Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

HTT08-01 会場:203 時間:5 月 20 日 09:00-09:15

海洋大陸における落雷活動モニタリングのための VLF 帯空電計測
Measurement of VLF sferics to monitor activity of cloud-to-ground lightning discharges in the Maritime Continent

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Electromagnetic wave radiated from lightning discharge is called as sferics. Measurement of sferics is one of the most efficient tools to monitor global activity of lightning discharges. There are mainly two advantages to observe sferics in extremely Low Frequency (ELF: less than 3 kHz) range and Very Low Frequency (VLF: 3-30 kHz) range.

One is a radio propagation characteristic in ELF and VLF range. Attenuation rate of ELF and VLF sferics is quite low. Therefore, radio waves emitted by cloud-to-ground (CG) lightning discharges can propagate long distance. This feature allows us to monitor the activity of CGs on a regional scale or on the globe with single or few observation sites.

The other is that electrical property of individual CGcan be derived based on the observation in ELF and VLF sferics. Methodology to estimate polarities, charge moment, and peak current of CGs has been established in previous works. These techniques make it possible to evaluate not only the activity of CGs but also that of thunderstorm.

We have developed new system to measure ELF and VLF sferics and applied to the observation to monitor the lightning activity in the Maritime Continent. Waveforms of vertical electric fields and horizontal magnetic fields are obtained with vertical dipole antenna and orthogonal loop antennas, respectively. This instrument has been installed at Tainan in Taiwan (23.1^{o}N, 121.1^{o}E), Saraburi in Thailand (14.5^{o}N, 101.0^{o}E) and Pontianak in Indonesia (0.0^{o}N, 109.4^{o}E).Furthermore, we prepare to install new system in the Philippines and Vietnam.

In this presentation, we introduce the speculation of our observation system. Estimated CGs distribution in the Maritime Continent based on our VLF observation is also shown as an initial result.

キーワード: 雷放電, 空電, ELF, VLF, 海洋大陸
Keywords: lightning discharge, sferics, ELF, VLF, Maritime Continent

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HTT08-02 会場:203 時間:5 月 20 日 09:15-09:30

Lightning in Typhoons
Lightning in Typhoons

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We have recently shown that lightning observations in intense typhoons precede the maximum intensity of the storms by approximately 30 hours. In this presentation we further this study by modeling the lightning activity in typhoons using the Weather Research and Forecasting (WRF) meso-meteorological model. The WRF model successfully simulates the growth and decay of typhoons, and accurately forecasts their development, tracks and intensities. The modeled lightning scheme correctly predicts that the maximum lightning activity occurs before the maximum sustained winds of the storms, with a similar lag of 30 hours as shown in the observations. In addition, the model simulations show that the location of the maximum lightning activity migrates from the outer bands of the typhoon toward the eye during intensification, with the maximum lightning activity closest to the eye approximately 12 hours before the maximum intensity of the hurricane. It is suggested that a sharp increase in forecast lightning, and the inward migration of the lightning maximum, can serve as markers from which to gain greater confidence in predictions portending further intensification of typhoons or conversely their decay.

キーワード: lightning, typhoon, VLF, model
Keywords: lightning, typhoon, VLF, model

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HTT08-03 会場:203 時間:5 月 20 日 09:30-09:45

氷河の色の衛星観測
Color of glaciers observed from satellites

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Color of glaciers is not always blue or white. It shows variety of color, such as brown, black, red, green, and yellow. These colors are usually due to impurities in snow and ice. Mineral dust blown from desert could change the color to brown, and black carbon from fuel or biomass burning could change to black. Microbes growing on snow and ice could change the color to red, green, yellow and black. Color of glaciers is glaciologically important since change of surface color results in reduction of surface albedo and accelerating glacier melting. However, we still do not exactly know geographical distribution of color of glaciers in the world. Sattelite remote sensing could be useful for investigating the spatial distribution of impurities of snow and ice over a large area of snowfields and glaciers.
Keywords: glacier, albedo, snow algae, cryoconite

Japan Geoscience Union Meeting 2012
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HTT08-04 会場:203 時間:5 月 20 日 09:45-10:00

マイクロサテライトを利用した水色衛星観測の新しい可能性
A new potential in the Ocean Color Observation by Micro-Satellites

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Since the launch of the Coastal Zone Color Scanner (CZCS) onboard Nimbus-7 in 1978, many ocean colour sensors, mostly in sun-synchronous orbit, have been launched into space by space agencies worldwide to observe biological and biogeochemical variables in the coastal and global oceans. These ocean color missions by the space agencies tend to be independent, providing separate data sets. However, a recent activity includes a merge of the satellite data set obtained from different sensors or missions, and shows an advantage to utilize many satellites for an increased data coverage and observation frequency. To put the advantage forward in the future ocean colour missions, practical issues, such as economic cost of launching many satellites, have to be solved. Meanwhile, technologies have also been evolving to result in manufacturing low-cost and small satellites (i.e. micro-satellites). Thus, we are now in a position to move forward from the classical observation style using an independent and single satellite to a new style using multi-satellite observation. In this presentation, we propose a utilization of multiple micro-satellites in the field of ocean colour observation as an example, showing some practical applications potentially useful for Asia.

キーワード: マイクロサテライト, 海色観測
Keywords: micro satellite, ocean colour

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HTT08-05 会場:203 時間:5 月 20 日 10:00-10:15

Robust Monitoring Techniques on Large Scale Carbon Dynamics for REDD+ in Tropical Peatland-Forest
Robust Monitoring Techniques on Large Scale Carbon Dynamics for REDD+ in Tropical Peatland-Forest

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The Earth remaining tropical forests are found mainly in the peatlands and lowland of the Amazon, Central Africa, and Southeast Asia, especially in regions of Kalimantan, Sumatra, and Papua New Guinea, where rich biodiversity can still be found and large amounts of carbon are stored in peat soils (UNDP, UNEP, WB, and WRI, 2000). Indonesia, for example, has a peatland area and carbon stocks of about 20Mha and 45-55GtC respectively, and a forest area and carbon stocks of about 88Mha and 10-26GtC respectively, indicating that more than half the amount of carbon in tropical peat is stored in the peat of Indonesia (Maria Strack ed., 2008, J. Jaenicke et al., 2008, J.O. Rieley et al., 2008, H. K. Gibbs et al., 2007). It is estimated that the Indonesian peat contains between 7.5-24.2 times more carbon below-ground than above-ground.

Therefore, REDD+ is very important for storage of carbon as well as the conservation of biodiversity. To establish REDD+, an MRV system that is coupled with two components ? satellite sensing and grand tools - is urgently required. Presently, our JST-JICA Project on ”Wild Fire and Carbon Management in Peat-Forest in Indonesia” is the only project in the world to propose all aspects of MRV in tropical peatlands, enabling it to contribute significantly to biodiversity estimation.

REDD+ itself is only considerd as one of Carbon Credit Mechanisms. However as MRV for REDD+ is composed of integrated system of satellite sensing and grand tools, REDD+ and MRV system contribute to develop new scientific fields and advance forest research in various tropical forest ecosystems, including forest management and social activity research. Thus, this JST-JICA project intends finally to establish REDD+ system in tropical peatland.

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キーワード: Biodiversity, Carbon Flux Model, Grand Tools, MRV, REDD+, Satellite Sensing
Keywords: Biodiversity, Carbon Flux Model, Grand Tools, MRV, REDD+, Satellite Sensing

Japan Geoscience Union Meeting 2012
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HTT08-06 会場:203 時間:5 月 20 日 10:45-11:00

Assessment of Field and Airborne Hyperspectral to Detect Peat Forest Degradation in Central Kalimantan, Indonesia
Assessment of Field and Airborne Hyperspectral to Detect Peat Forest Degradation in Central Kalimantan, Indonesia

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Microsatellite is a new paradigm in Remote Sensing technology. Toward a new paradigm to attach the hyperspectral sensor on board microsatellite in the very new future, it need some more efforts to assess the sensors performance for operational use. Integration field, airborne or current space-based hyperspectral sensors is still important to reveal the physical and biophysical correlation with spectral reflectance for environmental issue such as peat forest degradation.

Colored Dissolved Organic Matter (CDOM) of peatland water in canal and forest canopy were measured by using ground-based spectroradiometer and HyMap sensor onboard an airplane, which ranged from 350 nm up to 2500 nm, respectively.Coinciding with the duration of airborne hyperspectral measurement, the physical and biophysical parameters such as soil moisture, underground water level, tree species, tree height, trees diameter of breast height (DBH), and crown cover were measured on the ground.

In finding the best correlation among physical and biophysical parameters with hyperspectral reflectance, waveband ranged from 350 to 2500 nm explored to find the optimal wavebands against physical, biophysical parameters and water index. Meanwhile, several indices such as Water Band Index (WBI) and Normalized Difference Water Index (NDWI) were applied from spectral transformations (obtained from selected optimal waveband) to improve sensitivity of ground water analysis. The present study is directed (1) to analyze the empirical correlation between spectral characteristic and forest degradation condition, (2) to find the appropriate indices (vegetation or water), (3) to find the correlation between forest degradation and underground water level. The initial results of study will contribute to develop a monitoring system for forest degradation, and to build a new approach to assess the carbon emission from peatland soil to the river as an optional tool of MRV to reach REDD+ monitoring target.

キーワード: remote-sensing, satellite, hyperspectral, airborne, peat forest
Keywords: remote-sensing, satellite, hyperspectral, airborne, peat forest

Japan Geoscience Union Meeting 2012
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HTT08-07 会場:203 時間:5 月 20 日 11:00-11:15

森林のリモートセンシングーハイパースペクトルデータによる葉内化学物質の推定
Remote sensing of forest condition — estimation of foliar chemical components by using hyperspectral reflectance data

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Hyperspectral remote sensing is one of the strong tools for the detection of chemical/structural characteristics of plant tissue. Although several researchers have reported the potential of multiband reflectance-based indices (*ex*. NDVI) for the monitoring of leaf phenology and productivity of forest, new monitoring method using hyperspectral reflectance data and spectroscopic analyze technique is recently spotlighted for the detection of more detail biological characteristics such as leaf thickness and leaf concentrations in photosynthetic pigments, carbohydrates and nutrients (they are generally called 'leaf traits') (Asner and Martin, 2008; Asner *et al*., 2011). In this presentation, we summarize the current studies on the remote estimation of leaf traits of forest tree species briefly, and introduce our field studies about hyperspectral remote sensing of tree leaf traits under warming environment.

In some deciduous forests in Hokkaido region, we have carried out warming experiments to study the potential effects of global warming on forests. For example, in the Tomakomai Experimental Forest of Hokkaido University, soil temperature in 5 x 5 m area around mature oak (*Quercus crispula*, approx. 20 m height) has been elevated to 5 degC above control soil temperature from 2007 by heating cables dug into the soil (Nakamura *et al*., 2010). Several parameters have been monitored such as photosynthesis, herbivory, leaf traits and phenology. We measured the reflectance of intact leaf at visible-shortwave infrared spectral region (350-2500 nm) using a portable spectrometer (FieldSpec FR, ASD) after the monitoring of herbivory in July and September of each year. Hyperspectral images at the visible-near infrared region (400-1000nm, 150bands) of the oak canopy were captured at daily interval using the spectral camera system (ImSpector V10, Specim).

In 2009, the ratio of herbivory in summer and autumn was lower in soil warmed trees than control trees significantly. The leaf concentrations of total N and lignin were reduced and the concentrations in total phenol and tannin were increased in canopy leaves by soil warming. This result suggests that the soil warmed oak tree increased chemical materials rather than structural materials to protect against herbivory. To estimate the chemical defensive materials from hyperspectral reflectance data, we tested the utility of (1) simple regression model using Normalized Difference Spectral Index (NDSI) and (2) Partial Least Square (PLS) regression model. Root mean square error of cross validation (RMSECV) was smaller in PLS model than NDSI simple regression model. When the spatial variation of phenol concentration in the canopy top leaves was predicted by calculating the PLS regression in each pixel of hyperspectral canopy images, higher phenol concentration in the warmed trees was visualized successfully. Although future studies on validity of this method are needed, our results indicate that the monitoring of hyperspectral reflectance is an useful method in estimating specific canopy leaf traits in a cool temperature forest. We believe that such methods are essential to help us understand how forest will respond to future climate conditions.

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Japan Geoscience Union Meeting 2012
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HTT08-08 会場:203 時間:5 月 20 日 11:15-11:30

アジア・オーストラリアモンスーン地域における TRMM-LIS データを用いた気候学的発雷頻度
Climatological lightning frequency over Asian-Australian monsoon region observed by TRMM-LIS

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We explored regional and seasonal variations of climatological lightning frequency over Asian-Australian monsoon region in monthly and 10-day basis by utilizing 10-year (1998-2007) product of TRMM Lightning Imaging Sensor (LIS) data and precipitation data. Several high frequency lightning regions are detected in northeastern Pakistan and northern Bangladesh, and on the Malacca Strait. The last place is a peculiar place, since most of other high frequency areas are located over the land. There are some secondary peaks in the eastern Indochina Peninsular, southern India, and northwestern Australia. Although they are, in general, located in the relatively high precipitation areas, their peak locations and period are not exactly coincide.

キーワード: 発雷, TRMM-LIS, モンスーン, プレモンスーン
Keywords: lightning, TRMM-LIS, monsoon, pre-monsoon

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

HTT08-09 会場:203 時間:5 月 20 日 11:30-11:45

小型人工衛星画像を用いた森林火災検知
Wildfire detection using imagery from small satellites

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1. はじめに

東南アジアは熱帯雨林に覆われており、森林火災による焼失も広大である。特に、エルニーニョ現象が発生すると、インドネシア付近では 8 月から 9 月の降水量が減少するため、森林火災が起きやすい状態になることが知られている。エルニーニョ現象発生時のインドネシアの森林火災は広大な面積に及び、温室効果ガスと考えられている二酸化炭素を短期間に大量に排出する。また、インドネシアの炭素固定は、京都議定書の REDD+に関連して、国際的な興味が高まっている。

一方、インドネシアでいったん森林火災が起こると、現地の消火隊は必要に応じて消火活動を行うが、消火のための機材が十分でないため、広い範囲の消火は困難である。また、インドネシアの消防隊はアメリカのように航空機などを持たないため、森林火災が起こっても、その正確な位置を十分に把握していないと思われる。

本研究では、小型人工衛星により取得する画像が、インドネシアなど東南アジアの森林火災検知に使用できる可能性について、現状の人工衛星データとの比較から検討をおこなうことを目的とする。

2. 森林火災の衛星観測の現状

森林火災の衛星観測は 1990 年代から NOAA/AVHRR を用いた検知が行われていたが、2000 年代に入り、TERRA/AQUA に搭載された MODIS による検知が主となっている。MODIS データを用いた MOD14 と呼ばれるアルゴリズムは現在世界中で使用されているが、最近では火災検知アルゴリズムの改良が進んでいる。このように、AVHRR や MODIS が森林火災の検知によく使われているのは、1 日に 1〜2 回観測できるという時間解像度の細かさによる。一方で、森林火災検知の空間解像度は約 1km と、それほど細かいわけではない。時間解像度の高さでは、MTSAT が 30 分ごとに観測できるものの、赤外画像の解像度は赤道上で約 4km と、MODIS よりも粗い。これらの衛星情報は、解像度不足のため、位置は現地に行かないと正確に把握できない。

一方で、LANDSAT7 号の ETM+センサのバンド 6 は 60m の高解像度であるが、観測周期は 16 日である。また、TERRA に搭載されている ASTER の熱赤外バンドは 5 バンドあり、90m 解像度となっているが、やはり観測周期は 16 日となっている。　これらの衛星情報は、後日の解析の際には利用できるが、リアルタイムでの消火には、時間が経ちすぎて役に立たないことがほとんどである。

森林火災を人工衛星から検知するためには、出来るだけ細かい解像度と、出来るだけ多い観測回数があることが望ましい。しかし、現実的には 200m 程度の解像度と、3 日に 1 回程度の観測周期があれば、初期消火に役立つ情報を入手できると考えている。

3. 小型衛星による森林火災観測の例

これまで、小型衛星による森林火災観測は、ドイツの BIRD によりなされたことがある。

BIRD は German Aerospace Center(DRL) によって 2001 年 10 月に打ち上げられた 94kg の小型衛星で、森林火災を見るために, 0.84-0.90 μ m , 3.4-4.2 μ m, 8.5-9.3 μ m の 3 つの波長帯を 350m 解像度で観測が可能であったが、2004 年 2 月 13 日にセンサの異常により観測を終了した。この小型衛星により、森林火災の検知ができることが実験的に示されているが、消火までの実用には使用されなかった。森林火災の検知には、主に 4 μ m が、補助的に 9 μ m が使用された。

4. 検討すべき問題点

位置の同定は可視光学センサを同じ小型衛星に搭載し、同期させることにより、昼間であれば可能となるであろう。熱赤外センサと比較して、範囲は広めにとり、解像度は細かめにとれば、森林火災の補足とすることができる。しかし、夜間は光学センサから画像を得られないことに注意が必要である。

グランドトゥルースとの比較検証は、非常に難しい。これは、東南アジアではグランドトゥルースデータがほとんどとれないこと、および、小型衛星では位置精度が十分に得られない可能性があるためである。

森林火災以外への応用としては、火山の噴火などを準リアルタイムで観測できる可能性がある。一方、都市のヒートアイランド現象の分布を見ることが出来るかもしれないが、同じ時刻にしか撮影できないことや、日変化を追えないところから、限界があると思われる。

5. 森林火災発生予測との連携

FFMC や FWI など、気象データを用いた森林火災予測がカナダで開発され、現在では東南アジアへの適用が試みられている。こうした情報と連携できれば、森林火災が発生しやすいと計算された場所で、集中的に観測できるよう衛星を制御することにより、衛星からの観測機会を増やすことが可能になるであろう。

キーワード: 森林火災, 検知, 小型衛星
Keywords: wildfire, detection, small satellite

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非冷却ボロメータカメラの地球観測衛星への適用
Application to Earth observation satellite of Uncooled micro bolometer camera

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The 50 kg class satellite that detect a radiance of forest fire of 10 um band by a micro bolometer camera at an early stage for contributing to digestive activities is developed in the UNIFORM (UNiversity International FORmation Mission). It realizes low cost, quick fabrication, and on-demand operation, and the constellation operation of 3 satellites are planned in the mission. The heritage of Akatsuki Venus climate orbiter has been applied to the developing of the micro bolometer camera in the mission, and this application to Mars, asteroid, and lunar missions are also expected. Application to Earth observation satellites and the future view of Uncooled micro bolometer camera are shown in the presentation.

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

HTT08-11 会場:203 時間:5 月 20 日 12:00-12:15

液晶波長可変フィルタを用いた先進的リモートセンシング機器とその応用
Advanced remote-sensing sensors using a liquid crystal tunable filter and their applications

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New types of remote-sensing sensors for 50-kg class macro-satellites have been developed at Hokkaido University, a member of UNIFORM and Hodoyoshi projects promoted by the Japanese government. In those sensors, a liquid crystal tunable filter (LCTF) is applied to a space borne sensor for the first time. The LCTF is a kind of optical band pass filter that electrically controls the center wavelength in the visible (420-700 nm) and near infrared (650-1050 nm). Compared to conventional multispectral sensors using a rotating filter wheel with (normally less than 20) selected spectral bands, the advanced sensor using the LCTF has the great advantage of enabling multispectral observations with hundreds of bands. The LCTF can also reduce size, weight, and power consumption of multispectral sensors. In this presentation, applications of the advanced sensor using the LCTF to Earth observations by microsatellites are introduced.

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

HTT08-12 会場:203 時間:5 月 20 日 13:45-14:00

アジアにおける超小型衛星によるリモートセンシング
Microsatellite as a new remote-sensing tool in Asia

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50-kg class micro-satellite has following great advantages compared to big satellite, namely, 1) Low cost fabrication compared to middle- or large sized satellite, namely, few M EUR including bus and mission payloads. The launch cost will be 1+ M EUR as piggyback, 2) quick fabrication: about one year for flight model, enabling application of the latest technologies, 3) Constellation flight, enabling frequent monitoring from low altitude, 4) On-demand operation, taking detail information at point of focus, according to requirement of users. Here we introduce the latest technologies for remote sensing, which will be launched onboard micro-satellites developed in universities, including high functional 5-m resolution telescopic camera, which can select any colors from 400-700 nm or 650-1050 nm at 1 nm step, and a bolometer array camera. We would suggest applications of micro-satellite and its constellation in order to monitor every subject which has dynamical variations, such as, cloud structure, hydrology including CO2 flow, lightning, vegetation, agriculture, forest fire and smoke detection, dust, atmospheric and oceanic pollution, biology in ocean, glacier, and natural disasters. Here we show a sample application to thunderstorm monitoring which may contribute to the prediction of torrential rainfall and flood, combining a ground-based lightning detection network in SE Asia operated by Asian consortium on micro-satellite, which will involve experts in various research fields, especially with them in SE Asian countries.

キーワード: 超小型衛星, マイクロサテライト, アジア, リモートセンシング
Keywords: micro-satellite, Asia, remote-sensing

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

HTT08-13 会場:203 時間:5 月 20 日 14:00-14:15

Micro satellite development in Indonesia
Micro satellite development in Indonesia

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The micro satellite development in Indonesia, which is mainly conducted at the Indonesian National Institute of Aeronautics and Space (LAPAN), has been initiated after the applications of the remote sensing data result in significant contributions in various sectors (forestry, agriculture, meteorology, hidrology, disaster management, etc.).

The polar orbiting LAPAN TUBSAT (LAPAN A1) launched in 2007 is the first experimental micro satellite (57 kg weight) as the result of join cooperation between TU Berlin and LAPAN. Its payload carries two color video cameras for aerial surveillance monitoring. The LAPAN A2 micro satellite (70 kg weight) planned to be lauched in 2012 will have the similar characteristics with the LAPAN A1 except the LAPAN A2 is in the equatorial orbit. Next, the polar orbiting LAPAN A3 micro satellite (70 kg weight) will carry the multi-spectral imager payload and be lauched in 2013. Moreover, research analyses of the spectral performa, the geometric and radiometric correction algorithms, the camera band splitter design will be also explained.

キーワード: micro-satellite, remote-sensing, Indonesia, LAPAN
Keywords: micro-satellite, remote-sensing, Indonesia, LAPAN

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

HTT08-14 会場:203 時間:5 月 20 日 14:15-14:30

ベトナムにおけるマイクロサテライトのユーザーコミュニティー
Micro-satellite User Community in Vietnam: roadmap and challenges

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Located in the eastern part of the Indochina Peninsula, Vietnam is a region with complex topography, land surface conditions, coastlines. Under such geological conditions and largely influenced by monsoon, Vietnam is prone to natural disasters, such as typhoons, floods and droughts. Annual losses from natural disasters are nearly 1.5 percent of Vietnamese GDP. Given such circumstances, it is important to take measures for disaster damage mitigation and prevention in Vietnam. Thus a dense ground-based observation network as well as reliable remote sensing data are essential.

Recently, space technology in Vietnam has been strongly being supported by Vietnamese Government. The Space Technology Insitute was established in Nov 2006. The VINASAT-1 with weight of about 2800kg was launched in 2008. The Vietnam National Satellite Center, VNSC, was established in Sep 2011. VNSC is also implementing a project funded from the Japanese ODA loans, about USD 600 million, which aims to build a modern space center by 2018. Besides, several other satellites are under preparation phase. Since the current missions/projects mainly focus on large-size satellites, it appears that micro-satellites have not been sufficiently recognized inside the research community in Vietnam. Therefore, this presentation will discuss about potential vietnamese users and propose a roadmap in order to succesfully create an effective micro-satellite user community in Vietnam.

キーワード: マイクロサテライト, ベトナム
Keywords: micro-satellite, Vietnam

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

HTT08-P01 会場:コンベンションホール 時間:5 月 20 日 14:45-15:45

雷放電活動と気候再解析データの比較
Comparing of lightning activities and climatic reanalysis parameters

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The atmospheric convection is activated by the updraft associated with the heating of the surface by solar insolation. This activity carries water vapor and heat to higher altitudes. Maritime Continent (MC) is one of the most important regions for convection and lightning activity in the world, which is related to the global climatic phenomena including El Nino, Madden-Julian oscillation (MJO) and Asian monsoon. Therefore, detail research in this area leads to better understandings of the global climate change.

Until now only a few statistical studies on the lightning activity with energy information of individual discharge have been made for global scale since there have been no lightning observation network with uniform sensitivity. GEON, Global ELF observation Network, constructed and operated by Hokkaido University, provides information including energy of individual lightning stroke which occur anywhere in the world. GEON consists of four observation sites and detects electromagnetic waves in the frequency range of 1-100 Hz, radiated from cloud-to-ground lightning discharges, with a detection threshold of 950 C-km. The estimated average error in geolocation is about 600 km.

We compared GEON data with Outgoing Longwave Radiation (OLR) as a kind of proxy of cloud amount or strength of atmospheric convection. In the initial analysis areas of MC, Western Pacific Warm Pool (WPWP) and Eastern Indian Ocean (EIO) are examined from August 2003 to July 2004. It is found based on frequency analysis that lightning activities shows ~30 day periodicity while convective activities ~40 day periodicity. And cross spectrum of these data have ~30 day periodicity. At the presentation, we will show these results.

キーワード: 雷, 海洋大陸, 気候変動, ELF, 再解析データ
Keywords: lightning, Maritime Continent, climate change, ELF, reanalysis data

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(May 20-25 2012 at Makuhari, Chiba, Japan)

HTT08-P02 会場:コンベンションホール 時間:5 月 20 日 14:45-15:45

GEON-LLS を用いた東北地方における落雷位置、電荷モーメントの推定
Estimation of Lightning stroke locations and Charge Moment Changes in Tohoku region, Japan

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雷は対流性降水の発生頻度や雲内の対流活動の程度を表す指標になりうるとして、その有効性が認識されつつある。中でも LF〜ELF 帯の電波を用いた雷放電の観測は、少数のセンサーで広範囲をカバーすることが出来るため、特に海上や山岳域においては気象レーダーに代わる新たなデータソースとして活用できる可能性がある。例えば Price and Federmesser (2006) では、TRMM のデータを用いた解析により、雷放電の頻度と対流性降水頻度との間に非常に高い正の相関（R=0.81〜0.98）があることを見出した。Price らはこの結果から、雷のデータが強雨の発生頻度を示す指標として有効であると結論した。また最近では、衛星や地上電波観測等で推定した雷放電の頻度を気象モデルに同化させることで、密な気象観測の難しい海上や多島域における降水予測の精度向上に繋げようとする試みもある（Pessi and Businger,2009）。

このように雷のデータは、気象データの不足する地域における極端気象の実態把握、ならびにその予測精度向上に対し大きく貢献できるものと期待されており、このため雷と雲の構造や、局地気象場との対応関係を把握することは応用上極めて重要であると考えられる。しかし雷と気象場の関係を調査した先行研究の多くは、主として雷放電の「頻度」にのみ着目し、個々の放電の「規模」が考慮されていない。

本稿では、東北電力 (株) が運営する落雷位置標定システム（LLS: Lightning Location System）、ならびに東北大学、北海道大学の運営する ELF 帯磁場計測による全球落雷観測ネットワーク（GEON: Global ELF Observation Network）を組み合わせることで、落雷位置（頻度）と個々の落雷の規模に相当する電荷モーメントを推定する手法について紹介する。

LLS は東北地域を中心に 9 局の IMPACT センサーを配置したネットワークであり、東北、関東とその周辺の海上を含む地域で発生した対地放電を検出する。その位置標定精度は約数 km 程度と試算されているが（Honma et al., 1998）、雷の規模に相当する電荷モーメントの導出は難しい。一方で GEON は全球に 4 点の観測サイト（女川、エスレンジ、昭和基地、サンタクルーズ）を配置したネットワークであり、雷放電で発生する電磁波のうち ELF 帯（1-100Hz）磁場水平 2 成分を測定している。GEON によって計測された雷に伴う過渡波形から、電荷モーメントの導出が可能である (Sato et al., 2008, Yamashita et al., 2011)。しかし個々の雷放電の位置を正確に決めることは難しく、到来時間差法による位置標定法を用いても全球で約 600km 程度の誤差が発生してしまう（Yamashita et al., 2011）。

本研究ではこの両者を組み合わせることにより、LLS によって正確に位置標定された個々の落雷に対し、同時刻に GEON で観測された水平磁場波形から電荷モーメントを推定するアルゴリズムを開発した。

キーワード: 雷放電, 電波観測, 気象
Keywords: Lightning, Electromagnetic wave obserbation, Meteorology