi[3], Mitsuteru Sato[1], Kozo Yamashita[2]

[1]Cosmosciences, Hokkaido Univ., [2]Dept. of Geophysics, Tohoku Univ., [3]Stanford Univ.

Sprite is a transient luminous phenomenon in the mesosphere, induced by lightning discharges. Since its discovery in 1989, many optical and electromagnetic observations clarified its variations in shape and in physical processes. Now we have known the facts that there are some varieties of features, such as sprite-streamers with fine-structures and sprite-halos with pancake-structures. However, due to the atmospheric absorption and scattering, it is difficult to discuss its luminous intensity and relationships to the parent lightning quantitatively. After 2004, the beginning of optical observations with ISUAL/FORMOSAT-2 from space, the absolute luminosity of sprite became to be discussed. There is a compelling theory which predicts that sprite occurrence is dependent on the quasi-electrostatic field induced by lightning. In such a case, it is speculated that the intensity of the sprite emission should have a relationship to the charge moment of the parent lightning because the strength of the electric field is proportional to the charge moment of lightning. By Yoshida (2007), absolute optical energies emitted from sprites were estimated for 14 streamer type sprites, using ISUAL/Array photometer data. Furthermore, the optical energies of the streamer type sprites and the charge moments of their parent lightning estimated by ELF data show high correlation (correlation coefficient = 0.93).
However, the relationship between the optical energies of sprite-halos and the charge moments of their parent lightning is still unknown. In this study, we analyze 12 sprite-halos, using ISUAL/ Array photometer data and ELF data from July 2004 to October 2005.
The ISUAL instrument on board the FORMOSAT-2 satellite, which flies on a sun-synchronous (9: 30 to 21:30 local time) polar-orbit at an altitude of ~891 km, consists of an imager, a spectrophotometer (SP), and an array photometer (AP). It looks at the limb in the midnight direction. The AP consists of two multi-channel photometers simultaneously measuring two different wavelength ranges of 510-750 nm (N2 1PG) and 340-480 nm (N2 2PG) with blue and red filters, respectively. Each photometer has sixteen channels arrayed in the vertical direction. The output of each channel is recorded at a sampling frequency of 2 kHz or 20 kHz. Thus, the AP can measure temporal and vertical structure of sprites. We are able to estimate sprite luminous intensity from AP data.
Our team operates a worldwide ELF observation network, consisting of four observation sites located at Syowa in Antarctica, Onagawa in Japan, Kiruna in Sweden, and California in US. Observation system at each site records ELF magnetic waveforms in the wavelength range of 1-1 00 Hz continuously. We can estimate the lightning location and the charge moment for intense lightning events whose charge moment is larger than 350 Ckm.
We estimate lightning charge moment from ELF data and sprite luminous intensity from AP data. We analyze 12 events of sprite-halos observed from July 2004 to October 2005. The averages of the time-integrated luminous intensity are 9.0*10^22 photons for N2 1PG and 1.3*10^22 photons for N2 2PG bands, respectively. We show there is positive correlation between the optical energies and the lightning charge moments (correlation coefficient = 0.76), which does not conflict with a story of QE model qualitatively. We will analyze more events to discuss regional dependence of

this correlation between sprite luminosity and lightning charge moment.

Keywords: lightning, sprite, halo, ISUAL, ELF