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A newsletter on the Greenhouse gases Observing SATellite (GOSAT, "IBUKI") project from the NIES GOSAT Project Office.
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GREETINGS

On the Second Anniversary of GOSAT Launch

- Yasuhiro Sasano
Director, Center for Global Environmental Research, NIES

Two years have now passed since GOSAT "IBUKI" successfully went into orbit. Thinking about all the efforts many people in and out of Japan made in various aspects of the project, I would like to express my sincere gratitude to its staff and everyone involved as a member of this collaborative project among the Japan Aerospace Exploration Agency, the Ministry of the Environment, and the National Institute for Environmental Studies.

I hear different opinions about these two years since the launch of the satellite. Some say, "Even after two years, you haven't produced a visible result yet," and others say, "Two years or so is not enough to make a perfect observation of atmospheric minor components." As for me, I had long been involved in a project on stratospheric ozone layer observation using satellites before taking my current position, and I think I understand how challenging it is to expect a high accuracy in observing minor components in the atmosphere from space. From this point of view, I can say that "IBUKI" has been making a satisfying result as a satellite that observes minor components in the atmosphere. There is only a small negative bias of 2~3% with the carbon dioxide (CO_2) column amounts (concentration) data and an even smaller bias with the methane (CH_4) column amounts data when compared to the validation data acquired by the ground-based observation.

The retrieval of global CO_2 and CH_4 column amount data products is proceeding without any major problems, except that there are areas where the retrieval of column amounts is extremely difficult due to clouds and aerosols[1], as expected in the beginning. The distribution of data products to researchers and the general public is running smoothly as planned.

However, the challenge that "IBUKI" is facing now, is to take the first step towards contributing to measures against global warming. In other words, the GOSAT Project aims at estimating the regional (on a sub-continental scale as a initial goal) CO_2 flux (=emission and absorption) more accurately by adding the satellite observations to existing CO_2 concentration data of ground-based and airborne observations, using meteorological data and an atmospheric transport model. In order to realize this, it is necessary to further reduce the bias in concentrations, and to continue the leading-edge work in the world with accurate evaluation of the characteristics of sensors, with data processing algorithms, as well as with the atmospheric transport model, ultimately resulting in data products and reliable estimations of regional distributions of emissions and absorptions.

I feel that more efforts are called for in order for "IBUKI"'s data to be used for 'the climate change public policy making, including elaborating the targets for reducing greenhouse gases emissions' based on 'scientific research on carbon cycle in the earth system.' I hope for your continuing understanding and support for the project.

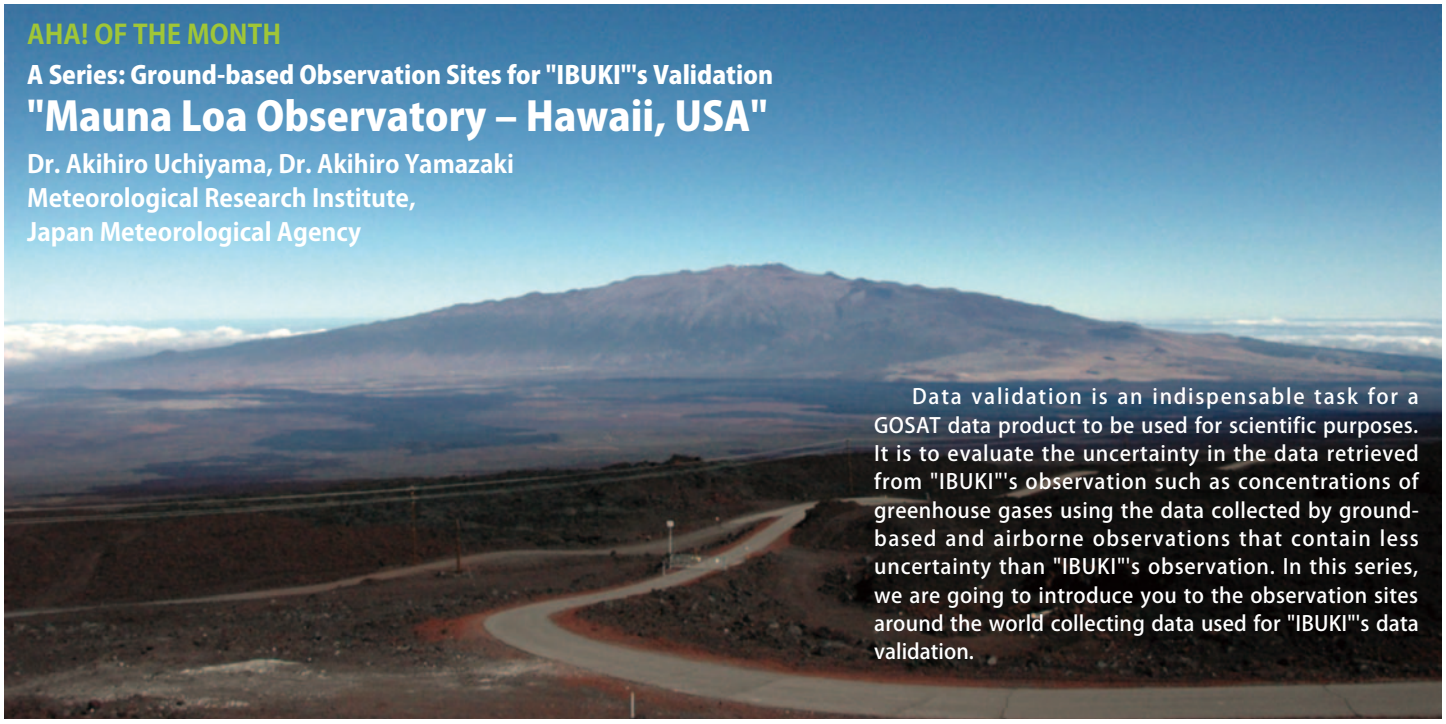
1 **An aerosol** is a tiny particle of liquid or solid that floats in the atmosphere.

AHA! OF THE MONTH

A Series: Ground-based Observation Sites for "IBUKI"'s Validation

"Mauna Loa Observatory – Hawaii, USA"

Dr. Akihiro Uchiyama, Dr. Akihiro Yamazaki
Meteorological Research Institute,
Japan Meteorological Agency



Data validation is an indispensable task for a GOSAT data product to be used for scientific purposes. It is to evaluate the uncertainty in the data retrieved from "IBUKI"'s observation such as concentrations of greenhouse gases using the data collected by ground-based and airborne observations that contain less uncertainty than "IBUKI"'s observation. In this series, we are going to introduce you to the observation sites around the world collecting data used for "IBUKI"'s data validation.

Image 2. Mt. Mauna Kea seen from the National Oceanic and Atmospheric Administration's Mauna Loa Observatory (MLO). The clean and stable air makes this location great for taking data for the Langley Method.

At an "IBUKI"'s ground-based validation site, the reference data on direct solar light spectra are collected using the FT-IR Spectrometer and on the vertical profile of aerosols using LIDAR, and at the same time, the data on aerosols are collected using the Skyradiometer. The Meteorological Research Institute received a funding from the validation team of the GOSAT Project as well as from other sources, and installed the Skyradiometers and the Sun Photometers at the Mauna Loa Observatory (MLO) of the National Oceanic & Atmospheric Administration to acquire data for calibration (Image 1).

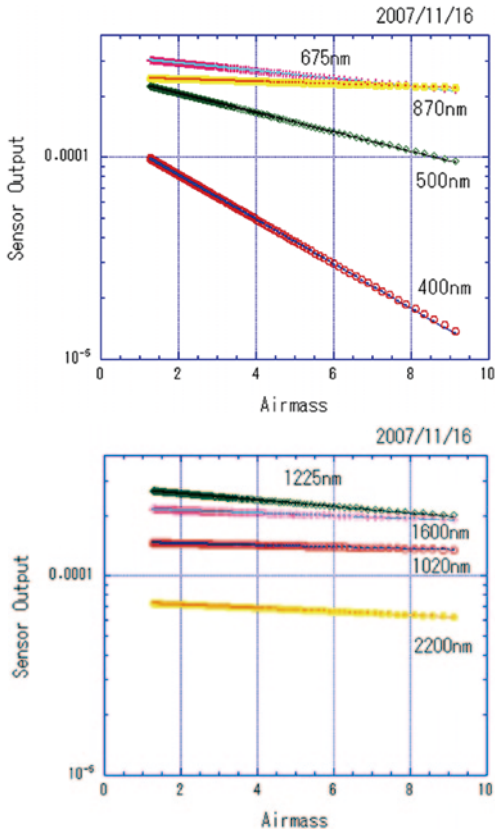
Image 1. The Skyradiometers (POM-02) and two Sun Photometers installed for calibration data acquisition at the MLO.

As you may know, MLO is the observatory where Dr. Charles Keeling started a regular observation of CO_2 in 1958, and the observation continues still today. The observatory is located at an altitude of 3397m, a location above the atmospheric boundary layer. Since it is above the stratocumulus clouds that form in the atmospheric boundary layer, the sky is mostly clear. The air is also stable because it is located in the subtropical high-pressure system. In the north of Mt. Mauna Loa, there is another mountain, Mt. Mauna Kea (Image 2). At the summit of Mauna Kea, a number of astronomical telescopes, including "the Subaru Telescope," are installed. This is also because the air is stable and the sky is usually clear.

The Skyradiometer is an instrument to retrieve the optical depth and property of aerosols by measuring the direct solar light and diffuse light. Since the spectra measured by the Fourier Transform Spectrometer installed on "IBUKI" are sensitive to aerosols in the atmosphere, it is necessary to collect information on the aerosols using LIDAR[1] and the Skyradiometers.

It is also necessary to calibrate the Skyradiometers carefully for taking accurate measurements. In order to retrieve aerosol properties, the Skyradiometers do not need to measure the absolute amounts of direct solar irradiance and diffuse radiance from the sky, but need to determine the relative amount of these direct and diffuse lights to the solar light in outer space.

To determine the calibration constant (assumed output value for sensor if direct solar irradiance was measured in outer space), the direct



Figrue 1. An example of Langley plot. The data make a good straight line. At MLO, it is possible to acquire a set of high-quality data like this example.

1 **LIght Detection And Ranging (LIDAR)** is an instrument to emit pulse laser light and record the light that comes back after being scattered by aerosols and clouds. The distance can be calculated from the round-trip time. The amount of substance is estimated from the number of returned light pulses.

Image 3. A map of Island of Hawaii (Credit: MLO website)

solar irradiance is measured at different air mass to extrapolate at the zero air mass (outer space). The method is called the Langley Method. This method requires that the air stays stable while the calibration data are collected. It is necessary to acquire the data at a location with the best possible conditions because it is a long known fact that a minor change in the air interferes with the accuracy of the calibration. MLO is one of the perfect locations for acquiring data for such purposes. Figure 1 in the previous page shows the result of calibration (Langley plot). The data points lie on a straight line like this image and it is possible to estimate the output value of sensor for outer space.

MLO is located in the middle of Mt. Mauna Loa, 18 miles (29 km) up on a mountain road (the Mauna Loa Road) winding through black molten rocks, from an intersection after road sign '27 miles' and before '28 miles' on the Saddle Road from Hilo City on the Island of Hawaii (Image 3). The Saddle Road has been properly maintained in recent years perhaps because it cuts across the Island of Hawaii, but some parts of the Mauna Loa Road are quite wild with some holes here and there. (For more information on MLO, please refer to their website: http://www.esrl.noaa.gov/gmd/obop/mlo/index.html)

MLO is one of the world's best observatories not only for its great weather condition, but also for its capability to measure a wide array of basic atmospheric parameters (air pressure, temperature, and humidity), as well as the data on amounts of water vapor and ozone that are needed to estimate the transmittance, and even other data such as the number of cloud condensation nuclei and aerosol scattering coefficient that tell the condition of the atmosphere. One of the downsides would be there are often cirrus clouds. Plus, the air from down below can be brought up by the valley wind even to this altitude during the day time, and interferes with the observation data. The amount of water vapor can change drastically depending on the wind direction. It is also costly because we have to travel overseas.

Using the radiometers calibrated with the MLO data as a reference device, we make comparative observations at the Meteorological Research Institute to transfer the calibration constants to the Skyradiometers in multiple locations. This way it contributes to other observation projects (Image 4).

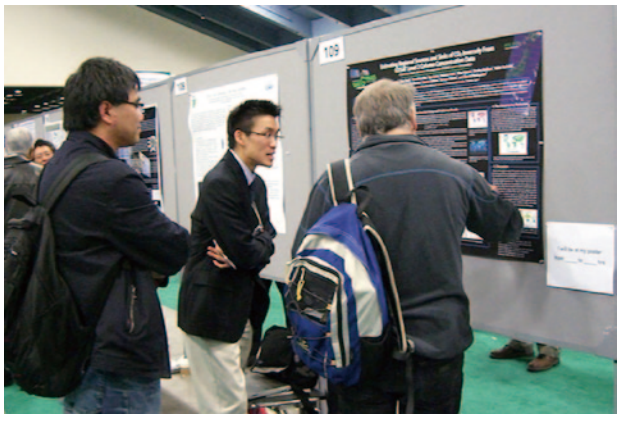
We use the aerosol optical property determined by the Skyradiometer for validation of other satellite observations. Other than validation, we can monitor the aerosols such as Asian dust, and investigate the relationship between the aerosol properties and radiation budget by combining Skyradiometer measurements and other radiometer measurements. For accurate monitoring, accurate measurement is necessary. For this reason, we need to continue observations for calibration at MLO in the future.

Image 4. Cross Comparison of the Skyradiometers at the Meteorological Research Institute (transferring calibration constants).

NEWS

Report : American Geophysical Union Fall Meeting 2010

- Yukio Yoshida Researcher, Satellite Remote Sensing Research Section, CGER, NIES



NIES CGER Specialist Hiroshi Takagi (middle) explaining the GOSAT related research.

The American Geophysical Union (AGU) held its annual Fall Meeting from December 13 to December 17, 2010 in San Francisco, USA. The AGU has held a session on satellite greenhouse gases measurement at every Fall Meeting for the last several years, and the GOSAT Project members have attended these sessions to give presentations each year. At the previous AGU Fall Meeting, perhaps because the timing was shortly after the first release of GOSAT data products, the GOSAT Project members took the lead and made presentations on satellite data calibration and on greenhouse gas concentration retrievals. However, this time, the presentations given by the researchers working on research selected at the GOSAT Research Announcements outnumbered the presentations given by the GOSAT Project members. The topics discussed were wide-ranged, including calibration, retrieval of concentrations, validation of the outcomes, and the applied studies using the released GOSAT data products.

There were a large number of presentations on the SWIR L2 data products (column-averaged carbon dioxide (CO_2) and methane concentrations) that I am responsible for, and I was able to have an active discussion with a great number of researchers.

The GOSAT Project also gave a report on the result of initial analysis on the project's ultimate goal, the CO_2 flux estimation, using the actual observational data (Photo).

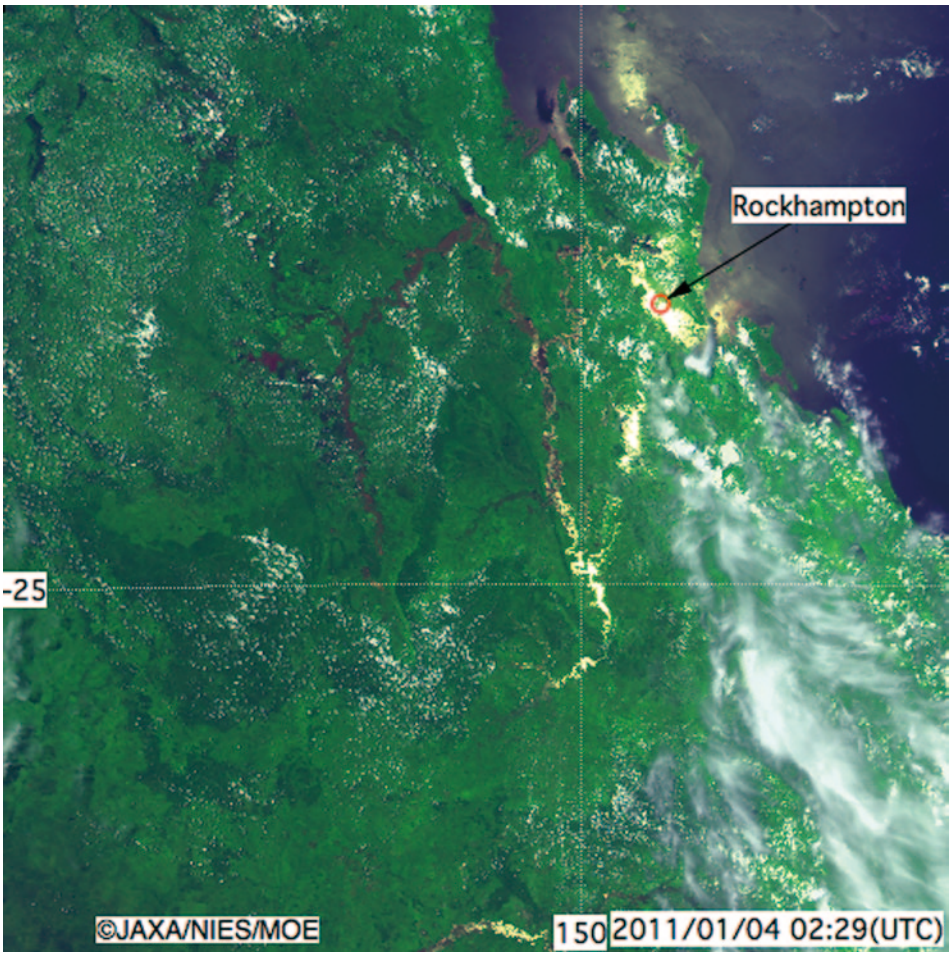
Now that two years have passed since the launch of GOSAT and we have accumulated a certain amount of data, the research topics are shifting from the calibration, retrievals, and validation to the applied studies using the results of determination.

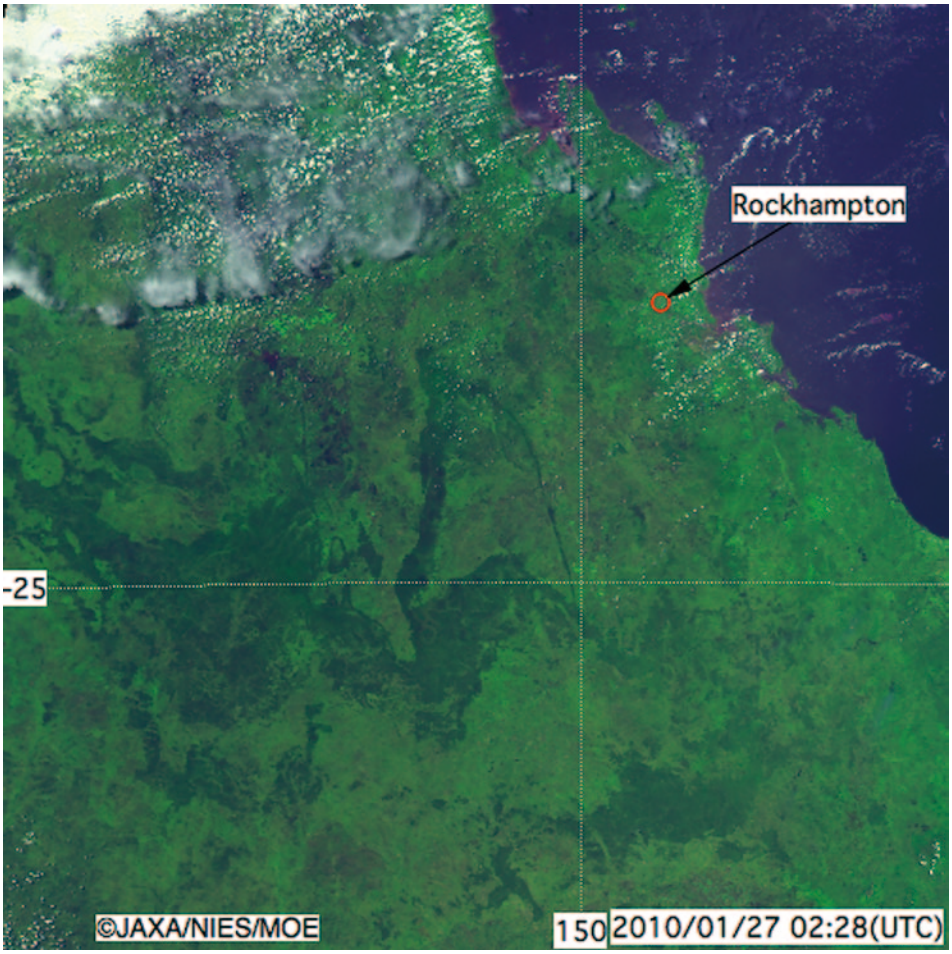
I am expecting to see even more presentations on research using GOSAT data products at the next AGU meeting.

IMAGES OF THE MONTH

FLOODING DAMAGE QUEENSLAND, AUSTRALIA

- Nobuyuki Kikuchi,
Specialist,
NIES GOSAT Project Office





The record-breaking flood that has hit Australia's Queensland state was captured in the images acquired by "IBUKI."

The upper image is a false color image produced from the CAI L1B data product acquired by "IBUKI"'s Clouds and Aerosol Imager on January 4, 2011. The golden glare in the image is reflection of sunlight. Queensland state is crossed by the Tropic of Capricorn, and the Sun is located right above the area in this time of year. The overflowing water of rivers shines acting as a mirror.

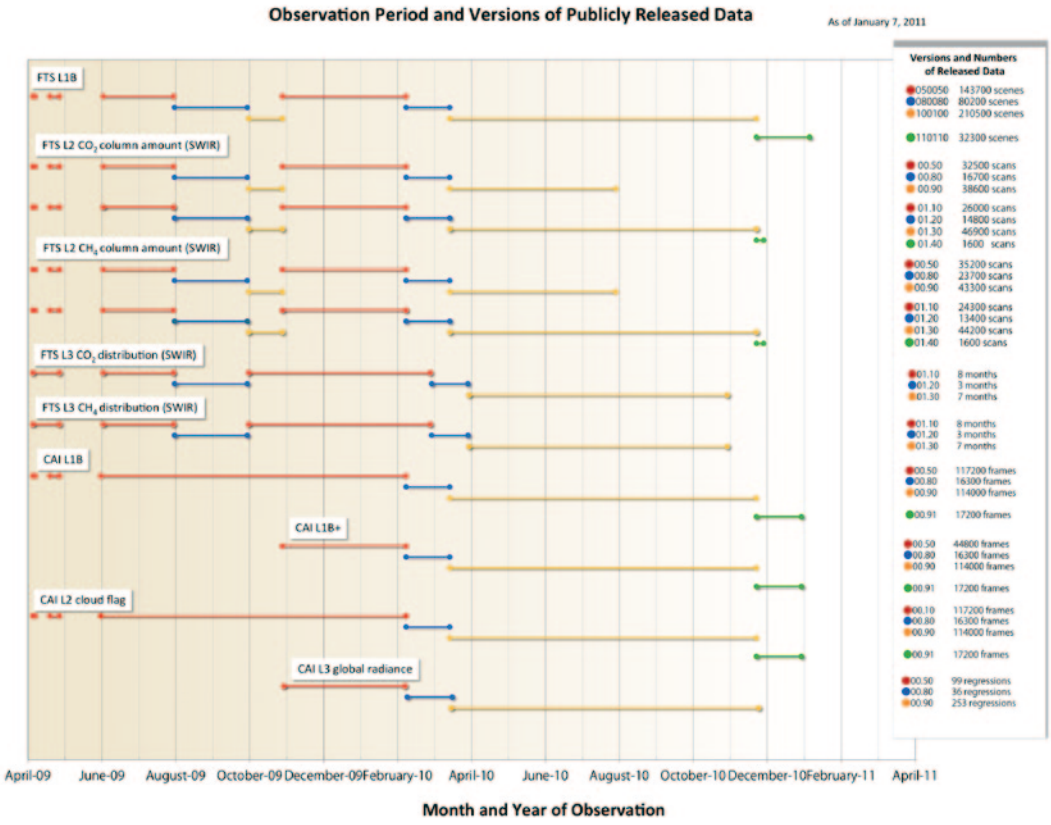
The lower image is a false color image of January 27, 2010, similarly produced as the top image. The latest image shows the rivers are flooding and spread wide while the rivers are almost invisible in the image from the same season last year.

The red circle indicates the heavily damaged Rockhampton city.

DATA PRODUCTS UPDATE

Data Processing Status Update from GOSAT Project Office

- Fumie Kawazoe,
Specialist,
NIES GOSAT Project Office



Here we report an update on data processing status for late December to early January.

Continued from last month, we are processing and releasing the V110110 of the FTS L1B data products, the latest version - V00.91 of the CAI L1B, CAI L1B+, and L2 cloud flag data products, and the latest version - V01.40 of the FTS L2 CO_2 and CH_4 column amount (SWIR) data products. We have newly released V01.30 and V01.40 of FTS L2 CO_2 and CH_4 column amounts for the months of October 2010 and November 2010, and V01.30 of FTS L3 for the month of October 2011. Please also visit the GOSAT User Interface Gateway (GUIG) (http://data.gosat.nies.go.jp) and check for the updates in the "Remarks on Monthly FTS SWIR L2 Product" and "Gallery" sections. The number of registered general users reached 957 as of January 7, 2011.

PUBLISHED PAPERS

Field of Research: Carbon balance estimation, atmospheric transport models
Name of Journal: International Journal of Oceanography (Volume 2010, Article ID 540783, 15 pages)
Title: A Short Surface Pathway of the Subsurface Indonesian Throughflow Water from the Java Coast Associated with Upwelling, Ekman Transport*, and Subduction
Authors: V. Valsala and S. Maksyutov

* Ekman Transport: the movement of ocean water caused by relatively steady winds such as trade wind. In the northern hemisphere, the movement is at a right angle to the right of wind direction, and in the southern hemisphere to the left of wind direction.

Field of Research: Carbon balance estimation, atmospheric transport models
Name of Journal: Atmospheric Chemistry and Physics (Volume 11, Number 2, January 2011, pages 543-556)
Title: A very high-resolution (1 km x 1 km) global fossil fuel CO_2 emission inventory derived using a point source database and satellite observations of nighttime lights
Authors: T. Oda and S. Maksyutov

Field of Research : Other (Future Technology)
Name of Journal: The Review of Laser Engineering (Volume 39, No 1, January 2011, pages 12-16)*
Title: Space-Borne Lidar Technology for Global Environmental Observation Research
Authors: D. Sakaizawa, M. Nakajima, T. Tanaka, I. Morino, and O. Uchino

* The paper is written in Japanese except for its abstract, figures, and tables.

CALENDAR

2011/03/11 Hosting The 1st Workshop on GOSAT Data Utilization at Tsukuba Internatinal Congress Center (EPOCHAL Tsukuba) in Tsukuba, Japan.

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