S001-01 **会場: C** **時間: 11月3日 9:10-9:25**

超高層大気イメージングシステムによる東南アジア・アフリカでの熱圏・電離圏の撮像観測

塩川 和夫 [1]; 大塚 雄一 [1]
[1] 名大 STE 研

Imaging observation of thermosphere and ionosphere in South-East Asia and Africa using the Optical Mesosphere Thermosphere Imagers

Kazuo Shiokawa[1]; Yuichi Otsuka[1]
[1] STEL, Nagoya Univ.

http://stdb2.stelab.nagoya-u.ac.jp/omti/index.html

The Optical Mesosphere Thermosphere Imagers (OMTIs) consists of 14 airglow imagers, 5 Fabry-Perot interferometers (FPIs), 3 airglow temperature photometers, and 3 meridian-scanning photometers to measure dynamical variations of the mesosphere, thermosphere and ionosphere through airglow emissions. In South-East Asia/Oceania and in Africa, three imagers are located at Kototabang (Indonesia), Darwin (Australia), and Abuja (Nigeria), and two FPIs are at Kototabang and Chiang Mai (Thailand). These instruments observe gravity waves in the mesopause region and plasma bubbles and nighttime medium-scale traveling ionospheric disturbances (MSTIDs) in the ionosphere as well as neutral wind variation in the lower thermosphere. In this presentation we show current status of these optical instruments and their contribution to understand the dynamics of the upper atmosphere and to capacity building in developing countries.

International collaborations of public outreach activities for the space science using 3D digital globe

Akinori Saito[1]; Takuya Tsugawa[2]; Yoko Odagi[3]; Chia-Hung Chen[4]
[1] Dept. of Geophysics, Kyoto Univ.; [2] NICT; [3] WDC for Geomagnetism, Kyoto Univ.; [4] Earth Science, NCKU

http://earth.dagik.org/

The importance of the public outreach activities of science have increased in these years. It is regarded as the obligation of scientists to contribute to the society by expanding the knowledge that they have achieved, and educating especially young generations with their expertise. Although some fields of science, such as astronomy, has spent a large number of efforts for the public outreach activities, the activity of the space scientists is generally low in most countries. The public outreach is very important for the space science because it is a relatively new field of study, and the social awareness of the crucial effects of the space science phenomena is quite low. To support the public outreach activities, we developed a portable three-dimensional digital globe system, Dagik Earth, and promote the activities using it under international collaborations. Three-dimensional digital globe is a powerful tool for audience to understand the global phenomena occurring on the Earth and planets. Miraikan, Japan, developed Geo-cosmos that is a 6-m spherical screen covered by LEDs, and NOAA, USA, developed Science on a sphere (SOS) that is a 1.8-m spherical screen projected by four PC projectors. Although these systems have great success in science museums, they are too complicated and expensive to be widely used out of the science museums. Dagik Earth is a portable and low cost system because it uses ordinal PC and one PC projector. It uses a spherical screen that can be an inflatable balloon for portable usage. The size of the spheres that have been used is from 8-cm to 16-m. A group leaded by Kyoto University has developed the software and contents of Dagik Earth, and distribute them with free of charge for the science and education usages. In Japan, it has been widely used for education and public outreach in schools, local science museums, universities and research institutes. Under the collaboration with the scientists in Taiwan, the Chinese version of Dagik Earth has been developed, and widely used in the science activities at schools and museums in Taiwan. It was also used in science public outreach events in Thailand, Indonesia, Singapore and Australia. We hope to expande the usage of Dagik Earth in the public outreach activities for the space science in the Asia-Oceania region under the international collaborations.

S001-03 会場: C 時間: 11 月 3 日 9:40-9:55

An introduction to the ionosphere research in Institute of Geology and Geophysics, Chinese Academy of Sciences

Guozhu Li[1]; Baiqi Ning[1]; Weixing Wan[1]; Libo Liu[1]; Biqiang Zhao[1]; Lianhuan Hu[1]; Xiukuan Zhao[1]
[1] IGGCAS, China

There has been a long history of ionosphere research with observations and numerical model simulations in the ionosphere group of Institute of Geology and Geophysics, Chinese Academy of Sciences (IGGCAS). In this talk, we will present a brief review on the observational studies of the middle and low latitude ionosphere in China, discuss and seek to enhance possible future cooperation in potential areas including the development of ground-based space environment observation network in the Asian and Oceanian regions. The talk will be focused on the following aspects: (1) The ground-based observational network conducted by IGGCAS, which mainly includes four types of instruments (ionosonde, GNSS receiver, all-sky meteor radar and magnetometer) deployed at four long-term observation sites around 120^oE (Mohe, Beijing, Wuhan and Sanya) for monitoring the lower thermosphere and ionosphere, and the Solar-Terrestrial Environment Research Network (STERN) which provides access to the observed data. (2) The outcomes (e.g., the validation of COSMIC ionospheric parameters with a chain of ionosondes, the East-West difference and nighttime enhancement in F region electron density, and the tidal wind mapping technique) derived from the observational network in recent years, and plans of expanding the present network of lower thermosphere/ionosphere observation. (3) The Sanya VHF coherent and UHF incoherent scatter radars designed for improved studies of the lower thermosphere and ionosphere in the Chinese low latitude region with high spatial and temporal resolution. Some recent results of ionospheric E- and F-region irregularities and meteor trail irregularities obtained from the Sanya VHF radar (which was installed in 2009) will be presented. (4) The future research topics of the IGGCAS ionosphere group, and plans for international cooperation.

南・東南アジアにおける赤道電離圏擾乱の GNSS・レーダー観測

大塚 雄一 [1]; 塩川 和夫 [1]; Abadi Prayitno[1]; Dao Tam[1]; 横山 竜宏 [2]; 津川 卓也 [2]; 西岡 未知 [2]; M Buhari Suhaila[3]; 山本 衛 [4]; Patra Amit[5]; Tulasi Ram Sudarsanam[6]
[1] 名大 STE 研; [2] 情報通信研究機構; [3] NICT; [4] 京大・生存圏研; [5] NARL, India; [6] IIG, India

GNSS and radar observations of equatorial ionospheric irregularities in South and Southeast Asia

Yuichi Otsuka[1]; Kazuo Shiokawa[1]; Prayitno Abadi[1]; Tam Dao[1]; Tatsuhiro Yokoyama[2]; Takuya Tsugawa[2]; Michi Nishioka[2]; Suhaila M Buhari[3]; Mamoru Yamamoto[4]; Amit Patra[5]; Sudarsanam Tulasi Ram[6]
[1] STEL, Nagoya Univ.; [2] NICT; [3] NICT; [4] RISH, Kyoto Univ.; [5] NARL, India; [6] IIG, India

Using a dual-frequency GNSS (Global Navigation Satellite System), TEC (Total Electron Content), which is integration of the plasma density along a ray path from the GNSS satellite to receiver, can be obtained. In Malaysia, 78 GPS receivers have been operating as MyRTKnet, which belongs to the Department of Survey and Mapping (JUPEM), Malaysia. GPS data in Indonesia, Singapore, and Thailand are provided by IGS (International GNSS Service) and SuGAr (Sumatran GPS Array) networks through the Scripps Orbit and Permanent Array Center. Using these GPS data, two-dimensional maps of the TEC have been made to investigate generation, development and propagation of equatorial plasma bubbles [Buhari et al., JGR, 2014]. We are planning to install multi-frequency GNSS receivers at Chiang Mai, Thailand and Biak, Indonesia in order to conduct geomagnetic conjugate observation and study longitudinal dependence of the plasma bubbles.

Using VHF radars, the ionospheric irregularities have been observed. EAR (Equatorial Atmosphere Radar) in Indonesia and Gadanki radar in India have measured 150-km FAI (Field-Aligned Irregularity) echo during daytime. The Doppler velocities measured by both radars are compared, and found that average of the Doppler velocities are consistent with each other whereas they differ on day-to-day basis [Patra et al., JGR, 2012, 2014]. This difference may arise from the longitudinal and/or latitudinal dependences of the neutral dynamics due to gravity waves and planetary waves. The Doppler velocity of the 150-km echo could represent ExB drift in the F region over magnetic equator, which affect electro-dynamics in the equatorial ionosphere. We will discuss advantage of the 150-km echo measurements at magnetic equator in the Indonesian and Indian longitudinal sectors.

Simultaneous observations of F-region field-aligned irregularity and total electron content after midnight at equatorial region

Tam Dao[1]; Yuichi Otsuka[1]; Kazuo Shiokawa[1]; Suhaila M Buhari[2]; Mamoru Yamamoto[3]
[1] STEL, Nagoya Univ.; [2] NICT; [3] RISH, Kyoto Univ.

We investigated the 2-Dimension structures of Field-Aligned Irregularity (FAI) echoes at post-midnight to find out the generation possibility of FAI that appeared after midnight. These data were observed with the Equatorial Atmosphere Radar (EAR) at Kototabang (0.20^{o}S, 100.32^{o}E; dip lat. 10.4^{o}S), Indonesia. We examined 14 post-midnight field-aligned Irregularities (FAIs) which appeared within the Equatorial Atmospheric Radar's field of view around midnight in June solstices from May 2010 to June 2013. The total electron content (TEC) are obtained from GPS receivers of the Sugar and IGS networks and MyRTKnet in Malaysia. The detrended TEC and rate of TEC index (ROTI) maps are made. Detrended TEC was made by subtracting 1-hour running average for the original TEC data for each satellite-receiver pair in order to obtain perturbation components of TEC. ROTI represents amplitude of the plasma density variations, especially irregularities with scale size of 3 km. Those maps cover the Southeast Asia region, covering a wide field-of-view compared to the EAR. We made simultaneous 2-dimensinal observations of total electron content and F-region field-aligned irregularity to the time when the FAI are first observed by the EAR. This study is to investigate whether the post-midnight FAIs are accompanied by the plasma bubble or MSTID. Among 14 days that FAIs appeared within the EAR's FOV on post-midnight time, we found 11 days in which TEC depletion performed around the time when the post-midnight FAIs first appeared. More detail will be discussed in the presentation.

アジア太平洋地域を中心とする低緯度電離圏研究計画の現状

山本 衛 [1]
[1] 京大・生存圏研

Status of research projects for low-latitude ionosphere over Asia and Pacific regions

Mamoru Yamamoto[1]
[1] RISH, Kyoto Univ.

Low-latitude ionosphere and variety of phenomena in the region are important reseach topics for years. There are much interests on couplings between the ionospheric plasma and the neutral atmosphere. Observations from the ground, satellite and rockets are very important to conduct this kind of studies. In this invited presentation, the author would like to show recent and/or near-future research projects that benefit the related studies in the Asia and Pacific regions.

近年の電離圏研究の研究トピックのひとつは磁気赤道域・低緯度域の擾乱現象である。プラズマバブルの精測とその発生原因の究明、衛星通信や衛星測位に対する影響などが研究テーマとなっている。また電離圏プラズマと背景の熱圏（電気的中性大気）の相互作用には、下層から伝搬してくる大気波動が電離圏に与える影響の解明を含み、強い興味が持たれている。電離圏の空間的に離れた領域が磁力線を通じて相互作用する現象も興味深い。これらの研究は地上や飛翔体（衛星やロケット）からの種々の観測によって支えらており、現在も様々な計画が立案・推進されている。この招待講演では、アジア太平洋地域の電離圏研究にかかわる最近あるいは近い将来の特色ある観測装置や計画について、著者の知る範囲で、完全さを求めず偏りを恐れず、なるべく多く紹介したい。研究分野の将来を考える議論の発端になればよいと思う。

Future plan of AVON (Asia VLF Observation Network) and cooperation with other ground-based network and satellite projects

Hiroyo Ohya[1]; Fuminori Tsuchiya[2]; Kozo Yamashita[3]; Yukihiro Takahashi[4]; Kazuo Shiokawa[5]; Yoshizumi Miyoshi[5]
[1] Engineering, Chiba Univ.; [2] Planet. Plasma Atmos. Res. Cent., Tohoku Univ.; [3] Dept. EE, Salesian Polytechnic.; [4] Cosmosciences, Hokkaido Univ.; [5] STEL, Nagoya Univ.

We introduce Asia VLF Observation Network (AVON) that we have operated since 2007. The observation targets of the AVON are the D- and lower E-region ionosphere, lightning activities, and ionospheric disturbances associated with lightning in Southeast Asia. The observation system is installed at 5 sites: Tainan site in Taiwan, Saraburi site in Thailand, Pontianak site in Indonesia, Los Banos in Philippines, and Hanoi in Viet Nam. At each site, we use an orthogonal loop antenna for the horizontal magnetic field measurements, and a dipole antenna for the vertical electric field measurements. At Tainan, Saraburi, and Pontianak sites, LF transmitter signals are observed with a monopole antenna. With a set of orthogonal loop and dipole antenna, tweek atmospherics (0.1 - 10.0 kHz) and broadband lightning atmospherics (1.0-40.0 kHz) are obtained. Analyzing the VLF/LF data obtained by AVON, we can estimate the reflection heights of each signal. The reflection height corresponds to variations in electron density in the D- and lower E-region ionosphere in Southeast Asia. So far, solar eclipse effects on the lower ionosphere [Ohya et al., JGR, 2012], and long recovery events associated with elves [Tsuchiya et al., 2013] using AVON data were reported. This network system can be utilized in cooperation with other ground-based and satellite-based observation projects to investigate energetic-particle precipitation effects on low-latitude ionosphere. In this session, we will introduce the AVON project in detail, and discuss the new possibilities for monitoring the ionosphere and magnetosphere.

実用宇宙天気におけるアジア・オセアニア連携の現状

石井 守 [1]; 斎藤 享 [2]
[1] 情報通信研究機構; [2] 電子航法研・航法システム

Current status of cooperation among Asia-Oceania region in operational space weather activities

Mamoru Ishii[1]; Susumu Saito[2]
[1] NICT; [2] NAV Department, ENRI

Recently it becomes very important to develop and to monitor the ionosphere above the ocean. The reason is because the region is very huge vacant area of observation, and the region is very important for using aviation. Now ICAO discusses the utility of space weather as mandatory information for civil aviation.

The measuring method of the ionosphere above the ocean is the followings; (1) oblique sounding, (2) trans-equatorial propagation, (3) occultation with low-altitude satellites, and (4) GNSS buoy. We will present the first two in this presentation as examples of cooperation in Asia-Oceania region.

NICT operate oblique sounding with domestic ionosondes for a long time. However, because of the shape of Japan, the observing points locate near the coast. Now we discuss the cooperation with RRA/KASI, South Korea for setting the observing points far from the coast.

For trans-equatorial propagation, we continue to receive the signal of radio Australia at Oarai station more than ten years. In addition this observation, we now plan to build a new system by using VHF radio wave.

In future, these observation should be input in GAIA model for data assimilation for precise space weather forecast.

近年、海上の電離圏観測手法の開発とその定常的観測が重要になってきている。これは、海上電離圏が広大な観測空白域になっていることに加え、ICAO 等で航空運用に宇宙天気情報を取り入れることを義務化する動きがあることから、特に実用宇宙天気において急務とされている課題と言える。

海上電離圏観測の手法としては、（１）イオノゾンデによる斜め伝搬（２）赤道越え電波伝搬（３）低高度衛星によるオカルテーションおよび（４）GNSS ブイ、が挙げられる。このうち、アジア・オセアニア連携で特に進めているものとして今回（１）（２）を紹介する。

イオノゾンデによる斜め伝搬は現在 NICT において定常的に観測を行い Web にて公開している。しかし我が国の形状から、国内間観測のみでは外海に出た観測点の確保が難しい。そこで、韓国 RRA および KASI との連携を行い、日本海および東シナ海上空の観測を密にとることを検討している。

また、赤道越え電波伝搬（Trans-Equatorial Propagation; TEP) では、現在ラジオオーストラリアの電波を大洗観測施設で受信する観測を 10 年以上にわたり行っているが、これに加えて新たに VHF-TEP システムの設置を検討している。

これらの結果を将来的には GAIA モデルに導入し、データ同化を行うことで西太平洋域上空の電離圏の状況を監視・予報することを目的とする。

Current status of space weather program in national space agency of Malaysia (ANGKASA)

Nyanasegari Bhoo Pathy[1]
[1] ANGKASA

Co-authors: Mhd Fairos Asillam, Zahira Md Radzi, Mohd Helmy Hashim, Farahana Kamarudin, Asnor Nadirah Ishak, Mohammad Redzuan Tahar, Karzaman Ahmad, Zulia Kurnia Dewi, Nor Rafidah Saibaka, Long Ahmad Bin Long Padang (Space Science and Research Unit, National Space Agency of Malaysia (ANGKASA), Ministry of Science, Technology and Innovation (MOSTI), MALAYSIA)

The growth of technology has left the society exposed to higher risk from space weather. Investments by global community into space weather research and technologies are rapidly advancing the state of knowledge and shows promising result in improving space weather prediction capabilities. Space weather effects over Malaysian sector are largely unknown due to scarcity of data and lack of understanding on the ionosphere in the equatorial region. The National Space Agency of Malaysia (ANGKASA) is moving ahead to develop our capability in monitoring and forecasting the effects from space weather with the combination of various ground instruments located in Malaysia such as Global Navigation Satellite System (GNSS) Continuously Operating Reference Station (GNSS CORS Scientific Network), Solar Telescope System at Langkawi National Observatory (LNO), Magnetic Data Acquisition System (MAGDAS) at LNO, Compound Astronomical Low-cost Low-frequency Instrument for Spectroscopy and Transportable Observatory (CALLISTO) and related space based data provided by international entities. To better classify the ionosphere, a local ionosphere index has been developed to closely describe the ionospheric disturbances over Malaysia. For this purpose, the total electron content (TEC) which is a parameter of interest in ionosphere, is assimilated as a remarkable parameter for deriving ionospheric perturbation index based on the real time data obtained from the GNSS CORS Scientific Network. This ionospheric perturbation index is developed to support both scientific basis underlying space weather research and development of space weather monitoring service in Malaysia. ANGKASA is working on a strong commitment with collaboration from local and international research institution to set-up a joint Space Environment Monitoring Centre with the aim of operationalizing space weather monitoring and early warning system in the not too distant future.

S001-10 **会場: C** **時間: 11 月 3 日 11:40-11:55**

International alliance of geomagnetic field network observation-30year’s history of global observation at Kyushu University-

Akimasa Yoshikawa[1]
[1] ICSWSE/Kyushu Univ.

For space environment monitoring, Kyushu University has developed a real time magnetic data acquisition system (the MAGDAS project) around the world. The number of observational sites is increasing every year with the collaboration of host countries. Now at this time, the MAGDAS Project has installed 73 real time magnetometers – so it is the largest magnetometer array in the world.

The history of global observation at Kyushu Univ is over 30 years and number of developed observational sites is over 140. To nurturing and operating such global network, international alliance is most important. However situations of host institutions are different so we need to construct an individual strategy for each observational site. Moreover, with increasing of observational sites, strategization for sustainability becomes more difficult. Especially, we are always experience a tension among different places of; goal of our own science, position as a data provider, expectation from developing countries, responsibility in an international alliance and limited resource and man power for project. In this presentation, we will trace of the history of global observation and discuss about problem for its sustainability.

CRUX 地磁気観測網の展開と研究成果について

尾花 由紀 [1]; 塩川 和夫 [2]; 寺本 万里子 [3]; 柿並 義宏 [4]; 才田 聡子 [5]
[1] 大阪電通大・工・基礎理工; [2] 名大 STE 研; [3] JAXA, 宇宙研; [4] 高知工科; [5] 北九州高専

CRUX Magnetometer Array for Study of Magnetic Pulsations

Yuki Obana[1]; Kazuo Shiokawa[2]; Mariko Teramoto[3]; Yoshihiro Kakinami[4]; Satoko Saita[5]
[1] Engineering Science, Osaka Electro-Communication Univ.; [2] STEL, Nagoya Univ.; [3] JAXA, ISAS; [4] Kochi Univ. of Tech.; [5] NITkit

In order to observe ULF pulsations and its spatial distribution, we constructed a new magnetometer array in New Zealand. In February 2011 and March 2012, we installed magnetometers in Middlemarch (-45.4 ° , 170.1 °) and Te Wharau, (-41.2 ° , 175.8 °) respectively. Coordination of these two and Eyrewell station (-43.4 ° , 172.4 °) operated by GNS Science allow us to study details of field line resonances in the New Zealand meridian lines. In this paper, we will introduce our latest scientific results and some issues which face us when we construct and operate magnetometer sites in foreign countries.

ニュージーランドにおける地磁気観測網の構築と、その観測データを用いた地磁気脈動観測研究の成果を報告する。我々は 2011 年 2 月と 2012 年 3 月にそれぞれニュージーランドの Middlemarch (-45.4 ° , 170.1 °), Te Wharau（-41.2 ° , 175.8 ° ）に磁力計を設置し、運用を続けている。同国には他に GNS Science が設置・運用している Eyrewell (-43.4 ° , 172.4 °) 地磁気観測点がある。これら 3 観測点は緯度にして約 2 ° ずつ離れており、ULF 地磁気脈動の研究、特に cross-phase 法を用いた磁力線共鳴振動の詳細研究に最適なデータセットを提供する。

我々の研究計画における最優先の研究課題は、磁力線両端の電離層が強い電気伝導度非対称を持つ際に現れる 1/4 波長モードの磁力線共鳴振動現象の調査である。これまでの研究で、明け方付近の時刻帯に (1) 異常に低い共鳴周波数、(2) 広い共鳴領域の幅、(3) 強い減衰、を示す磁力線共鳴振動が複数見つかった。これらの結果は 1/4 波長モード波の発生を強く示唆すものであり、その共鳴構造を初めて明らかにしたものである。

また、磁力線共鳴振動は磁気圏のプラズマ環境を地上観測から診断するプローブとしての役割も果たす。磁力線共鳴周波数から磁気圏赤道面のプラズマ質量密度を推定する研究は広く行われているが、ニュージーランド経度帯ではこれまで高時間分解能の地磁気多点観測が行われておらず、従ってこの経度帯のプラズマ質量密度の長期モニタリングも行われてこなかった。我々の研究により、磁気嵐中のプラズマ圏の枯渇・再充填や静穏期のプラズマ圏密度などが明らかになりつつあり、他の経度帯と比較検討が進められている。

講演ではこれらの研究結果を紹介するとともに、観測網構築にまつわる諸問題：国内外の個人・大学・研究機関との協力関係の構築、観測体制の維持やデータの公開等で直面する問題等について議論する。

Collaboration between Japan and Vietnam for the MicroDragon micro-satellite project

Huan Vi Duc[1]; Thao Nguyen Thi[1]; Duc To Anh[1]; Minh Ngo Duc[1]; Junichi Kurihara[1]; Yukihiro Takahashi[1]; Phuong Vu Viet[2]
[1] Cosmosciences, Hokkaido Univ.; [2] VNSC

MicroDragon is the first 50 kg class microsatellite of Vietnam National Satellite Center (VNSC). It is being developed by VNSC researchers under instruction of the Japanese professors come from five universities including Hokkaido University, The University of Tokyo, Keio University, Tohoku University and Kyushu Institute of Technology. Hokkaido University has been responsible for the development of the science payloads based on the demands and requirements from the scientific point of view.

Vietnam has a long coastal line with about 7% households in the fishery. Seafood plays an important role in developing Vietnam economics. However, with increasing exploitation, natural aquatic resources are decreasing quickly. Development of aquaculture is necessary for a sustainable economics. To do this, Vietnam needs an effective system which is an integration of remote sensing and sea water sampling to monitor coastal water quality. Therefore, Mission of MicroDragon is ocean color observation to provide data to researchers in fishery field and scientists in oceanography for assessing water quality and locating living resources. We will use two imagers being composed of Space-borne multispectral Imager and Triple Polarization Imager onboard and Fluoro probes in the sea for the missions.

The development of MicroDragon is planned to be finished by the end of 2017. By now, the project is heading to Preliminary Design Review in September 2015 after two years implementation since 2013.

電離圏研究の為の小型衛星コンステレーション計画―衛星システムへの要求と観測器

小山 孝一郎 [1]; 児玉 哲哉 [2]
[1] 九大・理; [2] EORC/JAXA

Tiny satellite constellation for ionosphere study -Requirements to the system and the instrumentation-

koichiro Oyama[1]; Tetsuya Kodama[2]
[1] ICSWE,Kyushu Univ.; [2] EORC/JAXA

Constellation of tiny satellite is expected to be applied to many scientific field. We propose to launch at least 6 tiny satellites and one small satellite for ionosphere study, especially to study the precursor feature of large earthquakes by working together with earthquake suffering countries (Oyama et al., 2008; Oyama et al., 2010). Although our main target is to find the concrete evidences for the ionosphere modification by large earthquake, expecting further application to the prediction of large earthquakes, the satellite mission itself is purely ionosphere study. The data obtained from constellation mission, which makes it possible to distinguish time and space variation of the parameter to be measured, can be used in many ionosphere studies which could not be studied by single satellite, such as simultaneous look at of 4 cell structures, the effect of sudden stratosphere warming and, seeding of plasma bubble and so on.

A small satellite accommodates 1. electron density, electron temperature by TeNeP (Oyama et al., 2015), 2. Major ion composition by Retarding potential analyzer, 3 components plasma drift by a drift meter, neutral wind by a baffled mass spectrometer, height profile of electron density by a topside sounder, and an optical instrument to measure velocity and direction of neutral wind at the height of -100km, All tiny satellite accommodate electron density and temperature probe.

Several disciplines for the mission are discussed also to get the maximum output from the mission (Oyama et al., 2009).

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Miniaturization of a plasma wave receiver system towards future space missions based on micro-/nano-satellites

Hirotsugu Kojima[1]; Mitsunori Ozaki[2]; Satoshi Yagitani[3]; Yoshiya Kasahara[3]
[1] RISH, Kyoto Univ.; [2] Electrical and Computer Eng., Kanazawa Univ.; [3] Kanazawa Univ.

Plasma waves sensitively reflect dynamic variations of in-situ environments in space, because space plasmas are basically collisionless. The environment in space is controlled by wave-particle interactions. The Langmuir wave is a good example in the meaning of showing the existence of energetic electron beam which energies are much higher than thermal velocities of background electrons. Such electrostatic waves well thermalize local plasmas along the direction to their electric field oscillations. On the other hand, some of plasma wave modes are electromagnetic. They propagate far from their source region. One can identify the dynamics of their source region as well as the magnetic field structure by conducting the analysis of time variations of their intensities and their propagation features. Thus, observation of plasma waves provide us of a plenty of information of electromagnetic behaviors in space. In particular, the multiple point observations of plasma waves via plural satellites lead to understanding of spatial variations of space environments. Furthermore, continuous observations are the best in the meaning of monitoring the space environment. Such observations of plasma waves can be realized only by micro- or nano-satellites.

Plasma wave receiver system onboard satellites typically observe plasma waves with their frequencies from 0 Hz to a few MHz. It consists of electric field sensors, magnetic field sensors and receivers. Unfortunately, a conventional type of plasma wave receivers does not fit micro- or nano- satellites, because their size and weight is relatively larger than that of an optical camera, which is frequently carried by micro- or nano-satellites. Miniaturizing plasma wave receiver system is essential in realizing missions using micro- or nano-satellites. In order to make plasma wave receiver systems fit micro- or nano-satellites, we have been attempting the miniaturization of plasma wave receiver system using ASIC (ASIC: Application Specific Integrated Circuit). The ASIC is an electronic device which is designed for a specific application. We succeeded in developing the ASIC chip which is dedicated to the plasma wave receiver system. The size of the chip we designed is 5mm x 5mm. It contains six-channels of waveform type receivers which can observe waveforms of plasma wave with their frequencies up to 100 kHz. The chip consists of analogue components such as low noise amplifiers and filters. By using this ASIC chip, we developed the small plasma wave receiver with other necessary peripheral components. The size of the board is 40mm x 50mm and its weight is 24.9g. This plasma wave receiver system is almost one-order smaller than conventional ones. We also succeeded in developing the small sensor preamplifiers using ASIC. Furthermore, we have just started to implement the digital part of the plasma wave receiver system into the same chip so-called the analogue-digital mixed signal chip. In the present paper, we show our attempts in miniaturizing plasma wave receiver system and discuss plausible missions using our small plasma wave receiver system under international collaborations with the Asian and Oceanian countries.

Mission plan for ionosphere/magnetosphere observation with satellite formation flying

Jaejin Lee[1]
[1] KASI, Korea

The ionosphere/magnetosphere disturbances caused by energy deposition from solar wind appear in a variety of scale size. For example, it is known that charged particle precipitation has scale size of several tens km while aurora brightenings appeal all longitude on aurora oval and the effect to ionosphere has global scale phenomena. In order to study the ionosphere/magnetosphere storms having complex structures, multi-point observation has been required in space physics society. For this purpose, KASI (Korea Astronomy and Space Science Institute) has a plan to launch a new mission that consists of one small satellite (mother sat) of 100 kg and four Cubesats (daughter sat) of 3 kg. These four Cubesats are deployed on orbit and separated from mother sat slowly and reach 100 km distance after 1 year. The mother sat has optical instruments and new particle detector package covering wide energy range while the daughter sats have simple particle detectors and magnetometers. With this mission, we can study multi-scale structures of ionosphere/magnetosphere in low earth orbit. Now this mission is under planning phase and we submit the proposal in 2016. If this mission is accepted by Korean government, it would be launched in 2020.

Multi-cubesat mission to measure spatial structure of lunar magnetic anomalies

Khan-Hyuk Kim[1]; Seul-Min Baek[1]; Ho Jin[1]; Ian Garrick-Bethell[2]
[1] School of Space Res., Kyung Hee Univ., Korea; [2] Earth & Planet. Sci., UCSC, USA

Although it has been well known that the lunar crust is magnetized since the Apollo era, the origin and history of the Moon's magnetic field still remain an open problem in lunar science. Until now, it has been discussed whether the crustal magnetism is associated with a steady magnetic field generated by a core dynamo. To address this open problem, magnetometer data acquired from Lunar Prospector and Kaguya spacecraft have been used. Mapping of the Lunar Prospector and Kaguya magnetometer data shows isolated and clustered magnetic anomalies on the lunar surface. In order to examine the characteristics (i.e., direction and strength of the dipole moment, and depth of the source) of the magnetic anomalies, a dipole model has been applied for each of lunar magnetic anomalies. These model magnetic parameters play a significant role in determining the origin and history of lunar magnetic field. However, those values depend on models and spatial structure of magnetic anomalies obtained from a single spacecraft. Thus, the results may be problematic and lead to false conclusions. To overcome these problems, it will require various altitude measurements extending nearly down to the surface using multi-satellite observations such as a fleet of cubesats to reveal the full spatial structure of lunar magnetic anomalies. Such multi-cubesat missions will enable to answer major questions in lunar science.

Taiwanese Participation in the ERG Project

Sunny W. Y. Tam[1]; Yoichi Kazama[2]; Shiang-Yu Wang[3]; Paul Ho[3]; Tzu-Fang Chang[1]; Chih-Yu Chiang[1]
[1] Institute of Space and Plasma Sciences, National Cheng Kung University, Taiwan; [2] Institute of Astronomy and Astrophysics, Academia Sinica, Taiwan; [3] Institute of Astronomy and Astrophysics, Academia Sinica, Taiwan

The upcoming ERG (Energization and Radiation in Geospace) satellite mission is a collaboration between Japan and Taiwan, as one of the instruments aboard the Japanese satellite, the Low-Energy Electron Instrument (LEP-e), is developed by a team in Taiwan that features the joint effort by Academia Sinica and National Cheng Kung University. The mission aims to investigate the dynamics in the inner magnetosphere, including the Van Allen Radiation Belts where the existence of highly energetic particles is common, with the primary goal to understand the acceleration and loss mechanisms of such energetic particles, especially electrons with energies in the relativistic range. The satellite is part of the ERG project, which will integrate data analyses and simulations based on the satellite measurements as well as ground-based network observations. With a variety of instruments aboard the satellite to provide measurements of electromagnetic fields as well as ions and electrons of a wide range of energies, ERG has the potential to contribute to space science research beyond its primary objective. For this reason, the Taiwanese team, has continually made efforts to promote the significance of ERG to its local space science community and to collaborate with Japanese scientists in the ERG team to explore the scientific potential of the project. Past efforts, for instance, included the organization of two science workshops in Taipei, Taiwan. Hence, the contribution by the Taiwanese team to the ERG project will not only be limited to the development of the LEP-e hardware and data pipeline processing, but will also include actively participating in the study of the radiation belts and raising the interest of other space scientists in the relevant research topics. This presentation by the Taiwanese team reports its past ERG-related activities beyond the instrumentation and discusses its future plan to facilitate the use of ERG data by scientists in Taiwan for the research of the radiation belts.

ERG/LEP-e Development and Its Current Status

B.-J. Wang[1]; Yoichi Kazama[2]; Hsin-Yo Chen[3]; S.-Y. Wang[4]; Tzu-Fang Chang[5]
[1] ASIAA, Taiwan; [2] Institute of Astronomy and Astrophysics, Academia Sinica, Taiwan; [3] ASIAA; [4] ASIAA, Taiwan;
[5] Institute of Space and Plasma Sciences, National Cheng Kung University, Taiwan

The ERG (Exploration of energization and Radiation in Geospace) mission is a collaboration project between ISAS/JAXA (Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency, Japan), NCKU (National Cheng Kung University, Taiwan) and ASIAA (Academia Sinica Institute of Astronomy and Astrophysics, Taiwan). The purpose of this mission is to explore the dynamics in the inner magnetosphere of the Earth. The Taiwan team is responsible for providing a particle instrument LEP-e (Low Energy Particle, Electron analyzer) as well as processing its mission data. The LEP-e will be installed on the ERG satellite for measuring 3-D electron distribution in an energy range of 10 eV to 19 keV with a resolution of 0.09 delta-E/E The field of view is 2.86 deg x 270 deg consisting of 10 coarse channels and 12 fine channels in azimuth. The geometric factor for a coarse channel and a fine channel are 9.6 x 10^{-4} cm^2 str keV/keV and 1.5 x 10^{-4} cm^2 str keV/keV, respectively. Now the flight model of LEP-e is under calibration and test. In this presentation, we will introduce the LEP-e instrument as well as reporting its current development status.

Japan-Taiwan collaboration for the ERG project toward its scientific goal

Tomoaki Hori[1]; Yoshizumi Miyoshi[2]; Yoichi Kazama[3]; T. F. Chang[4]; C.-Y. Chiang[4]; B.-J. Wang[4]; S. W. Y. Tam[4]; S.-Y. Wang[5]; Kunihiro Keika[6]; Yukinaga Miyashita[2]; Masafumi Shoji[7]; Kanako Seki[2]; Yoshiharu Omura[8]; Yusuke Ebihara[9]; Kazushi Asamura[10]; Takeshi Takashima[11]; Iku Shinohara[12]; Masaki Fujimoto[11]
[1] STE lab., Nagoya Univ.; [2] STEL, Nagoya Univ.; [3] PSSC,NCKU; [4] PSSC, NCKU, Taiwan; [5] ASIAA, Taiwan; [6] STEL, Nagoya Univ.; [7] STEL, Nagoya Univ.; [8] RISH, Kyoto Univ.; [9] RISH, Kyoto Univ.; [10] ISAS/JAXA; [11] ISAS, JAXA; [12] ISAS/JAXA

The Exploration of energization and Radiation in Geospace (ERG) is a scientific research project to explore geospace storms with a special focus on evolution of the Earth's radiation belt in the inner magnetosphere. The project consists of three cooperative research teams: the ERG satellite team, ground network observation team, and integrated studies/simulation team. This project proceeds as international collaboration. One of the most important efforts is the collaboration between Japan and Taiwan in terms of the development of the Low-Energy Particle electron (LEPe) instrument which is going to join the other scientific instruments onboard the ERG satellite. The LEPe instrument has been developed by the Taiwan ERG team primarily consisting of Academia Sinica, Institute of Astronomy and Astrophysics (ASIAA) and National Cheng Kung University (NCKU). In addition to the hardware development, our collaboration is extended to the scientific data management as well as scientific research activities. In this regard, ERG-Science Center (ERG-SC), a joint research center operated by Institute of Space and Astronautical Science/Japan Aerospace Exploration Agency (ISAS/JAXA) and Solar-Terrestrial Environment Laboratory (STEL), Nagoya University, works in close collaboration with the Taiwan team. We have been working together on the design and development of the scientific data format, data archive, and data analysis software for the upcoming LEPe data. Further, we have held annual scientific workshops in the past few years where scientists and students from both sides joined discussion of the scientific strategies using ERG project data as well as training session for the data analysis software developed by ERG-SC. We believe that these collaboration efforts will contribute to not only achievement of successful ERG science but also to our persistent, constructive relationship between the two communities.

Science Missions and Payloads Specifications of Philippines' First Earth-Observation Microsatellite: Diwata

Kaye Kristine Vergel[1]; Benjamin Jonah Magallon[1]; Yukihiro Takahashi[1]; Tetsuro Ishida[2]; Gay Jane Perez[3]; Mark Edwin Tupas[3]; Joel Marciano[3]
[1] Cosmosciences, Hokkaido Univ.; [2] Polar Science, SOKENDAI; [3] UP Diliman

The Philippines through the Department of Science and Technology (DOST) funded the program, Development of Philippine Scientific Earth Observation Microsatellite (PHL-MICROSAT). The program aims to build, launch and effectively utilize the Philippines' first microsatellite for multi-spectral, high precision earth observation. It is a collaboration between professors, scientists and engineers from the University of the Philippines, the Advanced Science and Technology Institute of the Department of Science and Technology (DOST-ASTI), and two Japanese universities, Tohoku and Hokkaido University.

The first microsatellite, Diwata, will be launched in 2016 from the International Space Station with an expected altitude of 400 km. It is expected to pass four times a day with an average of 6 minutes per pass. Diwata features target pointing capability which will allow off-nadir acquisition of images.It will carry three scientific and one engineering payload. The High Precision Telescope (HPT) which will have a GSD of 3m at 400 km altitude is equipped with 4 CCDs for each red, green, blue and near infrared region. The HPT, due to its high resolution of 3m will be used in monitoring the extent of damages from natural disasters such as storms. Images from the HPT will be useful in disaster management and resource allocation. The Space-borne Multispectral Imager (SMI) with Liquid Crystal Tunable Filter (LCTF) which will have a GSD of 80m at 400 km and has 2 CCDs for both visible (420-700 nm) and near infrared (650-1050 nm) regions with a 13 nm interval. It will be used in monitoring changes in vegetation and estimating the phytoplankton biomass of the Philippine oceans. The Wide Field Camera (WFC) with a panchromatic CCD with a field of view of 180^{o}x134^{o}; and a GSD of 7km will be used in observing cloud patterns and distribution as well as weather disturbances such as tropical storms. And lastly the Middle Field Camera (MFC) which is an engineering payload with a colored CCD and an expected GSD of 185m will help in the calibration of the attitude determination algorithm. It will assist in locating the images captured by the HPT and SMI.

In order to know the feasibility of our mission objectives, we simulated the pass of the microsatellite over the Philippines for a specific period of time. Using this simulation, we were able to obtain the frequency of image acquisition of a target location. From our findings, Diwata will be able to provide the Philippines with robust and efficient near real-time status of the country's environment which will enhance its response to calamity and disaster management and will improve land-use and aquatic resource assessment and monitoring.