Energetics of Sprites and Elves Derived from Coordinated ISUAL Array Photometer and Ground ELF/VLF Observations

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ABSTRACT:

The ISUAL array photometer (AP) on board the ROCSAT-2 satellite can capture TLEs (sprites, elves, blue jets, gigantic jets etc.) around the limb of the Earth. The AP consists of two photometers which measure optical emissions in the wavelength ranges of 370-450 and 530-650 nm selected by blue and red filters, respectively. Each photometer consists of 16 channels arrayed in vertical with a field of view of 0.23 degrees (vertical) by 22.5 degrees (horizontal). High time resolution (50 microseconds) and high spatial resolution (11 km in vertical) of the AP enable us to investigate rapid temporal and spatial evolution of sprites and elves. During the period from July 4 to October 14, 2004, the AP captured 31 sprite events, 24 sprite halo events and 189 elve events. From the blue/red emission intensity ratio of these events, we estimated the energies of electrons inducing optical emissions and their temporal and spatial variations. It is found that the energy of electrons inducing elves is high at their onset. It is also found that the energy of electrons inducing sprites becomes high with decreasing altitude.

To investigate the scale of lightning discharges producing the sprite and elve events observed by the ISUAL/AP, we estimated the charge moment values of ELF transients simultaneously observed on the ground. These ELF transients were measured using the Tohoku University ELF detection network: Syowa Station (69.0S, 39.6E) in the Antarctic, Onagawa Observatory (38.4N, 141.5E) in Japan, and ESRANGE (67.9N, 21.1E) in Sweden. Each site has the same type of a search coil magnetometer system. Furthermore, some of parent VLF sferics of the sprite and elve events observed by the ISUAL/AP were measured at Iitate Observatory (37.7N, 140.7E) in Japan using the VLF system. By comparing the results of these ELF/VLF observations with the results of ISUAL/AP observations, we discuss the overall energetics of sprites and elves.