Relationship between duration of optical emission of sprites and charge moment change of their parent CG

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In the period of a combined aircraft and ground-based campaign supported by NHK Cosmic Shore project, June 27 to July 10, 2011, an airborne high-speed camera captured over 60 TLEs at a frame rate of 8000/sec or 10000/sec. We analysed the light curve of sprites obtained from high-speed imagery, comparing with peak current of parent cloud-to-ground (CG) discharge estimated by NLDN and charge moment change calculated from ELF waveform recorded with global ELF observation network, (GEON), operated continuously by Hokkaido University. It is found that there exists a good correlation between the duration of the optical emission of sprites and the charge moment change of the parent CG with R^2~0.63.

1. Introduction

Sprites are transient luminous events induced by mostly positive cloud-to-ground (CG) lightning. Previous research suggests that the quasi-electrostatic (QE) model is basic mechanisms for the generation of sprites. QE fileds would be directly proportional to the charge moment change (CMC) and electron density/conductivity at the sprite altitude. Therefore, QE fields are more stronger, relaxation time of electric fields would be more shorter. It is considered that relaxation time of electric fields are related to optical relaxation time of sprites. By investigating the optical relaxation,there is some possibility of being clarified the streamer mechanism as the emission process of sprites.

2. Observations

2.1. Aircraft campaign in USA

Aircraft campaign supported by NHK (Japan Broadcasting Corporation) Cosmic Shore project was carried out in the period of June 25 - July 10, 2011 in the Midwest. Observation using a high-speed camera with a frame rate of 8000/sec or 10000/sec were made. The high-speed camera has a field-of-view (FOV) of 41° (horizontal) ×37° (vertical). ELF waveform was simultaneously recorded with global ELF observation network, (GEON), operated by Hokkaido University.

2.2. Data

We succeeded to capture 64 high-speed imagery using NHK high-speed camera. The number of analysed sprite events, whose whole structure are mostly covered by FOV of the camera, with sufficient S/N ratio of image data and identifiable ELF waveform is 20.

3. Relationship between duration of optical emission of sprite and CMC

We analysed the light curve of sprites obtained from high-speed imagery, comparing with peak current of parent cloud-to-ground (CG) discharge estimated by NLDN and charge moment change.

The duration time is calculated to use the light curve of sprite obtained from high-speed imagery. Figure 1 shows schematic diagram of light curve. Rise time (t1) is typically shorter than decay time (t2). Therefore, we regard decay time (t2) as duration time.

Charge moment change (CMC) is calculated to use Normalized Amplitude Method [Yamashita et al., 2011]. Normalized amplitude at 1Mm distance from the source is calculated using the actual observed

amplitude of the transient ELF waveform. Then, the charge moment change can be estimated using the normalized amplitude.

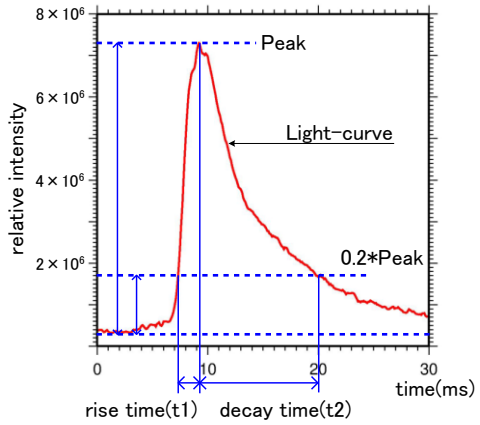

Figure 1. Schematic diagram of Light-curve.

Figure 2 shows scatter plots of charge moment change versus decay time (duration time) of the optical emission of sprites.It is found that there exists a good correlation between the duration time and the charge moment change of the parent CG with R^2~0.63.

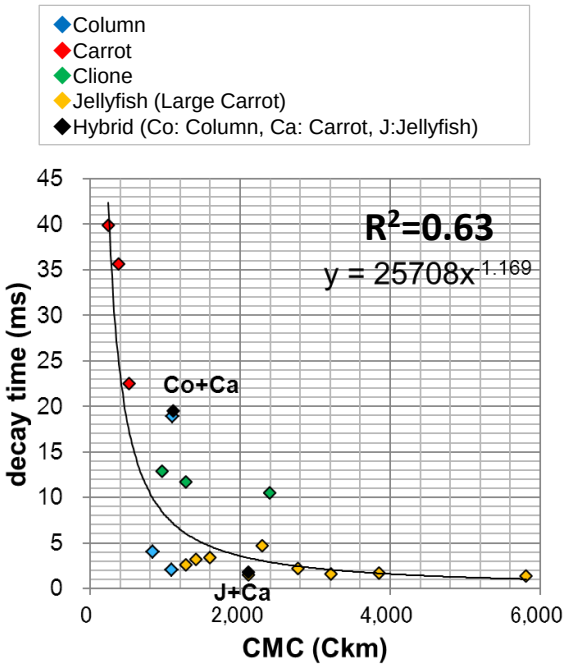

Figure 2. Decay time versus charge moment change for 20 sprite events.

4. References

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