Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

PEM09-P01 Room:Convention Hall Time:May 23 18:15-19:30

Split Condition of Sprite Streamer Tips Derived From High-Speed Camera Observations

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In order to clarify the split condition of sprite streamer tips, the detailed spatial and temporal development of sprite streamers are the key physical properties. According to the pervious ground-based observations using high-speed cameras, it was found that streamer tips usually appear at around ~80 km at the initial stage of the sprite development and propagate downward with an accelerated and expanded motions. After they reach ~70 km altitude, they tend to start splitting. However, detailed splitting mechanism of streamer tips is not fully understand yet since it is difficult to capture the detailed development and fine structures of the splitting streamer tips. In order to specify the detailed spatiotemporal evolution of sprite streamers and to identify the physical parameters determining the splitting condition of streamer tips, we have analyzed image data obtained by high-speed cameras onboard two jet aircrafts.

In the period from June 27 to July 10, 2011, we have succeeded in capturing 12 sprite events over the Great Plains in summer US, where the multiple splits of streamer tips are clearly measured by high-speed cameras with a sampling rate of 8300 fps. It was found that streamer tips initiated from approximately 75 km altitude propagate downward with an exponential increase of the brightness before they start splitting first. We estimated brightness changes of streamer tips at each frame of image data recorded by the high-speed cameras, and we also estimated the ratio of the streamer tip brightness just after the tip splits to that just before the tip reaches next split. It is found that the ratio of the brightness at the streamer tip initiation to the brightness just before the first split becomes greater than 1.0. However, it is found that the ratio of the brightness of 1st (2nd) split to 2nd (3rd) split becomes about 1.0. At the presentation, we will show more detailed results.

PEM09-P02 Room:Convention Hall Time:May 23 18:15-19:30

Statistical Features of Winter Lightning Activity in Tohoku District

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Coastal area of Sea of Japan is one of the well-known hotspots of winter lightning activity. Since winter lightning contains more electrically intensive discharges than summer lightning (Hojo et al., 1989), winter lightning often causes serious damage on electrical equipments in the coastal area (Transmission lines, wind turbines etc.). Previous research also indicates that thunder-day frequency in winter season in Japan has been increasing during the past several decades (e.g. Fujibe et al., 2005).

Numerous studies have been conducted concerning both the electrical and meteorological aspects of winter lightning activity in Japan (e.g. Michimoto, 1993 and Kitagawa and Michimoto, 1994). However, previous studies typically focused on the Hokuriku district of the mid-winter season. On the other hand, there have been few studies that examine statistical features of winter lightning activity in Tohoku district, mostly due to lack of available lightning observational data in this area.

This study investigates seasonal and inter-annual variability of lightning frequency in Tohoku district and the northern part of Hokuriku district based on the observational dataset obtained by Lightning Location System (LLS). The LLS has been operated by Tohoku Electrical Power Co. from 1994 to 2011, measuring real-time lightning location, polarity and peak current within Tohoku, Kanto and Hokuriku districts. The estimated lightning location accuracy and detection efficiency are approximately 2km and 63% respectively during the winter season (Honma et al., 1998 and Honma et al., 2010).

Based on the analysis of lightning location data, the maximum lightning frequency (maximum number of detected lightning discharges within a ten-day period) was found to appear typically from early October to late November in many parts of the study area. The seasonal variation of lightning frequency map shows that lightning hotspot appears around the northern part of Tohoku district during the late autumn season (October - November) and moves southward during the winter season (December - March). In addition, many of the lightning discharges during the late autumn season occur over the ocean area, as opposed to the lightning discharges during the winter season which are concentrated within the coastal area of Sea of Japan. Inter-annual variability of lightning frequency in the study area was also investigated. The results indicate that lightning frequencies in the late autumn season were remarkably high during the EL-Nino years (1997, 2002 and 2006), except for 2009.

Keywords: winter lightning, Lightning Location System

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Global lightning distribution with information of charge moment change

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Lightning is an electrostatic discharge phenomenon in the atmosphere. Primarily there are three types of discharges, namely, cloud-to-cloud discharge (CC), intra-cloud discharge (IC), and cloud-to-ground discharge (CG). Further, CGs are classified into two types: positive and negative polarities. Charge moment change (Qdl) is one of the parameters representing the significance of lightning discharge. In this study, base on the analysis of lightning waveform observed by global ELF observation network (GEON) we constructed an empirical model of the Qdl distribution, by fitting simple curves to the observational datasets for almost all the Qdl range, that is, from 0 to 3000 C-km. We examined the characteristics of the Qdl distribution in 7 regions where lightning activity is quite high, namely, Maritime Continent in Asia, Australia, Central Africa, South Africa, North America, South America, and South Pacific. The results show a large variation of the distribution depending on the location, season and current polarity. This empirical model of the Qdl distribution can be applied to various purposes, such as an estimation of global circuit current and comparison with meteorological parameters.

Keywords: lightning, charge moment change, global distribution, empirical model