

## GLIMS ミッションの概要 Overview of the GLIMS Mission

牛尾知雄<sup>1\*</sup>; 佐藤光輝<sup>2</sup>; 森本健志<sup>3</sup>; 鈴木睦<sup>4</sup>; 山崎敦<sup>4</sup>; 足立透<sup>5</sup>; 芳原容英<sup>6</sup>  
USHIO, Tomoo<sup>1\*</sup>; SATO, Mitsuteru<sup>2</sup>; MORIMOTO, Takeshi<sup>3</sup>; SUZUKI, Makoto<sup>4</sup>; YAMAZAKI, Atsushi<sup>4</sup>;  
ADACHI, Toru<sup>5</sup>; HOBARA, Yasuhide<sup>6</sup>

<sup>1</sup> 阪大, <sup>2</sup> 北大, <sup>3</sup> 近大, <sup>4</sup> 宇宙航空研究開発機構, <sup>5</sup> 気象研, <sup>6</sup> 電通大

<sup>1</sup>Osaka Univ., <sup>2</sup>Hokkaido Univ., <sup>3</sup>Kinki Univ., <sup>4</sup>JAXA, <sup>5</sup>MRI, <sup>6</sup>University of Electro-Communications

The Global Lightning and sprItE MeasurementS (GLIMS) on the International Space Station (ISS) is a mission to detect and locate optical transient luminous events (TLEs) and its associated lightning simultaneously from the non-sun synchronous orbit, and was launched successfully in July, 2012 as part of the multi-mission consolidated equipment on Japanese Exposure Module (JEM). Our mission goals are to identify temporal and spatial evolutions of lightning and TLEs and to clarify the occurrence conditions of TLEs and global occurrence locations and rates of TLEs from the nadir observation. To achieve these goals, two CMOS cameras, six Photometers, VLF receiver, and VHF interferometer with two antennas, are installed at the bottom of the module to observe the TLEs as well as parent lightning discharges at nadir direction. Though the luminous events so-called sprite, elves and jets have been investigated by numerous researchers all over the world based mainly on the ground observations, some important problems have not been fully understood yet such as generation mechanisms of columniform fine structure and horizontal offset of some sprites from the parent lightning discharges. So far, more than one thousand events were recorded, and this mission is continuously observing TLEs and lightning events. In this paper, in order to discuss on the TLE and lightning effect to atmosphere, mission overview, and some examples of the observation results are introduced. This is the first time to present on the results of the GLIMS mission from the meteorological aspects.

Keywords: Lightning, Sprite, TLE, ISS

## SMILES プロジェクトからの教訓と SMILES-2 へ向けて Lessons learned from SMILES project, and possible SMILES-2

鈴木 睦<sup>1\*</sup>; 佐野 琢己<sup>1</sup>; 西堀 俊幸<sup>1</sup>; 塩谷 雅人<sup>2</sup>  
SUZUKI, Makoto<sup>1\*</sup>; SANO, Takuki<sup>1</sup>; NISHBORI, Toshiyui<sup>1</sup>; SHIOTANI, Masato<sup>2</sup>

<sup>1</sup> 宇宙研, <sup>2</sup> 京都大学生存圏研究所

<sup>1</sup>ISAS, <sup>2</sup>Research Institute for Sustainable Humanosphere

Superconducting Submillimeter-Wave Limb-emission Sounder (SMILES) was the first instrument to use 4K cooled SIS (Superconductor-Insulator-Superconductor) detection system for the observation of the atmosphere in the frequency regions 625 GHz (Bands A and B) and 650 GHz (Band C) [1]. It has demonstrated its high sensitivity (System Temperature,  $T_{\text{sys}} \sim 250\text{K}$ ) for measuring stratospheric and mesospheric species, O<sub>3</sub>, HCl, ClO, HO<sub>2</sub>, HOCl, BrO, and O<sub>3</sub> isotopes from Oct. 12, 2009 to Apr. 21, 2010 [2-5]. So it was very successful scientific program, even though it have been conducted as an engineering demonstration program.

Since SMILES operation has terminated after only 6 months operation due to failure of sub-mm local oscillator (and later 4K cooler system), there exist strong scientific demand to develop successor of SMILES, the SMILES-2, which has optimized and enhanced frequency coverage to observe: (a) BrO and HOCl without interferences of stronger emission lines, (b) N<sub>2</sub>O, H<sub>2</sub>O, NO<sub>2</sub>, and CH<sub>3</sub>Cl not covered by the SMILES frequency regions, and (c) O<sub>2</sub> line to measure temperature.

This paper will describes (a) list of SMILES publications on timeline, (b) lessons learned from SMILES project, and (c) possible SMILES-2 observations based upon those SMILES lessons.

## ISS 曝露部搭載 S E D A - A P の観測結果と現状 Observation results and current status of SEDA-AP on the ISS - "Kibo" Exposed Facility

古賀 清一<sup>1\*</sup>; 松本 晴久<sup>1</sup>; 木本 雄吾<sup>1</sup>; 山田 理子<sup>1</sup>; 上野 遥<sup>1</sup>; 村木 綏<sup>2</sup>  
KOGA, Kiyokazu<sup>1\*</sup>; MATSUMOTO, Haruhisa<sup>1</sup>; KIMOTO, Yugo<sup>1</sup>; YAMADA, Noriko<sup>1</sup>; UENO, Haruka<sup>1</sup>;  
MURAKI, Yasushi<sup>2</sup>

<sup>1</sup> 宇宙航空研究開発機構, <sup>2</sup> 名古屋大学

<sup>1</sup>JAXA, <sup>2</sup>Nagoya University

To support future space activities, it is very important to acquire space environmental data related to space radiation degradation of space parts and materials and spacecraft anomalies. Such data are useful for spacecraft design and manned space activity.

On several satellite of the Japan Aerospace Exploration Agency (JAXA) since the Engineering Test Satellite-V (ETS-V), Technical Data Acquisition Equipment (TEDA) and SEDA have been installed for obtaining the data described above.

SEDA-AP measures space environment data on ISS orbit. SEDA-AP comprises common bus equipment supporting launch, RMS handling, the power/communication interface with JEM-EF, an extendible mast that extends the neutron monitor sensor 1 m separate from the bus structure, and equipment that measures space environment data. It has eight environment monitoring sensors, which measure neutrons, heavy ions, plasma, high-energy electrons and protons, atomic oxygen, space debris and dusts.

SEDA-AP was lanced on July 16 in 2009, and attached to Exposed Facility (EF) of "Kibo" on July 25 using the robot arm of "Kibo". Initial checkout was started on August 4 and successfully ended on September 17. The regular operation period ended in 2011. Afterwards, later operation period of three years has started, and operation is being continued now.

We will report the observation results and the current status of SEDA-AP.

キーワード: SEDA-AP, 宇宙環境

Keywords: SEDA-AP, Space Environment

## 超高層大気領域における ISS-IMAP による大気光と共鳴散乱光の観測 ISS-IMAP observation of the airglow and the ion resonant scattering in the Earth's upper atmosphere

齊藤 昭則<sup>1\*</sup>; 坂野井 健<sup>2</sup>; 吉川 一朗<sup>4</sup>; 山崎 敦<sup>3</sup>; 大塚 雄一<sup>5</sup>; 山本 衛<sup>1</sup>; 秋谷 祐亮<sup>1</sup>; 穂積 裕太<sup>1</sup>; 幸野 淑子<sup>1</sup>

SAITO, Akinori<sup>1\*</sup>; SAKANOI, Takeshi<sup>2</sup>; YOSHIKAWA, Ichiro<sup>4</sup>; YAMAZAKI, Atsushi<sup>3</sup>; OTSUKA, Yuichi<sup>5</sup>; YAMAMOTO, Mamoru<sup>1</sup>; AKIYA, Yusuke<sup>1</sup>; HOZUMI, Yuta<sup>1</sup>; YUKINO, Hideko<sup>1</sup>

<sup>1</sup> 京都大学, <sup>2</sup> 東北大学, <sup>3</sup> 東京大学, <sup>4</sup> 宇宙航空研究開発機構, <sup>5</sup> 名古屋大学

<sup>1</sup>Kyoto University, <sup>2</sup>Tohoku University, <sup>3</sup>University of Tokyo, <sup>4</sup>JAXA, <sup>5</sup>Nagoya University

ISS-IMAP (Ionosphere, Mesosphere, upper Atmosphere, and Plasmasphere mapping) mission have observed the airglow and the ion resonant scattering in the Earth's upper atmosphere since 2012. The scientific goals of ISS-IMAP are to elucidate following two processes: 1) energy transport process by the structures whose horizontal scale is 50-500km in the Earth's upper atmosphere, 2) the effect of the structures and disturbances on the space-borne engineering system. ISS-IMAP was installed on the Exposure Facility of Japanese Experiment Module, Kibo, of the International Space Station in August 2012. It consists of two sets of imagers, VISI and EUVI. Visible-light and infrared spectrum imager (VISI) observes the Mesosphere and the Ionosphere. Extra ultraviolet imager (EUVI) observes the Ionosphere and the Plasmasphere. VISI observes the airglow in the Nadir direction. The airglow emissions were mainly observed by VISI was 730nm (OH, Alt. 85km), 762nm (O<sub>2</sub>, Alt. 95km), and 630nm (O, Alt. 250km). Additional airglows, such as Sodium, were also observed. The global distributions of the airglow structures whose scale size is 50-500km in the night side of the Mesosphere and the Ionosphere have been obtained by the VISI observation. EUVI measures the resonant scattering of 30.4nm [He<sup>+</sup>] and 83.4nm [O<sup>+</sup>]. Its field-of-view is 15 degrees, and points the limb of the Earth to observe the vertical distribution of the ions. The observational results including its conjugate observation with the ground-based instruments will be introduced in the presentation.

キーワード: 電離圏, 熱圏, 中間圏, プラズマ圏, 国際宇宙ステーション, 大気光

Keywords: Ionosphere, Thermosphere, Mesosphere, Plasmasphere, International Space Station, Airglow

## JEM-GLIMSによる雷放電の電波および光学観測結果の比較 VHF and optical lightning observations by JEM-GLIMS

森本 健志<sup>1\*</sup>; 大井 一将<sup>1</sup>; 菊池 博史<sup>3</sup>; 佐藤 光輝<sup>2</sup>; 三原 正大<sup>2</sup>; 牛尾 知雄<sup>3</sup>; 山崎 敦<sup>4</sup>; 鈴木 睦<sup>4</sup>  
MORIMOTO, Takeshi<sup>1\*</sup>; OI, Kazumasa<sup>1</sup>; KIKUCHI, Hiroshi<sup>3</sup>; SATO, Mitsuteru<sup>2</sup>; MIHARA, Masahiro<sup>2</sup>; USHIO, Tomoo<sup>3</sup>; YAMAZAKI, Atsushi<sup>4</sup>; SUZUKI, Makoto<sup>4</sup>

<sup>1</sup> 近畿大学, <sup>2</sup> 大阪大学, <sup>3</sup> 北海道大学, <sup>4</sup> 宇宙航空研究開発機構 宇宙科学研究所

<sup>1</sup> Kindai University, <sup>2</sup> Osaka University, <sup>3</sup> Hokkaido University, <sup>4</sup> ISAS/JAXA

Global Lightning and sprfTe Measurements (GLIMS) mission is now ongoing on Exposed Facility of Japanese Experiment Module (JEM-EF) of the International Space Station (ISS). JEM-GLIMS mission is designed to conduct comprehensive observations with both the EM and the optical payloads for lightning activities and related transient luminous events (TLEs) expecting to give us many scientific impacts to the field. The integrated 4 sensors installed into Multi Mission Consolidated Equipment (MCE), which is the bus system, and is mounted at JEM-EF as GLIMS mission. The 4 sensors consist of very high frequency (VHF) broadband digital InTerFerometer (VITF), very low frequency (VLF) receiver, CMOS cameras at two different wavelengths, and photometers at six channels.

VITF consists of two sets of antennas, band-pass filters, amplifiers, and 2-channel-AD-converter. Impulsive EM radiations received by the antennas are digitized by the AD converter synchronizing with another channel through the filters and the amplifiers. A patch type antenna is developed within the size of 200\*200 mm. It is mounted on the antenna base made of aluminum alloy and Teflon block with the total height of 100 mm to gain its bandwidth and to reduce the interference from other structural objects. The same two units of antennas are installed with the separation of 1.6 m. Their bandwidths with the less return loss than 3 dB are from 70 to 100 MHz. The signals received by the antenna are transmitted along cables with the same lengths to the electronics. The AD converter records 130 waveforms as maximum of one dataset with the duration of 2.5  $\mu$ s with 200 MS/s. The developments of VITF are based on the heritage of VHF sensor on Mado-1 satellite.

JEM-GIMS mission payload was successfully launched at the end of July 2012, and transported and installed to the ISS. After the initial checkout and maintenance, its nominal operation is continued from December 2012. Through the operation period, VITF corrects numerous VHF EM data synchronized with optical signals. About 2,900 VITF datasets were obtained in 20 months. The timing of data acquisition is controlled by a photometer through this period. Namely, the EM and optical data are recorded being triggered by a photometer. 65 - 80% of optical observations are accompanied with VHF radiations. Though the discrimination is in progress, most optical signals are from lightning.

The estimations of the EM direction-of-arrival (DOA) are attempted using the broadband digital interferometry. Some results agree with the optical observations, even though DOA estimation has difficulties caused by its very short baseline of the antennas and multiple pulses in short time, namely burst-type EM waveforms. VITF is designed expecting to estimate the DOA with about 10 km resolution that is equivalent to the scale of a thundercloud. This paper makes comparative discussion about the observations by VITF and optical payloads, CMOS camera and photometer. It is found that the brighter lightning makes the denser VHF radiations.

キーワード: 雷放電, 国際宇宙ステーション, 高高度発光現象

Keywords: Lightning discharge, International Space Station, Transient luminous event

## JEM-GLIMS の天底観測に基づくスプライトの水平空間分布と親雷放電の特性 Horizontal Distributions of Sprites and Properties of Parent Lightning Discharges Derived from JEM-GLIMS Observations

三原 正大<sup>1\*</sup>; 佐藤 光輝<sup>1</sup>; 足立 透<sup>2</sup>; 高橋 幸弘<sup>1</sup>; 牛尾 知雄<sup>3</sup>; 森本 健志<sup>4</sup>; 鈴木 睦<sup>5</sup>; 山崎 敦<sup>5</sup>  
MIHARA, Masahiro<sup>1\*</sup>; SATO, Mitsuteru<sup>1</sup>; ADACHI, Toru<sup>2</sup>; TAKAHASHI, Yukihiro<sup>1</sup>; USHIO, Tomoo<sup>3</sup>; MORIMOTO, Takeshi<sup>4</sup>; SUZUKI, Makoto<sup>5</sup>; YAMAZAKI, Atsushi<sup>5</sup>

<sup>1</sup> 北海道大学, <sup>2</sup> 気象研究所, <sup>3</sup> 大阪大学, <sup>4</sup> 近畿大学, <sup>5</sup> ISAS/JAXA

<sup>1</sup> Hokkaido University, <sup>2</sup> Meteorological Research Institute, <sup>3</sup> Osaka University, <sup>4</sup> Kinki University, <sup>5</sup> ISAS/JAXA

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.

キーワード: スプライト, JEM-GLIMS, 水平空間分布

Keywords: sprite, JEM-GLIMS, horizontal distribution

## JEM-GLIMS 光学観測データから推定した雷放電・TLEsの全球発生頻度分布 Global Occurrence Rates and Distributions of Lightning and TLEs Derived from JEM-GLIMS Nadir Observations

佐藤 光輝<sup>1\*</sup>; 佐藤 剛志<sup>2</sup>; 三原 正大<sup>2</sup>; 清水 千春<sup>2</sup>; 足立 透<sup>3</sup>; 牛尾 知雄<sup>4</sup>; 森本 健志<sup>5</sup>; 鈴木 睦<sup>6</sup>;  
山崎 敦<sup>6</sup>; 高橋 幸弘<sup>1</sup>  
SATO, Mitsuteru<sup>1\*</sup>; SATO, Tsuyoshi<sup>2</sup>; MIHARA, Masahiro<sup>2</sup>; SHIMIZU, Chiharu<sup>2</sup>; ADACHI, Toru<sup>3</sup>;  
USHIO, Tomoo<sup>4</sup>; MORIMOTO, Takeshi<sup>5</sup>; SUZUKI, Makoto<sup>6</sup>; YAMAZAKI, Atsushi<sup>6</sup>; TAKAHASHI, Yukihiro<sup>1</sup>

<sup>1</sup> 北海道大学 大学院理学研究院, <sup>2</sup> 北海道大学 大学院理学院 宇宙理学専攻, <sup>3</sup> 気象庁気象研究所, <sup>4</sup> 大阪大学 大学院工学研究科, <sup>5</sup> 近畿大学 大学院理工学研究科, <sup>6</sup> 宇宙科学研究所 JAXA

<sup>1</sup>Faculty of Science, Hokkaido University, <sup>2</sup>Department of CosmoSciences, Graduate School of Science, Hokkaido University, <sup>3</sup>Meteorological Research Institute, <sup>4</sup>Graduate School of Engineering, Osaka University, <sup>5</sup>Faculty of Science and Engineering, Kinki University, <sup>6</sup>ISAS/JAXA

JEM-GLIMS is carrying out continuous nadir observations of lightning discharges and TLEs from the ISS since Nov. 20, 2012. For the period between Dec. 2012 and Nov. 2014, JEM-GLIMS succeeded in detecting a total of ~4,820 lightning events including ~530 TLEs. It is found that most of these events occurred in continental regions, that is, central Africa, Southeast Asia, North America, and the northern part of South America. It is also found that the lightning activities tend to be enhanced in the local summer hemisphere. These characteristics are comparable to those derived from the MicroLab-1/OTD and TRMM/LIS measurements. Using the JEM-GLIMS optical data, we have estimated the preliminary global occurrence rates of lightning discharges and TLEs. The global occurrence rate of lightning discharges is estimated to be 1.5 events/s, which is smaller than that derived from the previous satellite missions (~50 events/s). This discrepancy may be caused by the low detection efficiency of JEM-GLIMS due to the high trigger threshold level and the low telemetry speed and by the limited LT area (20-04 LT) where JEM-GLIMS can conduct the optical observations. The global occurrence rate of TLEs, that include both sprites and elves, is also estimated and is calculated to be 9.8 events/min. At the presentation, we will show more detailed global occurrence distributions and rates of lightning discharges and TLEs.

キーワード: 雷放電, スプライト, 国際宇宙ステーション  
Keywords: lightning, sprites, ISS

## IMAP/VISIによる熱圏・中間圏大気光ならびにオーロラ発光観測の最新状況 Recent results of airglow and auroral emissions in the lower- and upper-thermosphere obtained with IMAP/VISI on ISS

坂野井 健<sup>1\*</sup>; 山崎 敦<sup>2</sup>; 齊藤 昭則<sup>3</sup>; 秋谷 祐亮<sup>3</sup>; 穂積 裕太<sup>3</sup>; 大塚 雄一<sup>4</sup>; Perwitasari Septi<sup>1</sup>; 西谷 望<sup>4</sup>; 堀 智昭<sup>4</sup>

SAKANOI, Takeshi<sup>1\*</sup>; YAMAZAKI, Atsushi<sup>2</sup>; SAITO, Akinori<sup>3</sup>; AKIYA, Yusuke<sup>3</sup>; HOZUMI, Yuta<sup>3</sup>; OTSUKA, Yuichi<sup>4</sup>; PERWITASARI, Septi<sup>1</sup>; NISHITANI, Nozomu<sup>4</sup>; HORI, Tomoaki<sup>4</sup>

<sup>1</sup> 東北大学大学院理学研究科, <sup>2</sup>ISAS, JAXA, <sup>3</sup> 京都大学大学院理学研究科, <sup>4</sup> 名古屋大学太陽地球環境研究所

<sup>1</sup>Graduate School of Science, Tohoku University, <sup>2</sup>Institute of Space and Astronautical Science, JAXA, <sup>3</sup>Graduate School of Science, Kyoto University, <sup>4</sup>STEL, Nagoya University

We report the recent results on airglow and auroral distribution in the lower- and upper-thermosphere using IMAP/VISI measurement data, and also report the current status of the operation of IMAP/VISI. IMAP/VISI is a visible imaging spectrometer which aims to measure nightglow emissions from ISS (~400 km altitude) covering the wide range from +51 deg. to -50 deg. in geographical latitude. VISI adopts two field-of-views (+/-45 deg. to nadir) to make a stereoscopic measurement of the airglow and aurora emission to subtract background contaminations from clouds and ground structures.

Since the successful launch of IMAP on August 2012, we found that meso-scale (~10 - 50 km) wave pattern is always seen in the airglow emission at O2 762 nm mainly at mid-latitudes. The typical O2 airglow intensity is several hundreds R to several kR. We found the concentric gravity wave (CGW) patterns for more than 170 events out of ~4900 paths, and revealed that these CGW events tend to occur in the southern hemisphere. From the cross-correlation analysis between front FOV data and rear FOV data of which time difference is typically 90 s at the same location, we can determine the direction and phase speed of atmospheric gravity wave.

We compared the CGW pattern obtained with IMAP/VISI and the ionospheric data with Hokkaido HF radar (E-region irregularity) and the GEONET GPS stations (F-region TEC). IMAP/VISI measured westward moving concentric gravity waves in O2 airglow emission with the phase speed up to 160 m/s from 11 to 15 UT on Feb. 5, 2014. Simultaneously the Hokkaido HF radar measured south-westward moving successive echo structures. Phase speeds of CGWs along the E-region echo area and along the radar beams were consistent with those of radar echo structures. During this period, GPS network data showed the south-westward motion of MSTID in the F-region over Japan. This fact suggests that the F-region MSTID was coupled with the E-region gravity waves.

In addition, we changed the VISI operation modes in July 2013, and started the measurement of airglow and auroral measurements at O 557.7nm, Na 589nm and OH 828 nm, in addition to O 630nm, OH 730nm and O2 762nm. After the VISI mode change we routinely obtain the spectra of airglow emissions to estimate OH rotational temperature and faint emissions of sodium and oxygen.

Further, we carried out intensive VISI measurements for 630nm emission during the last winter period to observe MSTID event at mid-latitudes. We will give a talk on the latest results and current status of IMAP/VISI, and would like to point issues for future missions.

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キーワード: 宇宙ステーション, IMAP, 大気光, オーロラ, 衛星  
Keywords: ISS, IMAP, airglow, aurora, satellite



## O2 airglow concentric structure observed from International Space Station O2 airglow concentric structure observed from International Space Station

秋谷 祐亮<sup>1</sup>; 齊藤 昭則<sup>1\*</sup>; 坂野井 健<sup>2</sup>; 穂積 裕太<sup>1</sup>; 山崎 敦<sup>3</sup>; 大塚 雄一<sup>4</sup>; 西岡 未知<sup>5</sup>; 津川 卓也<sup>5</sup>  
AKIYA, Yusuke<sup>1</sup>; SAITO, Akinori<sup>1\*</sup>; SAKANOI, Takeshi<sup>2</sup>; HOZUMI, Yuta<sup>1</sup>; YAMAZAKI, Atsushi<sup>3</sup>;  
OTSUKA, Yuichi<sup>4</sup>; NISHIOKA, Michi<sup>5</sup>; TSUGAWA, Takuya<sup>5</sup>

<sup>1</sup> 京都大・理, <sup>2</sup> 東北大・PPARC, <sup>3</sup> 宇宙研, <sup>4</sup> 名古屋大・STE研, <sup>5</sup> 情報通信研究機構

<sup>1</sup>Grad. Sch. of Science, Kyoto Univ., <sup>2</sup>PPARC, Tohoku Univ., <sup>3</sup>ISAS/JAXA, <sup>4</sup>STEL, Nagoya Univ., <sup>5</sup>NICT

Visible and near-infrared spectral imager (VISI) for ISS-IMAP (the International Space Station - Ionosphere, Mesosphere, upper Atmosphere and Plasmasphere mapping) mission observes nighttime airglow emission from ISS. VISI observes the airglow in the nadir direction by two field-of-views (FOVs) which directs the forward and the backward to the ISS orbit. Some concentric structures which are difficult to observe the entire image by the ground-based imagers were detected from the space by VISI. Concentric structure in the 762-nm O<sub>2</sub> airglow emission observed on June 1, 2013 was analyzed in this study. Spatial scale of this concentric structure was determined to be 1,200 km from the center of the structure to its edge. Propagation velocity of the waves which spread radially from the center was derived as  $125 \pm 62$  m/s from the difference between the images taken by two FOVs of VISI. Duration time of the concentric structure was estimated to be 2 - 5 hours from the spatial scale and the propagation velocity of the waves. Concentric structure in GPS-TEC which was caused from the tornado was observed before the VISI observation had faster propagation velocity and longer wavelength than those in the airglow concentric structure. It was speculated that the O<sub>2</sub> airglow observed by VISI was caused by secondarily waves which propagate in the horizontal direction that were caused from the atmospheric gravity waves generated disturbance in the troposphere.

Keywords: airglow, concentric structure, atmospheric gravity waves, International Space Station, near infrared

## Statistical Study of Concentric Gravity Wave in the Mesopause by using the IMAP/VISI Data

### Statistical Study of Concentric Gravity Wave in the Mesopause by using the IMAP/VISI Data

PERWITASARI, Septi<sup>1\*</sup>; SAKANNOI, Takeshi<sup>1</sup>; OTSUKA, Yuichi<sup>2</sup>; YAMAZAKI, Atsushi<sup>3</sup>; MIYOSHI, Yasunobu<sup>4</sup>; HOZUMI, Yuta<sup>5</sup>; AKIYA, Yusuke<sup>5</sup>; SAITO, Akinori<sup>5</sup>  
PERWITASARI, Septi<sup>1\*</sup>; SAKANNOI, Takeshi<sup>1</sup>; OTSUKA, Yuichi<sup>2</sup>; YAMAZAKI, Atsushi<sup>3</sup>; MIYOSHI, Yasunobu<sup>4</sup>; HOZUMI, Yuta<sup>5</sup>; AKIYA, Yusuke<sup>5</sup>; SAITO, Akinori<sup>5</sup>

<sup>1</sup>PPARC, Tohoku University, <sup>2</sup>STEL, Nagoya University, <sup>3</sup>JAXA/ISAS, <sup>4</sup>Kyushu University, <sup>5</sup>Geophysics Department, Kyoto University

<sup>1</sup>PPARC, Tohoku University, <sup>2</sup>STEL, Nagoya University, <sup>3</sup>JAXA/ISAS, <sup>4</sup>Kyushu University, <sup>5</sup>Geophysics Department, Kyoto University

We report the first global study of concentric gravity waves (CGWs) in the mesopause region (~95 km) by using the IMAP/VISI data. CGWs have unique characteristic that shows a direct coupling between lower and upper atmosphere, makes it useful to study the role of gravity waves in atmospheric dynamic by transporting their energy and momentum from their sources in the tropopause to the mesopause region where the waves dissipate. The past studies have revealed the general properties of these CGWs such as: source, propagation mechanism and the effect of the background profile. However, they were mostly a single event studies and gave only limited information locally. Therefore, a statistical study on global distribution of the CGWs is needed to get more comprehensive understanding and the parameterization of gravity waves will also useful for the global circulation model. To address this issue, a space-based observation is more preferable since it covers a wider area. IMAP/VISI is the only space-based instrument that capable of imaging gravity waves in the MLT region in the nadir direction, makes it ideal for such a global study. The Visible and near-Infrared Spectral Imager (VISI) of the IMAP mission was launched successfully on July 21, 2012 with H-IIB/HTV-3 and installed onto the International Space Station (ISS). IMAP/VISI is now operated in the night side hemisphere with a range of +/- 51 deg. GLAT. IMAP/VISI is measuring three airglow emissions: OI (630 nm), OH Meinel (730 nm) and O2 (762 nm) with the typical spatial resolution of 16750 km. Since the start of nominal operation in October 2012, IMAP/VISI has been operated with approximately 15 paths/day.

In this study, we analyze the CGWs events from IMAP/VISI data of 2013. We found total 172 CGWs events in the O2 (762 nm) airglow emissions out of 4853 data paths. The monthly distribution of the CGWs occurrence shows a clear seasonal dependence with the peak around March-April and August-September. The weak background winds (from GAIA model) in the middle atmosphere during the March and September equinox are likely responsible for the seasonal dependence. We determined the source of CGWs by estimating the center of the circular pattern and applying a ray-tracing method. We found that in the southern hemisphere, the high activity of CGWs can be found in a band-like area between 30-500 S while in the northern hemisphere the latitudinal variation is bigger, means that the activity can be found in the area ranging from 0-500 N. In the southern hemisphere, the high occurrence region is co-located with the jet streams flow region. Therefore, we suspect that the source in the southern hemisphere is likely related with the jet stream activity. In the northern hemisphere, the sources were mostly found to be convective activities (convective plum, tropical storm and typhoon), which were identified from the meteorological satellite data. We have calculated the wave parameters for two months (March and April) and found that the small-scale waves (horizontal wavelength <100km) expand from the center up to several hundred km (100-600 km), while the large scale can expand up to 2000 km. We are deriving more data from the other months to investigate any wave parameters distribution tendency globally. We also found that generally the concentric pattern appeared as arc like shape instead of full circle. It indicates that the background wind filter allows the wave to propagate in a particular direction and filter out the other directions. Data from 2014 will also be added and if possible will also be presented in this meeting.

キーワード: Concentric Gravity Waves, IMAP/VISI, Mesopause, Airglow  
Keywords: Concentric Gravity Waves, IMAP/VISI, Mesopause, Airglow

国際宇宙ステーションからの撮像画像を用いた中間圏大気光メソスケール波動構造の研究  
Airglow image of mesospheric mesoscale wave captured from the International Space Station

穂積 裕太<sup>1\*</sup>; 齊藤 昭則<sup>1</sup>; 坂野井 健<sup>2</sup>; 秋谷 祐亮<sup>1</sup>; 山崎 敦<sup>3</sup>  
HOZUMI, Yuta<sup>1\*</sup>; SAITO, Akinori<sup>1</sup>; SAKANOI, Takeshi<sup>2</sup>; AKIYA, Yusuke<sup>1</sup>; YAMAZAKI, Atsushi<sup>3</sup>

<sup>1</sup> 京都大学大学院理学研究科地球物理学教室, <sup>2</sup> 東北大学大学院理学研究科惑星プラズマ・大気研究センター, <sup>3</sup> 宇宙航空研究開発機構 宇宙科学研究所

<sup>1</sup>Department of Geophysics, Graduate School of Science, Kyoto University, <sup>2</sup>Planetary Plasma and Atmospheric Research Center, Graduate School of Science, Tohoku University, <sup>3</sup>Institute of Space and Astronautical Science / Japan Aerospace Exploration Agency

Mesoscale wave-like structures in the mesospheric airglow were captured by an imaging observation from the International Space Station. Limb imaging observations with a digital single reflex camera provided us the horizontal structure of mesospheric airglow with unprecedentedly wide field-of-view(FOV). The FOV is 3,000 km width at the tangential point. Previous airglow observations captured small scale (10 - 400 km) structures by ground based airglow imagers and large scale (several 1,000s km) structures by satellite limb scanning. Our observation captured mesoscale wave-like structure, whose wavelength is about 1,000 km, and filled the gap of the previous observation. A data on August 26, 2015 shows wavelike oscillation in both peak intensity and layer height for OI, Na and OH airglow. Its wavelength is about 1,000 km and the wave existed region is about 2,500 x 3,000 km size over the Indian ocean and Australia. In the presentation, the cause of this structure will be discussed.

キーワード: 大気光, 重力波  
Keywords: airglow, gravity wave

国際宇宙ステーション GLIMS ミッションにより観測された雷発光とホイストラを用いた電離層 F 層の電子密度推定  
Estimating ionospheric property by using simultaneous observations of lightning and whistlers from ISS GLIMS mission

鈴木 克徳<sup>1\*</sup>; 柿沼 遠方<sup>1</sup>; 芳原 容英<sup>1</sup>; Linscott Ivan<sup>2</sup>; Inan Umran<sup>2</sup>; 佐藤 光輝<sup>3</sup>; 高橋 幸弘<sup>3</sup>;  
牛尾 知雄<sup>4</sup>; 河崎 善一郎<sup>4</sup>; 森本 健志<sup>5</sup>; 山崎 敦<sup>6</sup>; 鈴木 睦<sup>6</sup>  
SUZUKI, Katsunori<sup>1\*</sup>; KAKINUMA, Kanata<sup>1</sup>; HOBARA, Yasuhide<sup>1</sup>; LINSCOTT, Ivan<sup>2</sup>; INAN, Umran<sup>2</sup>;  
SATO, Mitsuteru<sup>3</sup>; TAKAHASHI, Yukihiro<sup>3</sup>; USHIO, Tomoo<sup>4</sup>; KAWASAKI, Zenichiro<sup>4</sup>; MORIMOTO, Takeshi<sup>5</sup>;  
YAMAZAKI, Atsushi<sup>6</sup>; SUZUKI, Makoto<sup>6</sup>

<sup>1</sup> 電気通信大学大学院 情報理工学研究科, <sup>2</sup> スタンフォード大学 電子工学科, <sup>3</sup> 北海道大学大学院 理学院宇宙理学専攻, <sup>4</sup> 大阪大学大学院工学研究科情報通信工学部門, <sup>5</sup> 近畿大学 理工学部, <sup>6</sup> 宇宙航空研究開発機構 宇宙科学研究所

<sup>1</sup>Graduate School of Informatics and Engineering, The University of Electro-Communications, <sup>2</sup>Department of Electrical Engineering, Stanford University, <sup>3</sup>Department of CosmoSciences, Graduate School of Science, Hokkaido University, <sup>4</sup>Information and communication engineering department, Osaka University, <sup>5</sup>Faculty of Science and Engineering, Kinki University, <sup>6</sup>Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency

雷放電における空電のうち電離層を透過し、磁気圏で観測されたものをホイストラという。ホイストラとなる空電は、分散性媒質である電離層プラズマを透過することにより、周波数によって異なる群遅延が生じる。本研究では、国際宇宙ステーション搭載の GLIMS (Global Lightning and SprItE MeasurementS) ミッションによる光学観測と電磁波観測により得られたホイストラより導出した群遅延を用いた解析と電磁波観測で得られたホイストラのみを用いたホイストラの分散性を用いた解析の 2 通りの方法より、電離層 F 層の最大電子密度の推定を行う。その結果、分散が小さいホイストラに関しては、上記 2 通りの方法および IRI においてよい一致が見られた。この方法は、洋上を含む世界中の雷活動領域上空での電離層 F 層の電子密度を導出するのに有用であると考えられる。

キーワード: ホイストラ, 電離層 F 層, GLIMS, 国際宇宙ステーション  
Keywords: Whistler, ionosphere F layer, GLIMS, International Space Station

## 630-nm airglow imaging observations of plasma bubbles from the International Space Station 630-nm airglow imaging observations of plasma bubbles from the International Space Station

大塚 雄一<sup>1\*</sup>; 山田 貴宣<sup>1</sup>; 坂野井 健<sup>2</sup>; 秋谷 祐亮<sup>3</sup>; 穂積 裕太<sup>3</sup>; 齊藤 昭則<sup>3</sup>; 山崎 敦<sup>4</sup>  
OTSUKA, Yuichi<sup>1\*</sup>; YAMADA, Takanori<sup>1</sup>; SAKANOI, Takeshi<sup>2</sup>; AKIYA, Yusuke<sup>3</sup>; HOZUMI, Yuta<sup>3</sup>;  
SAITO, Akinori<sup>3</sup>; YAMAZAKI, Atsushi<sup>4</sup>

<sup>1</sup>名古屋大学太陽地球環境研究所, <sup>2</sup>東北大学大学院理学研究科惑星プラズマ・大気研究センター, <sup>3</sup>京都大学大学院理学研究科地球物理学教室, <sup>4</sup>宇宙航空研究開発機構 宇宙科学研究所

<sup>1</sup>Solar-Terrestrial Environment Laboratory, Nagoya University, <sup>2</sup>Planetary Plasma and Atmospheric Research Center, Graduate School of Science, Tohoku University, <sup>3</sup>Department of Geophysics, Graduate School of Science, Kyoto University, <sup>4</sup>Institute of Space and Astronautical Science / Japan Aerospace Exploration Agency

Under the Ionosphere, Mesosphere, upper Atmosphere, and Plasmasphere mapping (IMAP) mission, imaging observations of airglow in the upper atmosphere from International Space Station has been conducted with Visible and Infrared Spectral Imager (VISI) since October 2012. We have analyzed images of the 630.0-nm airglow obtained by the Visual and Infrared Spectral Imager. We have succeeded to detect equatorial anomaly, and plasma bubbles. In the 630-nm airglow image observed by IMAP/VISI on ISS passing over Thailand on October 28, 2012, airglow depletion elongated in the north-south direction was observed. Simultaneously, field-Aligned Irregularity (FAI) echo was observed by the EAR in Indonesia. In order to compare spatial structure of the airglow depletion and FAI, we have mapped the FAI echo region onto the northern hemisphere along the magnetic field lines. We have found that the FAI echo region coincides with the airglow depletion observed by IMAP/VISI, indicating the airglow depletion is caused by a plasma bubble. We have carried out statistical analysis of plasma bubble, and found that plasma bubble most frequently occurs in spring and autumn equinoxes at African longitudinal sector. We have also measured zonal spacing of plasma bubbles and found that the spacing depends on longitude, suggesting that atmospheric gravity waves may seed plasma bubbles.

キーワード: 大気光, 電離圏, 宇宙ステーション, プラズマバブル, IMAP, VISI  
Keywords: airglow, ionosphere, international space station, plasma bubble, IMAP, VISI

## ISS-IMAPにより観測された赤道プラズマバブルの季節-経度依存性 Seasonal-longitudinal dependence of the occurrence of equatorial plasma bubbles observed by ISS-IMAP

高橋 明<sup>1</sup>; 中田 裕之<sup>1\*</sup>; 鷹野 敏明<sup>1</sup>; 齊藤 昭則<sup>2</sup>; 坂野井 健<sup>3</sup>

TAKAHASHI, Akira<sup>1</sup>; NAKATA, Hiroyuki<sup>1\*</sup>; TAKANO, Toshiaki<sup>1</sup>; SAITO, Akinori<sup>2</sup>; SAKANOI, Takeshi<sup>3</sup>

<sup>1</sup> 千葉大学大学院工学研究科, <sup>2</sup> 京都大学大学院理学研究科, <sup>3</sup> 東北大学大学院理学研究科惑星プラズマ・大気研究センター  
<sup>1</sup>Graduate School of Engineering, Chiba University, <sup>2</sup>Graduate School of Science, Kyoto University, <sup>3</sup>Planetary Plasma and Atmospheric Research Center, Graduate School of Science, Tohoku University

After sunset in the equatorial region, the small irregularities in the ionosphere grow large-scale depletion of the plasma as Equatorial plasma bubbles (EPBs). Because field-aligned irregularities inside EPBs affect radio waves and degrade the satellite-ground communications, it is very important to examine the dependence of their occurrence on parameters. The global observation of Equatorial plasma bubbles (EPBs) is inevitable. Since the Pacific Ocean spreads widely in the equatorial region, however, the observation of EPBs from the ground cannot be made at any longitude of equatorial region. On the other hand, the observation from the sky is very effective. In this study, the occurrence of EPBs are examined using airglow images obtained by Ionosphere, Mesosphere, upper Atmosphere, and Plasmasphere mapping on board International Space Station (ISS-IMAP). The seasonal-longitudinal dependence of their occurrence is also discussed. To do so, EPBs are chosen from 630-nm airglow images. Since the depletion of electron density is associated with EPBs, EPBs are visualized as dark trajectory. The orbital period of ISS is about 93 minutes and orbit inclination is 52 degrees. Moreover, the observation of airglow has made during the night. The observation is not uniform in longitude. Thus, the occurrence rate of EPBs is calculated by the number of EPBs over the duration of the observation in the latitude between from -30 to 30.

The occurrence rate determined by ISS-IMAP data is high at all longitude in the equinoctial seasons. This result is consistent with the occurrence rate determined by the plasma density data on DMSP satellite [Burke et al., 2004]. The orbital altitude of DMSP is 840 km, which is higher than the observation altitude of ISS-IMAP, which is about 250 km. This result implies that the altitudes of EPBs are not strongly dependent on the solar activity. On the other hand, the occurrence rate by ISS-IMAP is high at the American region as equinoctial seasons, which is not consistent with DMSP observation. As for the events observed during summer in the American sector, most of the events occurred simultaneous with geomagnetic storm. Since it is reported that penetration electric fields near dusk are eastward and enhances in the stormtime occurred in summer, it is considered that penetration electric fields prompt growth of EPBs especially in summer.

キーワード: 赤道プラズマバブル, 大気光, ISS, IMAP, 磁気嵐

Keywords: equatorial plasma bubble, airglow, ISS, IMAP, magnetic storm

**Characteristics of 100-1000 km-scale ionospheric disturbances observed by ISS-IMAP/VISI in collaboration with high-reso**  
**Characteristics of 100-1000 km-scale ionospheric disturbances observed by ISS-IMAP in collaboration with TEC map**

西岡 未知<sup>1\*</sup>; 津川 卓也<sup>1</sup>; 横山 竜宏<sup>1</sup>; 久保田 実<sup>1</sup>; 齊藤 昭則<sup>2</sup>; 坂野井 健<sup>3</sup>; 秋谷 祐亮<sup>2</sup>;  
大塚 雄一<sup>4</sup>; 石井 守<sup>1</sup>

NISHIOKA, Michi<sup>1\*</sup>; TSUGAWA, Takuya<sup>1</sup>; YOKOYAMA, Tatsuhiro<sup>1</sup>; KUBOTA, Minoru<sup>1</sup>; SAITO, Akinori<sup>2</sup>;  
SAKANOI, Takeshi<sup>3</sup>; AKIYA, Yusuke<sup>2</sup>; OTSUKA, Yuichi<sup>4</sup>; ISHII, Mamoru<sup>1</sup>

<sup>1</sup> (独) 情報通信研究機構, <sup>2</sup> 京都大学大学院理学研究科, <sup>3</sup> 東北大学大学院理学研究科, <sup>4</sup> 名古屋大学太陽地球環境研究所  
<sup>1</sup>National Institute of Information and Communications Technology, <sup>2</sup>Department of Geophysics, Kyoto University, <sup>3</sup>Department of Geophysics, Tohoku University, <sup>4</sup>Solar-Terrestrial Environment Laboratory, Nagoya University

Two-dimensional Total Electron Content (TEC) map has been used for revealing characteristics of meso-scale ionospheric disturbances, such as Medium-Scale Travelling Ionospheric Disturbances (MSTIDs) and Equatorial Plasma Bubble (EPBs). We have developed high-resolution TEC maps as "Dense Regional And Worldwide International Networks of GNSS-TEC observation (DRAWING-TEC)" project (<http://seg-web.nict.go.jp/GPS/DRAWING-TEC/>). The project provides regional and global maps of absolute value of TEC, de-trended TEC with 60-min window, and Rate of TEC change Index (ROTI). As of 2015, regional maps are produced over North America and Europe in addition to Japan. These regional maps are powerful tools for studying characteristics of MSTIDs and EPBs. However, it is impossible to detect MSTIDs and EPBs over oceans by only TEC data derived from ground-based GPS receivers. In contrast with GPS-TEC data, airglow images observed by ISS-IMAP/VISI cover all areas including continents and oceans. But detecting MSTIDs from the space-borne imager is difficult since the 630 nm-airglow is weak in the mid-latitude ionosphere. In this study, we analysis both GPS-TEC data and ISS-IMAP/VISI 630 nm imager data and succeeded in detecting MSTIDs using ISS-IMAP/VISI 630 nm imager data. The spatial structure and occurrence characteristics of MSTIDs detected from ISS-IMA/VISI 630nm imager will be discussed in this presentation.

キーワード: ionospheric disturbance, ISS-IMAP, VISI 630nm airglow, GPS-TEC map  
Keywords: ionospheric disturbance, ISS-IMAP, VISI 630nm airglow, GPS-TEC map

## ISS-IMAP/EUVIで観測された夕方側電離圏上部Heイオンの水平構造 Horizontal structures of Helium ion in the upper ionosphere observed by ISS-IMAP/EUVI

穂積 裕太<sup>1\*</sup>; 齊藤 昭則<sup>1</sup>; 山崎 敦<sup>2</sup>; 村上 豪<sup>2</sup>; 吉川 一郎<sup>3</sup>  
HOZUMI, Yuta<sup>1\*</sup>; SAITO, Akinori<sup>1</sup>; YAMAZAKI, Atsushi<sup>2</sup>; MURAKAMI, Go<sup>2</sup>; YOSHIKAWA, Ichiro<sup>3</sup>

<sup>1</sup> 京都大学大学院理学研究科地球物理学教室, <sup>2</sup> 宇宙航空研究開発機構 宇宙科学研究所, <sup>3</sup> 東京大学

<sup>1</sup>Department of Geophysics, Graduate School of Science, Kyoto University, <sup>2</sup>Institute of Space and Astronautical Science / Japan Aerospace Exploration Agency, <sup>3</sup>The University of Tokyo

Horizontal structures of ionised Helium in the upper ionosphere of dusk side were obtained from observation of resonant scattering light. The Extreme Ultra Violet Imager (EUVI) of the ISS-IMAP (Ionosphere, Mesosphere, upper Atmosphere and Plasmasphere mapping) mission has taken image of HeII radiation (30.4 nm) from the International Space Station (ISS) since October 2012. North-south asymmetry and longitudinal structure of ionised Helium were found. North-south asymmetry in solstice seasons is well consistent with the previous in-situ measurement and numerical simulation. However, the longitudinal structure is not reported before and cannot be explained by numerical simulation with SAMI2-model. The longitudinal difference of meridional wind is a candidate of the Helium ion structure.

キーワード: 上部電離層, ヘリウムイオン

Keywords: topside ionosphere, Helium ion