

Horizontal Distributions of Sprites and Properties of Parent Lightning Discharges Derived from JEM-GLIMS Observations

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Sprites are lightning-associated transient discharge phenomena occurring in the mesosphere and are mainly excited by positive cloud-to-ground (CG) discharges. Although a large number of studies on sprites have been performed by optical observations from the ground, airplanes and space and numerical simulations, the physical mechanism determining the horizontal distributions of sprites is not clear so far. Recent studies suggested that the in-cloud lightning currents associated with CG discharges would have an important role to determine the horizontal distributions of sprites. In order to clarify this, it is essential to carry out nadir observations of lightning discharges and sprites from the space using optical instruments and radio receivers. JEM-GLIMS is a space mission to conduct nadir observations of lightning discharges and sprites from International Space Station (ISS). In this mission, images of the lightning and sprite emissions can be captured by a wide-band CMOS camera (LSI-1) and a narrow-band CMOS camera (LSI-2). In addition to this, the absolute intensities of N_2 1P, 2P and N_2^+ 1N emissions of lightning discharges and sprites are measured by six-channel spectrophotometers (PH). In order to identify the sprite occurrences, we have developed new identification techniques: (1) a subtraction of the appropriately scaled LSI-1 image from LSI-2 image, (2) a calculation of intensity ratio between different PH channels, and (3) an estimation of the charge moment changes and polarity of the parent CG discharges using 1-100 Hz ELF waveform data. Using these methods, three events observed at (A) 05:08:14 UT on Dec. 21, 2013, (B) 03:48:24 UT on Jun. 10, 2014, and (C) 06:41:15 UT on Jun. 12, 2014 are confirmed that sprites were occurred. In the event (A), sprite emissions were detected at three different locations, and the distances between sprite elements are estimated to be 4.57 km, 6.57 km and 9.92 km. The average distance from the location of the peak lightning emissions is 19.83 km. It is also found that the peak lightning emissions was located by 15 km away from the return stroke position detected by WWLLN. In the events (B) and (C), sprite emissions were widely distributed, and the distances from the peak lightning emissions to the sprite emissions were 8.61 km, 9.66 km respectively. By simulating how sprite and lightning emissions occurring at different altitudes can be measured from the ISS, it is likely that LSI detected the vertical structures of sprite emissions. At the presentation, we will show the detailed characteristics of the horizontal distributions of sprites and the relation to their parent lightning discharges.

Keywords: sprite, JEM-GLIMS, horizontal distribution