Electric Fields in Sprites Estimated from ROCSAT-2/ISUAL Array Photometer Data

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To clarify the physical and chemical processes occurring in sprites, past ground-based observations have measured the spatio-temporal and spectral characteristics of sprites. Morrill et al. [2002] observed sprites by two narrow band cameras and estimated electric fields in sprites. They found that estimated electric fields followed the breakdown field (Ek) up to 55 km while the electric fields dropped below Ek above 55km. Ground spectral information of sprites, however, has large uncertainties due to an attenuation effect by atmospheric particles along the light path from the sprite emission region to the ground observation site. On this basis, optical observations from space are essential for the precise estimation of emission intensity.

In this study, we analyze data observed with the array photometer (AP) onboard the ROCSAT-2 satellite. The AP provides us spectral information by simultaneously measuring the two wave length ranges of 360-470 nm and 520-750 nm selected by blue and red filters, respectively. Each photometer has 16 channels aligned in vertical and vertical resolution corresponds to ~11 km in the case of sprite observing at the limb point of 3315 km away from the satellite. The time resolution of 50 or 500 microseconds enables us to detect fast temporal variation of sprites with average durations of several ms to several tens of ms. By calculating blue/red (B/R) emission intensity ratio, it is found that sprites are bluer in the earlier stage and at lower altitudes. Furthermore, we estimate electric fields from the peak B/R ratio using the quasi-static energy distribution of electrons. Above ~65 km, estimated electric fields are consistent with quasi-electrostatic fields induced by lightning discharges with charge moment values of 1000-2000 C-km. Below ~65 km, estimated electric fields are found to be much higher than the quasi electrostatic fields and even to be slightly higher than the conventional breakdown field. These strong electric fields estimated at lower altitudes are probably induced in the head of sprite streamers [Gerken et al., 2000; Pasko and Stenbaek-Nielsen, 2002; Liu and Pasko, 2004].