Development of Tohoku University SPRITE-SAT

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The 50-kg microsatellite called SPRITE-SAT is being developed by Tohoku University as of 2008, and it is launched by Japanese rocket H-IIA after the autumn of 2008. The satellite observes sprite, which is one of lightning-induced phenomena in the upper atmosphere, at the 660-km circular orbit. In this paper, the objectives of SPRITE-SAT, and the present status are reported.

The lightning discharge phenomena occur about four million times a day in the world, and it is familiar to human beings. The huge lightning-induced phenomenon called sprite in the upper atmosphere was discovered in 1989. Additionally, Terrestrial Gamma-ray Flashes (TGF) was discovered in 1994.

In the project SPRITE-SAT, following two primary missions are carried out: 1) Observing the lightning emissions and the sprite simultaneously from the right above, the mechanism of sprite is elucidated, 2) Observing the lightning emissions and the TGF simultaneously, the formation mechanism of TGF is elucidated. In the first mission, two CMOS cameras which have different spectra are used. In the second mission, a CCD camera and a Gamma-ray counter are used. The mission devices are independently integrated from commercial-off-the-shelf components.

The size of sprite phenomenon is about 50-km height and 2 to 50-km width, and it occurs in the altitude range of 40 to 90 km. The various observations were carried out from the ground and the space, and the vertical formation is being clarified. There is the only example of the observation from the right above at the International Space Station, but the numbers of lightning emissions were few, and the time accuracy was not precise. The SPRITE-SAT observes the horizontal formation of sprite, and the numbers of lightning emissions are secured, and the observation time is also precisely recorded.

TGF was the wonderful new discovery. In the RHESSI mission in 2002 operated by NASA, the observation of TGF was successful in the frequency of one chance every two days. The SPRITE-SAT simultaneously observes the TGF and the lightning discharge, and the clarification of two phenomena's relationship in terms of time and space is the mission objective.

At the present time, the observation of the lightning-induced phenomena in the upper atmosphere including sprite and the observation of TGF are planned in some projects in the world. The microsatellite project TARANIS is managed by French institutions and the launch in 2011 is planned. The ISS-based project ASIM is managed by Danish institutions and the launch in 2009 is planned. In addition, the project of observing TGF by a satellite is planned by Stanford University.

The launch of SPRITE-SAT will be earlier than other similar projects. The success of project SPRITE-SAT has the marvelous influence on the science of atmospheric electricity, the meteorology, the space and terrestrial physics, and the gamma-ray astronomy.

The size of SPRITE-SAT is 480x480x482 mm in the launch configuration, and the weight is about 41 kg. In the 660-km altitude and sun-synchronous circular orbit, the satellite goes around the earth in 98 minutes. The inclination is 98 deg, and the local time is 1pm. The attitude is stabilized by the gravity gradient torques using an extensible boom and magnetic coils, and the mission panel is always pointing to the earth. The attitude determination is carried out by using sun sensors and magnetic sensors, and the orbit determination is carried out by an onboard GPS receiver. The power subsystem consists of Si solar cells and Ni-MH batteries, and the average generated power after the any losses is 16.8W. The uplink communication is 1200 bps speed and the frequency is UHF. The downlink is 9600 bps speed at max and the S-band. The ground station installed in Tohoku University is used for all the operations.