ACG06-01 Room:315 Time:April 28 16:15-16:38

NASA Earth Science and Applications

FREILICH, Michael[1*]

[1]Director, Earth Science Div. NASA Headquarters

Earth is a complex, dynamic system we do not yet fully understand. The Earth system, like the human body, comprises diverse components that interact in complex ways. We need to understand the Earth's atmosphere, lithosphere, hydrosphere, cryosphere, and biosphere as a single connected system. Our planet is changing on all spatial and temporal scales. The purpose of NASA's Earth science program is to develop a scientific understanding of Earth's system and its response to natural or human-induced changes, and to improve prediction of climate, weather, and natural hazards. A major component of NASA's Earth Science Division is a coordinated series of satellite and airborne missions for long-term global observations of the land surface, biosphere, solid Earth, atmosphere, and oceans. This coordinated approach enables an improved understanding of the Earth as an integrated system.

Over the coming decades, NASA and the Agency's research partners will continue to pioneer the use of both spaceborne and aircraft measurements to characterize, understand, and predict variability and trends in Earth's system for both research and applications. NASA Earth System Science conducts and sponsors research, collects new observations, develops technologies and extends science and technology education to learners of all ages. We work closely with our global partners in government, industry, and the public to enhance economic security, and environmental stewardship, benefiting society in many tangible ways. We conduct and sponsor research to answer fundamental science questions about the changes we see in climate, weather, and natural hazards, and deliver sound science that helps decision-makers make informed decisions. We inspire the next generation of explorers by providing opportunities for learners of all ages to investigate the Earth system using unique NASA resources, and our Earth System research is strengthening science, technology, engineering and mathematics education nationwide.

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

ACG06-02 Room:315 Time:April 28 16:38-17:00

JAXA's Earth Observation Missions

NAKAMURA, Kenji[1*] ; FUKUDA, Toru[2]

[1]Earth Observation Research Center, Japan Aerospace Exploration Agency/Dokkyo University, [2]Earth Observation Research Center, Japan Aerospace Exploration Agency

The Japan Aerospace Exploration Agency (JAXA) is promoting the Earth observation from space. JAXA is now operating GOSAT (the Green House Gases Observing Satellite) and GCOM-W1 (the Global Change Observation Mission 1st-Water). The GOSAT mission is a joint effort of JAXA, the National Institute for Environmental Studies (NIES) and the Ministry of the Environment (MOE). GOSAT has been launched in January 2009, and is equipped with the Fourier Transform Spectrometer and the Cloud Aerosol Imager providing global distribution of carbon dioxide and methane with seasonal changes. GCOM-W1 was launched in May 2012 for global water cycle observation and has the AMSR-2 (Advanced Microwave Scanning Radiometer 2). AMSR-2 follows the design of AMSR which was aboard ADEOS-2 satellite, but with improvements in antenna size and onboard calibration, etc. JAXA is also operating the Precipitation Radar (PR) aboard the TRMM (Tropical Rainfall Measuring Mission) satellite and Advanced Microwave Scanning Radiometer (AMSR-E) aboard Aqua satellite of the National Aeronautics and Space Administration (NASA). TRMM is a joint venture of JAXA and NASA. The TRMM satellite was launched in 1997 and is still in operation. The Precipitation Radar (PR) aboard the TRMM satellite is the first spaceborne radar dedicated for precipitation observation developed by JAXA and the National Institute of Information and Communications Technology, Japan (NICT). The data from PR for more than 16 years contributed much for better understanding the precipitation system climatology over tropical and subtropical regions. The Global Precipitation Measurement (GPM) which is led by JAXA and NASA with international collaboration is a multi-satellite system dedicated for the global precipitation observation. The core satellite of GPM will be launched by JAXA at the end of February 2014. JAXA has developed the dual-wavelength radar (DPR) with NICT for the GPM core satellite. DPR will observe rain including solid precipitation with better accuracy than TRMM PR. The ALOS-2 (Advanced Lang Observing Satellite-2) which is equipped with an L-band Synthetic Aperture Radar (PALSAR) is scheduled to launch in 2014. ALOS-2 is a follow-on mission from ALOS contributing to cartography, disaster monitoring, resource survey, etc. EarthCARE for cloud and aerosol observation is a collaboration mission with the European Space Agency (ESA). JAXA has developed a W-band Cloud Profiling Radar (CPR) with NICT for EarthCARE. CPR has high sensitivity to clouds with Doppler function. Using the Doppler function CPR can measure the vertical movement of clouds which is important to understand the cloudy systems. JAXA is also developing GCOM-C1 (the Global Change Observation Mission 1st-Climate) which is for surface and atmospheric measurements related to the carbon cycle and radiation budget. An SGLI (Second Generation Global Imager) will be aboard the satellite. JAXA is also studying future sensors including small sensors for the International Space Station (ISS).

Keywords: Earth observation, satellite, remote sensing

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

ACG06-03 Room:315 Time:April 28 17:00-17:15

Greenhouse gas observation by GOSAT during its five-year nominal operation period

YOKOTA, Tatsuya[1*] ; KIKUCHI, Nobuhiro[1] ; YOSHIDA, Yukio[1] ; BRIL, Andrey[1] ; OSHCHEPKOV, Sergey[1] ; INOUE, Makoto[1] ; MORINO, Isamu[1] ; UCHINO, Osamu[1] ; KIM, Heon-sook[1] ; TAKAGI, Hiroshi[1] ; SAITO, Makoto[1] ; MAKSYUTOV, Shamil[1] ; YUKI, Akira[1] ; KANEKON, Sayaka[1] ; KAWAZOE, Fumie[1] ; AJIRO, Masataka[1]

[1]National Institute for Environmental Studies

The Greenhouse gases Observing SATellite (GOSAT) recently completed its planned nominal operation period of five years on 23 January 2014, and it now entered the phase of extended operation. During the past five years, almost all of the GOSAT standard data products were opened to general users. These data products are publicly available and can be obtained through the GOSAT User Interface Gateway (GUIG, http://www.data.gosat.nies.go.jp/). From the spectral data that GOSAT collected, the concentrations of major greenhouse gases (GHGs), namely carbon dioxide (CO_2) and methane (CH_4), were retrieved, and their precisions are now at the level of much less than 1%. These concentration data are used to estimate the monthly surface fluxes of CO_2 and CH_4 on sub-continental and ocean-basin scales. The data are also utilized to monitor GHGs' temporal and spatial changes. Various reports on the results of GOSAT data analysis have appeared in peer-reviewed journals so far. The topics reported include the detection of large GHG point sources and anomalies in the inter-annual trend of CO_2 uptake by terrestrial biosphere.

In this presentation, we will summarize the five-year-long GHG observation by GOSAT and present the global distributions of the GHG concentrations and the surface flux estimates. Also, we will touch on the current status of researches conducted within the framework of the GOSAT Research Announcement.

Keywords: greenhouse gases, carbon dioxide, methane, column concentration, flux, GOSAT

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

ACG06-04 Room:315 Time:April 28 17:15-17:30

The NASA Orbiting Carbon Observatory - 2 (OCO-2), the next step in CO2 measurements from space

CRISP, David[1]*

[1] Jet Propulsion Laboratory, Caltech

Global, space-based remote sensing observations of atmospheric carbon dioxide (CO_2) and methane (CH_4) hold substantial promise for future, long-term monitoring of these important greenhouse gases. These measurements will complement those from the existing ground based greenhouse gas monitoring network with increased spatial coverage and sampling resolution. The principle challenge for this approach is the high precision and accuracy needed to resolve the small (<0.3 percent) variations in the background distributions of these gases associated with their emission sources and natural sinks. The European Space Agency (ESA) EnviSat SCIAMACHY and Japanese Greenhouse Gases Observing Satellite (GOSAT) TANSO-FTS were the first two space-based sensors designed to return high resolution spectra of the reflected sunlight in molecular oxygen (O_2), CO_2, and CH_4 bands at near-infrared wavelengths. These spectra are being analyzed to yield spatially resolved estimates of the column-averaged CO_2 and CH_4 dry air mole fractions (X_{CO2}, X_{CH4}) over the sunlit hemisphere. The availability of these data has already enabled substantial improvements in instrument calibration techniques, remote sensing retrieval algorithms, and data validation techniques. However, sensors with greater sensitivity, coverage, and resolution are needed to implement the space-based segment of a global greenhouse gas monitoring system.

In July of 2014, these space-based greenhouse gas pathfinders will be joined by the NASA Orbiting Carbon Observatory-2 (OCO-2). This satellite will fly at the front of the 705-km Afternoon Constellation (A-Train), along an orbit track aligned with the ground footprints of the CloudSat radar and CALIPSO lidar. Its 3-channel, imaging, grating spectrometer has been optimized to record high resolution spectra of reflected sunlight in the 765 nm O_2 A-band and in the 1610 and 2060 nm CO_2 bands. Coincident O_2 and CO_2 spectra are combined into soundings that are analyzed with a full-physics retrieval algorithm to yield estimates of X_{CO2} with accuracies exceeding 0.3 percent over most of the Earth. The OCO-2 spectrometer will collect up to 1 million of these soundings each day along a narrow ground track as it flies over the sunlit hemisphere. Between 20 and 30% of these soundings are expected to be sufficiently cloud free to yield full-column estimates of X_{CO2}. Even with these assets, OCO-2 is still only a research satellite, designed to validate a space-based CO_2 measurement approach. A coordinated network of satellites with similar capabilities will be needed to discriminate and quantify the CO_2 emissions from fossil fuel combustion, land use practices, and other human activities in the presence of the much larger CO_2 fluxes associated with the natural carbon cycle.

Keywords: Carbon Dioxide, Greenhouse Gases, Remote Sensing, Orbiting Carbon Observatory - 2

ACG06-05 Room:315 Time:April 28 17:30-17:45

NIES GOSAT-2 Project

MATSUNAGA, Tsuneo[1*] ; MORINO, Isamu[1] ; YOSHIDA, Yukio[1] ; SAITO, Makoto[1]

[1]National Institute for Environmental Studies

GOSAT-2, a successor of Greenhouse Gases Observation Satellite (GOSAT), is currently being developed by Ministry of the Environment, Japan Aerospace Exploration Agency, and National Institute for Environmental Studies (NIES). Its target launch year is FY2018.

In the presentation, the schedule of NIES GOSAT-2 project will be introduced.

Keywords: GOSAT, GOSAT-2, satellite, greenhouse gas

ACG06-06 Room:315 Time:April 28 17:45-18:00

Development of a 3D solar induced chlorophyll fluorescence simulator for satellite fluorescence observation

KOBAYASHI, Hideki[1*] ; NAGAI, Shin[1] ; INOUE, Tomoharu[1] ; ICHII, Kazuhito[1]

[1]Japan Agency for Marine-Earth Science and Technology

Recent studies show that the vegetation canopy scale chlorophyll fluorescence can be observed from satellite, such as GOSAT and OCO-2, using Fraunhofer lines (e.g. Frankenberg et al., 2011). Satellite-based fluorescence can be used to infer the photosynthetic capacity of plant canopy. To understand how the canopy scale bidirectional fluorescence observations are related to three-dimensional fluorescence distribution within a plant canopy, it is necessary to evaluate canopy scale fluorescence emission using a detail plant canopy radiative transfer model. In this study, we developed a three-dimensional plant canopy radiative transfer model that can simulate the bidirectional chlorophyll fluorescence radiance. This modeling was based on the 3D radiative transfer model, forest light environmental simulator (FLiES) (Kobayashi and Iwabuchi, 2008). FLiES is a Monte Carlo ray-tracing model to simulate radiative field in shortwave (solar domain) and long-wave (thermal infrared) radiation in 3D landscape. To realize individual tree crown shapes, the original FLiES model used geometric objects such as cone, cylinder, and spheroid. Recently, FLiES has been extending to utilize voxel-based tree crown datasets, which are favorable to LiDAR based tree crown data sets. In this presentation, we show the current status of the development of the 3D chlorophyll fluorescence simulator.

Keywords: GOSAT, plant canopy radiative transfer model, chlorophyll fluorescence, GPP

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

ACG06-07 Room:315 Time:April 29 09:00-09:15

Orbital checkout status of the DPR on the GPM core spacecraft

KOJIMA, Masahiro[1*] ; FURUKAWA, Kinji[1] ; MIURA, Takeshi[1] ; HYAKUSOKU, Yasutoshi[1] ; KAI, Hiroki[1] ; ISHIKIRI, Takayuki[1] ; IGUCHI, Toshio[2] ; HANADO, Hiroshi[2] ; NAKAGAWA, Katsuhiro[2] ; OKUMURA, Minoru[3]

[1]Japan Aerospace Exploration Agency, [2]National Institute of Information and Communications Technology, [3]NEC TOSHIBA Space systems

The Dual-frequency Precipitation Radar (DPR) on the Global Precipitation Measurement (GPM) core satellite was developed by Japan Aerospace Exploration Agency (JAXA) and National Institute of Information and Communications Technology (NICT). The GPM is a follow-on mission of the Tropical Rainfall Measuring Mission (TRMM). The objectives of the GPM mission are to observe global precipitation more frequently and accurately than TRMM. The frequent precipitation measurement about every three hours will be achieved by some constellation satellites with microwave radiometers (MWRs) or microwave sounders (MWSs), which will be developed by various countries. The accurate measurement of precipitation in mid-high latitudes will be achieved by the DPR. The GPM core satellite is a joint product of National Aeronautics and Space Administration (NASA), JAXA and NICT. NASA developed the satellite bus and the GPM microwave radiometer (GMI), and JAXA and NICT developed the DPR. JAXA and NICT developed the DPR through procurement. The contract for DPR was awarded to NEC TOSHIBA Space Systems, Ltd.

The configuration of precipitation measurement using an active radar and a passive radiometer is similar to TRMM. The major difference is that DPR is used in GPM instead of the precipitation radar (PR) in TRMM. The inclination of the core satellite is 65 degrees, and the flight altitude is about 407 km. The non-sun-synchronous circular orbit is necessary for measuring the diurnal change of rainfall similarly to TRMM. The DPR consists of two radars, which are Ku-band (13.6 GHz) precipitation radar (KuPR) and Ka-band (35.5 GHz) precipitation radar (KaPR). The objectives of the DPR are
(1) to provide three-dimensional precipitation structure including snowfall over both ocean and land,
(2) to improve the sensitivity and accuracy of precipitation measurement,
(3) to calibrate the estimated precipitation amount by MWRs and MWSs on the constellation satellites.

The DPR consists of Ku-band (13.6 GHz) precipitation radar (KuPR) and Ka-band (35.5 GHz) precipitation radar (KaPR). The KuPR unit will measure 2.6m X 2.4m X 0.7m in size. The KaPR unit will measure 1.3m X 1.5m X 0.8m in size. Both KuPR and KaPR have almost the same design as TRMM PR. The DPR system design and performance were verified through the development test and the proto flight test. DPR has handed over to NASA and integration of the DPR to the GPM core spacecraft have completed in May 2012. GPM core spacecraft satellite system test has completed in November 2013. The results of the satellite system test concerning to the DPR satisfied system requirements.

GPM core observatory was shipped to Tanegashima Space Center, JAPAN and Launch Site Operations has started on November 2013 and GPM core observatory will be launched in February 2014. DPR orbital check out will be started in March 2014 and it will be completed in April 2014. The orbital check out status of DPR will be reported .

Keywords: GPM, DPR

ACG06-08 Room:315 Time:April 29 09:15-09:30

Status of the Japanese Global Precipitation Measurement (GPM) Research Project

OKI, Riko[1*] ; KACHI, Misako[1] ; KUBOTA, Takuji[1] ; MASAKI, Takeshi[1] ; KANEKO, Yuki[1] ; FURUKAWA, Kinji[1] ; TAKAYABU, Yukari[3] ; IGUCHI, Toshio[2] ; NAKAMURA, Kenji[4]

[1]JAXA, [2]NICT, [3]University of Tokyo, [4]Dokkyo University

The Global Precipitation Measurement (GPM) mission is a satellite program led by Japan and the U.S., to measure the global distribution of precipitation accurately in a sufficient frequency so that the information provided by this program can drastically improve hydrological predictions, climate modeling, and understanding of water cycles. The GPM Core Observatory carries the Dual-frequency Precipitation Radar (DPR) developed by Japan Aerospace Exploration Agency (JAXA) and the National Institute of Information and Communications Technology (NICT), and the GPM Microwave Imager (GMI) developed by the National Aeronautics and Space Administration (NASA). The frequent precipitation measurement about every three hours will be achieved by constellation satellites with microwave radiometers or microwave sounders, which will be developed by international partners. JAXA also provides the Global Change Observation Mission (GCOM) 1st ? Water (GCOM-W1) named "SHIZUKU," launched on May 18, 2012, as one of constellation satellites.

The Japanese GPM research project conducts scientific activities on algorithm development, ground validation, application research including production of research products. In addition to those activities, we promote collaboration studies in Japan and Asian countries, and seek potential users of satellite precipitation products. JAXA develops the DPR Level 1 algorithm, and the NASA-JAXA Joint Algorithm Team develops the DPR Level 2 and DPR-GMI combined Level2 algorithms. JAXA also develops the Global Rainfall Map algorithm, which is a new version of the Global Satellite Mapping of Precipitation (GSMaP), as one of national products to distribute hourly and 0.1-degree horizontal resolution rainfall map. In the GPM era, the GSMaP algorithm will be improved by refining rainfall retrievals over land, considered the orographic rainfall effects, added the rain gauge corrected rainfall product. In the future, information from the Dual-frequency Precipitation Radar (DPR) will be compiled as a database to improve the retrieval accuracy of weak rainfall in mid-to-high latitudes.

The GPM Core Observatory is scheduled to be launched from the JAXA Takengashima Space Center by the H-IIA F23 rocket around 3:07 a.m. thru 5:07 a.m. (JST) on February 28 (Fri.,) 2014. After the initial checkout (about 2-month,) calibration and validation of the DPR, GMI and other products will be implemented toward the public release of all products to general users. Data release date is currently scheduled to be 6-month after the launch.

Keywords: GPM, DPR, GSMaP, ground validation

ACG06-09 Room:315 Time:April 29 09:30-09:45

Initial validation results of Dual-frequency Precipitation Radar on Global Precipitation Measurement Core Observatory

KUBOTA, Takuji[1*] ; IGUCHI, Toshio[2] ; SETO, Shinta[3] ; AWAKA, Jun[4] ; URITA, Shinji[5] ; YOSHIDA, Naofumi[5] ; OKI, Riko[1]

[1]Japan Aerospace Exploration Agency, [2]National Institute of Information and Communications Technology, [3]Nagasaki University, [4]Tokai University, [5]Remote Sensing Technology Center of Japan

The Global Precipitation Measurement (GPM) Mission consists of a Tropical Rainfall Measuring Mission (TRMM)-like non-sun-synchronous orbiting satellite (GPM Core Observatory) and a constellation of satellites carrying microwave radiometer instruments. The GPM Core Observatory, which will be launched in 28 February 2014, carries the Dual-frequency Precipitation Radar (DPR) developed by the Japan Aerospace Exploration Agency (JAXA) and the National Institute of Information and Communications Technology (NICT). The DPR consists of two radars; Ku-band (13.6 GHz) precipitation radar (KuPR) and Ka-band (35.55 GHz) radar (KaPR). The DPR is expected to advance precipitation science by expanding the coverage of observations to higher latitudes than those obtained by the TRMM Precipitation Radar (PR), by measuring snow and light rain via high-sensitivity observations from the KaPR, and by providing drop size distribution (DSD) information based on the differential scattering properties of the two frequencies. For operational productions of precipitation datasets, it is necessary to develop computationally efficient, fast-processing DPR Level-2 (L2) algorithms that can provide estimated precipitation rates, radar reflectivity factors, and precipitation information, such as the DSD and precipitation type. The L2 algorithms have been developed by the DPR Algorithm Development Team under the NASA-JAXA Joint Algorithm Team.

Before the launch of the GPM Core Observatory, synthetic DPR Level-1 (L1) data are needed as a test bed for the DPR L2 algorithms. In this work, we use data simulated from the TRMM/PR. The primary advantage is that measured Ku-band data from the TRMM/PR, obtained under a wide variety of meteorological conditions, forms the basis of the simulation. As such, the results can be compared directly to the standard TRMM/PR retrievals. Thus, "at-launch" codes of DPR precipitation algorithms, which will be used in GPM ground systems at launch, were evaluated using synthetic data based upon the TRMM/PR data. Results from the codes (Version 4.20131010) of the KuPR-only, KaPR-only, and DPR algorithms were compared with "true values" calculated based upon drop size distributions assumed in the synthetic data and standard results from the TRMM algorithms at an altitude of 2 km over the ocean. The results indicate that the total precipitation amounts during April 2011 from the KuPR and DPR algorithms are similar to the true values, while the estimates from the KaPR data are underestimated. By analysis results, the underestimation of the KaPR can be caused by a problem in the attenuation correction method. This was verified by the improved codes (Version 4.20131129), and so this problem has been resolved in the latest version.

After the launch, calibration and validation of the DPR products will be implemented toward the public release of all products to general users. Data release date is currently scheduled to be 6-month after the launch. In this work, we introduce initial validation results of the DPR-L2 product, mainly based upon comparisons of the TRMM/PR product.

Keywords: Global Precipitation Measurement, Dual-frequency Precipitation Radar, algorithm, validation

ACG06-10 Room:315 Time:April 29 09:45-10:00

Expectations for the Global Precipitation Measurements for Precipitation Sciences

TAKAYABU, Yukari[1*] ; OKI, Riko[2] ; IGUCHI, Toshio[3] ; AONASHI, Kazumasa[4] ; KACHI, Misako[2] ; KUBOTA, Takuji[2] ; HAMADA, Atsushi[1] ; TAKAHASHI, Nobuhiro[3] ; NAKAMURA, Kenji[5]

[1]The University of Tokyo, [2]Japan Aerospace Exploration Agency, [3]National Institute of Information and Communications Technology, [4]Meteorological Research Institute, Japan Meteorological Agency, [5]Dokkyo University

Three dimensional precipitation data observed with Ku (13.8GHz) band Precipitation Radar (PR) on board the Tropical Rainfall Measurement Mission (TRMM) satellite have enabled us to discover various precipitation characteristics over the tropics and subtropics between 36N and 36S. Precipitation system regimes are estimated with precipitation characteristics. The multiple instrument observations of TRMM have also made us quantify the discrepancies between TRMM Microwave Imager (TMI) vs. PR estimated rainfall, and provided us with opportunities to investigate various approaches to improve the rainfall retrieval algorithms.

With the launch of the GPM/DPR, scheduled in February 2014, dual band measurements from space with Ku (13.6GHz) and Ka (35.5GHz) band frequencies will be started. Increasing information of the drop size distributions with DPR should improve the accuracy of precipitation profile structures, which are essential to study precipitation characteristics. GPM/DPR will provide excellent cross calibrations for constellation microwave observations to construct better mapping of precipitation from 65N to 65S, which covers 91% of the earth surface. Weak rainfall measurements will enable us better energy budget calculations after all, as well as more precise examinations of rainfall system lifecycles. We can also expect reexamination and further improvements of TRMM PR rainfall products by comparing Ku-band retrievals with DPR retrievals.

Three dimensional satellite measurement of precipitation at mid-to-high latitudes is a completely new scientific experiment. Since the precipitation systems there are very different from those in the tropics and subtropics, we can certainly expect further scientific discoveries to improve our knowledge of precipitation characteristics with thorough observations from the satellite. Using this outcomes, we also expect to provide useful knowledge to improve the numerical models for weather predictions and climate projections.

Keywords: GPM, DPR, Precipitation Science, TRMM, precipitation characteristics, satellite constellation

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

ACG06-11 Room:315 Time:April 29 10:00-10:15

The Global Precipitation Measurement (GPM) Mission: Advancing precipitation measurement for science and society

KIRSCHBAUM, Dalia[1*]

[1]NASA Goddard Space Flight Center

Too much or too little rain can serve as a tipping point for triggering catastrophic flooding and landslides or widespread drought. Knowing when, where and how much rain is falling globally is vital to understanding how vulnerable areas may be more or less impacted by these disasters. Global Precipitation Measurement (GPM) is an international satellite mission to provide next-generation observations of rain and snow worldwide every three hours. The foundation of the GPM mission is the Core Observatory satellite provided by NASA and JAXA. This satellite, launching in early 2014, carries advanced instruments that will set a new standard for precipitation measurements from space. The Core satellite will measure rain and snow using two science instruments: the GPM Microwave Imager (GMI) and the Dual-frequency Precipitation Radar (DPR). The GMI captures precipitation intensities and horizontal patterns, while the DPR provides insights into the three dimensional structure of precipitating particles. Together these two instruments provide a database of measurements against which other partner satellites' microwave observations can be meaningfully compared and combined to make a global precipitation dataset.

Data collected from the Core satellite serves as a reference standard that will unify precipitation measurements from research and operational satellites launched by a consortium of GPM partners in the United States, Japan, France, India, and Europe. The GPM constellation of satellites can observe precipitation over the entire globe within 3 hours of acquisition. The GPM mission will help advance our understanding of Earth's water and energy cycles, improve the forecasting of extreme events that cause natural disasters, and extend current capabilities of using satellite precipitation information to directly benefit society.

ACG06-12 Room:315 Time:April 29 10:15-10:30

Development of attenuation correction method for GPM/DPR

SETO, Shinta[1*] ; IGUCHI, Toshio[2]

[1]Graduate School of Engineering, Nagasaki University, [2]National Institute for Information and Communications Technology

A new attenuation correction method is developed for the Dual-frequency Precipitation Radar (DPR) on the core satellite of the Global Precipitation Measurement (GPM) mission. Hitschfeld and Bordan's attenuation correction method (HB method) assumes relation between the specific attenuation k and the effective radar reflectivity factor Z_e (k-Ze relation) as $k=aZ_e{}^b$. The new method is based on HB method, but k-Ze relation is modified as $k=eaZ_e{}^b$ by using dual-frequency ratio of Z_e (DFR) and surface reference technique (SRT). Therefore, the new method is called HB-DFR-SRT method (H-D-S method in short). While the authors' previous attenuation correction method called HB-DFR method (H-D method in short) results in underestimation of precipitation rates for heavy precipitation, H-D-S method and its improved version try to correct the negative bias by means of SRT. When only single-frequency measurement is available, H-D-S method can be easily switched to HB-SRT method (H-S method in short), which is similar to the attenuation correction method used in the TRMM/PR standard algorithm.

The attenuation correction methods are tested with a simple synthetic dataset of DPR. As long as SRT gives the prefect estimates of path integrated attenuation (PIA) and the parameters of k-Ze relation (a and b) are given properly so that e could be vertically constant, H-S method is much better than the dual-frequency methods. In reality, SRT has error and we cannot give the parameters of k-Ze relation properly so that e should be vertically variable. Tests with SRT error and vertical variation of e show that H-D method is better than H-S method for weak precipitation but H-S method is better than H-D method for heavy precipitation. It is because SRT is unreliable for weak precipitation and DFR is unreliable for heavy precipitation. H-D-S method shows not the best but stable results for both weak and heavy precipitation, and it may work well for medium precipitation. Quantitative evaluation should be done with real measurement dataset of DPR.

Keywords: DPR, GPM, attenuation correction

ACG06-13 Room:315 Time:April 29 10:30-10:45

Analysis of rain characteristics by using CloudSat and TRMM/PR

TAKAHASHI, Nobuhiro[1*]

[1]National Institute of Information and Communications Technology

Spaceborne cloud/precipitation radars are suitable for understanding the global climate (especially precipitation in this study) that means both the average figure of the Earth climate and the local climate in the global climate. In terms of precipitation climatology, major parameters are the precipitation amount and its diurnal/seasonal changes as well as the drop size information that is a kind of proxy of the precipitation processes such as warm/cold rain. The purpose of this study is to develop the climate map of precipitation by using CloudSat that equips W-band (94 GHz) radar and TRMM/PR that equips Ku-band (13.8 GHz) radar; rain amount is estimated by the TRMM/PR level 2 product (2A25) and the drop size information is obtained by combining the CloudSat and TRMM/PR. The basic idea of the analysis method is to compare the histograms of radar reflectivity factor (Z) at near-surface range bin at the overlapping Z range (weak to moderate rain echo). Because the both satellites have different orbit, only the statistical approach is available. Since the different Mie scattering effect appears for the different frequency and drop size, the Z value of rainfall is different between w- and Ku-band radar observations and it reflects the difference in the histograms of w- and Ku-band. Based on these characteristics, drop size information is estimated by comparing the histograms. In this study, median diameter (D0) is estimated. For the comparison of the estimation, D0 is estimated by TRMM/PR only.

Climate data are created in 10 x 10 degrees in latitude and longitude boxes and each box consists of the unconditional and conditional rain rate (the former corresponds the rain amount) and D0 (median diameter) both from the CloudSat-TRMM/PR combined analysis and TRMM/PR-only analysis for every seasons (DJF, MAM, JJA, and SON), diurnal cycle (night time/day time orbit) and over land or ocean.

The results show that the general characteristic of global maps of D0 through the year and local time is apparent land-ocean contrast; larger D0 appears over land and smaller D0 appears over ocean except for relatively small D0 over southeastern Asia to China. Also, relatively larger D0 appears in tropical area and mid latitude summer. Diurnal change of D0 can be seen by comparing the day/night time D0; D0 is larger in the night time over ocean while day time D0 is larger over land. Tropical Ocean shows smaller seasonal change, while larger changes are seen over mid-latitude area. Comparison of the two estimates of D0 between CloudSat-TRMM/PR combined estimation and TRMM/PR-only estimation.

Since the Dual-frequency Precipitation Radar (DPR) onboard Global Precipitation Measurement (GPM) core satellite, which is launched in February 2014, can estimate the drop size distribution (DSD), the approach in this study can be useful of evaluation of the algorithm for DSD estimation.

Keywords: rain, drop size distribution, CloudSat, TRMM

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

ACG06-14 Room:315 Time:April 29 11:00-11:15

Characteristic differences between the heaviest rainfall and the strongest convection

HAMADA, Atsushi[1*] ; TAKAYABU, Yukari[1]

[1]Atmosphere and Ocean Research Institute, The University of Tokyo

Regional and seasonal differences in the rain characteristics between rain-rate and convection extreme events are examined using 11-yr measurements from the Precipitation Radar (PR) onboard the Tropical Rainfall Measuring Mission (TRMM) satellite. After defining a rainfall event as a set of contiguous rainy pixels of TRMM PR measurements, three different types of regional extreme rainfall events are defined, using the maximum values of near-surface rainfall rate (NSR) and 30-dBZ echo top height (ETH30) in rainfall event; Rainfall events of which the maximum NSR is within top 0.1% at a grid but the ETH30 is not are defined as R-only extreme events, those of which the maximum ETH30 is within top 0.1% but the NSR is not are defined as H-only extreme events, and those of which both of the maximum NSR and maximum ETH30 are within top 0.1% are defined as RH extreme events. This is done on a local basis with 2.5 x 2.5 degree horizontal resolution to examine regional extreme events.

It is shown that the fractional occurrence of RH extreme events are less than 30% in most regions, indicating that only a few dozen percent of convection extremes are related to rain rate extremes. There are robust differences in echo profiles, rainfall characteristics, and local environments between R-only and H-only extreme events. These characteristic differences are basically independent on region and season, except for their seasonal occurrence. R-only extreme events exhibit lower echo-top height than H-only extremes, linear downward increase of radar reflectivity (Ze) below freezing level, and sharp upward decrease of Ze in 5-7 km, whereas H-only extreme events exhibit slight downward decrease of Ze below freezing level. R-only extreme events are almost in phase with mean monthly rainfall, while H-only extremes tend to peak slightly out of phase with rainy season. Local environments related to R-only extremes are less convectively unstable, wetter in the low-middle troposphere, and larger moisture flux convergence in the lowermost troposphere, compared with those related to H-only extremes. The features related to R-only extreme events imply a dominance of warm-rain process.

Keywords: precipitation, extreme event, TRMM

ACG06-15 Room:315 Time:April 29 11:15-11:30

The next-generation GSMaP MWI precipitation retrieval algorithm

AONASHI, Kazumasa[1*]

[1]Meteorological Research Institute Japan Meteorological Agency

1. Introduction

The current GSMaP Microwave Imager (MWI) precipitation retrieval algorithm degrades retrieval accuracy for weak precipitation areas where MWI brightness temperatures (TBs) are sensitive to physical variables other than precipitation. In order to address this issue, we have been developing a new algorithm that retrieves the physical variables including precipitation from MWI TBs. The basic idea of this algorithm is to derive the statistically optimal values of the physical variables, based on Bayes's theorem (Elsaessar and Kummerow 2008, Boukabara et.al 2011). We adopted an ensemble-based variational method (EnVA) for deriving the optimal values from MWI TBs that are non-linear functions of the physical variables. The retrieval algorithm consists of the precipitation detection part and the retrieval part for physical variables in precipitation areas. In this presentation, we will report the precipitation detection part.

2. Precipitation detection part

In the precipitation detection part, we chose surface temperature (Ts), sea surface wind speed (SWS), precipitable water content (PWC), and cloud liquid water content (CLWC) as the over-sea control variables, Ts and surface emissivity (Es) as the over-land control variables, assuming no precipitation.

The EnVA employed forecasts of a cloud-resolving model (CRM) as the first guess of the physical variables, and estimated the first guess error covariance from CRM ensemble forecast. The EnVA calculated innovations and post-fit residuals of MWI TBs that were then used for the precipitation detection.

Keywords: GSMaP, MWI, GPM, GCOMW, precipitation retrieval

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

ACG06-16 Room:315 Time:April 29 11:30-11:45

Gage Adjusted Global Satellite Mapping of Precipitation (GSMaP Gauge)

MEGA, Tomoaki[1*] ; USHIO, Tomoo[1] ; KUBOTA, Takuji[2] ; KACHI, Misako[2] ; AONASHI, Kazumasa[2] ; SHIGE, Shoichi[4]

[1]Graduate School of Engineering, Osaka University, [2]Japan Aerospace Exploration Agency, [3]Meteorological Research Institute, [4]Graduate School of Science, Kyoto University

Fresh water is one of the most important resources for human. Precipitation is the main source of fresh water. Precipitation is also heating atmosphere by latent heat and one of important energy transport mechanism of atmosphere. Knowledge of world precipitation activity is important information for not only human activity, but also earth science.

Passive Microwave Radiometer (PMR) is a small and low power consumption sensor, thus many space-borne PMRs observe precipitation from low earth orbit. Space-born PMR provides uniform quality and stable observation data all over the world. PMR have become the precipital sensors for global precipitation retrieval, since these emission and scattering signals have a more direct relationship with precipitation rates than infrared radiometer (IR). The Global Satellite Mapping of Precipitation (GSMaP) project is developing PMR algorithm to provide global precipitation map with space-born PMRs. The GSMaP's goal is to develop the algorithm of high precision and eventually to produce a global precipitation map with high temporal (one hour) and special resolution (0.1 degree). PMR swathes, however, do not cover all surface in one hour. Therefore, it is necessary to utilize a gap-filling technique to generate precipitation maps with high temporal resolution. GSMaP derives Moving Vector (MV) from two successive IR images. GSMaP algorithm interpolates precipitation between gaps when PMRs overpass successive swath with MV by Kalman-filter. GSMaP algorithm now produces 0.1-grid-resolution precipitation map every one hour. Some evaluations, however, show the tendency of underestimation compared to some ground based observations, because PMR precipitation estimation over land has difficulty due to emission variability in surface. Rain gauge provides reliable data, and a rain gauge collects precipitation for certain period at a fixed location. PMR observes signals from precipitation instantaneously. We are developing the GSMaP gauge adjusted product (GSMaP Gauge). The GSMaP Gauge algorithm fits the GSMaP precipitation map to NOAA Climate Prediction Center (CPC) global rain gauge data set. The CPC data set is provided daily with low resolution (0.5-grid-degree). Quality of the CPC data set is not uniform (Quality of gauge-based analysis depends on density of rain gauge). We fill the gap of the precipitation estimation between the satellite and rain gauge attributable to the retrieval difficulty, the spatial and temporal resolution difference. The GSMaP Gauge succeeded to reduce the under estimation of the GSMaP algorithm. In this presentation, we introduce the GSMaP Gauge and its performance.

Keywords: Precipitation, Satellite observations, Microwave observations, Remote sensing

ACG06-17 Room:315 Time:April 29 11:45-12:00

Current Status of the Products of AMSR2 on GCOM-W1 Satellite

OKI, Taikan[1*] ; KACHI, Misako[2] ; NAOKI, Kazuhiro[2] ; HORI, Masahiro[2] ; MAEDA, Takashi[2] ; IMAOKA, Keiji[2]

[1]Institute of Industrial Science, The University of Tokyo, [2]Earth Observation Research Center, Japan Aerospace Exploration Agency

The Advanced Microwave Scanning Radiometer 2 (AMSR2), on board the first generation satellite of Global Change Observation Mission - Water (GCOM-W1 or "SHIZUKU") satellite, is multi-frequency, total-power microwave radiometer system with dual polarization channels for all frequency bands. The GCOM-W1 satellite was launched on May 18, 2012 (JST), and has started scientific observation since July 3, 2012. After the calibration and validation phase, which confirmed that all the pre-defined release accuracies are satisfied, the AMSR2 bright temperature product (Level 1) and geophysical parameter product (Level 2) were released to public since January 2013 and May 2013, respectively.

Monitoring and validation of the AMSR2 geophysical parameters have been continued for further improvements of the observation accuracy in future algorithms. For example, the precipitation product is validated by comparing with the Precipitation Radar (PR) on board the Tropical Rainfall Measuring Mission (TRMM) satellite, and relative errors were 48% over ocean and 88 % over land for the period from September 1, 2012 to August 31, 2013.

Quality control (QC) of in-situ data is also improved for the better validation. New QC method for buoy data, which is used in the validation of the sea surface temperature (SST) and sea surface wind speed products, is introduced to remove unreliable in-situ observation data from comparisons, including overlap check, movement speed check, comparison with numerical model, and statistical check by Bayes' theorem. Those efforts will contribute to improve the algorithm for future version-up.

The AMSR2 standard products have been distributed through the GCOM-W1 Data Providing Service (https://gcom-w1.jaxa.jp/), and quick look of the products, browse images of all AMSR2 brightness temperatures and geophysical parameters are available at the JAXA Satellite Monitoring for Environmental Studies (JASMES) for Water Cycle (http://kuroshio.eorc.jaxa.jp/JASMES/WC.html).

Keywords: earth observation, hydrologic cycles, geophysical products, validation, data distribution

ACG06-18 Room:315 Time:April 29 12:00-12:15

Applications of ocean surface wind direction signals in microwave imager observation for atmospheric humidity analysis

KAZUMORI, Masahiro[1*]

[1]Japan Meteorological Agency

An empirical relative wind direction (RWD) model function was developed to represent azimuthal variations of oceanic microwave brightness temperatures of vertical and horizontal polarizations. The RWD model function was based on measurements of observed brightness temperature from the Advanced Microwave Scanning Radiometer and wind vector from SeaWinds, both on board the Advanced Earth Observing Satellite - II, and Special Sensor Microwave Imager Sounder (SSMIS) first guess departure and wind vector data in European Centre for Medium-Range Weather Forecasts (ECMWF) Integrated Forecasting System. The model function was introduced to a microwave ocean emissivity model; a FAST microwave Emissivity Model (FASTEM) in a radiative transfer model for satellite radiance assimilation. Performances of the RWD model function were much more realistic than present azimuthal model functions in FASTEM for low wind speed and high frequency channels.

An assimilation experiment using the RWD model function was performed in the ECMWF system. The experiment demonstrated reductions of first guess departure biases arising from modelling of the azimuthal variations in areas of high wind speed and low variability of wind direction. For example, bias reductions in ascending and descending SSMIS 19 GHz vertical polarized brightness temperature in Somali jet at the Arabian Sea were approximately 0.6 K and 0.7 K. The bias reductions were found for all assimilated microwave imager channels in a wide wind speed range. Moreover, analysis increments of specific humidity in the lower troposphere were reduced (e.g., 0.3 g kg^{-1} reduction at 1000 hPa in the Somali jet). We found improvements of relative humidity and temperature in short-range forecasts in the lower troposphere. The experiment results clearly showed the importance of modelling the azimuthal variation of emissivity for assimilation of microwave imager observations. The RWD model function should be included in the radiative transfer model used in the microwave radiance assimilation observation operator.

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

ACG06-19 Room:315 Time:April 29 12:15-12:30

Polar Research using Satellite Microwave Remote Sencing

ENOMOTO, Hiroyuki[1*] ; ALIMASI, Nuerasimuguli[1] ; SURDYK, Sylviane[1] ; FUJITA, Shuji[1] ; YABUKI, Hironori[2] ; SUGIMURA, Takeshi[1] ; SUGIYAMA, Shin[3] ; HOLMRUND, Per[4] ; INGVANDER, Susanne[4]

[1]National Institute of Polar Research, [2]JAMSTEC, [3]Hokkaido University ILTS, [4]Stockholm University

Satellite Microwave remote sensing is the powerful tool to investigate polar regions. The data enables monitoring and surveying ice sheet, sea ice,snow cover conditions for large scale and continuous monitoring in the changing climate, and , and studying their changing mechanisms. Satellite passive microwave observation has almost 30-years long data set which contribute climatological study. The recent GCOM-W data is useful for more precise investigations.

For the Arctic study, GRENE Arctic climate research project(2011-2016) has started by integrating Japanese scientific activities. satellite microwave data is very important to this project since satellite data expands availability of site data to large area and long term. The Arctic project enhances interdisciplinal study and collaboration between modelling and observation. Multi-discipilinaly information and scale-upping by satellite is very important.

Keywords: Polar region, Arctic, Antarctic, Cryosphere, satelllite, Mirowave

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

ACG06-20 Room:315 Time:April 29 12:30-12:45

Sea-ice production in Antarctic coastal polynyas estimated using AMSR-E data

NIHASHI, Sohey[1*] ; OHSHIMA, Kay I.[2]

[1]Department of Mechanical Engineering, Tomakomai National College of Technolog, [2]Institute of Low Temperature Science, Hokkaido University

Coastal polynyas are newly-forming sea-ice areas formed by divergent ice drift due to prevailing winds and/or ocean currents. In coastal polynyas, huge amounts of heat flux from the ocean to the atmosphere occur because the heat insulation effect of sea-ice is greatly reduced in the case of thin ice, and accordingly sea ice is formed actively. Dense water formed in Antarctic coastal polynyas with the intense sea-ice production is a major source of Antarctic Bottom Water, which is a key player in the global climate system.

In this study, an algorithm for estimating daily thin ice thickness is developed based on a relationship between polarization ratios (PR) of AMSR-E brightness temperatures (TBs) and thermal ice thickness. The TBs at 89 GHz and 36.5 GHz are used. The thermal ice thickness is based on heat flux calculation using ice surface temperatures derived from satellite thermal infrared images. We used cloud-free MODIS images.

In the Antarctic Ocean, landfast sea-ice (fast ice), which is stationary sea ice attached to coastal features such as grounded icebergs, is formed along the coast. Antarctic coastal polynyas tend to be formed adjacent to fast ice. The AMSR-E ice thickness algorithm possibly mis-classifies fast ice as thin ice, because the PR values of thin ice and fast ice are similar. Thus, also the fast ice detection algorithm is developed. Monthly fast ice extent is detected based on microwave characteristics that the horizontally- and vertically-polarized TBs of fast ice tend to be lower than those of thin ice and are similar to those of ice sheet close to the coast.

The spatial resolution of AMSR-E is about 6.25 km, and the pixel density is four times higher than that of SSM/I which has been used in previous studies. This advantage is critical for the coincident detection and monitoring of coastal polynyas and fast ice because their areal extent is fairly small (tens to a hundred kms at most). The accuracy of the created AMSR-E dataset is validated from comparisons with backscatter images acquired by ASAR on Envisat.

Sea-ice production in Antarctic coastal polynyas is estimated based on heat flux calculation using the AMSR-E dataset. For the estimation, it is assumed that heat from the ocean below is negligible and that all of the heat loss to the atmosphere goes towards freezing. The sea-ice production estimated using the AMSR-E data has been improved from the SSM/I ice production because of the finer spatial resolution. First, the AMSR-E data can better resolve the high production area close to the coast. Second, false sea-ice production in the fast ice pixels mis-included by SSM/I is corrected because AMSR-E can detect fast ice that cannot be resolved by SSM/I. In fact, the total sea-ice production in each polynya by AMSR-E does not change much from the SSM/I ice production for many polynyas because these two effects of opposite direction compensate for each other. The AMSR-E dataset presented in this study would give the boundary/validation data of sea-ice production and fast ice for modeling studies.

Keywords: AMSR-E, Antarctic Ocean, Coastal polynyas, Sea-ice production, Antarctic Bottom Water

ACG06-21 Room:315 Time:April 29 14:15-14:30

A proposal of mission combining active and passive microwave sensors and its applications for global water cycle

EBUCHI, Naoto[1*]

[1]Hokkaido University

A mission carrying active and passive microwave sensors is proposed to monitor the global water cycle and air-sea coupling. The passive microwave sensor will be a successor of AMSR2 on GCOM-W2, which was launched by JAXA on 12 May 2012. Channels to observe solid precipitation will also be added to AMSR2. The active sensor will be a scatterometer at operated at Ku- and Ka-bands. The Ka-band scatterometer can measure vector wind fields near the coasts with higher spatial resolution than the Ku-band scatterometer, which is similar to SeaWinds on QuikSCAT and ADEOS-II and OSCAT on Oceansat-2. Merits of the combination of the active and passive microwave sensors will be discussed in aspects of sensor and science synergisms. The microwave radiometer contributes to improve accuracy of vector wind measurements by the scatterometer under rain conditions. The wind direction provided by the scatterometer improves accuracy of the SST, water vapor and precipitation measured by the radiometer. The science synergy includes applications for studies of monsoon, tropical cyclones, air-sea coupling in various scales, global and regional water cycles, sea ice, soil moisture and snow over land.

Keywords: remote sensing, microwave radiometer, microwave scatterometer, water cycle, air-sea interaction

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

ACG06-22 Room:315 Time:April 29 14:30-14:45

Upwelling events at the western African coast related to atmospheric structures: An analysis with satellite observations

DESBIOLLES, Fabien[1*] ; BLANKE, Bruno[1] ; BENTAMY, Abderrahim[2]

[1]Laboratoire de Physique des Oceans (LPO), UMR 6523 CNRS-Ifremer-IRD-UBO, Brest, France, [2]Laboratoire d'Oceanographie Spatiale (LOS), IFREMER, centre de Brest, France

Satellite scatterometers provide continuously valuable surface wind speed and direction estimates over the global ocean on a regular grid both in space and time. The Level 3 data derived from the Advanced Scatterometer (ASCAT), available at 1/4^o spatial resolution (hereafter AS25), and Quick Scatterometer (QuikSCAT), available on 1/2^o and 1/4^o horizontal grids (QS50 and QS25 respectively), are studied at regional scales in both the Benguela and Canary upwelling systems. They are compared to the European Center for Medium-Range Weather Forecast surface wind analysis, with insight into their intrinsic and effective spatial resolutions. In the coastal band, the finest spatial patterns are found in the QS25 winds and are O(75km). This demonstrates the sensitivity of the high-resolution satellite-derived winds to coastal processes related to sea surface temperature (SST) perturbations and land-sea transition. More specifically, mesoscale coupling processes between SST and winds play a leading part in structuring the wind stress curl in both the Canary and Benguela upwelling systems. These processes act especially over the upwelling extension zone (O(100km) off the coast). Next, short-lived upwelling episodes (SUEs) calculated from SST anomalies are defined consistently with the QS25 effective resolution. These cold events refer to local, short-lived perturbations that add to seasonal upwelling variability. We characterize concomitant atmospheric synoptic conditions for SUEs identified at chosen latitudes and highlight two subregions in both upwelling systems, with contrasted patterns for the alongshore wind stress component and curl. The complexity of the latter patterns is closely linked to local, short-term SST variability. Closer to the shore, wind stress curl patterns derived from QS25 are only loosely related to SST/wind interactions and, as a working hypothesis, can also be associated with orographic effects that may play an important role in cooling processes. The derivation of a realistic coastal wind drop-off from satellite observations is an almost impossible task, first because a blind zone at the coast, second because the horizontal scales of pure orographic effects (a few tens of kilometers) are finer than the effective resolution of the satellite-derived product (~75km). However, an alternative assessment can be given by evaluating the ocean response to contrasted coastal wind profiles. Numerical sensitivity experiments show that the imbalance between Ekman transport and Ekman pumping has an impact on ocean dynamics: a reduction of the wind in the QS25 forcing, partly induced by orography, contributes to SST cooling.

Keywords: scatterometry, upwelling dynamics, SST/Wind Interactions, orography effects, air-sea coupling

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

ACG06-23 Room:315 Time:April 29 14:45-15:00

The GNSS Ocean Winds and AIS Mission, An Earth Science and Marine Safety Satellite Constellation

ROSE, Randall[1*] ; GLEASON, Scott[1] ; RUF, Christopher[2] ; KITAZAWA, Yukihito[3] ; TANIMOTO, Kazuo[4]

[1]Southwest Research Institute, [2]University of Michigan, [3]IHI Corporation, [4]Meisei Electric Co., Ltd.

Recent developments in electronics and nano-satellite technologies combined with modeling techniques developed over the past 20 years have enabled a new class of remote wave and wind sensing capabilities that offer markedly improved performance over existing observatories while opening avenues to new applications. Most existing space borne ocean wind observatories operate in the C and Ku-bands which obscures key information about the ocean and the global climate. Using GNSS-based bi-static scatterometry performed by a constellation of nano-satellites, ocean wave and wind data can be provided with unprecedented temporal resolution and spatial coverage across the full dynamic range of ocean wind speeds in all precipitating conditions.

The NASA Cyclone Global Navigation Satellite System (CYGNSS) is a space borne mission being developed to study tropical cyclone inner core processes. CYGNSS consists of 8 GPS bi-static radar receivers to be deployed on separate nano-satellites in October 2016. It is anticipated that numerous additional Earth science applications can also benefit from the cost effective high spatial and temporal sampling capabilities of GNSS remote sensing. These applications include monitoring of rough and dangerous sea states, global observations of sea ice cover and extent, meso-scale ocean circulation studies, and near surface soil moisture observations.

The Automatic Identification System (AIS) is a maritime system used for global identification and tracking of ships. It is proposed as part of the GNSS Ocean Winds and AIS (GOWA) nano-satellite constellation concept to combine and improve upon the GNSS remote sensing capability of CYGNSS with a space based AIS system. GOWA will be capable of monitoring both the ocean roughness and the locations of ship traffic at the same time. This will result in both an increase in maritime safety and valuable Earth science measurements of ocean winds, sea ice and land surfaces.

This presentation will present a summary of the CYGNSS mission and plans for future instrument development to increase the number of science observations. The goal of this development is to enable the GOWA mission being proposed for Japanese science and maritime safety applications.

Keywords: GNSS, Earth Science, Remote Sensing, Satellites, GPS

ACG06-24 Room:315 Time:April 29 15:00-15:15

Development of Cloud Profiling Radar (CPR) for Earth Clouds, Aerosols and Radiation Explorer (EarthCARE) mission

SEKI, Yoshihiro[1*] ; TOMITA, Eiichi[1] ; KIMURA, Toshiyoshi[1] ; NAKATSUKA, Hirotaka[1] ; AIDA, Yoshihisa[1] ; OKADA, Kazuyuki[1] ; IIDE, Yoshiya[1] ; KADOSAKI, Gaku[1] ; TAKAHASHI, Nobuhiro[2] ; OHNO, Yuichi[2] ; HORIE, Hiroaki[2] ; SATO, Kenji[2]

[1]Japan Aerospace Exploration Agency, [2]National Institute of Information and Communications Technology

Earth Clouds, Aerosols and Radiation Explorer (EarthCARE) is a Japanese-European collaborative Earth observation satellite mission aimed to deepen understanding of the interaction process between clouds and aerosols and its effects on the Earth's radiation. The outcome of this mission is expected to improve accuracy of the Global Climate Change prediction.

The EarthCARE spacecraft, which weighs approximately 2,250kg and goes along a Sun-Synchronous 400km-hight orbit around the Earth, accommodates four instruments which are to observe the Earth's clouds, aerosols and radiation. The observation data acquired simultaneously by the four sensors will be processed into a variety of synergy products including vertical profiles of clouds and aerosols, microscopic cloud parameters, radiation fluxes and so on. As one of those observatories, the Cloud Profiling Radar (CPR), which has a 2.5m-diameter main reflector and W-band 1.5kW transmitter and receiver, is the world's first space-borne Doppler cloud radar jointly developed by the Japan Aerospace Exploration Agency (JAXA) and the National Institute of Information and Communications Technology (NICT), which provides vertical velocity as well as vertical structure inside clouds. The other payloads on the satellite are the Atmospheric Lidar (ATLID) for vertical structure measurement of clouds and aerosols, the Multi-Spectral Imager (MSI) for horizontal distribution measurement of clouds and aerosols, and the Broad-Band Radiometer (BBR) for measurement of radiation fluxes at top of the atmosphere. ATLID, MSI, BBR and the base-platform of the spacecraft are developed by the European Space Agency (ESA).

In Japan, the critical design review of the CPR has been completed in 2013 and CPR proto-flight model is currently being manufactured, integrated, and tested. After handed-over to ESA, the CPR will be installed onto the EarthCARE satellite together with the other instruments, tested, transported to Guiana Space Center in Kourou, French Guiana and launched by a Soyuz launcher in JFY2016.

Keywords: Cloud, Aerosol, Radiation, EarthCARE, CPR, Cloud Profiling Radar

ACG06-25 Room:315 Time:April 29 15:15-15:30

Shortwave direct aerosol radiative forcing using CALIOP and MODIS measurements

OIKAWA, Eiji[1*] ; NAKAJIMA, Teruyuki[1] ; WINKER, David[2]

[1]AORI, University of Tokyo, [2]NASA Langley Research Center

The aerosol direct effect occurs by direct scattering and absorption of solar and thermal radiation. Shortwave direct aerosol radiative forcing (SWDARF) under clear-sky condition is estimated about 5 Wm^{-2} from satellite retrievals and model simulations [e.g., *Yu et al*., 2006]. Simultaneous observations of aerosols and clouds are, however, very limited to validate the estimation of SWDARF under cloudy-sky condition. In 2006, the CALIPSO (Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations) satellite was launched with the space-borne lidar, CALIOP (Cloud-Aerosol Lidar with Orthogonal Polarization). This enabled us to get data of the vertical distribution of aerosols and clouds all over the world. *Oikawa et al.* [2013] estimated SWDARF under clear-sky, cloudy-sky, and all-sky conditions using CALIOP Version 2 data and MODIS (Moderate resolution Imaging Spectrometer) data. They investigated four scenarios for evaluating the SWDARF: clear-sky, the case that aerosols exist above clouds (above-cloud case), the case that aerosols exist below high-level clouds (below-cloud case), and the case that aerosols are not detected by CALIOP in cloudy-sky condition. The cloudy-sky SWDARF is, then, estimated by the latter three scenarios. The all-sky SWDARF is the combination of clear-sky and cloudy-sky SWDARF weighted by the cloud occurrence.

We calculated SWDARF from 2007 to 2009 using CALIOP Level 2 Cloud and Aerosol Layer Products Version 2 (V2) and Version 3 (V3) with the method of *Oikawa et al.* [2013]. The procedure of daytime calibration, cloud screening, and aerosol-cloud classification are improved in the V3 algorithms [*Powell et al*., 2010; *Vaughan et al*., 2010; *Liu et al*., 2010]; therefore, the distributions of aerosols and clouds are significantly changed from V2 data. Compared V3 data with V2 data, the total cloud fraction and occurrence probability of above-cloud case decrease. In clear-sky condition, marine aerosols increase and single scattering albedo (SSA) of total aerosols increases over the ocean. In cloudy-sky condition, smoke and polluted dust decrease. Annual zonal averages of SWDARF from 60^{o}S to 60^{o}N under clear-sky, cloudy-sky, and all-sky are -2.85, -0.16, and -0.78 Wm^{-2} for V2 data and -3.70, -1.07, and -2.02 Wm^{-2} for V3 data. It indicates that SWDARF largely depends on the retrieval and classification algorithms of aerosols and clouds.

Previous studies reported that the aerosol absorption above clouds cause the underestimation of cloud optical thickness (COT) in the satellite retrievals [*Haywood et al*., 2004; *Coddington et al*., 2010]. We, therefore, have a plan to examine the effect on SWDARF from underestimation of COT.

Keywords: aerosol, radiative forcing, DARF, CALIPSO, CALIOP

ACG06-26 Room:315 Time:April 29 15:30-15:45

A new method for estimating biases in multi-spectral cloud parameter retrievals caused by cloud horizontal inhomogeneity

NAGAO, Takashi[1*] ; NAKAJIMA, Takashi[1]

[1]Tokai University

Clouds play an important role in terrestrial atmospheric dynamics, thermodynamics, and radiative transfer and are key elements of the water and energy cycles. Modification of cloud properties, lifetime, and amount by indirect aerosol effects has an effect on radiative forcing in the climate. Cloud observations using satellite-borne multispectral imagers (e.g. Aqua/MODIS, GCOM-C/SGLI and EarthCARE/MSI) provide data sets useful for understanding cloud characteristics and their distributions on a global scale. Previous studies, however, pointed out that cloud parameters (e.g. cloud optical thickness, cloud particle effective radius and cloud top temperature) retrieved from multispectral measurements were significantly impacted by vertical and horizontal inhomogeneities of clouds, bimodal particle size distributions in drizzling clouds, and three-dimensional radiative transfer. In this study, we suggest a new method for estimating bias in multi-spectral-retrieved cloud parameters caused by cloud horizontal inhomogeneity. The impact of cloud horizontal inhomogeneity is considered as a key for interpreting discrepancies between cloud parameters from satellite observations and in-situ measurements or numerical cloud models. The estimation method considers the bias as the combination of the following two impacts: One is the impact of clear-contamination in cloud pixel, which is parameterized by cloud-fraction. The other is the impact of subpixel scale variance of cloud properties (but no clear-contamination), which is parameterized by variance of multi-spectral radiances in sub-pixels, and based on error propagation theory. We evaluate the method by using high-spatial resolution measurements of Landsat 8. Additionally, to apply the method to several multi-spectral imagers (e.g. MODIS, GCOM-C/SGLI and EarthCARE/MSI), we also investigate co-variance matrices of adjacent pixels or sub-pixels obtained from different IFOVs because the accuracy of the method depends on the accuracy of the co-variance matrix.

ACG06-27 Room:315 Time:April 29 15:45-16:00

A study of the earth radiation budget using a 3D Monte-Carlo radiative transfer code (2)

OKATA, Megumi[1*] ; NAKAJIMA, Teruyuki[1]

[1]University of Tokyo, Atmosphere and Ocean Research Institute

The purpose of this study is to evaluate the earth radiation budget when data are available from satellite-borne active sensors, i.e. cloud profiling radar (CPR) and lidar, and a multi-spectral imager (MSI) in the project of the Earth Explore/EarthCARE mission. The scientific requirement of the evaluation accuracy is less than 10 Wm-2 for the upward broadband radiative flux for the instantaneous 10kmx10km footprint of CPR (EarthCARE, 2006). For this purpose, we first developed forward and backward 3D Monte Carlo radiative transfer codes called MCsatr that treat a broadband solar flux calculation including thermal infrared emission calculation by k-distribution parameters of Sekiguchi and Nakajima (2008). We have developed Forward and Backward Monte Carlo radiative transfer codes, and we have also developed both of two types for deciding optical mean path by extinction transmittance and scattering transmittance for Forward Monte Carlo radiative transfer code.

In evaluation system, 3D extinction coefficient fields are constructed by two methods: 1) the Minimum Information Deviation Profiling Method (MIDPM) (Barker and Donovan et. al., 2011) and 2) numerical simulation by bin-spectral non-hydrostatic cloud model. In the MIDPM, we first construct a library of pair of observed vertical profiles from active sensors and collocated imager products at the nadir footprint, i.e. spectral imager radiances, cloud optical thickness (COT), effective particle radius (RE) and cloud top temperature (Tc). We select a best matched active sensor-derived vertical profiles from the library for each of off-nadir pixels of the imager where active sensor-derived vertical profile is not available, by minimizing the deviation between library imager parameters and those at the pixel, to construct the 3D cloud field. We applied this method to data of Cloudsat/CPR and AQUA/MODIS for a case of summer stratus cloud of California coast on July 2, 2007.

The second construction of 3D cloud systems is performed by numerical simulation of Californian summer stratus clouds using an non-hyderostatic atmospheric model coupled with a bin-spectral cloud microphysics model based on the NHM+ACBM model (Iguchi et al., 2008; Sato et al., 2009, 2011). Most inner region of a three-fold nesting system is an area of 30km$*$30km$*$1.5km with horizontal (vertical) grid spacing of 100m (20m) and 300m (20m). Two different cell systems were simulated for small and large cloud condensation nuclei (CCN) concentration. The area mean cloud optical thickness, $<$COT$>$, and standard deviation are 3.0 and 4.3 for pristine case and 8.5 and 7.4 for polluted case.

We then re-calculated the solar radiation field by two types of Fowrad MCstar. We compared flux reflectivities of the 3D atmospheres with those by Plane Parallel Approximation (PPA) and Independent Pixel Approximation (IPA) (Cahalan et al., 1994). As expected, the reflectivity difference between 3D and PPA clouds increases with increasing COT horizontal variability of the 3D clouds. The reflectivity difference between 3D and PPA reaches 0.078 at maximum, which is equivalent to a solar radiative flux error of 70 Wm-2.

On the other hand, the IPA result between the two cases are significantly different. We infer this difference is caused by difference in the spatial characteristic size of inhomogeneity. The mean extinction of the cloud system is of 5 to 8 km-1, so that the kilometer-size clouds in the satellite case are optically dense enough to be approximated by IPA. The difference is less than 0.010 in reflectivity or 10 Wm-2 in upward flux. On the other hand, the model simulation case is optically thin to be approximated by IPA. The error reaches 0.07 at maximum by pristine case. A future work is needed to correct this significant error utilizing the 3D structure of the cloud system.

Keywords: 3D radiative transfer, MIDPM, Monte Carlo

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

ACG06-28 Room:315 Time:April 29 16:15-16:30

Synergistic use of the geostationary and the polar orbit satellites for surveying the cloud evolution process: plan

NAKAJIMA, Takashi[1*] ; NAGAO, Takashi[1] ; LETU, Husi[1]

[1]Tokai University

The use of spaceborne radar and imager aboard the CloudSat, Aqua, EarthCARE, GCOM-C1, and the 3rd generation geostationary satellites for investigating cloud evolution process, is suggested. These satellites have been in orbit or will be launched in the middle of 2010-era and contribute for observing aerosols, clouds on the earth system. Since aerosols and clouds exert an important influence on the planet water and energy balances, more understanding of their lifecycle is required. Optical thickness and particle size of clouds are primal information for estimating the cloud evolution process. These parameters are retrieved from multi-spectral imageries obtained from space-borne satellite sensors. Recently, active sensors, such as the CloudSat cloud profiling radar (CPR) and the CALIPSO Lidar present a new epoch of aerosol and cloud observation with the purpose of revealing transition of particles, from cloud condensation nuclei to rain droplets via cloud and drizzle particles. They observe vertical cross section of the cloud system along the satellite footprint. As follow on the CloudSat / CALIPSO, the EarthCARE that has both active and passive sensors is planed by JAXA, NICT, and ESA collaboration. Doppler capability of the EarthCARE CPR will reveals vertical motion of cloud particles. Moreover, the 3rd generation geostationary weather satellite will appear in 2015 and observe aerosol and cloud system in every 10 or 2.5 minutes. Therefore, it is expected that the combined use of polar orbital passive/active sensors and geostationary satellites reveal details of cloud evolution process, statistically and dynamically. In this presentation, we introduce recent progresses of aerosol and cloud observations from satellites, showing the multi-sensor views of cloud growth process obtained from an active radar (CPR) and a passive imager (MODIS).

Keywords: Cloud evolution, Satellite, GCOM, EarthCARE

ACG06-29 Room:315 Time:April 29 16:30-16:45

Retrieval algorithm for aerosols based on GCOM-C1/SGLI

SANO, Itaru[1*] ; MUKAI, Sonoyo[1] ; NAKATA, Makiko[1] ; HOLBEN, Brent[2] ; DUBOVIK, Oleg[3] ; KOKHANOVSKY, Alexander[4]

[1]Kinki University, [2]NASA/GSFC, [3]Lille University, [4]EUMETSAT

It is known that atmospheric aerosols have valuable information in many research fields. However estimation of aerosol direct and indirect effects on climate changes in the 5th report of IPCC still involves large uncertainty due to lack of precise aerosol properties.

JAXA (Japanese space agency) is developing the GCOM-C (Global change observing mission?climate) satellite series, which are expected to provide us new aerosol information as well as geo-physical parameters for thirteen years after launch. The first of GCOM-C series will carry the SGLI (second generation global imager) sensor which observes total radiance from near UV to thermal infrared wavelengths including polarization measurements at red and near IR. This work intends to develop an efficient algorithm for aerosol retrieval based on this polarization information to be given by GCOM-C1/SGLI.

Keywords: Aerosol, SGLI, GCOM-C

ACG06-30 Room:315 Time:April 29 16:45-17:00

Ocean primary production algorithm for the GCOM-C1/SGLI

HIRAWAKE, Toru[1*] ; FUTSUKI, Ryosuke[1] ; SHINMYO, Katuhito[1] ; TAKAO, Shintaro[2] ; FUJIWARA, Amane[3] ; SAITOH, Sei-ichi[1]

[1]Faculty/Graduate School of Fisheries Sciences, Hokkaido University, [2]Faculty of Environmental Earth Science, Hokkaido University, [3]National Institute of Polar Research

One of the objectives of second-generation global imager (SGLI) on the earth observation satellite, Global Change Observation Mission 1st-Climate (GCOM-C1) is to understand the global carbon cycle. Therefore, estimation of column integrated daily net primary production (PP_{eu}) as carbon assimilation by photosynthesis of phytoplankton in the ocean is essential for the objective of SGLI/GCOM-C1 project. Most of the algorithms developed in the past used chlorophyll *a* (chl *a*) concentration. However, estimation of chl *a* concentration from satellite data has uncertainty due to the effect of pigment packaging that leads to underestimation, and the interference of colored dissolved organic matter (CDOM) which leads to overestimation. Another uncertainty is derivation of photosynthetic rate of phytoplankton. Although the vertically generalized productivity model (VGPM) which is one of the frequently used algorithms expressed the maximal photosynthetic rate ($P^B{}_{opt}$) as a function of sea surface temperature (SST), the SST derived $P^B{}_{opt}$ had large error, particularly in the polar waters. Furthermore, discussion on the effect of global warming to primary productivity in the ocean using satellite data is facilitated, if the photosynthetic rate is an independent parameter on the SST.

To reduce these issues, light absorption coefficient of phytoplankton (a_{ph}) was used in the algorithm for SGLI/GCOM-C1; product of $P^B{}_{opt}$ and chl *a* in the VGPM, which means productivity at the depth with the maximal photosynthetic rate within a water column, was expressed by photosynthetic available radiation (PAR) absorbed in phytoplankton. In situ primary production and optical data to develop the algorithm were measured in the North Pacific, Japan Sea, East China Sea, Southern Ocean, Chukchi Sea (Arctic Ocean), Bering Sea. Additional datasets of the Bermuda Atlantic Time-series Study (BATS), Hawaii Ocean Time-series (HOT) and The California Cooperative Oceanic Fisheries Investigations (CalCOFI) were also obtained for the development and validation of the algorithm. Accuracy in the estimation of product of $P^B{}_{opt}$ and chl *a* (P_{opt}) and PP_{eu} were fairly well and estimated values from the new algorithms almost satisfied a factor of 2 of the values measured in situ. If accurate value of aph is derived from SGLI data, global estimation of PP_{eu} without the issues of pigments packaging, CDOM and SST are expected.

Keywords: primary production, phytoplankton, absorption coefficient, GCOM-C, SGLI

ACG06-31 Room:315 Time:April 29 17:00-17:15

Global snow and ice cover observations using GCOM-C1/SGLI for studying climate changes

HORI, Masahiro[1*] ; AOKI, Teruo[2] ; STAMNES, Knut[3] ; TANIKAWA, Tomonori[1] ; KUCHIKI, Katsuyuki[2] ; LI, Wei[3] ; CHEN, Nan[3]

[1]Japan Aerospace Exploration Agency, [2]Meteorological Research Institute, [3]Stevens Institute of Technology

The "Global Change Observation Mission-Climate" (GCOM-C) is a project of Japan Aerospace Exploration Agency (JAXA) for the global 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). GCOM-C 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. In addition, one of important objectives of the GCOM mission is to monitor long-term trend of the geophysical parameters for understanding the mechanism of earth's climate system. For this purpose, the data from GCOM series satellites are not enough. Thus, JAXA launched a website named "JAXA Satellite Monitoring for Environmental Studies (JASMES)" for semi-near real-time monitoring of earth's environmental variables. Through this website JASMES provides users with not only satellite datasets (flat binary) but also information on the current status of the climate variables such as solar radiation reaching the earth's surface (photosynthetically available radiation: PAR), snow and cloud cover, dryness of vegetation (water stress trend), wild fire and so on. MODIS data since February 2000 are currently processed for this analysis but SGLI data will be used after the launch of GCOM-C. Furthermore, the data from Advanced Very High Resolution Radiometer (AVHRR) onboard polar orbiting satellites operated by the National Oceanic and Atmospheric Administration (NOAA) since 1978 are also under preparation toward establishing a half-century long datasets of remote sensing after the success of the GCOM mission. This presentation will summarize the SGLI cryospheric products and validation plans, and also briefly introduce the JASMES dataset.

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

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

ACG06-32 Room:315 Time:April 29 17:15-17:30

Development of GCOM-C1 land surface reflectance product

MURAKAMI, Hiroshi[1*]

[1]JAXA, Earth Observation Research Center

Land-surface reflectance (RSRF) product is one of the essential products of Global Change Observation Mission-Climate 1/ Global Imager (GCOM-C1/SGLI; to be launched in JFY 2016); it is an input of other land algorithms, such as Leaf Area Index (LAI) and land cover classification (LCC), and will be used for surface albedo in the radiation budget, and used as the background of aerosol and cloud estimation. RSRF is estimated by subtracting scattering and absorption of an atmospheric molecule and aerosol from the top-of-atmosphere (TOA) radiance in cloud-free areas observed by the satellite (i.e., atmospheric correction). However, in order to extract the information on aerosols from the TOA radiation, it is necessary to know the information on land surface used as a background beforehand.

Experiential assumption and a candidate model about the spectral characteristic of aerosol and surface reflectance are often used in the presumption. Since the presumption can influence the output results, it is necessary to accumulate the knowledge of the various spectral characteristics and to perform suitable selection. Change of RSRF by the sun and the satellite geometries (BRDF) should be modeled when we preset the land-surface reflectance, because the satellite observes targets from a specific direction.

Candidate models of aerosol in the atmospheric correction (size distribution and vertical distribution, refractive index, etc.) may be able to be consistent with ones in the traditional aerosol-estimation algorithms which use candidate models as well. Since RSRF is used as a background of aerosol estimation, the consistency will be important for the product evaluation and accuracy improvement. There are groups which study aerosol properties by ground observation network, SKYNET, AERONET, etc., their regional characterization, spectral reflectance of the land surface, and observation and modeling (canopy radiation transfer) of the BRDF in the GCOM-C1 science team. The GCOM-C1 science team held a mini-workshop in summer of 2012, and decided that JAXA develops the land-surface atmospheric correction algorithm step by step by integrating their results . We confirmed importance of the consistency with the algorithms, such as LCC, LAI, albedo, etc., which use the estimated RSRF and BRDF.

We plan to develop the algorithm based on the existing knowledge (i.e., a traditional algorithm) for the at-launch version. Gas absorption of SGLI bands by water vapor, ozone, oxygen, and NO2 will be considered by using objective analysis data or Climatology. The surface elevation will be corrected by using objective-analysis sea-level pressure data and high-spatial resolution digital elevation data, DEM. Influence of surface slope will be reduced by using surface normal vector calculated by the DEM and solar vector. GCOM-C1/SGLI has an near-ultra violet (NUV) 380nm band, which will be used for the presumption of surface reflectance in the GCOM-C1 atmospheric correction, because reflectance and its directionality is generally small in the NUV and blue wavelengths. The presumption of the NUV band uses vegetation and land-cover information assumed from near infrared (NIR) and short-wave infrared (SWIR) reflectance, which are not so much affected by aerosols, and RSRF in the previous days by assuming temporal change of RSRF is generally smaller than the change of the atmosphere.

For the future algorithm version after the satellite launch, we expect to improve the presumption by knowledge from the canopy radiation transfer, LCC and vegetation phenology, adopt new aerosol estimation schemes, or use results of the aerosol-transport model to find the optimal aerosol models. SGLI has a polarization radiometer which observes the Stokes vector of red and NIR bands with 45-deg along-track slant view. It may be able to improve atmospheric correction accuracy after accumulation of surface BRDF and polarization knowledge in the future.

Keywords: GCOM-C1, SGLI, land surface reflectance, atmospheric correction

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

ACG06-33 Room:315 Time:April 29 17:30-17:45

Assessing the variations of the Alaskan tundra vegetation using MODIS NDVI 250-m imagery

SETIAWAN, Yudi[1*] ; KUSHIDA, Keiji[1]

[1]College of Bioresource Sci., Nihon Univ. Japan

Improving the understanding of Alaskan tundra vegetation using remote sensing data is a challenging task due to a general lack of consistency and coverage from historical and existing platforms. Furthermore, it should be essential for many aspects of global environmental change research.

Vegetation dynamics of the land surface is an integrated reflection of the vegetation and physical and chemical factors that shape the environment of a given land area and determinants for overall biological diversity patterns. In this paper, we demonstrate an approach for displaying detailed information of the Alaskan tundra ecosystem from the vegetation dynamics point of view. We assumed that locations displaying similar temporal vegetation patterns are inferred to have a similar vegetation and/or environment characteristics. Differences among land cover types as reflected in temporal profiles of NDVI are caused by differences in vegetation type composition and/or in their densities, and their responses to local environmental conditions, consequently, the use of long time-series NDVI will capture such different patterns in seasonal growth cycles.

The clustering method yields sets of clusters, which each cluster represents a significant different NDVI pattern at detailed information in the land cover type. However, the complexity and enormous amount of time-series NDVI datasets may lead to the difficulty of obtaining the actual number of clusters in this study. Therefore, to provide maximum effectiveness of the clustering algorithm, we first consider the number of clusters 15 which correspond to the number of dominant physiognomy of Alaska tundra ecosystem (Raynold et al., 2005). The number of clusters was then evaluated based on a statistical measurement of how separate that pattern is to patterns in its own cluster compared to patterns in other clusters. This separability analysis was applied to discriminate among high detailed significant patterns that were theoretically defined to portray the specific characteristics of each land cover type.

Keywords: Vegetation dynamics, Tundra vegetation, Alaska, MODIS

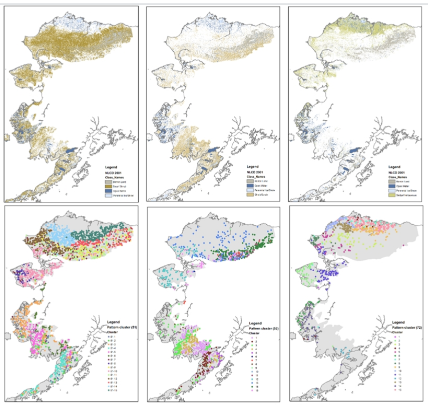

Figure 1. Three-dominant land cover classes of NLCD 2001 in Alaskan tundra: a) dwarf shrub, b) shrub/scrub, and c) sedge/herbaceous. Distribution of the 15-clusters for: d) dwarf shrub, e) shrub/scrub and f) sedge/herbaceous