FORMOSAT-2/ISUALによる雷放電の多波長フォトメータ観測

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Multi-wavelength photometric observation of lightning by FORMOSAT-2/ISUAL

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In recent years, scientists have clarified that satellite-based optical measurement of lightning flashes is highly useful to understand the meteorological and climatological aspects of the electromagnetic environment of the Earth's atmosphere on a global level. Such studies have also found the effectiveness of lightning data to improve the forecast technique of severe weather systems which potentially have strong impact on our life and social infrastructures. Based on these findings, the next US geostationary meteorological satellite, GOES-R, is scheduled to be launched in 2015, deploying a lightning sensor. However, these observations use monochromatic or panchromatic optical imaging technique at a conventional normal video frame rate, which makes it difficult to resolve detailed characteristics of lightning temporally and spectrally.

The present study aims at developing a new technique to derive detailed electrical properties of lightning, analyzing the data obtained by FORMOSAT-2/ISUAL which is the first spaceborne multicolor lightning detector with high temporal resolution. The data analyzed here include satellite optical data from ISUAL spectrophotometer and ground-based radio data from Duke ULF/VLF/LF sensors, National Lightning Detection Network (NLDN), and North Alabama Lightning Mapping Array (LMA). We first classified the ISUAL-recorded events into cloud-to-ground (CG) lightning and intra-cloud (IC) lightning based on Duke and NLDN data. Then, we estimated optical characteristics of CG and IC lightning by analyzing the ISUAL spectrophotometer data. It was found that the ISUAL-recorded optical waveform of lightning flashes is strongly correlated with Duke-recorded current moment waveform, suggesting a possibility to derive electrical properties of lightning from satellite optical data in a quantitative manner. The ISUAL data also suggested that the optical color of CG strokes tends to change to red at the time of optical peaks while the color of IC pulses tends to stay unchanged. These tendencies were consistently found in about 90 % of 51 lightning events analyzed here. Furthermore, in one event which was simultaneously detected by ISUAL and LMA, the color of lightning was found to slowly change to red as the altitude of optical source gradually decreased. All of these results suggest that the color of lightning flashes strongly depends on the altitude. Using this feature, it is possible to discriminate CG and IC lightning by spaceborne optical measurement. In this presentation, we will show the effectiveness and limitation of this new technique and some preliminary results as to the global distributions of CG and IC lightning discharges.