Spatial and temporal distribution of heavy rainfall during 9-10 September 2015 in East Kanto region, Japan

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East Kanto region of Japan experienced a record heavy rainfall on 09-10 September 2015, caused severe damage of life and properties. Rainfall amount of this event was recorded by Automated Meteorological Data Acquisition System (AMeDAS) rain gauges at every 10 minute time interval. The maximum 24-hrs rainfall (0600 UTC 09 Sept 2015 to 0600 UTC 10 Sept 2015) was reached about 500 mm in some part of the Tochigi prefecture. Estimated rainfall rate from Japan Meteorological Agency (JMA) C-band radar and X-band polarimetric Radar Information Network (XRAIN) are also available for the event at different scale. Spatial and temporal resolution of JMA radar data are 1000-m and 5-min and for XRAIN radar, it is 250-m and 1-min. Both estimated radar rainfall data were compared with rain gauge data to examine their performance.
Based on 24-hrs total rainfall, JMA and XRAIN radar display different rainfall distribution especially in the case of higher rain intensities. Both radar data do not show the dependency of rainfall with respect to elevation for this case. In higher rainfall zone of the event, JMA radar rainfall is overestimated. XRAIN radar reflects some underestimation especially over mountain region, but it provides close rainfall with rain gauge data in the rest part of the Kanto region. XRAIN also shows remarkable variation of rainfall with respect to time but, it is almost not possible to get such information from the JMA radar because of its coarse spatial and temporal resolution observation.

Keywords: Radar rainfall, Heavy rainfall, Spatial and temporal variation, Frequency distribution, Rain gauge

Osaka Urban Phased Array Radar and Lightning Network Experiment

Osaka Urban Phased Array Radar and Lightning Network Experiment

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Osaka University, Toshiba and the Osaka Local Government started a new project to create the Osaka Urban Demonstration Network. The main sensors of the Osaka Network are 2-node Phased Array Radar Network and Broadband Observation Network for Lightning and Thunderstorm. Data products which are created both in locally and Toshiba Computer Cloud, include single and multi-radar data, vector wind, quantitative precipitation estimation, VIL, Lightning location, nowcasting, and analysis. These new products are transferred to Osaka Local Government in operational mode and evaluated by several section in Osaka Prefecture.

キーワード：Radar、Lightning
Keywords: Radar, Lightning

Airborne campaign using LCTF multi-spectral camera in the Philippines

Airborne campaign using LCTF multi-spectral camera in the Philippines

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The airborne campaign using the Liquid Crystal Tunable Filter (LCTF) multi-spectral camera has been conducted in the Philippines on August 2015 and March 2016. In this campaign, a simultaneous ground validation using spectrometer as well as an on-site discerning of vegetation types were carried out. The main purpose of this campaign is the spectral data acquisition and validation for the Philippine Scientific Earth Observation Microsatellite (PHL-MICROSAT).
The Department of Science and Technology (DOST) and University of the Philippines-Diliman (UPD) have started an international joint program for the development of microsatellites with two Japanese universities, Hokkaido and Tohoku University. The LCTF is a light weight (80 g) and small size (30mm cube) component for spectroscopy, developed by Hokkaido University, was applied for the Spaceborne Multi-spectral Imager (SMI) mounted on the Philippines' first microsatellite, Diwata-1.
As the spectrum of vegetation includes several kinds of information such as vegetation types and growth stages, forests and agricultural crops have been studied using spectral instruments in past publications [e.g., Schmidt and Skidmore, 2003; Shibayama and Watanabe, 2007]. Besides, it is well known that such spectral information changes due to several observational factors, such as the influence of specular reflection, difference of spatial resolution and also varying weather condition at the time of acquisition [e.g., Shaw and Burke 2003; Peltoniemi et al., 2015].
In order to evaluate the LCTF spectral image, we compared the spectral data obtained by the LCTF camera with that of other sensors, and investigated the characteristic of the LCTF spectral image. In this paper, we report the latest results and discuss the relationship between these spectral data.

キーワード：超小型衛星、スペクトル計測
Keywords: Microsatellite, Spectral measurement

Impacts of extreme climate events on coastal environment: A case study from Southwest Sea in Vietnam

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Climate change related to emission of greenhouse gas from human activities is the most important environmental problem of twenty-first century. Such climate change maybe influence to marine ecosystems through extreme weather events like El Nino Southern Oscillation (ENSO), or monsoon causing damage on both fishery and aquaculture. Therefore, the relationship between climate events (such as Monsoon, ENSO) and the variation of marine environment can be used as a proxy to access the damage of climate change on marine ecosystems. However, the mechanisms linking climate events and ecosystem change depend on geographical features, and are difficult to identify due to the synergistic effects of multiple climates and stressors. To understand the response of marine ecosystem to the variation of climate events, satellite remote-sensing data, in-situ observations, and climate indices data in Southwest Sea of Vietnam are combined to examine the spatio-temporal distribution of environment factors for a long period (2002-2012). Beside that, statistical analysis was also implemented to test whether the relationship between paired factors. By combining the results with meteorological knowledge, mechanisms driving the variation of marine ecosystem in this region were explored and discussed.

Keywords: Climate Change, Remote Sensing, El Nino Southern Oscillation, Monsoon, Coastal environment

Relation between charge amounts of lightning discharges derived from ELF waveform data and severe weather
Relation between charge amounts of lightning discharges derived from ELF waveform data and severe weather

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In order to measure the lightning currents and to estimate charge amounts, induction magnetic coils named as Rogowski coils installed at tall towers are generally used. However, such Rogowski coils can measure only the lightning discharges directly hitting the towers. Recently, it is shown that the ELF magnetic field waveforms measured at the 300 km distance from the lightning is comparable to the lightning current waveforms. Therefore, the charge amounts of any lightning discharges occurring within the area where the induction magnetic fields are measured can be easily estimated from ELF waveforms by quantitatively evaluating the relation between ELF waveforms and the current waveforms. Lightning discharges usually occur within active thunderclouds, and previous studies suggested that there are close relations between lightning activities and severe meteorological phenomena. However, in these studies, only the occurrence frequencies of lightning discharges are considered to estimate such relation. As lightning is a discharge phenomenon, it is more important to investigate the relation between electrical properties of lightning discharges, such as polarities, peak currents, and charge amounts, and the meteorological parameters of the severe weather.
In this study, the lightning current waveforms measured by a Rogowski coil installed at Mt. Ogami and ELF waveforms measured at Onagawa observatory are analyzed as a first step. To validate the similarity between current waveforms and ELF waveforms, we investigated the correlation of these two waveforms. Then, the average correlation coefficient and standard deviation are estimated to be $r=-0.84$ and $\sigma=0.14$, respectively. This result indicates that there are high similarities between these two waveforms. From these quantitative analyses, empirical equations that enable us to directly convert from the magnetic field intensities into the charge amounts were obtained.
As a next step, using ELF waveform data obtained at Kuju station in Kyushu and lightning data of the Japan Lightning Detection Network (JLDN), charge amounts for the lightning discharges occurring when down bursts were confirmed in the Kanto Plain are estimated by applying the empirical equations. Then, we newly found a clear characteristics showing that the time variation of charge amounts was drastically changed just before the downburst onset. At the presentation, we will show the results in one down burst event more in detail, and we will also show the statistical results for other downburst events.

キーワード：雷
Keywords: lightning

シビア気象の規模発達直前予測を目指すアジア域での雷放電励起ELF波動観測計画
Future Observations of Lightning-exciting ELF Waves in Asian Region for the Nowcasting of Severe Weather Development

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We analyzed the characteristics of the electromagnetic waves in the ELF range measured near the lightning discharges (~300 km distance) and compared them to the lightning current waveform measured by Rogowski coils. From these data analyses, it is found that the shape of the ELF magnetic field waveforms is highly correlated with that of the lightning current waveform, which implies that the measured ELF magnetic field is not the radiative magnetic field but the induction magnetic field. By appropriately scaling the ELF magnetic field waveform and by integrating the waveform, we can estimate the lightning current waveform and the charge amount of any lightning discharges occurring within ~1000 km range from the observation site. Recently, it is shown that the charge amount of the lighting discharges derived from the ELF waveform data and its temporal variation may become a good proxy to nowcast severe weather development [*Shimizu et al.*, 2015; presented at this meeting]. The estimation of the lightning charge amount is also useful to evaluate the damage on the urban information and communication technology (ICT) systems caused by lightning discharges. From these reasons, we have installed ELF observation system at two observation sites in Japan. In Asian region, the VLF observation system (AVON) was already installed to continuously monitor the lightning activities. However, the ELF observation system has not been installed in Asian region, yet. At the presentation, the importance of the measurements of the ELF magnetic field waveforms will be presented. In addition, the future plan of the ELF magnetic field waveform measurements in Asian region will be discussed.

キーワード：雷放電、ELF波動、シビア気象、直前予測
Keywords: lightning, ELF waves, severe weather, nowcasting

CP-SAR onboard Microsatellite for Global Land Deformation Observation

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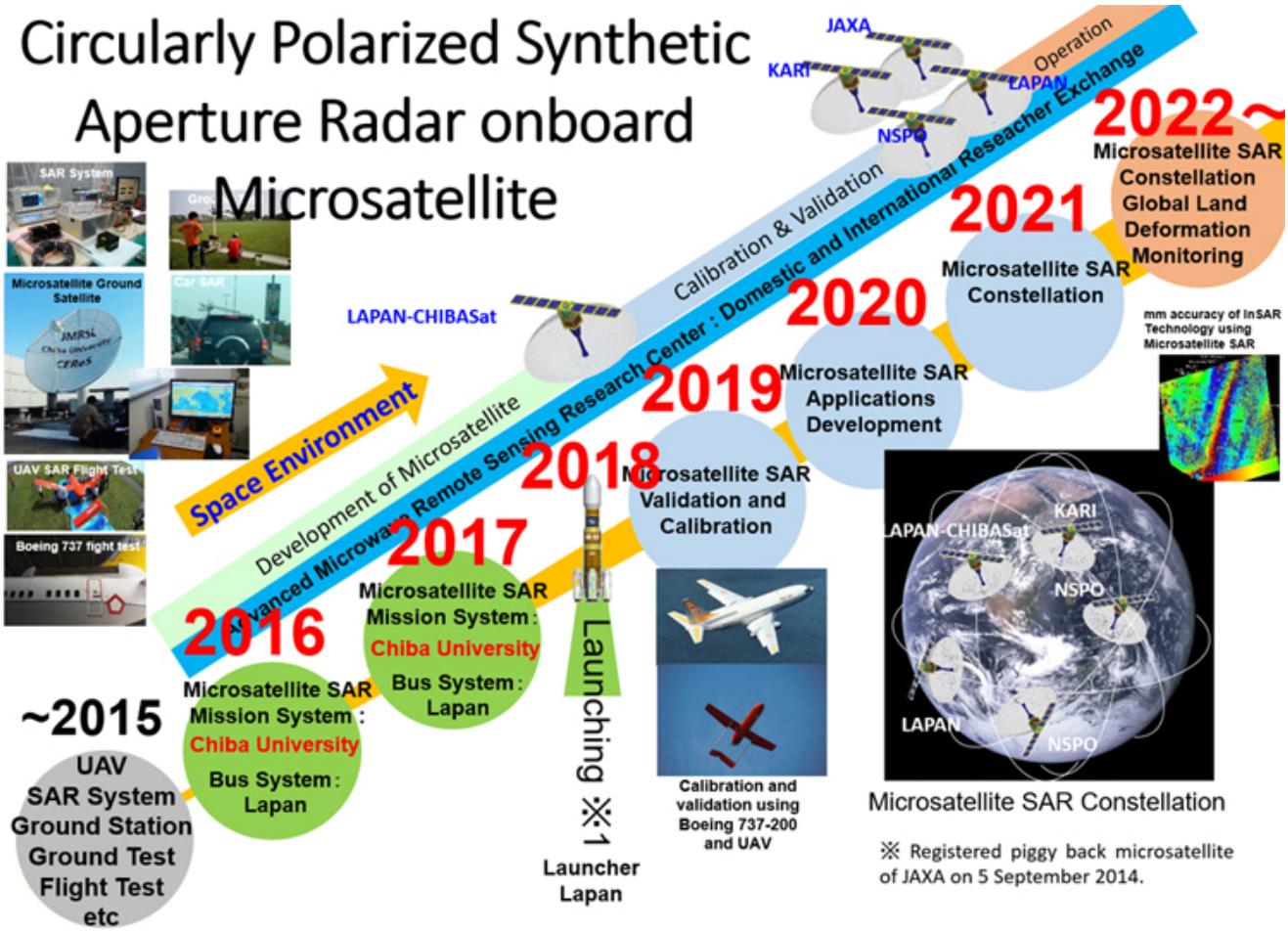
Chiba University and Indonesian National Institute of Aeronautics and Space (Lapan) are collaborating to develop Circularly Polarized Synthetic Aperture Radar (CP-SAR) onboard microsatellite (150 kg class) for global land deformation monitoring. This paper explains the progress report of development of CP-SAR sensors (L, C and X bands) for flight tests using unmanned aerial vehicle (UAV) and Boeing 737-200 as microsatellite prelaunch experiments, including anechoic chamber experiment for full polarization of CP-SAR scattering. This paper also introduces application developments of SAR images using InSAR, DInSAR and PS-InSAR techniques for high precision land deformation observation to monitor and predict natural disasters.

Keywords: CP-SAR, microsatellite, land deformation, InSAR, disaster



災害監視に最適な超小型衛星コンステレーションに関する研究
Optimum micro-satellite constellation for disaster monitoring

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Artificial satellites are generally categorized according to weight: pico-satellites (<1 kg), nano-satellites (1-10 kg), micro-satellites (10-100 kg), mini-satellites (100-1000 kg), and large satellites (>1000 kg). Among the above categories, micro-satellites have made the most remarkable progress over the past few years, and a few hundred of universities, institutes, and companies have launched their own micro-satellites into space. A significant feature of recent micro-satellites is that their missions are getting closer to practical applications of remote-sensing data, such as disaster monitoring. However, due to limitations of spatial resolution and data rate, a single micro-satellite cannot cover a large area in the same way as a larger satellite covers the Earth's surface globally and periodically. In addition, designed life time of micro-satellites is not so long compared with larger satellites. Therefore, a constellation of microsatellites is essentially important, especially for disaster monitoring application that requires rapid response to the specific disaster area. This paper reviews previous satellite constellations for disaster monitoring and discusses a micro-satellite constellation optimized for disaster monitoring.

キーワード：超小型衛星コンステレーション、災害監視
Keywords: micro-satellite constellation, disaster monitoring

Diwata, the Philippines first earth-observation microsatellite
Diwata, the Philippines first earth-observation microsatellite

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Diwata, the Philippines first earth-observation microsatellite
The Philippines, a country in the southeast asia, is vulnerable to a lot of natural hazards. It is located in the pacific ring of fire making it susceptible to earthquakes and volcanic activities. Due to its location, the country also experiences a lot of tropical storms. In a year, on average, about eighteen to nineteen typhoons enter the Philippine area of responsibility. Aside from the large volume of rainfall that these typhoon carry, it also bring strong winds. According to the Philippines' Climate Change Commission, from 1990 to 2006, the annual average damage of typhoons to the agricultural sector alone amounted to 184 million USD. Driven by these hazards, the Philippine government is continuously investing in different technologies that will help in disaster mitigation and management. One of these project is the program, *"Development of Philippine Earth Observation Microsatellite (PHL-MICROSAT)"*, funded through the Department of Science and Technology (DOST) which aims to build, launch and effectively utilize the Philippines' first microsatellite for earth-observation.
PHL-MICROSAT is a collaboration between scientists, engineers and professors from the University of the Philippines, the Advanced Science and Technology Institute (ASTI) of the DOST and two Japanese universities, Hokkaido and Tohoku University. Under the program, the Philippine will launch two microsatellites. The first one, named Diwata, will be released from the International Space Station, in the first quarter of 2016. Onboard Diwata are three scientific and one engineering payload. The High Precision Telescope (HPT) which will have a GSD of 3 m 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 3 m 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 65 m at 400 km and has 2 CCDs for both visible (433-740 nm) and near infrared (730-1020 nm) regions with a 1 nm step 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 will have a field of view of 180x134 degrees and a GSD of 7 km will be used in observing cloud patterns 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 185 m 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, 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.

キーワード：Microsatellite、Natural disaster
Keywords: Microsatellite, Natural disaster

Micro-Dragon, the microsatellite for observing ocean environment in Vietnam

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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.
Mission of MicroDragon is ocean color observation over Vietnam Ocean to provide data for assessing water data by using two imagers being composed of Space-borne multispectral Imager and Triple Polarization Imager onboard and Fluoro probes in the sea for the missions. Micro-Dragon is Sun-synchronous orbit satellite integrated Attitude determination and control system (ADCS) that is able to receive ocean color data over Vietnam Ocean many times per day. Therefore, one of its applications will be a response system to quickly cope with harmful algae (e.g. red tides and harmful algal blooms) over Vietnam Ocean that has damaged human and marine ecosystems. By using the space-borne ocean color observation system and the marine sensor, networks which can detects ocean anomalies in-real time and disaster information. The system are suitable for capturing subtle changes and detect anomalies in ocean environments in real-time. The end of 2017, the development of MicroDragon will be finished. By now, the project is heading to Critical Design Review in September 2016 after three years implementation since 2013.

Keywords: microsatellite, ocean environment, red tides, harmful algal blooms, ocean hazard

Preliminary Analysis on Rising 2 images' spectral information and its potential for disaster monitoring and prediction

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Importance of disaster monitoring, prediction and mitigation has increased in the past years mainly due to climate change. Based from the Inter-governmental Panel on Climate Change-Fifth Assessment Report (IPCC-AR 5), regions in West, East and South-East Asia will experience an increased in mean annual temperature and precipitation will likely be more extreme in mid- and late- 21st century. The increase on the occurrence of severe typhoons and droughts will be observed in the said regions. In-order to cope up and adapt with the problems brought by Climate change, remote sensing with the use of micro-satellite as a platform has become an indispensable tool. Satellite remote sensing can cover a very large area and produce detailed image of the land and can repeatedly observe the area in a short period of time.
One of the most recent earth-observation microsatellite is Rising-2, which was launched last May 24, 2014. It is equipped with 5 scientific payloads: High Precision Telescope (HPT) with 5m spatial resolution at nadir and has four (4) CCD detector, for Red, Green and Blue region and the fourth CCD has Liquid Crystal Tunable Filter (LCTF) for 650 to 1000 nm spectral range; Bolometer (BOL) with 1km spatial resolution and spectral range of 8 to 14 μm; Lightning Spectrum Imager-1 (LSI-1) and Lightning Spectrum Imager-2 (LSI-2) with a field of view of 342 km and a spectral range of 744 to 826 nm and 762 nm respectively; Wide Field Camera (WFC) with a field of view of 140 degrees.
In this study, six (6) images captured in Japan observed at 665 nm, 683 nm, 700 nm, 720 nm, 750 nm and 873 nm wavelengths using Rising-2's High Precision Telescope were acquired and analysed. Image matching and geo-referencing were done to get the overlap and spatial resolution of the 6 images. Spectral information then is acquired by using calibration parameters for the HPT. From the spectral information, land cover and condition of the vegetation were then classified by using different indices like NDVI and NDWI. Preliminary results show that spectral analysis has a very huge potential for disaster monitoring, prediction and mitigation.

Keywords: Remote Sensing, Microsatellite, Disaster monitoring

地上雷放電観測網及び超小型衛星を用いたアジアにおける極端気象の監視と予測
Monitoring and prediction of extreme weather using lightning detection network and micro-satellites in Asia

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Thunderstorm causes torrential rainfall and is the energy source of typhoon. In these decades it has been revealed that lightning discharge is a very good proxy of thunderstorm activity. We have constructed the most advanced lightning detection network using VLF radio wave in Southeast Asia, AVON. On the other hand, some developing countries in SE-Asia are going to own few micro-satellites dedicated to meteorological remote-sensing in several years as well as Japan. Making use of the lightning activity data measured by the ground-based VLF network, and information on the extent and 3-D structures of thunderclouds observed by the on-demand operation of remote-sensing micro-satellites, we will get a new way to obtain very detail semi-real time information that cannot be achieved only with existing observation methods, such as meteorological radar or surface meteorological data acquisition system. Based on those measures, we will establish the methodology to grasp the development of thunderstorms occurring in whole area of Southeast Asia and to predict their near future activities as well as typhoon intensity.

キーワード：雷放電、超小型衛星、極端気象、予測、監視、アジア
Keywords: lightning, micro-satellite, extreme weather, prediction, monitoering, Asia

