Current Status and Future Collaborative Observation Plan of JEM-GLIMS Mission

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In order to study the occurrence characteristics, spatial distributions, and occurrence conditions of TLEs and to identify the relations with their parent CG discharges, JEM-GLIMS (Global Lightning and sprIte MeasurementS on JEM-EF) instruments will be launched by H-II B rocket this summer and will be installed at Exposed Facility (EF) of Japanese Experiment Module (JEM) at International Space Station (ISS). JEM-GLIMS consists of two sets of optical instruments (CMOS cameras and photometers) and two sets of electromagnetic wave receivers (VLF receiver and VHF interferometer). All these instruments are pointed to the nadir direction. For JEM-GLIMS mission, it is very important to conduct simultaneous ground-based and space observations. At the presentation, future observation plan under the collaborations between European TLE communities and JEM-GLIMS team is presented.

1. Introduction

One of the problems in the sprite studies is that we do not have clear answer to the occurrence condition of sprites, which is not yet solved from the discovery of sprites in 1989 and up to now. Though the quasi-electrostatic (QE) field model is regarded as the most reliable model explaining the generation mechanism of sprites, it is recently implied that this model cannot reasonably explain observed characteristics of sprites [1][2]. All disagreements between the model and the observed characteristics are originated in the poor knowledge about the occurrence condition of sprites. In order to clarify the occurrence condition and generation mechanism of sprites, it is essential to carry out the nadir observation of sprites from the satellite altitude and to identify the spatial distribution and temporal evolution of sprites. Thus, we planed a space mission to observe lightning and TLEs from the nadir direction, which is named as JEM-GLIMS (Global Lightning and sprIte MeasurementS on Japanese Experiment Module) [3].

2. GLIMS Instruments

JEM-GLIMS consists of two types of optical instruments (CMOS cameras and photometers), two types of electromagnetic wave receivers (VLF receiver and VHF interferometer) and an onboard data processing unit. JEM-GLIMS instruments are installed inside the Multi mission Consolidated Equipment (MCE), which is a bus system for JEM-GLIMS and other four science and engineering missions. Figure 1 is a picture of the flight model of


Fig.1 Picture of the flight model of MCE.

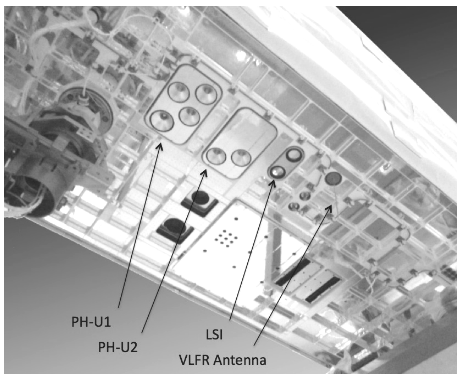

Fig.2 Picture of the base plate of MCE.

MCE, and Figure 2 shows the picture of the base plate of MCE. As shown in Figure 2, JEM-GLIMS optical instruments and radio receivers are installed at the base plate of MCE and are pointed to the nadir direction.

2.1. Optical Instruments

The optical instruments consist of two wide FOV CMOS cameras (LSI) and six-channel spectro-photometer (PH) [4][5]. LSI uses a STAR-250 CMOS device as a detector, which has 512 × 512 pixels with 25 × 25 μm^2 pixel size, and has 28.3° × 28.3° FOV. LSI-1 equips a wide band optical filter (766 - 832 nm) and mainly measures lightning emission, while LSI-2 equips a narrowband optical filter (762 ± 7 nm) and mainly measures TLE emission. Five of six PH channels have 42.7° FOV and use photomultiplier tube (PMT) as a photon detector. They equip band-pass filters (150 - 280 nm, 316 ± 5 nm, 337 ± 5 nm, 392 ± 5 nm, and 762 ± 5 nm) for the absolute intensity measurement of the TLE emission. One of six photometers equips a wide-band filter (600 - 900 nm) to detect lightning occurring within 86.8° FOV. These output signals will be recorded with the sampling frequency of 20 kHz with a 12-bit resolution.

2.2. Electromagnetic Wave Receivers

In order to detect whistler wave in the VLF range excited by lightning discharges, one VLF receiver (VLFR) is installed. VLFR consists of a 15 cm monopole antenna directing nadir direction and attached at the base plate of MCE and consists of a VLF receiver that records waveform data with a sampling frequency of 100 kHz with 14-bit resolution. VHF interferometer (VITF) that measures VHF pulses emitted by lightning discharges is also installed [6]. VITF consists of two patch-type antennas installed at the base plate of MCE and separated by 1.5 m and of one receiver which records pulse data with a sampling frequency of 200 MHz with 8-bit resolution.

3. GLIMS Operations

In 2010 all the fabrications of JEM-GLIMS instruments and the environmental tests were completed. In 2011 all the function check tests and system environment tests of MCE were also finished. Now, JEM-GLIMS was delivered to the launch site, Tanegashima Space Center in Japan, and will be launched this summer as a cargo payload of the third H-II Transfer Vehicle (HTV-3) by using H-II B launcher. JEM-GLIMS will be installed at JEM EF, ISS. After the initial checkout operation for a few months, JEM-GLIMS will start continuous observation from this winter. In this nominal operation, JEM-GLIMS instruments will be operated by TLE mode mainly, which is the observation mode of lightning and TLEs when ISS located night-side. All science data acquired by optical and electromagnetic instruments are continuously transmitted to the ground with a 5.8 kbps telemetry speed, which enables to obtain 53 optically transient events.

4. Collaborative Ground-Space Observations

It is essential to compare JEM-GLIMS science data with lightning and TLE data obtained by the ground-based optical and electromagnetic observations because the nadir observation of TLEs from space is challenging since the optical detectors naturally detects not only TLE emissions but also much stronger lightning emissions simultaneously. From this reason, ground-based observation data are essential for a validation of the sprite detection by JEM-GLIMS. In addition to this, simultaneous JEM-GLIMS and ground-based optical observations enable to detect TLEs three-dimensionally. These data will essentially contribute to the studies on horizontal distributions, occurrence conditions and generation mechanisms of TLEs. Thus, we are planning to conduct simultaneous ground-based and space observations under the collaborations between European TLE communities and JEM-GLIMS teams.

5. References

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