# Development of the optical instruments onboard SPRITE-SAT

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The horizontal distribution of sprites is difficult to investigate with the ground-based observation. That can provide a hint to understand the mechanism of sprite generation, for example, the relationship between the EMPs and the number of columniform sprites. The nadir observation from space with satellite is effective method for continual and statistic investigation in the horizontal distribution of sprites.

SPRITE-SAT is a satellite to observe sprites, lightning, and terrestrial gamma-ray flashes (TGFs), which will be launched in 2008. SPRITE-SAT has gravity-gradient boom on its upper panel, in order to point its bottom panel to the center of the earth. This boom also plays a role as an antenna which captures VLF electric field coming from the lightning discharges.

We attach lightning and sprite imager (LSI) to the bottom panel of the satellite, which consists of two CMOS sensors. We arrange two different optical filters in order to observe lightning and sprites emissions separately. The center wavelength and bandwidth (FWHM) of these filters are 792 nm and 100 nm for lightning (LSI-1), and 767 nm and 14 nm for sprites (LSI-2), respectively. Since there is the O2 absorption line at 762 nm, the lightning emission coming from lower atmosphere is absorbed by O2 enough to easily separate sprites and lightning emission near this wave length. The spatial resolution of LSI is 600 m/pixel at sprite generation altitude in nadir direction. The size of elements of sprites on the LSI images will be from ˜2 to tens of pixels. The signal to noise ratio (SNR) of LSI-1 and LSI-2 are more than 27 and 80, respectively. These values are enough to detect the horizontal structures of sprites and lightning. The time resolution of LSI is 33ms. Since the duration time of sprites is from few ms up to hundreds of ms, it's impossible to image the time development of sprites. Here we concentrate to capture the time-integrated horizontal structure with good SNR. FOV of the LSI is about 40 degrees circle, and this is equivalent to 300 km square at sprite generation altitude. Taking into account of the global occurrence rate of lightning and sprite, the expected detection rate of sprites by LSI is 0.87 events per a day. Four successive images are stored by center triggering logic. The total amount of image data is about 2.6 Mbytes for one sprite event, which will be compressed and downloaded to the ground. In order to save images of sprite events, we evaluate the difference of two successive images. When the difference is large enough, the image data showed above are stored and sent to the earth stations in Japan and Sweden.

We also attach a wide field CCD camera (WFC) with a fish-eye lens to the bottom panel to identify the location of lightning discharge which causes TGFs. FOV of WFC covers whole disk of the earth visible from the satellite altitude, which is 2800 km radius circle on the surface. The spatial resolution near the center of the image is 3 km, and time resolution is 16.7 ms. WFC saves two or three successive images when terrestrial gamma-ray counter (TGC) detects TGFs.