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Variations of sferic waveforms in VLF range observed by AVON

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Previous studies suggested that there exists a good relationship between lightning activity and atmospheric convection [e.g. Deierling and Petersen, 2008]. The lightning data can be used as a proxy for the presence of deep atmospheric convection. Previous researches estimated statistically the total optical lightning flashes for understanding the relationship between lightning activities and atmospheric convection [e.g. Boccippio et al., 2000]. However it is difficult for optical observation to estimate electrical properties of lightning discharge. When we can measure electrical properties of each lightning and the flashes of lightning, it is possible to understand more detailed relationship between the lightning activity and atmospheric convection.

In this study, we use Asia VLF observation Network (AVON) and estimate the location of lightning and electrical characteristics of each lightning stroke in South-East Asia. AVON monitors electromagnetic waves in the frequency range of 0.1 kHz – 40 kHz. We estimate the lightning locations using 3 stations of AVON, that is, at Tainan, Taiwan, Saraburi, Thailand and Potianak, Indonesia, by time-of-arrival method and the charge moment change (CMC) using the waveform of sferics in VLF range. However, there is a difficulty in estimating CMC with VLF wave forms occurred at long range (>200 km) since the ground wave is overlapped by sky waves. We investigated the relationship between the ground wave and sky waves for different ranges. The observed data is from 06:00(UT), December 1st 2010 to 00:00(UT), December 2nd 2010 and the total number of analyzed events is 72. We divided to consider change of the ground wave and sky waves by depending on ranges at intervals of 100km.

It is found that the sky waves are dominant as compared with the ground wave at long range and it is possible that we estimate CMC of CG lightning, considering low frequency of the lightning discharge. We found that there was the time variation of arrival time for sky waves because of the changes of the ionospheric height. It could be possible to identify a lightning pulse as one of them using sky waves, considering the ionospheric height. We discuss about the geolocation of CG lightning using arrival times of sky wave and estimation of CMC using observed data from AVON.

Keywords: lightning, cloud-to-ground lightning, lightning geolocation, sferic waveform, very low frequency