Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

ACG39-01 Room:301A Time:May 19 16:15-16:30

Long-term continuous observation of global water cycle by AMSR series

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In monitoring global environment and climate from space, the highest priority has been given to the continuity, frequency, and uniformity of the data records. These are also important to make satellite Earth observation an infrastructure in the society. The Global Change Observation Mission (GCOM) is designed to satisfy those needs. GCOM is a concept to perform global Earth observation from many perspectives, comprising of two polar-orbiting satellite series and spreading over three generations to achieve long-term and consistent data records. Two satellite series are GCOM-W (Water) and GCOM-C (Climate). The GCOM 1st ? Water (GCOM-W1) is the first satellite of the series and launched on May 18, 2012. The sole mission instrument on the satellite is the Advanced Microwave Scanning Radiometer-2 (AMSR2), which is a multi-frequency passive microwave radiometer system and serves as the major instrument to cover water-related geophysical parameters in the GCOM mission. AMSR2 is a successor instrument to the AMSR for the Earth Observing Systems (AMSR-E) and AMSR on the Advanced Earth Observing Satellite-II (ADEOS-II). Microwave radiometers have been playing an important role in measuring global water and energy cycles. Based on the accumulation of data records such as by the Scanning Multichannel Microwave Radiometer (SMMR) and the Special Sensor Microwave/Imager (SSM/I), the AMSR series made a significant progress in spatial resolution and frequency range. Although the characteristics of AMSR2 is similar to AMSR-E, the instrument had improved and enhanced in several important aspects such as calibration accuracy, spatial resolution, and reliability of instrument, as the latest instrument of the AMSR series. In addition to the basic product of brightness temperatures (Tbs), various water-related geophysical products are generated from Tbs obtained by AMSR2. They include integrated water vapor (total precipitable water), integrated cloud liquid water, precipitation, sea surface temperature, sea surface wind speed, sea ice concentration, soil moisture content, and snow depth. These products, as well as many geophysical parameters from the A-Train constellation and GCOM-C1, are expected to be utilized in many research areas covering water cycle and climate variability, and operational applications such as numerical weather forecast, drought monitoring, and fishery.

Keywords: satellite, remote sensing, water cycle, microwave radiometer

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ACG39-02 Room:301A Time:May 19 16:30-16:45

Observation of atmosphere-ocean interactions by AMSR2 on GCOM-W1

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The GCOM-W mission aims to establish the global and long-term observation system to collect data, which are needed to understand mechanisms of climate and water cycle variations, and demonstrate its utilization. We plan to obtain continuous and calibrated data over a period of 15 years with three GCOM-W satellites. The first generation of the GCOM-W satellite, GCOM-W1, was launched in May 2012. The GCOM-W1 satellite carries a multi-frequency, multi-polarization microwave radiometer, AMSR2, which continues Aqua/AMSR-E observations of integrated water vapor, cloud liquid water, precipitation, sea surface temperature, sea surface wind speed, sea ice concentration, snow depth, and soil moisture. In this paper, we will report validation of the sea surface temperature and wind speed observed by AMSR2 on GCOM-W1. Also we will discuss utilizations of the data from AMSR2 for studies of air-sea interactions and possibility of application to practical purposes.

Keywords: Remote sensing, Air-sea interaction, Atomosphere-ocean interaction, Microwave radimometer, GCOM-W1, AMSR2

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Sea ice algorithm improvement for AMSR2

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In recent years, the decline trend of the Arctic sea ice extent is becoming obvious. In May 2012, passive microwave sensor AMSR2 on-board satellite GCOM-W1 was launched by JAXA. On 16, September, 2012, AMSR2 recorded the minimum Arctic sea ice extent in the history of satellite observation. The passive microwave sensor on-board satellite can penetrate clouds and can monitor the global sea ice extent on daily basis. The authors have been working on sea ice monitoring from space, and now involved in improving sea ice algorithms for ASR2. The initial result of the study is presented at the conference.

Keywords: sea ice concentration, Sea of Okhotsk, GCOM-W1, remote sensing

Japan Geoscience Union Meeting 2013
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ACG39-04 Room:301A Time:May 19 17:00-17:15

Scientific progresses from 15 years observation of TRMM and expectations to the GPM

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Tropical Rainfall Measuring Mission (TRMM) satellite, which was launched in November 1997, is a unique satellite equipped with a space-borne precipitation radar (PR). TRMM satellite has continued observation of precipitation from space for more than 15 years and has accumulated valuable data. Even one of the very early images obtained from TRMM PR surprised scientists with a discovery of precipitating particles at the level as high as 18km from the earth surface.

The primary advantage of the TRMM observation is its 3-dimensional measurements of precipitation with TRMM PR. Besides, its sun-unsynchronous orbit observation, multi-sensors (PR, TMI, VIRS, LIS, and CERES), as well as accumulation of 15 years continuous observation data provide us with very precious scientific data. They enabled us not only to improve the accuracy of precipitation estimates in the tropics and subtropics, but also to characterize the precipitation from region to region, thus revealed the mechanism and its variations of meteorological state associated with various types of precipitation. In such manner, 15 years of observation with TRMM brought us unprecedented opportunity for the progress of precipitation sciences.

On the other hand, TRMM data availability enabled us to estimate the diabatic heating of the atmosphere with moist convection, which is important to understand the large-scale circulation of the atmosphere on earth, and to evaluate the climate models. It is also utilized aiming to contribute to the infrastructure of flood alert systems as a flying precipitation gauge.

In this paper, we review the scientific achievements in Japan with TRMM, and discuss our expectations to the upcoming Global Precipitation Measurement (GPM) Mission; GPM will cover 65N-65S, with its primary satellite equipped with Dual-frequency Precipitation Radar (DPR), associated with a constellation of satellites equipped with Microwave Imagers to cover the globe in 3hourly temporal resolutions.

Acknowledgments: Scientific results reviewed in this paper are provided from members of the JAXA PMM Science Team, and are gratefully appreciated by the author.

Keywords: TRMM, GPM, Precipitation Radar, Precipiation Characteristics, Dual-frequency Precipitation Radar

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ACG39-05 Room:301A Time:May 19 17:15-17:30

A developing precipitation retrieval algorithm for the GPM/DPR and the TRMM/PR

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The core satellite of the Global Precipitation Measurement (GPM) mission, which is scheduled to be launched in 2014, will carry the Dual-frequency Precipitation Radar (DPR). DPR is a successor of the single-frequency Precipitation Radar (PR) currently working on the Tropical Rainfall Measuring Mission (TRMM) satellite.

Precipitation radar measurement depends on drop size distribution (DSD) rather than precipitation rates. Generally, DSD is assumed to follow an exponential or a Gamma distribution with two unknown parameters. Here, DSD can be represented on a 2-dimensional plane. For a single-frequency radar measurement, as two parameters cannot be determined, an empirical power law between radar reflectivity factor Z and rain rate R (Z-R relationship) is used. Assuming Z-R relationship is equivalent to constraining DSD on a 1-dimenisonal curve. In the standard algorithm of PR, an empirical power law between specific attenuation k and Z (k-Z relationship) is given to correct attenuation (Hitschfeld-Bordan method; HB method). Assuming k-Z relationship is also equivalent to constraining DSD on another 1-dimensional curve. Fortunately, space-borne or air-borne radars such as PR can measure surface backscattering cross section and surface reference technique (SRT) is applied to estimate path integrated attenuation (PIA). By referring to PIA estimates, k-Z relationship can be adjusted. However, the adjustment depends on the accuracy of SRT, and is applied simultaneously for all range bins. Therefore, DSD cannot have 2-dimensional degrees of freedom. The accuracy of DSD estimation by PR depends on not only the accuracy of Z but the accuracy of constraints such as k-Z relationship.

In a developing algorithm for DPR, k-Z relation is assumed and the HB method is applied for each frequency. Once attenuation-corrected radar reflectivity factor Ze is given at both frequencies, the dual-frequency ratio (DFR) of Ze's is calculated, and DSD parameters are retrieved easily from the DFR (DFR method). However, the retrieved DSD generally does not agree with assumed k-Z relations. Then, k-Z relations are adjusted to fit the DSD. The HB method and DFR method can be applied again by using the adjusted k-Z relations. By iterating a combination of the HB method and the DFR method, k-Z relations are improved. This is termed HB-DFR method (Seto et al. 2013). Though k-Z relations are adjusted simultaneously for all range bins using SRT method, this method can adjust k-Z relation at a range bin independently of other range bins. Therefore, in this method, DSD is represented on a 2-dimensinal plane.

This method has no big differences from other dual-frequency retrieval methods in terms of the performance for dual-frequency measurement. But, this method can be smoothly applied to single-frequency measurement or the case that some range bins lack either of dual-frequency measurements, just by setting that DFR method and adjustment of k-Z relation are not applied for range bins without dual-frequency measurements. By the DPR, dual-frequency measurements are limited to inner swath of normal scans. In outer swath and in interleaved scans, single-frequency measurement by KuPR or KaPR is available. To have seamless 2-dimensional estimates of precipitation, this method is suitable. In the future, the DPR algorithm is applied to the PR measurements to produce long-term dataset with temporally constant quality.

Keywords: precipitation, radar, DSD, GPM, TRMM, DPR

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ACG39-06 Room:301A Time:May 19 17:30-17:45

NEW GSMAP MICROWAVE IMAGER OVER-LAND PRECIPITATION RETRIEVAL ALGORITHM

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1. Introduction

We have been developing precipitation retrieval algorithms for Microwave Imagers (MWI) under the Global Satellite Mapping of Precipitation (GSMaP) project to monitor global precipitation distribution. These algorithms have been adopted as Japan Aerospace Exploration Agency (JAXA) near-realtime precipitation retrieval system (http://sharaku.eorc.jaxa.jp/GSMaP/index.htm).

The basic idea of the MWI precipitation retrieval algorithm is to find surface precipitation rate that gives forward-calculated brightness temperatures (TBs) best-fit with the observed TBs. The conventional over-land precipitation retrieval algorithm (Aonashi et al. 2009) generally tends to underestimate Precipitation Radar (PR) surface rain (Rainsurf).

The objective of the present study is to develop new MWI over-land precipitation algorithm that alleviates the above retrieval bias. For this purpose, we derived the indices from MWI TBs that affected the relation between MWI TBs and the surface precipitation, using TRMM MWI (TMI) and PR data sets. Then, we corrected the forward calculation part of the algorithm with these indices.

We validated the performance of the new algorithm using TRMM data sets for 2004.

2. The conventional over-land algorithm

The conventional over-land algorithm for TMI consists of the forward calculation part and the retrieval part. In the forward calculation part , we derive look-up tables (LUTs) between high-frequency (37 and 85 GHz) polarization-corrected brightness temperature (PCT) depressions and the surface precipitation using the radiative transfer model (RTM) (Liu, 1998). The retrieval part finds surface precipitation rates that give forward-calculated PCT at 37 GHz (PCT37) and 85 GHz (PCT85) best fit with the TMI TBs.

3. The new over-land algorithm

We derived the indices from MWI TBs that affected the relation between MWI TBs and the surface precipitation. Then, we corrected the forward calculation part of the algorithm with these indices.

For this purpose, first, we performed forward calculation experiments to examine the dependency of PCT depressions to the variations in the precipitation-related variables. The results showed that PCT37 depression was sensitive to freezing level height (FLH) and depth of frozen precipitation (DFP) while it had little sensitivity against other frozen precipitation properties. It was also found that PCT85 was much sensitive to the DFP and other frozen precipitation properties than PCT37.

As the MWI index for DFP, we introduced the ratio of PCT85 depressions to PCT37 depressions (R8537) as the index of the frozen precipitation depth. We expressed R8537 in terms of ratio of precipitation retrieved from PCT85 depression (rain85) to those from PCT37 (rain37) using the conventional over-land algorithm. We also employed PCT37 in no rain areas (PCT37nr) for the indirect index of FLH, since PCT37nr can be regarded as a function of surface temperature.

Then, we checked the PCT depressions to the above MWI indices by comparing TMI retrievals and PR Rainsurf for 1998, for various R8537 and PCT37nr classes. The results show:

1) Relationship between Rain85 and Rainsurf is very sensitive to R8537.

2) Relationship between Rain37 and Rainsurf mainly depends on PCT37nr. Rain37 underestimates Rainsurf for low PCT37nr cases

Then, we derived linear fitting coefficients between Rain37, Rain85 and Rainsurf for each R8537 and PCT37nr class for 1998. The new algorithm used these fitting coefficients for the statistical correction of the LUTs.

4. Validation results

We validated the performance of the new algorithm using TRMM TMI and PR data sets over land for 2004. The results indicate that the new algorithm with statistical LUT correction using R8537 and PCT37nr alleviated negative bias of the TMI precipitation retrievals compared to the conventional algorithm. The new algorithm also reduced the zonal mean retrieval differences between the over-land TMI retrievals and PR Rainsurf.

Keywords: GSMaP, Microwave Imager, Precipitation retrieval, TRMM, GCOMW1, AMSR2

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ACG39-07 Room:301A Time:May 19 17:45-18:00

Performance of the GSMaP data over Vietnam and a case study of its correction by using artificial neutral networks

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The performance of the Global Satellite Mapping of Precipitation data (GSMaP - MVK version 5.222.1) is examined by comparing with the rainfall gauged at 57 meteorological stations of Vietnam and the gridded Asian Precipitation - Highly-Resolved Observational Data Integration Towards Evaluation of Water Resources data (APHRODITE - V1003R1). Results show that correlation coefficients between GSMaP and rain-gauge observations for the period of 2001-2007 are commonly in the [-0.3,0.6] range, which are significantly lower compared to the [0.7,0.99] range of the APHRODITE data. The lowest correlated regions for GSMaP are located mainly in the coastal zone of Central Vietnam. An EOF analysis of the datasets shows that GSMaP well represents the first two principal rainfall regimes for Vietnam consisting of the May-October regime in North Vietnam and in the west side of the TruongSon mountain range; and the September-November rainfall regime in Central Vietnam. The first and the second eigenmodes of GSMaP respectively explained 83.95% and 11.12% of rainfall variances, which are in good agreement with APHRODITE. Both GSMaP and APHRODITE show topographic effects, which result in more precipitation in the windward side of the TruongSon mountain range during both summer and winter monsoon seasons. However, GSMaP largely underestimates the topographic effects on winter monsoon rainfall, particularly in the coastal zone of Central Vietnam. A case study of GSMaP correction by using artificial neutral networks (ANN) is implemented over the ThuBon-VuGia basin in Central Vietnam. Validation results through spatial correlation, amplitude and Nash?Sutcliffe efficiency coefficient show that the ANN correction method significantly improves the GSMaP rainfall quality over the basin for both the dependent and independent periods of 2001-2005 and 2006-2007, respectively.

Keywords: GSMaP, satellite rainfall, artificial neutral network, winter monsoon

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ACG39-08 Room:301A Time:May 20 09:00-09:15

LAND VALIDATION for GCOM-C1/SGLI (VNR) using UAV

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Japan Aerospace Exploration Agency (JAXA) is going to launch new Earth observation satellite GCOM-C1 in near future. The core sensor of GCOM-C1, Second Generation Global Imager (SGLI) has a set of along track slant viewing Visible and Near Infrared Radiometer (VNR). These multi-angular views aim to detect the structural information from vegetation canopy, especially forest canopy, for estimating productivity of the vegetation. SGLI Land science team has been developing the algorithm for above ground biomass, canopy roughness index, shadow index, etc.

In this paper, we introduce the ground observation method developed by using Unmanned Aerial Vehicle (UAV) in order to contribute the algorithm development and its validation. Mainly, multi-angular spectral observation method and simple BRF model have been developed for estimating slant view response of forest canopy. The BRF model developed by using multi-angular measurement has been able to obtain structural information from vegetation canopy. In addition, we have conducted some observation campaigns on typical forest in Japan in collaboration with other science team experienced with vegetation phenology and carbon flux measurement. Primary results of these observations are also be demonstrated.

Keywords: UAV, Second Generation Global Imager (SGLI), Multi-angular observation, Forest canopy, Vegetation productivity

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ACG39-09 Room:301A Time:May 20 09:15-09:30

GCOM-C1 ocean product development

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Global Change Observation Mission for Climate (GCOM-C) is planned to be launched in FY2015. JAXA is designing, developing, and characterizing the satellite and sensor intensively in these years. Data product development has been conducted by JAXA and GCOM-C Principal Investigators (PIs) which has been organized in summer 2009 as the first research period (2009-2012). The first version of the algorithms are being examined by using in-situ data and simulation L1B data (HDF5 format) in EORC. The next research period will start from April 2013 (until March 2016), and it will more focus on development of the standard algorithm (operational processing codes) and validation preparation for the first version of the standard products which will be released to the public one year after the launch.

The GCOM-C1 standard ocean products includes sea-surface temperature, ocean color (normalized water-leaving radiance, chlorophyll-a concentration, suspended solid concentration, colored dissolved organic matter absorption, and photosynthetically available radiation). In addition to the above, we defined the research products, inherent optical properties, euphotic zone depth, net primary productivity, phytoplankton functional type, and redtide detection.

SGLI has 250m spatial resolution with 1050-km swath, which is expected to improve the coastal monitoring. Although the offshore ocean-color products show good accuracy showing seasonal and interannual changes properly, we still have some problems about the ocean color retrievals in the coastal area where the water has complex composition and the atmosphere is affected by the terrestrial aerosols.

We have started characterization study of coastal in-water optical properties (spectral absorption and back scattering) and aerosol characteristics in some coasts mainly around Japan, e.g, Mutsu, Tokyo, and Ariake Bays and so on. The obtained optical properties will be analysed by a consistent way, and the characterization results will be used in the satellite data retrievals (atmospheric correction and inversion of in-water optical properties) in each area. The analysis needs to make measurements in the variety of (typical) coastal areas. The observations will be conducted in collaboration with our GCOM-C1 science team, other collaborative research organizations, and international partners.

Keywords: GCOM-C, SGLI, ocean color, satellite

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ACG39-10 Room:301A Time:May 20 09:30-09:45

Global snow and ice cover observations using GCOM-C1/SGLI

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The ”Global Change Observation Mission-Climate” (GCOM-C) is a project of Japan Aerospace Exploration Agency (JAXA) for the global and long-term observation of the Earth environment. The GCOM-C is a part of the JAXA’s GCOM mission which consists of two satellite series, GCOM-C and GCOM-W (Water), spanning three generations in order to perform uniform and stable global observations for 13 years. The first generation of GCOM-C (GCOM-C1) carries a multi-spectral optical radiometer named Second Generation Global Imager (SGLI), which will have special features of wide spectral coverage from 380 nm to 12 micrometer, a high spatial resolution of 250m, a field of view exceeding 1000km, two-direction simultaneous observation, and polarization observation. The GCOM-C mission aims to improve our knowledge on the global carbon cycle and radiation budget through high-accuracy observation of global vegetation, ocean color, temperature, cloud, aerosol, and snow and ice. As for the cryosphere observation, not only snow and ice cover extent but also snow physical parameters are retrieved from SGLI data such as snow grain sizes at shallow layers, temperature, and mass fraction of impurity mixed in snow layer and so on. These snow physical parameters are important factors that determine spectral albedo and radiation budget at the snow surface. Thus it is essential to monitor those parameters from space in order to better understand snow metamorphosis and melting process and also to study the response of snow and sea-ice cover extent in the Polar Regions to a climate forcing such as global warming. This presentation will summarize the SGLI cryospheric products and validation plans.

Keywords: Snow Cover, Snow Grain Size, Snow Impurity, Surface Temperature, Remote Sensing, GCOM

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ACG39-11 Room:301A Time:May 20 09:45-10:00

Expectations for the GCOMC satellite mission on long-term climate observation and clouds science study

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Clouds are key observation target for calculating earth energy budget and climate change study. Satellite remote sensing can observe the earth surface and the atmosphere with wide range and frequently, it is an efficient way for monitoring change of cloud properties and cloud spatial distributions. The Global Change Observation Mission (GCOMC)/Second Generation Global Imager (SGLI) is an passive optical radiometer for monitoring climate change, which is scheduled to launch in around 2014 by the Japan Aerospace eXploration Agency (JAXA).

The GCOM-C mission measures essential geophysical parameters on the Earth surface and in the atmosphere to facilitate understanding of the global radiation budget. There are 19 channels, including two polarized VNR channels in SGLI. The SGLI sensor is an optical sensor capable of multi-channel observation at wavelengths from near-UV to thermal infrared. The SGLI consists of two radiometer instruments, the Visible and Near Infrared Radiometer (VNR) and the Infrared Scanner (IRS). SGLI-VNR is capable of observing polarized, non-polarized radiance and multi-angle scanning. Sensor characteristics of polarized and multi-angle scanning are very important for determining the ice cloud shapes and aerosol studies. In the GCOMC satellite mission, cloud properties such as the cloud optical thickness, the effective particle radii, and the cloud top temperature will be retrieved from SGLI-VNR data. The International Satellite Cloud Climatology Project (ISCCP) cloud product will be produce and cloud inhomogeneity of the warm water cloud will be discussed. This is one of the new sciences of the GCOM-C satellite mission in terms of cloud sciences. Furthermore, ice crystal scattering database will be developed for ice cloud remote sensing.

Long-term cloud remote sensing data is important on improving the accuracy of the climate model and climate change study. There was a 40 year time-series cloud remote sensing data observed by the satellite instruments such as NOAA/AVHRR, Terra-Aqua/MODIS, ADEOS-II/GLI, and NPP/VIIRS until now. GCOMC/SGLI will continue the current satellite mission to observe the cloud property and contribute to the long-term climate change study.

Keywords: GCOMC/SGLI, Cloud science, Climate change, Ice cloud shapes

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ACG39-12 Room:301A Time:May 20 10:00-10:15

Food security packaging with utilization of numerical modeling and satellites observations

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We are plan to packaging process (called ”food security package”) for the estimation of global yield by a coupling model of hydrological and crop-growth modules. Driving forces of crop-growth such as precipitation, solar radiation, soil moisure will be given by satellite drived-products. In addition, initial and several condition such as crop calender, land-use map and so on also needs to assist satellite-based products. In this presentation, we will explain the overview of food security package, and the requirements of satellite-based products.

Keywords: yield estimation, hydrological modeling, satellite observation

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ACG39-13 Room:301A Time:May 20 10:15-10:30

Status of Next Generation Japanese Geostationary Meteorological Satellites Himawari-8/9 and Their Products

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The Japan Meteorological Agency (JMA) plans to launch and operate Himawari-8 and Himawari-9, which are the next generation Japanese geostationary meteorological satellites following the currently operational satellite MTSAT-2 (Himawari-7). JMA plans to launch Himawari-8 in 2014 and commence its operation in 2015, when MTSAT-2 is scheduled to complete its designed period of operation. JMA also plans to launch Himawari-9 in 2016.

Himawari-8 and -9 carry the Advanced Himawari Imager (AHI) units, comparable to the Advanced Baseline Imager (ABI) on board GOES-R, which is also the next generation satellite planned to be launched by the National Ocean and Atmosphere Administration / the National Environmental Satellite, Data, and Information Service (NOAA/NESDIS) in the United States. The observing functions of AHI will be enhanced from those of MTSAT-2 as follows:

- Multi-channel capacity (16 channels)
- High spatial resolution (0.5 -1.0km for visible and 2km for infrared)
- Fast imaging (a full disk scan within 10 minutes)
- Rapid scanning with flexible area selection and scheduling

Observation images of AHI are expected to contribute to improvement of weather watch, tropical cyclone analysis, numerical weather prediction and climate/environment monitoring. Development for the utilization of the AHI images is ongoing. JMA makes a strong effort, in particular, to upgrade Atmospheric Motion Vector (AMV) products and develop new products of volcanic ash and yellow sand analysis.

JMA has set up a web page with information on Himawari-8 and -9 at http://mscweb.kishou.go.jp/himawari89/index.html. This page provides information on the schedule, specifications of the spacecraft and AHI, including estimated spectral response functions (SRF) and simulated AHI proxy data.

Keywords: Himawari-8, geostationary meteorological satellite, AHI

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ACG39-14 Room:301A Time:May 20 10:30-10:45

Use of earth observing satellite data at Japan Meteorological Agency

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Earth observing satellites have been used for diverse operations and researches at Japan Meteorological Agency (JMA): They include numerical weather prediction (NWP), environmental and disaster monitoring, and verification of models and products.

Operational geostationary satellites such as MTSAT are inevitable because of their capability of frequent, long-term measurements and real-time data dissemination. However, due to their measurement limitation to visible (VIS) and infrared (IR) band, we face the difficulty to obtain information below thick clouds or vertical information about the temperature, humidity, cloud and precipitation. In contrast, they are provided by low earth orbiting (LEO) satellites carrying microwave (MW) sensors, IR multi-channel sounders, and cloud- and precipitation-radars. Thus, it is essential to take comprehensive advantage of both operational geostationary and LEO satellites.

For example, MW imagers have been used for analysis of sea surface temperature, sea-ice and snow depth, NWP and reanalysis even in cloudy regions. In the typhoon analysis, while IR/VIS cloud imagery of MTSAT is usually used to estimate the central position and pressure, MW imagers can help to identify the center, and the development of deriving maximum wind speed in typhoon region with TRMM/TMI is underway.

For NWP, satellite data are essential to data assimilation that creates initial state analysis, providing model boundary dataset, and verification of model and analysis. Increasing accuracy and variety of satellite data and advancement in data assimilation system have significantly improved the NWP accuracy for the past 20 years. For example, cloud and precipitation vertical information from TRMM/PR and Cloudsat/CPR contributes to model verification. Assimilation of radiances of MW sounders and imagers and hyperspectral IR sounders, radio propagation refractive data from the global navigation satellite system (GNSS) occultation, sea surface winds of MW scatterometers generates accurate analysis of the information of temperature, humidity and wind. In the current assimilation system, however, the accuracy of analysis related to cloud and precipitation is not sufficient. The important challenge is the effective assimilation of cloud- and precipitation-affected radiances and cloud- and precipitation-radars.

Keywords: satellite, typhoon analysis, data assimilation, JMA

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Current status and future plan of the JAXA/EarthCARE algorithm development and production model

Takuji Kubota[1*], Riko Oki[1], Maki Hirakata[1], Satoru Fukuda[1], Tomoyuki Nomaki[1], Toshiyoshi Kimura[1], Teruyuki Nakajima[2]

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EarthCARE (Earth Clouds, Aerosols, and Radiation Explorer) is a joint Japanese-European mission, and the mission is designed to produce the maximum synergetic collaboration of European and Japanese science teams. For Level 2 and higher data products, Japan originally develops the algorithms to release as Japanese products from JAXA, although continuous exchanges of information will be conducted between Japan and Europe through the Joint Algorithm Development Endeavor (JADE). The JAXA/EarthCARE algorithm development team as Prof. T. Nakajima (University of Tokyo) as the lead scientist consists of Prof. H. Okamoto (Kyushu University) and Mr. Y. Ohno (NICT) for CPR; Dr. T. Nishizawa (National Institute for Environmental Studies) for ATLID; Prof. T.Y. Nakajima (Tokai University) for MSI; Prof. H. Okamoto for CPR-ATLID synergy and CPR-ATLID-MSI synergy; Prof. M. Satoh (University of Tokyo) for model simulation; and Prof. T. Nakajima (University of Tokyo) for Four-Sensor Synergy Algorithm. The EarthCARE team in JAXA determined a list of products that will be processed and released from Japan on July 2011. JAXA L2 products are divided between standard products and research products. JAXA standard products will be processed and released from JAXA Mission Operations System Office (MOS). Agreed with ESA in Operation Interface Agreement (OIA), L2a standard products will be provided by 24 hours after observation, and L2b standard products will be provided by 48 hours after observation. On the other hand, research products are defined to be more challenging variables, and they are further divided between ER products and LR products. The ER (an abbreviation for ”EORC Research”) products will be processed and released from JAXA Earth Observation Research Center (EORC). The timeline is not defined in JAXA, but will be done on best-effort basis. The LR (an abbreviation for ”Laboratory Research”) products will be processed and released from the cooperation with Japanese Laboratories (including universities and research institutes), which are also on best-effort basis.

Keywords: Cloud, Aerosol, Radiation, Satellite, Cloud Profiling Radar

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

ACG39-16 Room:301A Time:May 20 11:15-11:30

Development of cloud algorithm for EarthCARE/MSI: Interpretation of retrievals using cloud simulation and active sensors

Takashi Nagao[1*], NAKAJIMA, Takashi Y.[1], ISHIDA, Haruma[2], SUZUKI, Kentaroh[3]

[1]Tokai University, [2]Yamaguchi University, [3]NASA Jet Propulsion Laboratory

Clouds exert an important influence on the earth water and energy balances and processes that relate to clouds underpin key climate feedbacks. Cloud remote sensing using the spaceborne instruments has been providing useful information about spatial distribution and time series of cloud microphysical properties, and contributing to better understanding of climate study. The satellite-base passive sensors that measure radiation in multi-spectral bands from the visible through the thermal infrared such as Aqua/MODIS and ADEOS-II/GLI are ones of the most commonly used instruments for cloud remote sensing. From the measurements of the passive sensors, cloud droplet effective radius (CDER), cloud optical thickness (COT) and cloud top temperature (CTT) of clouds can be retrieved. These are most important cloud microphysical properties that relate to radiation characteristic of clouds. Moreover, they are also indicators of the droplet growth such as condensational growth and collection processes. However, it is complex to interpret the retrieved CDERs and COTs in term of cloud structure and droplet growth, because clouds are usually vertical inhomogeneous and horizontal inhomogeneous.

In this presentation, we will introduce recent progresses in the interpretation of CDER and COT in term of vertical and horizontal inhomogeneity by using numerical cloud models and active instruments. First, based on the results of remote sensing simulation by using numerical cloud model, we attempt to illustrate how the values of retrieved CDER, COT and CTT are determined from in-cloud vertical structure and horizontal inhomogeneity at sub-pixel scale. Second, we attempt to seek the linkages of CDER, COT to droplet growth in nature based on synergistic use of the spaceborne active and passive sensors (CloudSat and Aqua/MODIS). Finally, we will mention about our research strategy using next coming EarthCARE mission.

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ACG39-17 Room:301A Time:May 20 11:30-11:45

Greenhouse Gases Observing Satellite (GOSAT) for observing global CO_2 & CH_4 and for estimating carbon fluxes

Tatsuya Yokota[1*], Nobuhiro Kikuchi[1], YOSHIDA, Yukio[1], Makoto Inoue[1], MORINO, Isamu[1], UCHINO, Osamu[1], SAEKI, Tazu[1], TAKAGI, Hiroshi[1], Shamil Maksyutov[1], KAWAZOE, Fumie[1], AJIRO, Masataka[1]

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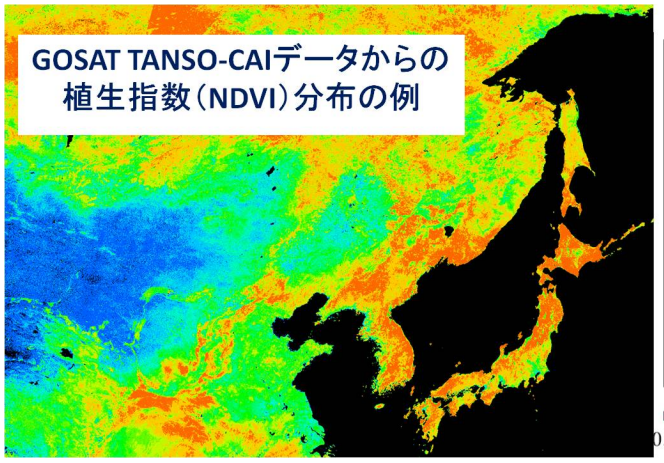
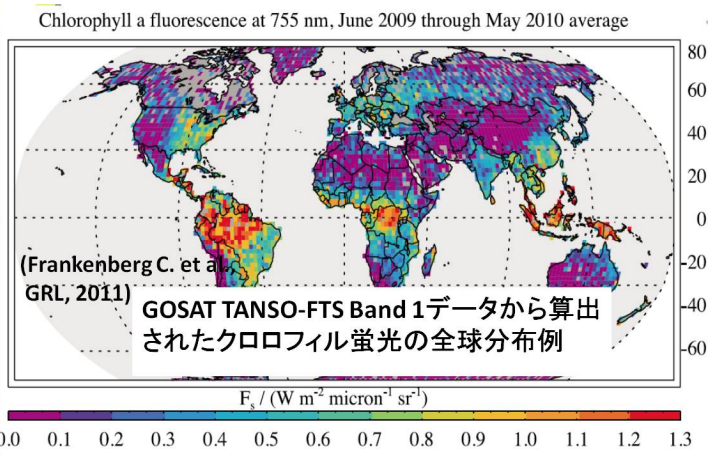
Please refer to the Japanese abstract.

Keywords: greenhouse gases, carbon dioxide, methane, global distribution, transport model, sources and sinks





Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

ACG39-18 Room:301A Time:May 20 11:45-12:00

Middle atmospheric sciences using data from the Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES)

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The Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES) aboard the Japanese Experiment Module (JEM) of the International Space Station (ISS) made atmospheric measurements of minor species in the stratosphere and mesosphere for about six months from October 2009 to April 2010. High-sensitivity measurements of SMILES had been performed by a receiver using superconductor-insulator-superconductor (SIS) mixers, cooled to 4.5 K by a compact mechanical cryocooler. Mission objectives are: i) Space demonstration of 4-K mechanical cooler and super-conductive mixer for the submillimeter limb-emission sounding in the frequency bands of 624.32- 627.32 GHz and 649.12- 650.32 GHz, and ii) global measurements with its high sensitivity for atmospheric minor constituents in the middle atmosphere (O3, HCl, ClO, HO2, HOCl, BrO, O3 isotopes, HNO3, CH3CN, etc), contributing to the atmospheric sciences. Thus global and vertical distributions of about ten atmospheric minor constituents related to the ozone chemistry are derived. See Kikuchi et al. (2010) in more detail about the SMILES mission.

In this talk, we will introduce an overview of the SMILES measurements and show some observational results in association with middle atmospheric chemistry and dynamics. To support the SMILES observational results, we also used outputs from nudged chemistry-climate models (MIROC3.2-CTM and SD-WACCM) in a complementary way. One of the most unique characteristics of the SMILES measurements is that the data from SMILES can be used to capture the diurnal variation of atmospheric minor constituents such as O3, ClO, HO2 and BrO, since the ISS took the non-sun-synchronous orbit. In particular we will give some detailed view on the global pattern of diurnal ozone variations throughout the stratosphere as reported by Sakazaki et al. (2013). These results demonstrate that the SMILES high sensitivity measurements are expected to provide further insights into atmospheric chemistry and dynamics.

References

Kikuchi, K., et al. (2010), Overview and early results of the Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES), J. Geophys. Res., 115, D23306, doi:10.1029/2010JD014379.

Sakazaki, T., et al. (2013), Diurnal ozone variations in the stratosphere revealed in observations from the Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES) onboard the International Space Station (ISS), J. Geophys. Res., in press.

Keywords: middle atmosphere, satellite measurements, atmospheric dynamics, atmospheric chemistry

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ACG39-P01 Room:Convention Hall Time:May 19 18:15-19:30

DEVELOPMENT OF AVOBE GROUND BIOMASS ESTIMATION ALGORITHM FOR GCOM-C1/SGLI BASED ON MULTI-ANGLE OBSERVATION DATA

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Japan Aerospace Exploration Agency (JAXA) will launch new Earth observation satellite GCOM-C1 in near future. GCOM-C1 will be equipped Second-generation Global Land Imager (SGLI) as core sensor. Since SGLI can observe nadir and off-nadir angle with along track direction simultaneously, it is expected to retrieve forest Above Ground Biomass (AGB) using bi-directional spectral data.

For the estimation of forest AGB, difference of bi-directional reflectance of each observation angle caused by forest canopy structure will be key information.

Authors have been developed basic AGB estimation algorithm for SGLI. This algorithm is based on the empirical model related to the relationship between reflectance shift on the Red-NIR plane for different viewing angle and AGB.

Since the algorithm requires the bi-directional reflectance on fixed observation geometry, we have also developed bi-directional reflectance simulator, BiRS, which employ not only sun-target-sensor geometry but also forest structure based on canopy structure model.

Keywords: Second Generation Global Imager (SGLI), Multi-angular observation, Forest canopy, Biomass Estimation

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

ACG39-P02 Room:Convention Hall Time:May 19 18:15-19:30

Snow grain size retrieved with ground and satellite-based remote sensing at SIGMA-A on northwestern Greenland ice sheet

Katsuyuki Kuchiki[1*], Teruo Aoki[1], Masashi Niwano[1], Hiroki Motoyoshi[2], Sumito Matoba[3], Satoru Yamaguchi[2], Tomonori Tanikawa[4], Rigen Shimada[5]

[1]Meteorological Research Institute, [2]Snow and Ice Research Center, National Research Institute for Earth Science and Disaster Prevention, [3]Institute of Low Temperature Science, Hokkaido University, [4]Earth Observation Research Center, Japan Aerospace Exploration Agency, [5]Graduate School of Science, Chiba University

Snow grain size is one of the most important physical parameters which represent the qualitative snow surface condition. A metamorphosis of snow grains such as sintering or melting causes a snow grain growth, thus the estimation of snow grain size is useful for detecting signs of snowmelt. Snow grain size can be remotely sensed from the near-infrared albedo or reflectance. Furthermore, the vertical information of snow grain size also can be estimated using the wavelength dependence of the photon penetration depth. The snow grain size derived from the shorter wavelength contains the information on a deeper snow layer than those from the longer wavelength. To validate the remote sensing of snow grain size and its vertical profile, snow grain sizes retrieved with ground and satellite-based remote sensing using different spectral channels at 865, 1240 and 1640 nm were compared with in-situ measurements at the SIGMA-A site (78^{o}03'N, 67^{o}38'W, 1,490 m a.s.l.) on northwestern Greenland ice sheet during June 26 to July 16, 2012.

The ground-based remote sensing are from spectral albedos measured with a spectrometer, while the satellite-based remote sensing are from reflectances at the top of the atmosphere by Terra/Aqua MODIS. The snow grain sizes retrieved from both the ground and satellite-based method were consistent well for the same spectral channels with the root mean square differences of less than 0.1 mm. This result implies that the algorithms for snow grain size retrieval were reasonable each other. In-situ measured snow grain size was defined as the width of the narrow portion of broken crystals. On July 4 and 5, melt forms with the radius of 0.5 mm beneath surface hoar of 0.15 mm were measured with snow pit work. The snow grain radii derived from the 1640, 1240 and 865 nm channels were 0.1, 0.25 and 0.6 mm, respectively, which agreed with the in-situ measured profile of snow grain size. During July 6 to 9, the top 10 cm snow layer was mainly composed of melt forms around 0.50 mm. The remotely sensed snow grain radii were 0.1, 0.6 and 1.1 mm for the 1640, 1240 and 865 nm channels, respectively. The overestimation at 865 nm might be result from the reduction in the snow reflectance by the ice layers observed in near snow surface. The underestimations at 1640 nm were also reported in previous studies when the grain size was large. The size derived from the 1640 nm channel would be affected by the microstructures on snow crystal surface as well as the grain size itself due to the smaller penetration depth for large snow grains. After the rainfall event from July 10 to 13, the extreme melt was detected as the increase of the MODIS-derived snow grain radii up to 0.4, 1.0 and 1.3 mm for the 1640, 1240 and 865 nm channels, respectively.

Keywords: snow grain size, remote sensing, MODIS, Greenland

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

ACG39-P03 Room:Convention Hall Time:May 19 18:15-19:30

Satellite observation of marine ecosystem and ocean biogeochemistry

Takafumi Hirata[1*], Koji Suzuki[1], Yasuhiro Yamanaka[1]

[1]Hokkaido University

The oceans absorb approximately 25-30% of anthropogenic carbon dioxide released into the atmosphere. While physics, as represented by temperature and wind speed etc., contribute to carbon flux between the atmosphere and the ocean, marine biota also plays a significant role via photosynthesis on fixation and export of the carbon within the surface ocean and from the surface to the deep ocean, respectively. Especially, the photosynthesis requiring the carbon dioxide in its process can even accelerate the ocean absorption of the carbon dioxide. An ability of the carbon fixation and the export is dependent on photosynthesizing microbe, or phytoplankton. While a large-sized phytoplankton such as diatom fixes and exports the carbon faster than other phytoplankton, cocolithophore even releases the carbon dioxide during its calcium fixation, reducing a net amount of its carbon fixation. Therefore, variability in marine ecosystem structure would, at least partly, explain spatial or temporal anomaly of the carbon flux within the ocean. Currently, the ocean colour remote sensing is only a practical means to observe marine biological and biogeochemical variables with considerable frequency for the large-scale oceans. Under the JAXA GCOM-C project, we have been developing novel algorithms to observe the marine ecosystem structure (especially phytoplankton community structure) and other biogeochemical variables. In this presentation we show these observed by satellite as well as a comparison with the state-of-the-art marine ecosystem model.

Keywords: Biogeochemistry, Ocean Ecosystems, Satellite observation, Ocean color

Japan Geoscience Union Meeting 2013
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ACG39-P04 Room:Convention Hall Time:May 19 18:15-19:30

Wildfire monitoring utilizing multiple satellites

Koji Nakau[1*]

[1]Hokkaido University

Wildfire is not only one of the severe cause of forest degradation, but also ineligible source of GHGs. It emits CO2 as much as 1/4 to 1/2 of GHG emission by fuel combustion. For certain portion of wildfire are ignited by human, wildfire is important in terms of human controllable climate change as well as natural disaster. Although wildfire burns several km^2 in maximum in Japan, some wildfire ignited by a lightning burn more than $1000km^2$ (corresponds to one half of entire Tokyo) in Boreal forest. Because it is difficult to fight against strong intensity, it is important to extinguish wildfire in early stage or monitoring precise location. To achieve such sophisticated fire suppression, a wildfire monitoring system to detect small wildfire utilizing multiple satellites from micro satellite to large satellites. Also, a wildfire alert system to push needed wildfire information to firefighter is indispensable for social implementation for efficient wildfire suppression. Therefore, author developed wildfire detection algorithms for coming satellites including UNIFORM/VOL, GCOM-C1/SGLI and ALOS2/CIRC. an as well as improved wildfire detection algorithm for existing sensors MODIS and Terra/ASTER. Utilizing these algorithms, author also implemented wildfire alert system for peat-land fire in Indonesia. This technology will be used in Southern part of Africa in near future.

Keywords: Satellite, Wildfire, Disaster, International Collaboration, Social Impremention

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

ACG39-P05 Room:Convention Hall Time:May 19 18:15-19:30

Monitoring of agrometeorological information in major grain belts using global satellite data

Hideyuki Fujii[1*], Masahiro Hori[2], Keiji Imaoka[2]

[1]The University of Tokyo, [2]Japan Aerospace Exploration Agency

The JAXA Satellite Monitoring of Agrometeorological Information (JASMAI) is a monitoring system of major grain belts with global satellite products, which provides information on soil moisture, solar radiation, surface temperature, and snow cover at 62 countries and regions in near real-time. In this presentation, more detail will be introduced.

Keywords: satellite observation, drought

Japan Geoscience Union Meeting 2013
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ACG39-P06 Room:Convention Hall Time:May 19 18:15-19:30

Retrieval of effective particle radius of clouds using MTSAT-2 and Fengyun-2E satellite data

Hiroya Endo[1*], Yuichiro Oku[2], Weiqiang Ma[1], Hirohiko Ishikawa[1]

[1]Disaster Prevention Research Institute, Kyoto University, [2]Osaka City Institute of Public Health and Environmental Sciences

Aerosols, the tiny particles suspended in the atmosphere, can exert an important impact on radiative forcing and cloud-precipitation system of the earth. It is known that an increase in aerosols causes an increase in number density of cloud droplets but a decrease in cloud droplet size for given liquid water content. Furthermore, recent studies have shown that a marked increase of absorbing aerosols in South Asia has altered the characteristic of Asian monsoon. Therefore, it is important to obtain observational data of cloud particle properties such as an effective radius toward the deeper understanding of aerosol-cloud-climate interactions.

In this study, a method is proposed which retrieve effective particle radius of optically thick water clouds using hourly observation by geostationary meteorological satellites, Multi-functional Transport Satellite-2 (MTSAT-2) and Fengyun-2E (FY-2E). The use of ”the geostationary satellite” has a merit that it provides globally high temporal resolution, typically one or half hour, rather than the observation by polar orbital satellites such as the Advanced Very High Resolution Radiometer (AVHRR) boarded on the NOAA polar platforms or the MODerate resolution Imaging Spectrometer (MODIS) boarded on the Terra polar platforms whose observation interval is approximately once or twice a day.

Our retrieval method basically follows Kaufman and Nakajima (1993) in which the cloud effective particle radius is estimated from the cloud reflectance at 3.7 um band using NOAA/AVHRR instruments. At first, the retrieval developed for NOAA/AVHRR is directly adapted to MTSAT-2 and FY-2E data and the cloud effective radius is calculated. The results show confliction between effective radius values retrieved from MTSAT-2 and from FY-2E. In order to obtain harmonic results, several modifications and improvements are added to the original method and the more accurate algorithm is established. A good correlation is achieved between the retrieved values from two different satellites after careful consideration of response functions of each imager and scattering properties of water clouds. The validity of cloud effective radius obtained by this procedure is confirmed by comparing the results with those obtained by the MODIS cloud products.

The newly developed method is applied to obtain the distributions of the cloud effective particle radius over South Asian region for 2012. Well known characteristics, such that the cloud effective particle radius is smaller in continental clouds than in maritime clouds, are confirmed from FY-2E observations. It is also suggested that the cloud effective particle radius over the Indian subcontinent becomes larger and that over Arabian Sea becomes smaller during summer monsoon season.

The method also allows high temporal resolution and global scale observations of the effective radius compared to the conventional observations using polar orbital satellites.

Keywords: Satellite observations, Geostationary meteorological satellite, Effective particle radius of clouds, Aerosol indirect effects

Japan Geoscience Union Meeting 2013
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ACG39-P07 Room:Convention Hall Time:May 19 18:15-19:30

Evaluation of cloud radiative forcing simulated by the NICAM with A-Train

Tempei Hashino[1*], SATOH, Masaki[1], HAGIHARA, Yuichiro[2], KUBOTA, Takuji[3], MATSUI, Toshihisa[4], NASUNO, Tomoe[5], OKAMOTO, Hajime[2]

[1]Atmosphere and Ocean Research Institute, The University of Tokyo, [2]Research Institute for Applied Mechanics, Kyushu University, [3]JAXA Earth Observation Research Center, [4]NASA Goddard Space Flight Center, [5]Japan Agency for Marine-earth Science and Technology

Global satellite observation provides valuable information not only to the retrievals of physical quantities relevant to aerosol and clouds but also to the evaluation of these simulated by GCMs and cloud resolving models. We discuss synergetic use of A-Train satellite observations to evaluate cloud and precipitation fields simulated by a global cloud-resolving model (GCRM). Our previous efforts were made in evaluating cloud microphysical quantities by comparing simulated satellite signals against observation. However, for the context of climate prediction, it is crucial to understand the differences in terms of the radiation energy budget. In this presentation, effective ways to evaluate the relationships between vertical profiles of active sensors and TOA cloud radiative forcing are discussed.

The outputs from the Nonhydrostatic Icosahedral Atmospheric Model (NICAM) are run through a satellite signal simulator (Joint Simulator for Satellite Sensors) to simulate CloudSAT/CALIPSO/CERES data. This study uses a merged dataset for CloudSat and CALIPSO, and CERES SSF level2 is co-located to the grid. A simple CloudSat cloud-type scheme is applied to the observed and simulated merged dataset. Then, the cloud radiative forcing will be evaluated for each cloud type.

Keywords: global cloud-resolving model, A-Train, cloud radiative forcing, satellite data simulator

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(May 19-24 2013 at Makuhari, Chiba, Japan)

ACG39-P08 Room:Convention Hall Time:May 19 18:15-19:30

Low cloud distributions around anticyclone observed by the CALIPSO satellite in the mid-latitude ocean

Hitoshi Hirose[1*], Noriyuki Nishi[1], Yuichiro HAGIHARA[2]

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Cloud cover is important to analyze the future climate change because variations of cloud cover largely affect the global radiation budget. Low cloud thickness is sometimes a few hundred meters so that most of global climate model cannot simulate correct features of low cloud with their poor vertical resolution. Therefore many previous studies have prospected the factor which controls the variation of low cloud cover. Wood and Bretherton (2006) reported that a strength of inversion above a marine boundary layer strongly governed seasonal variations of low cloud cover. This is because the strong inversion tends to catch water vapor from the sea surface, and then to make thick low cloud under the inversion.

Most of previous studies have focused on the subtropical west coastal ocean where low cloud is dominant all year around. In contrast, the analysis of low cloud in the mid-latitude ocean is still not sufficient partly because it is difficult to observe low cloud with a satellite due to high cloud cover. Moreover in the mid-latitude ocean, it is necessary to analyze shorter time scales than in the subtropical ocean due to prevailing moving cyclones and anticyclones. On such a time scale, we need to consider many factors such as a large scale descending motion, warm or cold advections near the sea surface, and ocean surface wind speed in addition to the strength of inversion. Therefore this study first investigated horizontal distributions of the inversion strength above marine boundary layer and moving cyclones and anticyclones in the mid-latitude ocean with every six hours reanalysis data. As a result, it was found that the inversion above marine boundary layer became strong around anticyclones and on the other hand weak around cyclones in the mid-latitude ocean.

Norris and Iacobellis (2005) reported that low clouds over the mid-latitude ocean had a particular distribution around cyclones and anticyclones as well as inversion strength. However in this report, the accuracy of height information is rough because the cloud top height is retrieved from the infrared brightness temperature observed by satellites. And the analysis region is limited in the northern Pacific region which has many ship passages because this study uses ship observations in order to distinguish low cloud types.

Low cloud height above the marine boundary layer is important to analyze low cloud cover variations because low cloud height affects a convective structure within the marine boundary layer. Therefore this study utilized the CALIPSO satellite which can observe vertical distributions of cloud fractions, and analyzed vertical structure of low cloud around cyclone and anticyclone in detail. As the result it was found the correspondence that low cloud height became low where a large scale descending motion was strong in the mid-latitude ocean. Another result is that low cloud around anticyclones in the northern Pacific ocean has somewhat different distributions from that in the southern Pacific ocean because in the northern Pacific ocean the structure of marine boundary layer may be affected by a strong subtropical anticyclone in summer and by a strong cold air from the Asian continent in winter. On that day we will present the result how do the difference of the factors, inversion strength, a large scale descending, warm or cold advection over the sea surface, affect low cloud cover and the visible optical thickness of low cloud respectively.

Instead of the CALIPSO vertical feature mask (VFM), we utilize new cloud mask data which are developed in Hagihara et al. (2010). This new cloud mask data overcome the problem which the CALIPSO VFM may mistake aerosol or noise for cloud, and as the result improve overestimation of low cloud cover (Rossow and Zhang., 2010). This work was supported by JSPS KAKENHI Grant number 22340133.

Keywords: low cloud, mid latitude, CALIPSO, anticyclone, inversion, marine boundary layer

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ACG39-P09 Room:Convention Hall Time:May 19 18:15-19:30

Aerosol algorithm of GOSAT/TANSO-CAI

Satoru Fukuda[1*], Hideaki Takenaka[2], Teruyuki Nakajima[2]

[1]Japan Aerospace Exploration Agency, [2]The University of Tokyo/Atmosphere and Ocean Research Institute

GOSAT (Greenhouse gases Observing SATellite) is an Earth observing satellite, launched in January 2009. The satellite equips two sensors, TANSO-FTS (Thermal And Near-infrared Sensor for carbon Observations ? Fourier Transform Spectrometer) and TANSO-CAI (Thermal And Near-infrared Sensor for carbon Observations ? Cloud and Aerosol Imager). TANSO-FTS is a primary sensor of the satellite devoted to measuring concentrations of greenhouse gasses such as carbon dioxide and methane. On the other had, TANSO-CAI is a secondary sensor and the purpose of this is to detect clouds and aerosols with four bands, 380 nm, 674 nm, 870 nm, and 1600 nm, from near ultraviolet to near infrared. The precision of retrieval of greenhouse gases gets lower, when an area is contaminated with clouds or aerosols but greenhouse gases are retrieved without any consideration for clouds or aerosols. Aerosol retrieval is also important for understanding the direct and indirect influence of aerosols on climate as assessed by the IPCC-AR4.

In this study, we have developed an aerosol remote sensing algorithm to implement for operational process. Over the ocean area, two-channel method (Higurashi and Nakajima; 1999, 2000) is implemented. Both of Aerosol Optical Thickness (AOT) and Angstrom Exponent (AE) are retrieved by use of 674 nm and 870 nm. Over the land area, we uses a modified Kaufman (MK) method, which is a modified version of Kaufman method (Kaufman et al., 1997) and retrieved AOT with use of 380 nm. It is difficult to estimate the ground reflectance with use of minimum reflectance (MR) method because of the observation frequency is not enough for TANSO-CAI case. In MK method, we use NDVI, which is calculated by MR of 674 nm and 870 nm, and the MR of 674 nm to estimate the reflectance of 380 nm. The relationships between NDVI, MR of 674 nm and 380 nm are determined empirically.

It is thought that the values of retrieved AOT are influenced by the assumptions of characteristics of aerosol particle, such as mode radius and standard deviation of particle size distribution function, single scattering albedo (SSA) and aerosol layer height. These parameters are fixed in the current version of operational algorithm. We performed sensitivity tests to study such assumptions do not cause a significant error for retrieval other than the assumption of SSA. Mode radius and standard deviation of particle size distribution function do not produce large errors even if they are fixed in the algorithm. However, SSA is thought to be the reason of large error if they are far from real value. We have calculated correlation coefficient between AOT of CAI and AOT of AERONET(AErosol ROBotic NETwork) in condition that both SSA is fixed and SSA is from averaged value of AERONETS. The result shows that correlation coefficients are improved in some sites, but in some other sites, correlation coefficients are not improved. We need to investigate this result further.

We further discuss a use of the 1600-nm channel as a reference band of Kaufman method to estimate the ground reflectance at 680 nm to retrieve AOT at 680 nm.

Keywords: aerosol, remote sensing, GOSAT, TANSO-CAI

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ACG39-P10 Room:Convention Hall Time:May 19 18:15-19:30

Development of generalized satellite remote sensing algorithm for aerosol properties.

Makiko Hashimoto[1*], Teruyuki Nakajima[1], Hideaki Takenaka[1], Akiko Higurashi[2]

[1]Atmosphere and Ocean Research Institute, [2]National Institute for Environmental Studies

In late years, high accurate multiple-wavelength, multiple-angle observation data have been obtained by grand-based spectral radiometers and multi wavelength imager sensors on board the satellite. Associated with the situation, the optimized multi-parameter remote sensing method by Bayesian theory has become popularly used(Turchin and Nozik, 1969; Rodgers, 2000; Dubovik *et al*., 2000). With the progress of computing technology, this method has being combined with radiation transfer calculation numerically solved each time in iteration for solution search, without using LUT (Look Up Table), as shown by successful examples of a flexible and accurate remote sensing (Dubovik *et al*., 2011).

We are developing a new Bayesian type inversion method, which combine the MAP method (Maximum a posteriori method) in Rodgers (2000) with the Phillips-Twomey method (Phillips, 1962; Twomey, 1963) as a smoothing constraint for the state vector.

Defining a radiance (measurement) vector at TOA by L and a geophysical (state) parameter or vector determining radiance by u, we express the observation as follows: $L = f(u) + e$, where e is the error caused by several error sources (observation error, modeling error in radiance and error in numerical calculation), and f is the forward operator to model the observation. L and u are defined in the target region determined by spatial and temporal dimensions, (x, y, t). Then, the cost function (E) is expressed as the sum of those of MAP method and of Phillips-Twomey method:

$$E = (L - f)^T S_e^{-1} (L - f) + (u - u_a)^T S_e^{-1} (u - u_a) + \mathrm{SUM}_k [\, w_k \, |A_k + D_k \, u \,|^2]$$

where, T is the transposed matrix, S_e and S_a are the covariance matrix for the observation operator, respectively. u_a is a priori (climatic) value. A_k indicates boundary condition in a certain region. D_k is a quadratic differential operator for structural valuables. w_k is a factor chosen to give appropriate relative weighting to the constraints. To minimize the cost function, we used a Newton method, and the solution may be obtained by several iterations. In our algorithm, L is the radiance observed by satellite and u is the aerosol properties: as of now, the aerosol optical depth (AOT) of fine particles, sea salt particles and dust particles, and the soot fraction in fine particles.

We conducted numerical tests for the retrieval of aerosol properties for GOSAT CAI imager data, to test this algorithm. In this test, we used the simulated radiance data observed by a satellite (5 by 5 grid) using a radiation transfer calculation model, Rstar code (Nakajima and Tanaka, 1986, 1988) assuming wavelengths of 380, 674, 870 and 1600 [nm], atmospheric condition of the US standard atmosphere, fine particle AOTs as 0.2, sea salt particle AOTs as 0.0 and dust particle AOTs as 0.1 for all grids.

For the test, we set to our algorithm each initial and a priori value, (0.001, 0.1) for fine particles and (0.001, 0.5) for dust particles, respectively. We gave the value corresponding to 10% error in measurements for S_e, and the value assuming that a priori AOT has |0.1| differences for S_a.

We calculated the difference between simulated true values and retrieval values of AOT; dAOT= [(retrieval value) - (true value)]/(true value). The result of the experiment shows the algorithm could retrieve AOT of fine and dust particles, and dAOT of fine and dust particles are about -0.15 and +0.07 under the present condition of test experiment, and it was confirmed that our new algorithm works and can derive AOT with a certain accuracy. We will test several other conditions by numerical test, and discuss the information content of several parameter needed for retrieval (e.g. S_e, S_a, w) and the boundary condition and errors included in the retrieval algorithm.

Keywords: Satellite remote sensing, Aerosol

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Development of a radiative flux evaluation program with a 3D Monte Carlo radiative transfer code

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In this study, we have developed a 3D Monte-Carlo radiative transfer code that can treat a broadband solar flux calculation, also implemented with k-distribution parameters of Sekiguchi and Nakajima (2008). We used this code for generating the radiative flux profile and heating rate profile in the atmosphere including broken clouds. In order to construct 3D extinction coefficient fields, we tried following three methods:, 1) stochastic clouds generated by randomized extinction coefficient distribution and regularly-distributed tiled clouds, 2) numerical simulations by a non-hydrostatic model with bin cloud microphysics model and 3) Minimum cloud Information Deviation Profiling Method (MIDPM).

The second construction of 3D cloud systems was performed by numerical simulation of Californian summer stratus clouds using a non-hydrostatic atmospheric model with a bin-type cloud microphysics model based on the JMA NHM model (Iguchi et al., 2008; Sato et al., 2009, 2012). The numerical simulations were conducted on horizontal (vertical) grid with a spacing of 100m (20m) and 300m (20m) in a domain of 30 km,30 km,1.5 km with a horizontally periodic lateral boundary condition. Two different cell systems were simulated depending on the cloud condensation nuclei (CCN) concentration. In the case of level scale resolution 100m, a regional averaged cloud optical thickness, <COT>, and standard deviation, standard deviation of COT, are 3.0 and 4.3 for pristine case and 8.5 and 7.4 for polluted case.

In the MIDPM method, we first constructed a library of the pair of observed parameters from CLOUDSAT/CPR and collocated AQUA/MODIS imager products at the footprint of CPR along the CLOUDSAT orbit, i.e. the profile of effective radar reflectivity factor, dBZe(z), spectral MSI radiances, cloud optical thickness (COT), effective particle radius (RE) and cloud top temperature (Tc) for a case of summer stratus cloud off California coast on July 2, 2007. We then selected a best matched radar reflectivity factor profile from the library for each of off nadir pixels of MODIS where CPR profile is not available, by minimizing the deviation between library MODIS parameters and those at the pixel.

Using these constructed 3D cloud systems, we calculated the radiation field by our Monte-Carlo radiative transfer code at wavelengths of 0.5, 1.6 and 2.1 microns. We compared a reflectivity of 3D with plane parallel and a reflectivity of 3D with IPA. Independent Pixel Approximation (IPA) is an approximation calculated as plane parallel

each pixel for radiation. In the case of wavelength 0.5 microns, as expected, all the discrepancy between 3D cloud and equivalent IPA cloud cases are smaller than the discrepancy between 3D cloud and equivalent plane parallel cloud cases. At a maximum the reflectivity difference for the IPA cloud cases for NHM+ACB model and MODSI/CPR result reaches a value up to 0.040, whereas plane parallel show a large reflectivity difference as 0.010. Each values convert to incident radiative flux then the values are 30Wm-2 and 10Wm-2 respectively. We made sure of the high resolution reduce the accuracy of the difference between the 3D clouds case and IPA clouds case. Then we validate the evidence for tiled clouds we found the relativity of solar zenith angles and the relativity solar azimuth angles for the difference between 3D clouds and IPA clouds. For relativity of solar zenith angles the difference is thickness of stratum. For the relativity solar azimuth angles the difference is amount of cloud. We should calculate the radiation field in many cases of clouds both the realistic clouds case as MODIS/CPR and tiled clouds and so on.

Keywords: Monte Carlo, radiative transfer, radiative flux, 3D cloud, satellite observation, model

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Dual Ka-band radar field campaign for GPM/DPR algorithm development

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Dual Ka-band radar system is developed by the JAXA for the GPM/DPR algorithm development. The dual Ka-radar system which consists of two identical Ka-band radars can measure both the specific attenuation and the equivalent radar reflectivity at Ka-band. Those parameters are important particularly for snow measurement. Using the dual Ka-radar system along with other instruments, such as a polarimetric precipitation radar, a wind-profiler radar, ground-based precipitation measurement systems, the uncertainties of the parameters in the DPR algorithm can be reduced. The verification of improvement of rain retrieval with the DPR algorithm is also included as an objective. Observations using the dual Ka-radar system were performed in Okinawa Island, in Tsukuba, over the slope of Mt. Fuji, in Nagaoka, and in Sapporo, from 2011 to 2013. Through those experiments the main results are the *k-Ze* relationships on various precipitation types. The feasibility of total attenuation in melting layer has been studied. Different *k-Ze* relationships have been obtained in snow observations. The vertical variations of rainfall are also analyzed for the DPR algorithm development.

Keywords: GPM/DPR, Ground Validation, Ka-band Radar, k-Z relationship

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ACG39-P13 Room:Convention Hall Time:May 19 18:15-19:30

Estimation of errors due to aerosol scattering on the remote sensing of the lower tropospheric ozone with measurement of

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abstract

Estimation of errors due to aerosol scattering on the remote sensing of the lower tropospheric ozone with measurement of solar UV-Vis. backscattered spectra from space

The lower tropospheric ozone is a major photochemical oxidant affecting human health and vegetation. In recent years, the long-range transport of the tropospheric ozone from the Asian Continent affects air quality in Japan and other wide areas. Remote sensing from a satellite is effective to observe such extensive/transboundary air pollution. However, it has been quite difficult to measure the lower tropospheric ozone from the satellite.

We have proposed that it can be evaluated with simultaneous measurement of solar backscattering spectra in the ultraviolet(UV) and visible(Vis) regions. Because the atmospheric Rayleigh scattering cross-section is much larger in UV than that in Vis, lower tropospheric light path length of the solar scattered radiation observed from space is significantly different in these two wavelength regions. This difference in the light path changes ozone column amount along it in the lower troposphere, and enables us to evaluate the lower tropospheric ozone mount.

The accuracy/precision in this evaluation depends on the accuracy/precision both in the ozone column measurement from UV/Vis solar backscattered spectra and in the model calculation of the light path length in these wavelength region. In this study, we estimate errors in the mode calculation of the light path length with a simulation of

UV/Vis solar backscattered spectra measurement. The scattering by atmospheric aerosols is one of most significant factors influencing the light path length of the solar scattered radiation because the quantification of its vertical profile is quite difficult because it is highly variable temporary and spatially. Variation of the light path length with model profiles of aerosol extinction coefficient based on a lidar measurement is calculated with SCIATRAN (Rozanov et al., 2005) to estimate errors due to the difference between the ”true” aerosol profile and the ”assumed” profile.

Keywords: Remote Sensing

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Lower troposphere ozone derivation by remote sensing : earth surface albedo presumption in airplane observation

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abstract

The lower tropospheric ozone is a major photochemical oxidant affecting human health and vegetation. In recent years,the long-range transport of the tropospheric ozone from the Asian Continent affects air quality in Japan and other wide areas. Remote sensing from a satellite is effective to observe such extensive/transboundary air pollution. However, it has been quite difficult to measure the lower tropospheric ozone from the satellite.

We have proposed that it can be evaluated with simultaneous measurement of solar backscattering spectra in the ultraviolet(UV) and visible(Vis) regions. Because the atmospheric Rayleigh scattering cross-section is much larger in UV than that in Vis, lower tropospheric light path length of the solar scattered radiation observed from space is significantly different in these two wavelength regions. This difference in the light path changes ozone column amount along it in the lower troposphere, and enables us to evaluate the lower tropospheric ozone amount.

We carried out aircraft experiments to validate this method over Tsukuba on 10th and 13rd September 2012. UV and Vis backscatter spectra were measured with two Maya2000pro (Ocean Optics) spectrometers at two altitudes 2500 ft (760 m) and 25000 ft (7600 m). Simultaneously, ozone profile was measured with ozone monitors on-board the aircraft, with ozonesonde launched near Tsukuba, and the tropopheric ozone lidar. Because aerosol scattering may significantly affect the evaluation of the lower tropospheric ozone amount, in situ aerosol observation with the CRDS, PSAP, and PASS instruments and the lidar observation were carried out in the Meteorological Research Institute. In this study, surface scattering spectra, which significantly affects both the evaluation of ozone column amount from the measured spectra and the light path length. In this study, we estimate the surface scattering spectra from the solar back scattering spectra at 2500 ft level, considering the influence of aerosol scattering and absorption.

Keywords: lower troposphere ozone, remote sensing, earth surface albedo

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Lithosphere-Atmosphere-Ionosphere Observation by Small Satellite Constellation

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Current status of the ELMOS small satellite constellation will be presented.

Keywords: Small Satellite Constellation, Lithosphere, Atmosphere, Ionosphere, GPS occultation, Numerical Weather Prediction

Japan Geoscience Union Meeting 2013
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Doppler wind lidar measurement from space

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Wind profile is fundamental in many atmospheric phenomena. About 1,300 weather stations launch radiosondes to obtain profiles of pressure, wind, temperature, and humidity. Most of the weather stations are on land, while the stations on the sea are very sparse. Spaceborne infrared and visible imagers and microwave scatterometers can make wind measurement only at a specific altitude. Weather prediction and scientific people expect the realization of a global observation system for three-dimensional wind measurements. The spaceborne Doppler lidar is one of the candidate sensors for the global wind measurements. The working group on Japanese spaceborne Doppler Lidar has been established to realize for wind measurements from space. In this presentation, we describe wind measurement with the Japanese spaceborne Doppler Lidar and the activities and goals of this working group.

Keywords: wind measurement, spaceborne lidar, Doppler lidar, global climate model, weather prediction

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Production of Global Satellite Mapping of Precipitation and Evolution for the Global Precipitation Measurement Mission

Misako Kachi[1*], Takuji Kubota[1], Satoshi Kida[1], Tomoo Ushio[2], SHIGE, Shoichi[3], Kazumasa Aonashi[4], OKAMOTO, Ken'ichi[5], Riko Oki[1]

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Japanese Global Rainfall Map algorithm has been developed based on heritages of the Global Satellite Mapping for Precipitation (GSMaP) project, which was sponsored by the Japan Science and Technology Agency (JST) under the Core Research for Evolutional Science and Technology (CREST) framework between 2002 and 2007. The GSMaP project utilized accomplishments of observations by the Precipitation Radar (PR) onboard the Tropical Rainfall Measuring Mission (TRMM), and produce high-resolution and high-frequent global rainfall map based on multi-satellite passive microwave radiometer observations with information from the Geostationary InfraRed (IR) instruments. Output product of GSMaP algorithm is 0.1-degree grid for horizontal resolution and 1-hour for temporal resolution. The GSMaP near-real-time version product (GSMaP_NRT) has been in operation at JAXA since October 2008 in near-real-time basis, and browse images and binary data available at JAXA GSMaP web site (http://sharaku.eorc.jaxa.jp/GSMaP/). Altough the itinial GSMaP algorithm used passive microwave imagers only, SSMIS instruments onboard DMSP F16 and F17 has been introduced to GSMaP_NRT since 14 June 2010, in response to decrease of number of available passive microwave imagers. In addition, microwave sounders, AMSU-A/MHS instruments onboard NOAA-19 and MetOp-A has been introduced to the system since 1 August 2011.

With the objective of neccessity of continuous and log-term rainfall data set, GSMaP Reanalysis version (GSMaP_MVK V5.222) was produced and released recently. Reanalysis version is available for the period from March 2000 to November 2010, and will be updated in future. GSMaP_MVK product differs sligtly from the GSMaP_NRT product in terms of input data and algorithms. GSMaP_MVK uses all available microwave imager, microwave imager/sounder, and sounder data as inputs, since its processing is not in near-real-time basis. In addition, a full version of the algorithm (morphing and Kalman filtering by forward and backward processes) are used. GSMaP_MVK is available to registered users via JAXA GSMaP web site, as well as GSMaP_NRT. Users of GSMaP product extends broad user community, such as flood alert and weather services, and data utilization demonstrations are underway in several Asian and African countries.

The development of GSMaP algorithm was originally started for the Global Precipitation Measurement (GPM) mission, which is successor and extend mission of the TRMM. The GPM Core Observatory, which is a U.S-Japan joint mission, is scheduled to be launched in early 2014, and new version of GSMaP product is one of GPM products produced in JAXA. New version will include several updates of microwave imager and sounder algorithms and databases, and introduction of rain-gauge correction. As JAXA GPM product, we will provide 0.1-degree grid and hourly product for standard and near-realtime processing. Outputs will include hourly rainfall, gauge-calibrated hourly rainfall, and several quality information (satellite information flag, time information flag, and gauge quality information) over global areas from 60S to 60N. In addition, monthly rainfall product in 0.1-degree grid will be provided as JAXA GPM product.

Keywords: satellite observation, precipitation, high-resolution, high-frequent, GSMaP, GPM

Japan Geoscience Union Meeting 2013
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Gauge Adjusted Global Satellite Mapping of Precipitation (GSMaP_Gauge)

Tomoo Ushio[1*], Satoru Yoshida[1], Shoichi Shige[3], Kazumasa Aonashi[4], Takuji Kubota[2], Misako Kachi[2], Riko Oki[2]

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Precipitation is one of the most important parameters on the earth system, and the global distribution of precipitation and its change are essential data for modeling the water cycle, maintaining the ecosystem environment, agricultural production, improvements of the weather forecast precision, flood warning and so on. The GSMaP_MVK is a product of surface rainfall rate with 0.1 degree and 1 hour resolution on a global basis using the data from microwave radiometers on low earth orbit and infrared radiometers on geostationary orbit, and has been widely used through internet. However, some validation results from the hydrological madel show that the GSMaP_MVK sometimes underestimates the surface rainfall rate. In this presentation, the GSMaP_Gauge which is a gauge adjusted product to the GSMaP_MVK for climatological studies are introduced, focusing particularly on structure and performance of the algorithm and some initial evaluation tests. Additionally, the concept and theoretical basis of the near real time product of the GSMaP_Gauge named as GSMaP_Gauge_NRT is introduced.

Keywords: Precipitation, Satellite, GPM

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Semi-diurnal variation of precipitation over the tropics analyzed from TRMM 3G68 data

Toshiro Inoue[1*], HAMADA, Atsushi[1]

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Diurnal variation of deep convection and/or rainfall over the tropics has been studied using satellite data and/or surface data. Many numerical models have still deficiency in representation of this diurnal variation. While semi-diurnal variation of rainfall was reported in the global cloud system resolving model (Nonhydrostatic ICosohedral Atmospheric Model; NICAM) by Tomita et al. (2005) and Yasunaga et al. (2011) for aqua-planet experiment. Miura et al. (2007) simulated the realistic structure of a Madden-Julian Oscillation (MJO) event that occurred during December 2006 using the NICAM with land-sea contrast. Some areas over the tropics show semi-diurnal variation of rainfall in the 3.5 km grid hindcasting experiment of this NICAM MJO simulation. Here, we studied the semi-diurnal variation of rainfall using microwave (TMI) and radar (PR) observations from TRMM and infrared observations from geostationary satellite.

Harmonic analysis is applied for the 14 years TRMM 3G68 TMI data of December over the tropics. Amplitude of diurnal variation is larger over the southern Africa, Madagascar, Amazon and maritime continent. Semi-diurnal variation over the southern Africa, Amazon and western Pacific indicate larger amplitude. Semi-diurnal variation over the southern Africa and Amazon is characterized as primary peak in the afternoon and secondary peak in the morning from TMI and PR. PR observation indicates that afternoon peak is mostly consist of convective rain and morning peak is mostly consists of stratiform rain over both area. Infrared observation indicates that afternoon peak coincides with large number of deep convective cloud that is rapidly increasing stage of size, while morning peak coincides with re-enhanced size of deep cloud. This cloud configuration suggests that afternoon peak corresponds to developing stage of convective cloud and morning peak corresponds to re-enhanced anvil cloud.

Keywords: TRMM, precipitation, semi-diurnal variation, NICAM

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Study of tropospheric tomography for water vapor distribution with Neural Network

Akimitsu Hiroki[1*], Katsumi Hattori[1], Shinji Hirooka[1]

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Many meteorological disasters such as flood and landslides with torrential rain have been reported, and the mechanism of the precipitation system has been studied. Grasp of the situation of the precipitation with the portable radar is important, and a practical use study is investigated in Meteorological Research Institute or Osaka University. However, in the developing countries such as Indonesia and the Philippines, the observation with the radars have difficulty in realization under the present conditions at the point of cost and the maintenance. The water vapor tomography using a GPS and/or broadband satellite is thought to be effective as a situation of the precipitation monitoring system for the radars in the above-mentioned countries. When the development of a rain cloud bringing the damage of a heavy rain and the thunderstorm happens, there is an inflow of the water vapor from the neighborhood. It is thought that the measurement with the GPS elucidates the meteorological important flow and distribution of water vapor. Therefore, in this study, we develop water vapor tomography, the three-dimensional water vapor distribution, from GPS data and AMeDAS observation data using algorithm of residual minimization learning neural network (RMTNN). The numerical simulation demonstrate three-dimensional water vapor distribution can be estimated from GPS data. The details will be shown at our presentation.

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Cloud observation by next generation Earth observing satellites

Takashi Nakajima[1*], Takashi M. Nagao[1], Husi Letu[1], Haruma Ishida[2], Yoshiaki Matsumae[1]

[1]Tokai University, [2]Yamaguchi University

The use of some polar orbital satellites GCOM and EarthCARE for observing clouds is suggested in this paper. Since clouds exert an important influence on the planets water and energy balances and processes, more observations and understanding life-cycle of these particles are required. Adding to some passive sensors, the CloudSat and the CALIPSO present a new epoch in cloud observation with the purpose of revealing the particle transition. It is expected that the combined use of polar orbital passive/active sensors and geostationary satellites reveal details of cloud evolution process using multi-spectral capability and the vertical observation capability of active/passive sensors. In this paper, we would like to introduce recent progresses of cloud observations from satellites, to show multi-sensor views of cloud droplet growth process and comparison results between observations and models.

Keywords: Atmospheric observation, Earth observing satellite, cloud properties

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Satellite Image Analysis for Channels covering East Asia Region and Hidden Periodicities for Time Series Data

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Image analysis and time series analysis for MTSAT-2 images covering East Asia region of channels (IR1 and IR3) are discussed. The new time series data derived from fractal analysis of the time series images illustrated in 600x462 pixels from 2009 to 2010 are generated and power spectra for the ratio of cloud covers, water vapor, and space packing exponents with periodic peaks are calculated by using Fourier transform and periodicities of peaks in autocorrelation function are analyzed.

Caotic behaviors of orbits for their time series data restructured with three dimensional space of states are observed. The branch points of the system, the points of intersections where the amplitude of the fluctuations in four moving average curves become smaller at the same time, are evaluated with the time interval related to the periodic peaks. The features of the branch points and between the ratio of cloud cover or the ratio of water vapor and the space packing exponent are described.

Correlations between time series data of hourly air temperature from 1991 to 2010 observed at Kobe station and Niigata station are discussed.

For time series data of hourly air temperature in 1996, 2000, 2009, and 2010, power spectra with periodic peaks are calculated by using Fourier transform, respectively. A first peak of power spectra is determined and time intervals between nearest neighbor peaks are evaluated. As a result, hidden periodicities are observed. In addition, the features of power spectra for the ratio of cloud covers and space packing exponents by image analysis and time series analysis for MTSAT-2 images covering East Asia region of channels IR1 in 2009 and 2010 are described and similarities between the hidden preiodicities for time series data of hourly air temperature are suggested.

Keywords: MTSAT-2 images, Time Series Analysis, Fourier transform, continuous wavelet transform, hidden periodicities

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Terrestrial Water Storage in Northeastern Asia with GRACE satellite

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Monthly measurements of time-variable gravity from the GRACE (Gravity Recovery and Climate Experiment) satellite mission was used to investigate the temporal change of Terrestrial Water Storage (TWS) in the arid regions of Northeastern Asia, during the period of April, 2004 to December, 2010. The study area was a square between 40 degree N and 50 degree N, and between 90 degree E and 115 degree E, which includes most of Mongolia and a part of northern China.

The results show that decreasing trend of TWS was observed in mountainous areas and in Inner Mongolia, while TWS is fairly constant in the central area of Mongolia. These findings are consistent with the reported decrease of glaciers [Kadota et al., 2011] and the depletion of groundwater level in Inner Mongolia during the last several decades [Kitawaki, et al., 2010]. TWS observed in the central Mongolia does not contradict with hydrological characteristics of the region with dry climate, where precipitation almost equals evaporation [Kaihotsu et al., 2004], and groundwater level hardly shows noticeable change without excessive human influence.

Autocorrelation between TWS from GRACE and the surface soil moisture from the microwave remote sensing of AMSR-E (Advanced Microwave Scanning Radiometer for Earth Observation System) [Fujii, et al., 2009] was investigated, where the latter was processed with the same filters used with GRACE. It was found that there is a higher correlation in the dry regions, which indicates that there is a possibility that TWS variations in dry regions depend mainly on that of the surface soil moisture. On the other hand, the soil moisture is well-correlated with TWS at 3 month earlier in the mountainous regions. This suggest linkage between snow and soil moisture in the region.

These results indicate the potential of GRACE to provide information on hydrological change, such as soil moisture, groundwater storage, glacier, etc, in the arid and semi-arid regions, even though variations of TWS are relativity smaller in the regions.

Keywords: arid region, Mongolia, Hydrological change, climate change, AMSR-E

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Land-cover change detection in Siberia using Landsat

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Siberia is well known one of the most vulnerable ares for climate change. As a result of climatic change, large areas have undergone land cover change (e.g., ecological succession after forest fire and permafrost degradation), and the change affects ecological functions. It is important to monitor the process of the land cover change for understanding the role of terrestrial ecosystems in the carbon and water cycles, the frequency of natural disasters, and the impact of ecosystem services. Land cover map is used as the basis for ecosystem management, conservation and restoration activities. Therefore, timely and accurate land cover map is needed at the regional scale. In order to produce land cover map, remote sensing is a very useful tool for repetitive sampling over large areas. A method to produce the land cover map based on high temporal frequency sensors, such as MODIS and SPOT VGT, has already been established. However, the spatial resolution of 1 km limits the performance of land cover map. The land cover maps includes a potential source of error because of the heterogeneity of the landscape at the subpixel scale. According to a comparative study, the pixel-level classification accuracy is not high, ranging between 50 and 58%. Medium spatial resolution sensors, such as Landsat TM/ETM+, allows the direct comparison of the field plot with a 30 m image pixel. The objectives of this study is to produce accurate land cover map using Landsat, and to better understand the relation between climate change and land cover change.

Keywords: land cover change, climate change, Siberia, Landsat