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

U01-01 Room:IC Time:May 23 09:00-09:30

JAXA Earth Observation Program

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To understand and analyze global environmental conditions is an essential element of guaranteeing our safety and quality of life. Among other things, we need to be able to spot environmental disasters in a timely manner, and to monitor and manage the Earth's natural resources. For this purpose, Japan has launched a number of Earth Observation remote sensing satellites since 1987. Data collected by these satellites allow us to understand the processes and interactions among land masses, oceans, and atmosphere. We use these data in many ways for the benefit of our everyday lives: weather forecasts, disaster monitoring, exploitation of natural resources, and environmental protection of forestry and fishery. JAXA is committed to promoting the observation of Earth from satellites. The Earth Observation System has been established with the aim of improving the accuracy of monitoring and forecasting global environmental changes. JAXA's Earth Observation System is responsible for developing Earth Observation satellites; collecting observation data via ground stations; and the recording, storage and use of the data in research.

At the 2002 World Summit on Sustainable Development, the GEO (Group on Earth Observation) was proposed and established by the G8 (Group of Eight) leading industrialized countries. The GEO is constructing a Global Earth Observation System of Systems (GEOSS) on the basis of a 10-Year Implementation Plan for the period of 2005 to 2015. The Plan defines a vision statement for GEOSS, its purpose, scope, expected benefits, and the nine ”Societal Benefit Areas” of disasters, health, energy, climate, water, weather, ecosystems, agriculture, and biodiversity. Japan Aerospace Exploration Agency's (JAXA) earth observation satellite program is expected to develop GEOSS, particularly the areas of climate, water, and disaster. This paper describes the outline of JAXA's earth observation program including operating satellites [Greenhouse gas Observing SATellite (GOSAT), Tropical Rainfall Measurement Mission (TRMM), and Global Change Observation Mission-Water 1 (GCOM-W1)] as well as new generation satellites [Advanced Land Observing Satellite (ALOS)- 2/3, GCOM-C, Global Precipitation Measurement (GPM), Earth Cloud, Aerosol, and Radiation Explorer (EarthCARE) and GOSAT-2].

Keywords: JAXA, Earth Observation

U01-02 Room:IC Time:May 23 09:30-10:00

The Role of Space Observations in an Integrated Earth System Science

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The vantage point of space provides a unique way of studying the earth in its entirety as an integrated system made up of interacting components –

ocean, atmosphere, biosphere, cryosphere, land surface. NASA's fleet of operating satellites, together with related surface-based and airborne observing capability, allows scientists to study the Earth –

characterizing its variability on a broad range of spatial and temporal scales, understanding the processes that drive it, improving our predictive capability, and applying that knowledge for the benefit of society.

NASA's program is an end-to-end one, beginning with the development of technology and new techniques, through their testing, implementation, and utilization, provision of data sets to a broad spectrum of global users, as well as by maintaing an active research program that supports investigators in academia, laboratories of NASA and other US government agencies, the private sector, and non-profit entities.

NASA implements its programs in cooperation and consultation with a range of domestic and international partners. In this talk, the status of NASA's current and planned Earth Science programs will be presented, along with a sample of results from the program. Particular attention will be paid to examples that represent the values of international cooperation in the observational and research program.

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U01-03 Room:IC Time:May 23 10:00-10:25

TRMM achievements and GPM plan in Japan

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The Tropical Rainfall Measuring Mission (TRMM) which was launched in November 1997, and is still working. TRMM is equipped with a precipitation radar (PR), a microwave radiometer (TMI), a visible/infrared radiometer (VIRS), a lightning imaging sensor (LIS) and an Earth radiant energy sensor (CERES). TRMM was designed as a flying rain gauge for tropical rainfall observation and PR is the essential instrument. PR has a limited swath width and works as a reference for microwave radiometers which have much wider swath. Based on the very successful result of TRMM, the Global Precipitation Measurement (GPM) has been proposed. To overcome the severe sampling issue, GPM consists of a core satellite which is a kind of TRMM follow-on, and multi-satellites which have microwave radiometers. For observation of cold regions, better sensitivity is required for the radar and also more channels are needed to microwave radiometers. For the radar, to expand the dynamic range, another radar with higher frequency was developed. For the accuracy of the rain retrieval, precipitation echo profiles from two radars will be utilized.

Japan Aerospace Exploration Agency (JAXA) has developed DPR, and one of the main parts of science activities in Japan is focused on DPR. Algorithm for DPR is being developed under close collaboration between Japan and US, and the prototype of the algorithm is nearly completed. For the DPR algorithm development, JAXA developed a ground-based Ka-band (35 GHz) radar system. This system consists of identical two radars. The concept of the system is to observe the same precipitation system from opposite directions. The Ka-band radiowave suffers from severs rain attenuations. Due to the rain attenuation, rain echo from one radar reduces when the range is longer. The same thing occurs but opposite direction from the other radar. By summing up the two rain echoes, the rain attenuation can be eliminated, and the true equivalent radar reflectivity can be derived. Using the true equivalent radar reflectivity, the rain attenuation or specific rain attenuation can be estimated. The observational result on the scattering and attenuation is important, particularly for solid precipitation measurements.

The data from TRMM PR are accumulated over more than 15 years. The PR performance is very stable and data quality is well confirmed. This fact greatly helped for understanding precipitation climatology over tropical and subtropical regions. JAXA is developing a satellite based global precipitation map called GSMaP which mainly uses microwave radiometer derived rain rates tuned using PR data. Generally speaking, the results are reasonable. There, however, are several discrepancies with ground based rain gauge data. One of them seems to be due to warm rain or orogoraphic rain. The microwave radiometer rain retrieval over land uses scattering signatures of ice particles which exist in the upper layer of cloud or precipitation systems. However, there exists warm rain which does not have much ice particles but sometimes causes much rain.

Rain retrieval from space is a kind of ill-posed problem, since many parameters are included in the retrieval algorithm. So, the parameters must be validated in various climate regimes. Asia is largely influenced by the Asian monsoon activity, and also by various topographies. Comparisons of the rain estimate from space with ground measured rain data were performed under collaborations with Asian countries. Application including flood warning is also explored.

Keywords: precipitation, satellite, radar, algorithm

U01-04 Room:IC Time:May 23 10:25-10:50

Next-Generation Global Satellite Precipitation Data Products: U.S. Status

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In the modern age the scientific understanding of global precipitation patterns and processes, and the application of this information for societal benefits, depends critically on satellite data. Over the past 15 years the Tropical Rainfall Measuring Mission (TRMM) has acquired a key role in advancing these studies, thanks to the dedicated cooperation of the Japanese Aerospace Exploration Agency (JAXA) and the U.S. National Aeronautics and Space Administration (NASA). Now the two agencies are developing the Global Precipitation Measurement (GPM) mission, scheduled to launch in early 2014, as an international satellite mission to unify and advance precipitation measurements from a constellation of research and operational sensors to provide "next-generation" precipitation products every 3 hours around the globe. Compared to current global rainfall products, GPM data products will be characterized by: (1) more accurate instantaneous precipitation measurements (especially for light rain and cold-season solid precipitation), (2) more frequent sampling by an expanded constellation of domestic and international microwave radiometers including operational humidity sounders, (3) inter-calibrated microwave brightness temperatures from constellation radiometers within a unified framework, and (4) physically-based precipitation retrievals from constellation radiometers using a common a priori cloud/hydrometeor database derived from GPM Core sensor measurements.

How do we achieve these advances? The cornerstone of the GPM mission is the deployment of a Core Observatory in a unique 65-deg. non-Sun-synchronous orbit to serve as a physics observatory and a calibration reference to improve precipitation measurements by a constellation of 8 or more dedicated and operational, U.S. and international passive microwave sensors. The Core Observatory's Ku/Ka-band Dual-frequency Precipitation Radar (DPR) will provide measurements of 3-D precipitation structures and microphysical properties, which are key to achieving a better understanding of precipitation processes. The Core Observatory will also carry a 13-channel (10-183 GHz) GPM Microwave Radiometer (GMI). The combined use of DPR and GMI measurements will place greater constraints on possible solutions to radiometer retrievals to improve the accuracy and consistency of precipitation retrievals from all constellation radiometers. Compared to TRMM sensors, the GPM instruments will have improved detection of falling snow, estimation of light rain, and, for the first time, quantitative estimation of microphysical properties of precipitation particles.

The GPM constellation is planned to consist of 8 or more microwave sensors provided by partners, including both conical imagers and cross-track sounders. Besides NASA and JAXA, planned partnerships include microwave radiometers on the French-Indian Megha-Tropiques satellite and U.S. Defense Meteorological Satellite Program (DMSP) satellites, as well as humidity sounders or precipitation sensors on operational satellites such as the Suomi National Polar-orbiting Partnership (NPP) satellite, NOAA-NASA Joint Polar Satellite System (JPSS) satellites, European MetOp satellites, and DMSP follow-on sensors. In addition, data from Chinese and Russian microwave radiometers may be available through international cooperation. All of these data, together with surface precipitation data, will be combined in various ways. For example, the U.S. team is developing a combined algorithm that unifies and advances work done in the TRMM era.

The talk will end with a short summary of the expected path to full GPM-based precipitation estimates after launch. This includes consideration of the key practice in TRMM, and now GPM, of carrying out scheduled, consistent reprocessings of the entire data record.

Keywords: TRMM, GPM, satellite precipitation

U01-05 Room:IC Time:May 23 10:50-11:15

The Global Water Cycle Observation by the Global Change Observation Mission 1st - Water "SHIZUKU" (GCOM-W1)

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Japan Aerospace Exploration Agency (JAXA) launched the Global Change Observation Mission 1st - Water (GCOM-W1) or "SHIZUKU" (meaning "droplet" in Japanese) on 18 May 2012 (JST) from JAXA's Tanegashima Space Center. GCOM-W1 is not a name of single satellite mission. It is a part of global and long-term observation program with two complementary medium-sized satellites (GCOM-W and GCOM-C series) and three generations (10-15 years) for stable data records.

The Advanced Microwave Scanning Radiometer 2 (AMSR2) onboard the SHIZUKU satellite is a successor instrument to the Advanced Microwave Scanning Radiometer for EOS (AMSR-E) onboard NASA's Aqua satellite, which was launched in 2002. In response to the successful observation and achievements of AMSR-E, AMSR2 is developing based on AMSR-E, and its basic performance and observation frequencies will be similar to that of AMSR-E based on the minimum requirement of data continuity of AMSR-E, with several enhancements. Higher level products of AMSR2 will be the same to current seven geophysical parameters derived by AMSR-E; they are precipitable water, cloud liquid water, precipitation, sea surface temperature, sea surface wind speed, sea ice concentration, snow depth, and soil moisture.

Furthermore, The GCOM-W1 satellite was installed in front of the Aqua satellite on the "A-Train" orbit to keep continuity of AMSR-E observations and provide synergy with the other A-Train instruments for new Earth science researches. Unfortunately, AMSR-E reached its limit to maintain the rotation speed necessary for regular observations (40 rotations per minute), and the radiometer automatically halted its observations and rotation. It, however, has restarted observation in low rotation mode with 2-rpm in December 2012 in order to perform cross-calibration with AMSR2.

The SHIZUKU satellite has joined the A-train orbit since 29 June 2012, and started normal observation since 3 July 2012. The first light of AMSR2 was released on 4 July, and since then, many observation results has obtained; such as melting of entire surface ice sheets over Greenland in July, rainfall by Typhoon HAIKUI (TC1211) in August, and new record minimum of the Arctic sea ice extent in September. Browse images of AMSR2 can be available in near-real-time at the web site of JAXA Satellite Monitoring for Environmental Studies (JASMES) for Water Cycle (http://suzaku.eorc.jaxa.jp/GCOM_W/JASMES_daily/index.html).

AMSR2 Level 1 brightness temperature products have released to public since 25 January 2013 via the GCOM-W1 Data Providing Service System (https://gcom-w1.jaxa.jp/), and level 2 geophysical parameter products will be released to public in May 2013. The Data providing Service System also distributes products of series of AMSR instrument, including AMSR-E and AMSR onboard the Advanced Earth Observing Satellite-II (ADEOS-II). Near-real-time products are already distributed to weather agencies, such as Japan Meteorological Agency (JMA), National Oceanic and Atmospheric Administration (NOAA), and European Centre for Medium-Range Weather Forecasts (ECMWF), and will be used in operational weather forecasts and other applications.

Keywords: satellite remote sensing, microwave radiometer, global water cycles, climate, AMSR, earth observation

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U01-06 Room:IC Time:May 23 11:15-11:40

The A-Train: A unique view of the Earth System

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The A-Train provides a unique view of the Earth system through the eyes of different sensors each viewing different aspects of the evolving system. When combined, these observations have provided a number of unexpected new capabilities that are now revealing new insights on the composition of the atmosphere, the movement of water through the planets water cycle with links to the climate system through the influence of water on the Earth's energy balance. This talk will highlight a number of new emerging findings that are a direct consequence both of the diversity of data types and the combination of sensor data. Emphasis on how these collated observations are advancing our understanding of key processes of the Earth system, how this understanding is influencing the development of weather and Earth system models, and the promise of an even more expanded view of Earth with the expected new additions to the A-Train.

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U01-07 Room:IC Time:May 23 11:40-12:05

Collaboration with NASA-ACOS team on GOSAT sensor calibration, data retrieval, validation, and carbon flux estimation

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More than four years have passed since the Greenhouse gases Observing SATellite (GOSAT) was launched. Over those years, the members of the GOSAT Project at JAXA and NIES collaborated closely with those of the NASA Atmospheric CO_2 Observations from Space (ACOS) team through frequently exchanging information and research findings during bi-weekly teleconferences, field campaigns, and annual workshops. The major outcomes brought through the GOSAT-ACOS collaboration are as follows. 1) Microscopic vibrations in the TANSO Fourier Transform Spectrometer (FTS) aboard the satellite were discovered and their influence on the collected data was evaluated and removed. 2) By collecting and analyzing vicarious calibration data cooperatively during the US Railroad Valley field campaigns, details on the characteristics of TANSO FTS, along with the instrument's degradation trend, was elucidated. 3) The inter-comparisons of algorithms, developed independently by the two teams, for retrieving ground surface pressure and concentration of CO_2 from the satellite data lead to significant improvement in the quality of the concentration data products. 4) The two teams' collaboration accelerated the validation of the retrieved concentration data products in the community of the Total Column Carbon Observation Network. 5) The GOSAT-ACOS cooperation also made the inter-comparisons of the satellite-based CO_2 flux estimates possible among the participants of the GOSAT Research Announcement studies and the NASA OCO-2 science team. We herein explain the above items and also report the progress of the GOSAT Project.

Keywords: satellite-based greenhouse gas remote sensing, carbon dioxide, methane, calibration, data validation, carbon flux estimation

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U01-08 Room:IC Time:May 23 12:05-12:30

Atmospheric CO2 Observations from Space by the GOSAT Mission

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Fossil fuel combustion, deforestation, and other human activities are now adding more than 30 billion tons of carbon dioxide (CO2) to the atmosphere each year. These CO2 emissions are superimposed on an active carbon cycle, driven by natural processes in the land biosphere and oceans. These processes emit more than 25 times as much CO2 into the air each year as human activities and then reabsorb at least that much, along with about half of the human contributions. Precise measurements of atmospheric CO2 concentrations over the past 50 years indicate that these natural carbon sinks have somehow been keeping up with the 5-fold increase in the fossil fuel CO2 emission rates over that period, reducing the rate of buildup of CO2 by a factor of two. The nature and location of these increasingly efficient CO2 sinks is still largely unknown. Because of this, it is impossible to predict how much longer they will continue to control the atmospheric CO2 buildup rates.

While the ground-based greenhouse gas monitoring network now provides a strong global constraint on both human and natural CO2 fluxes into the atmosphere, it still does not have the resolution and coverage needed to identify and quantify sources and sinks on regional scales. One way to improve the spatial and temporal coverage and resolution is to retrieve precise, spatially-resolved, global measurements of CO2 from space. High resolution spectroscopic observations of reflected sunlight by CO2 and O2 bands are well suited for monitoring surface CO2 fluxes. These measurements can be analyzed to yield estimates of the column-averaged CO2 dry air mole fraction, XCO2, which are most sensitive to CO2 variations near the surface. The Japanese Greenhouse gases Observing SATellite (GOSAT, nicknamed Ibuki) was the first satellite specifically designed to exploit this approach. The NASA Atmospheric CO2 Observations from Space (ACOS) team has been collaborating closely with the GOSAT Project team to perform annual vicarious calibration campaigns, retrieve XCO2 from GOSAT TANSO-FTS spectra, and validate these results against a variety of standards, including surface-based XCO2 retrievals from the Total Carbon Column Observing Network (TCCON). Recent XCO2 products from this collaboration show little or no bias and have random errors that are typically less than 0.5% on regional scales over much of the Earth. These XCO2 estimates are now being used in flux inversion models to assess their impact on our understanding CO2 sources and sinks. This experience is expected to accelerate the delivery of high quality XCO2 products from the NASA Orbiting Carbon Observatory-2 (OCO-2), once it has been successfully launched.

Keywords: carbon dioxide, CO2, carbon cycle, remote sensing, GOSAT

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U01-09 Room:IC Time:May 23 14:15-14:45

Hinode for exploring magnetic activities on the Sun

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Hinode, launched on September 2006, has been continuously observing our Sun to understand the processes of magnetic field generation, the processes responsible for energy transfer from the photosphere to the corona, and the mechanisms responsible for heating, dynamics and eruptive flares. Solar Optical Telescope (SOT) provides 0.2-0.3 arcsec observations of magnetic and velocity fields at the solar surface, whereas X-Ray Telescope (XRT) and EUV Imaging Spectrometer (EIS) provide soft X-ray images and EUV spectroscopic data for diagnosing thermal properties and dynamics in the corona. Observations with these telescopes have already produced over 600 publications on refereed journals, including the Hinode special issue in SCIENCE magazine. These three state-of-the-art telescopes were developed under collaboration with NAOJ as a domestic partner, NASA and STFC (UK) as international partners. Scientific operation of the Hinode mission is conducted by the Hinode science team organized at ISAS/JAXA. This team mainly consists of scientists from institutes in the partner countries. Support for the post-launch operation is provided by JAXA and NAOJ (Japan), NASA (U.S.A.), STFC (U.K.), ESA, and NSC (Norway).

Keywords: The Sun, International Collaboration

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U01-10 Room:IC Time:May 23 14:45-15:15

Hinode: A Premiere Solar Physics Observatory Resulting from NASA-JAXA Cooperation

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Hinode is the second JAXA and NASA partnership for solar astrophysics. Institutions funded by both agencies contribute instrumentation, mission operations, and science data analysis. In each step in the process of executing this mission, JAXA and NASA jointly convert science goals to instrumentation performance requirements to instrument-collected data. The result is the premier solar physics observatory in the last decade. Hinode has observed the formation of polar X-ray jets at a resolution sufficient to address theoretical predictions for magnetic recognition. Measurements of the polar magnetic field by Hinode have discovered the existence of 'patches' of concentrated field, revealing a latitudinal dependence of the polarity reversal that accompanies the progression of the solar cycle. Observations of flares, Coronal Mass Ejections and the acceleration regions of the fast and slow solar wind being used to develop next-generation models for space weather. We will discuss the partnership and provide an overview of the last seven years of observatory success.

Keywords: Hinode, NASA-JAXA coordination, solar physics, space weather, solar cycle

U01-11 Room:IC Time:May 23 15:15-15:45

ISAS-NASA Cooperation in the GEOTAIL mission

Atsuhiro Nishida[1*]

[1]ISAS

ISAS and NASA cooperated in the GEOTAIL satellite project to study the physics of space plasma in the Magnetotail. Instruments on board are designed to measure the electric and magnetic fields, ions and electrons, and plasma waves, focusing primarily on clarification of the magnetic reconnection process which plays a key role in energization of plasma in space. ISAS developed and has operated the spacecraft, whereas NASA provided the launch. Responsibilities for science instruments, telemetry data acquisition, and data provision and archiving are shared by both. The satellite has taken two orbit phases: a nightside double lunar swingby orbit extending to distances up to 220 Re and a low inclination orbit covering the geocentric distances of 10 to 50 Re. It was launched from the Kennedy Space Center on 24 July, 1992, and the satellite is still functioning in good shape. ISAS-NASA collaboration in the GEOTAIL project has been a pleasant and productive experience. U.S. and Japanese scientists shared the common objective and respected each other. Often each party went out its way to accommodate the other party; for example, ISAS scientists helped U.S. PI teams in their hardware integration and test procedures and operations, and NASA team members helped to convince the NASA reviewers of the ISAS standards for procedures. Scientifically the project has been recognized as a great success. Among the notable results are elucidation of the microscopic structure and energy conversion process at the reconnection site, discovery of the electrostatic solitary waves in collisionless space plasma, and clarification of the relation between reconnection and auroral phenomena. GEOTAIL was a member of the International Solar Terrestrial Physics Program (ISTP) comprising a network of about a dozen spacecraft deployed in the near-Earth space by ISAS, NASA, ESA and IKI in 1990s, and it played a leading role as the first to be launched.

Keywords: magnetosphere, reconnection, ISAS-NASA cooperation

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U01-12 Room:IC Time:May 23 15:45-16:15

Near-future opportunities for international collaborations in magnetospheric research

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The successful launch of NASA's Van Allen Probes in August 2012 has opened a window of opportunities for collaborative magnetospheric research with other missions in the magnetosphere, including JAXA's ERG spacecraft scheduled for launch in 2015. Both missions have the radiation belt as the science target. NASA's soon-to-be-launched Magnetospheric Multiscale (MMS) mission will also provide a similar opportunity for the ERG mission. In this presentation, we will take the Van Allen Probes and ERG missions as an example to illustrate what kind of science can be achieved by international collaboration. The Van Allen Probes are two identical spacecraft orbiting on nearly identical elliptical orbits with apogee of 5.8 Re, inclination of 10 degrees, and orbital period of 10 hours. The spacecraft carry a comprehensive set of particle and fields experiment to address the spatial and temporal variations of particle phase space density and the interaction of particles with waves over a wide frequency range. ERG will be similarly instrumented and will have a similar orbit but with a higher inclination (~30 degrees). We use predicted orbits for the spacecraft to outline possible science focus areas during the nominal mission period (~1 year) of ERG.

Keywords: Van Allend Probes, ERG, Magnetosphere, Radiation belt