NIES GOSAT PROJECT NEWSLETTER

Independent Administrative Institution
National Institute for Environmental Studies (NIES)
A newsletter on the Greenhouse gases Observing SATellite
(GOSAT, "IBUKI") project from the NIES GOSAT Project Office.
http://www.gosat.nies.go.jp/

ISSUE #7
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CONTENTS

GREETINGS

GOSAT PROJECT ~THOUGHTS ON PRESENT AND FUTURE

— Mr. Takashi Hamazaki,
Director, Program Management and Integration Department,
Space Applications Mission Directorate,
Japan Aerospace Exploration Agency (JAXA)
Former JAXA GOSAT Project Manager

Time flies. It has already been one and half year since "IBUKI" was launched into space. "IBUKI" is keeping up its excellent operation as world's first and unique satellite dedicated to observing global greenhouse gases. From the start of GOSAT Project team in April 2003 until the launch in January 2009, it was all about a series of challenges to overcome technical issues. Among all those challenges, there was one issue that we had such a difficult time to fix because we did not expect it to happen at all.

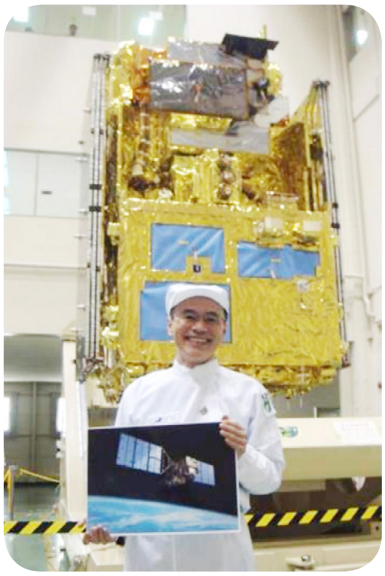


Photo 1. "IBUKI" and Mr. Hamazaki, the former JAXA GOSAT Project manager.

The issue was that even micro vibrations of the instruments and a little change of stiffness of thin cables aboard the satellite would affect the accuracy of data. In addition, there were some cases of malfunction of satellite components as well as manufacturing defects, and each time they happened we had to stay until late at night or even until early morning for emergency meetings and fact checking. If I think about it now, they are all good memories.

Above all, however, what I put most of my efforts into was the attempt to engage the "All IBUKI Team" - JAXA, NIES, Ministry of the Environment (MOE), GOSAT Science Team, manufacturers, and oversea institutes that support us with data use - to work together. Each of these groups has its own sense of value and sense of speed. For example, NIES and GOSAT Science Team value the accuracy of data the most while JAXA values to present the results as early as possible, and MOE values each decision to be reflected in government's policy. We spent numerous hours of discussion to reconcile them. I believe that the realization of "IBUKI" was possible because the passions of everyone involved came together.

Photo 2. Mr. Hamazaki (right) explaining "IBUKI" to Dr. Rajendra K. Pachauri, the chairman of Intergovernmental Panel on Climate Change.

Now we receive requests for "IBUKI"'s data from countries around the world. The contribution of "IBUKI" is talked about in various international conferences. Dr. Rajendra K. Pachauri, the chairman of Intergovernmental Panel on Climate Change (IPCC) showed a great interest in "IBUKI" as well. When I visited him to explain "IBUKI," I was surprised and delighted to be asked if he could take home the presentation board. I hope "IBUKI"'s data are used for organizations such as IPCC and become a universal gauge. The international race of realizing the first satellite dedicated to observe atmospheric greenhouse gases ended with "IBUKI"'s windfall victory after the European plan was canceled and OCO's launch was failed. However, there has been the second race started already. NASA has initiated the development of OCO-2, and plans for similar satellites are under consideration in Europe, Canada, Korea, and China. Japan seems to have gotten a late start in this race, but I am willing to put another effort into realizing the next generation "IBUKI."

NEWS

Field Campaign for Vicarious Calibration of "IBUKI" in Railroad Valley, NV, USA

- Tomoaki Tanaka, NIES Postdoctoral Fellow,
Center for Global Environmental Research (CGER), NIES

Photo 1. The base camp at RRV.

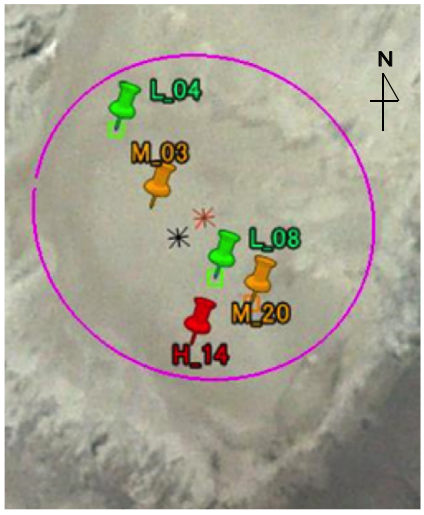


Figure 1. The field of view of TANSO-FTS (purple circle) and sites where the radiance of the ground was measured.

RRV2010 measurement pattern

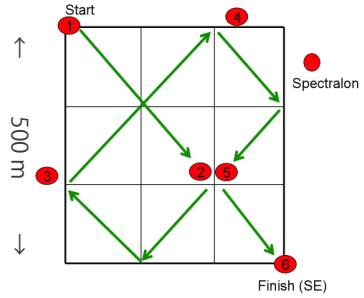


Figure 2. The geometry of ground observation at RRV.

Table 1. Observation sites and "IBUKI"'s paths. (H, M, L indicate the level of reflectance.)

Date	measurement sites	GOSAT path
6/21	M03, L08	36
6/22	M03, L04	37
6/23	M03	no overpass (ASTER)
6/24	M03, H14	36
6/25	M03, M20	37

1. Introduction

Atmospheric CO_2 Observations from Space (ACOS)[1], NASA Ames Research Center (AMES), Japan Aerospace Exploration Agencies (JAXA), and NIES carried out a field campaign for vicarious calibration of the Greenhouse Gases Observing Satellite (GOSAT, "IBUKI") from 21st to 25th of June, 2010 in Railroad Valley, NV, USA (RRV). The vicarious calibration in this case refers to a method to calibrate satellite's radiance[2] by comparing the values of radiance from the ground obtained by the satellite sensor with the value obtained by a radiometer on the very ground at the same time.

RRV is a 30 km-long and 20 km-wide playa (a dried-up lake) located in east-central Nevada. Its land surface is flat and the reflectance is almost homogeneous spatially all across. RRV is appropriate for this calibration campaign because its area is bigger than the field of view of Thermal And Near infrared Sensor for carbon Observation Fourier Transform Spectrometer (TANSO-FTS) aboard "IBUKI."

2. Observation

We set up a base camp in RRV (Photo 1), and installed a series of observation instruments including meteorological instrumentation and a whole-sky camera in the surrounding area. The radiance on the ground was measured at several different sites within eight kilometers of the base camp (Figure 1). Instruments used to measure the radiance on the ground are FieldSpec Portable Spectroradiometer (ASD Inc.). These spectroradiometers can measure the radiance within the wavelength range of 350~2500 nm.

An observer measured the radiance from the ground in a manner as Figure 2 shows to figure out the radiance in TANSO-FTS's field of view. As the green lines show in the Figure 2, the ground was measured along the diagonal flow lines. The red dots indicate the spots where the Spectralon was measured. Spectralon is a reflectance reference board and was used to calibrate the spectroradiometers.

The observation was carried out using two spectroradiometers synchronized with the "IBUKI" path 36 on June 21 and June 24, and with the path 37 on June 22 and june 25. On June 23, "IBUKI" did not pass over RRV area, however the observation on the ground was conducted on the M03 site because ASTER[3] was observing the area at the time. Table 1 shows the location of observation sites and "IBUKI"'s corresponding paths.

3. In the End

During the RRV campaign, we shared the responsibilities of setting up the camp and preparing meals. It was not easy physically because these tasks had to be done in the heat under the blazing sun. Even under such circumstance, each participant worked on their duties energetically and did not hold back one's effort to make RRV campaign a success. I am honored that I could be a part of it.

1 ACOS: Atmospheric CO_2 Observations from Space (ACOS) is a group formed around the OCO Science Team, including the research members from NASA's JPL, Caltech, and Colorado State University. Using "IBUKI"'s data, ACOS team has collaborated with the GOSAT project to develop and enhance the CO_2 retrieval algorithm for both GOSAT and OCO-2 projects.

2 Radiance: One of the ways to measure intensity of light. The unit is W $sr^{-1}m^{-2}\mu m$. W (watt) is a unit of power. sr (steradian) is a unit of solid angle. μm (micro meter) is a unit of length (in this case, of wavelength of light).

3 ASTER: Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) is an advanced optical sensor comprised of 14 spectral channels ranging from the visible to thermal infrared region. It is a cooperative effort between NASA, Japan's Ministry of Economy, Trade and Industry (METI). ASTER is on Terra satellite launched in December 1999 as part of NASA's Earth Observing System (EOS).

INTERVIEW

Remote Sensing Society of Japan
Former President

RYUTARO TATEISHI

Professor,
Center for Environmental Remote Sensing (CEReS)
Chiba University

"IBUKI" observes the Earth's atmosphere from space using light. The technology to observe a physical object using electromagnetic wave as such is called remote sensing. Remote sensing has been used not only in the field of scientific researches like "IBUKI"'s case, but also for practical applications such as meteorology, agriculture, forestry, fishery, disaster prevention, resource exploration, and mapping. In recent years, in addition to weather satellite images, we can easily access high-resolution satellite images just as in Google Earth. Remote sensing is becoming familiar for us.

For July and August issues, NIES GOSAT PROJECT NEWSLETTER is going to bring you the interviews with Remote Sensing Society of Japan (RSSJ)'s former President Ryutaro Tateishi and current President Shuichi Rokugawa. RSSJ is an academic society with the objective of advancement of remote sensing and its applications.

In this issue, we interviewed the former President Tateishi, and asked to talk about what remote sensing is. Former President Tateishi is a professor of The Center for Environmental Remote Sensing (CEReS) at Chiba University, specialized in extracting and monitoring the land surface information from satellite images. He currently works on the global or continental land cover mapping and monitoring, the research on creating land cover data of infrastructure in Japan, and organizing a store-and-share system for geospatial data. (Interviewer: NIES GOSAT Project Tatsuya Yokota. May 27, 2010.)

Yokota (Y): Thank you for spending time with us today for this interview. Professor Tateishi, you have served as the president of Remote Sensing Society of Japan for the past two years. Could you share with us what the good and inferior aspects about this organization are? Also, what are your expectations on this organization for the future?

Professor Tateishi (T): Well, the board members change quite frequently, and this can be both good and bad for running the organization. As you might know, the term for the board member is only for two years. You spend the first year to get settled into the position, and then you can spend the second year to do your job, but then you already have to pass the position to someone else. The fact that you have to be prepared to leave so soon is one downside. However, if you look at the bright side of this, the organization is more diverse. In other words, more people can serve as board member, and have the chance to operate the organization. These are the good and bad aspects. This kind of way of operation is also reflected in that the organization is quite open. It is never like only certain people control the operation of this organization.

Y: That is true. This organization seems to have members with a range of backgrounds. Perhaps because remote sensing is a method, and it is applied not only in the studies of the land, ocean, and air, but also in other various fields of study. People from all of these studies participate in this academic society because remote sensing is a method for their studies. May I ask what your thoughts are on this?

T: Yes, that is true. The fact that a variety of fields of study are involved is one of its characteristics.

In fact, I didn't have a structured plan on what I was going to do during these two years. I just worked on issues that came up in front of me. Consequently, I worked on other tasks that needed to be sorted out beforehand as well.

There is one example. It was when someone proposed that there should be a textbook on remote sensing. As you may know, there are some books on remote sensing, but none of them are appropriate for classroom use. So, we had a discussion on this idea. Since the college courses consist of 15 classes, we decided to make a textbook that has 15 chapters. I have actually asked you to write a part of this book, too. For the first chapter of this book, I had to define what remote sensing is. I was assigned to write this part, but the book was going to have Remote Sensing Society of Japan as the editorial body. So, I asked the board members for opinions on my version of the definition, and I got so many opinions. This made me realize that which area of study remote sensing should belong to had not been decided yet.

If you look at oversea materials, you often see expressions such as "Remote sensing is science and technology which…" In other words, it explains that remote sensing is science as such and technology as such. If it is translated into Japanese, the latter half sounds natural, but doesn't the first half sound a little bit off? In Japanese,

the translation for the word science, -kagaku- is used when there is something to be pursued logically or for something like pursuit of a truth. I felt like it is not appropriate to define remote sensing as one of areas of study in science.

On the other hand, there is no independent category for remote sensing in the Grants-in-Aid for Scientific Research.[1] Then again, one board member brought up a question; is it possible to say "remote sensing studies?" Responding to this, as I reported in today's general meeting, we established the "Area of Study Working Group." For the next year, the working group is going to reexamine what remote sensing as an area of study can be. It all started because we were making a textbook. We thought this is a good chance to really think about this. This is one example of how I worked on issues as they arose.

Y: Remote sensing covers a wide range of subjects. Among all, which subject is your specialty?
T: Well, I received my doctoral degree from Institute of Industrial Science, the University of Tokyo, for studying three-dimensional visualization of elevation data, in other words, methods of visualizing the geospatial data. At that time, I used to use the satellite images as patterns of the land surface. After that, I worked on research in classification and correction for land use and land cover regarding data processing, mainly for satellite data. What led to my current research was that I was involved in one research for Grants-in-Aid for Scientific Research on Priority Areas in 1980s.
Y: Wasn't there 'remote sensing' as one of priority areas then?
T: Right. That is when I met mapping, including global land cover, and became interested in such global subjects. After that, in 1990s, I was a chairman of a working group called Global Environmental Databases, one of 50+ working groups of International Society for Photogrammetry and Remote Sensing (ISPRS). It was a working group on how to gather and integrate various global data to utilize them. I gained a great interest in global data in addition to my preexisting interest in global land cover. In 2000s, Geographical Survey Institute (current Geospatial Information Authority) started up the Global Map project, and I was invited to one of its working groups on creating land cover data sets. I have served as a chairman there up to the present. So, for now, producing data on land cover and on forest cover percentage for the Global Map take up about 60 percent of my research.
Y: Is this a plan to make a map of forest cover percentage and land cover of not only Japan but also of whole world?
T: Yes, the output is going to be global, but the process is continent by continent. We are planning to use MODIS[2] data.

"I give it high marks for the great significance it carries by being ahead of the world producing CO_2 data and distributing them."

Y: What is your current impression on GOSAT? Do you have any suggestion for GOSAT Project?
T: In fact, my focus of research is land, and I am not very familiar with atmosphere or greenhouse gases. So, when GOSAT Project was formed and "IBUKI" was launched, I did not have much background information or did not know such plan was in works. I was actually a little surprised that Japan was going that far in this field. I cannot make technical comments, but I give it high marks for the great significance it carries by being ahead of the world producing CO_2 data and distributing them. I hear that there are some issues such as noises that need to be removed, but this attempt to work on global mapping of greenhouse gases is a project that Japan should be proud of. GOSAT is the only one in the world that is acquiring this type of satellite data.
Y: Well? Thank you. It is true that "IBUKI" (GOSAT) is the only satellite that is mainly dedicated to this purpose. There are researchers in the world who are working towards similar goals, but you might be able to say we are ahead of the world at the moment.
T: In my impression, I see you succeeded half way already just because of that. There might be a room for improvement for the data quality, but I have a very high regard for the project. I also hope that you distribute data that we can use. To remove the aerosol, you don't necessarily have to do it elegantly. If you have aerosol data from somewhere else, I think it is reasonable for you to use it, too. I understand your real goal is to create a global mapping, but if the reliable data are only available in certain parts, that is ok, too. If the data are available in public already, I hope you validate the data, and disclose information on the reliability of the data, and keep up the great effort.
Y: Thank you for your opinion.
T: It is a project that deserves 'congratulations!'.
Y: Thank you very much for today.
T: It's my pleasure.

1 Grants-in-Aid for Scientific Research: Grants awarded to promote Japan's creative and pioneering research raging from the humanities and social sciences to the natural sciences, offered by Ministry of Education, Culture, Sports, Science and Technology (MEXT) and Japan Society for the Promotion of Science.

2 MODIS: Moderate Resolution Imaging Spectroradiometer. An optical sensor instrument developed by NASA that has 36 channels from visible to infrared on board Terra (launched on 1999) and Aqua satellite (launched on 2002) of NASA Earth Observing System (EOS).

AHA! OF THE MONTH

"IBUKI"'s Observation Time and Location

- Hiroshi Watanabe, NIES GOSAT Project Office Manager

"IBUKI" goes around the globe in a "sun-synchronous sub-recurrent" orbit in order to observe each point at the same time of a day to acquire data under the same condition. In a sun-synchronous orbit, the plane of a satellite's orbit turns 360 degrees during the period of revolution of the Earth. In other words, the spatial relationship between the plane of a satellite's orbit and the sunlight are fixed all the time. "IBUKI" is also set to pass the descending node - the point at which the satellite nadir crosses the Equator moving from North to South - always at around 1PM local mean time. In a sub-recurrent orbit, a satellite repeats almost the same orbit at a constant frequency. "IBUKI" makes one round in 98 minutes and after three days of 44 rounds, "IBUKI" is back to the original orbit. Each orbit is called "path" and numbered from 1 to 44 so that the number increases as the path goes west. "IBUKI" orbits at the distance of 666 km from the Earth surface. It is farther than International Space Station(ISS) (at about 400 km from the Earth) and much closer than the satellites in geostationary orbit such as Multi-functional Transport Satellite (MTSAT) and Geostationary Meteorological Satellites (GMS)(at approximately 36,000 km).

The observation of greenhouse gases by "IBUKI" covers the entire globe evenly (though more frequently at high latitude). Each measurement by Thermal And Near infrared Sensor for carbon Observations - Fourier Transform Spectrometer (TANSO-FTS) targets the ground inside a circle of 10 km in diameter (Figure 1). Normally, "IBUKI" observes five points as a set, tilting the sensor little by little in a direction at a right angle to the orbit (5-point observation mode). Each observation point is called standard mesh point. In oceanic regions, the sun reflection is low, and the sensor often targets the areas of sun's mirror reflection on the ocean called sun glint. An example of 5-point observation and sun glint near Japan (descending, daytime) is shown in Figure 2. There are 56,000 observation points if the entire globe is observed on the 5-point observation mode (Figure 3). Points observed during the daytime (hours of sunlight) are 28,000. For a point to be used for the retrieval of greenhouse gases, the signals of reflection at the point have to be strong enough and the point should not have any cloud. Out of all those points, only a few percent survive. However, that number is still larger than 200 points of pre-existing ground observation sites (Figure 4). Above all, "IBUKI" has an advantage to measure in the regions of world where there were no ground observation sites at all. For information on the relationship between observation dates and paths as well as standard mesh points, please refer to the entry named "The explanation of the "GOSAT Path Calendar" is here." under "Technical Information" tab on the NIES GOSAT Project Website.

http://www.gosat.nies.go.jp/eng/technology/technology.htm

Additionally, more details of observational status (and schedule) can be found at "Observational Information" under "Selection Menu" after logging in at GOSAT User Interface Gateway.

Another sensor aboard "IBUKI," TANSO - Cloud and Aerosol Imager (TANSO-CAI) observes the condition of land surface and clouds during the daytime (hours of sunlight). Its Band 1 to 3 observe the areas of 1000 km wide surrounding satellite nadir point at a spatial resolution of 500 m. Band 4 observes the areas of 750 km at a spatial resolution of 1500 m.

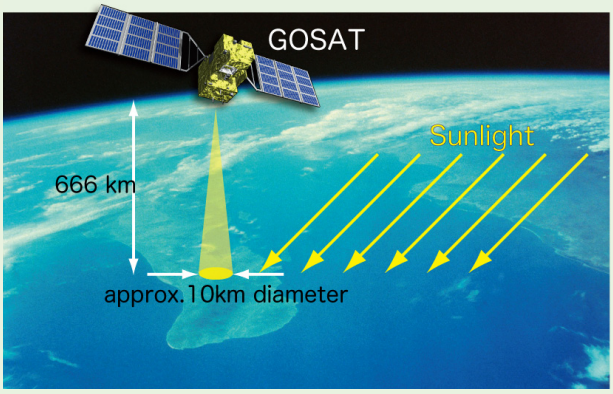


Figure 1. Schematic illustration of how GOSAT makes observations.

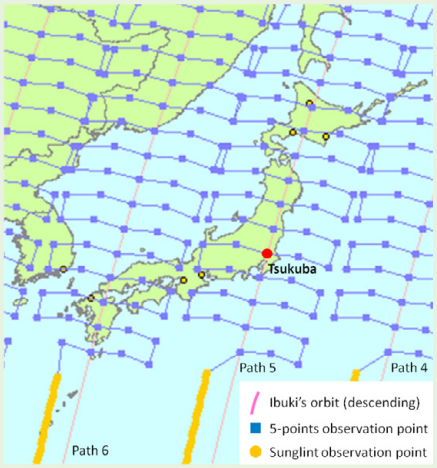


Figure 2. "IBUKI"'s observation points near Japan (descending).

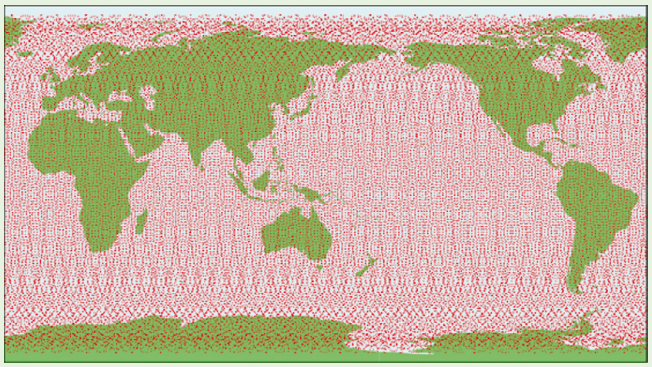


Figure 3. All the observation points of "IBUKI" when operating in 5-point observation mode (for three days, 44 rounds).

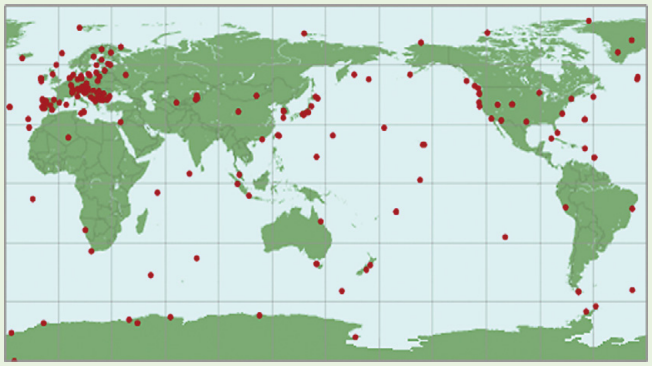
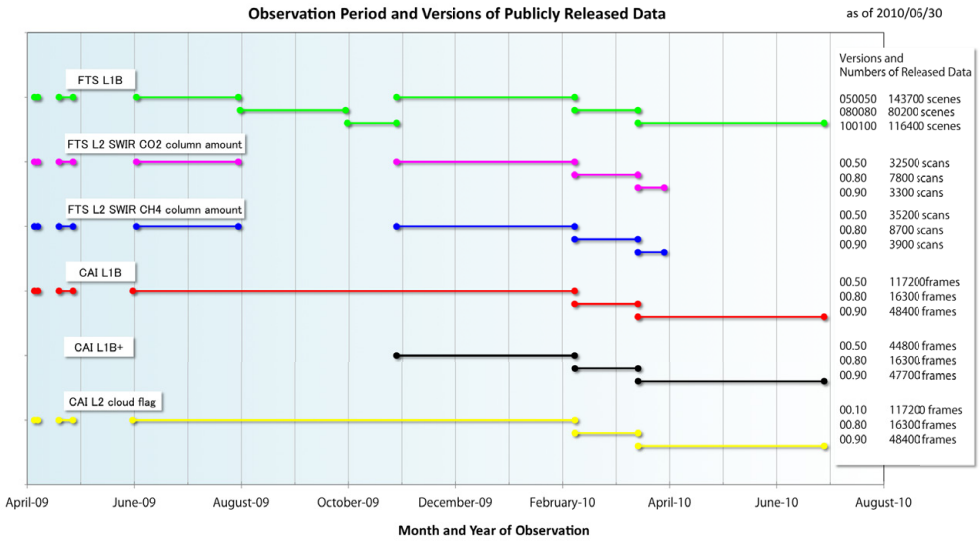


Figure 4. Ground observation sites. (Source: World Data Center for Greenhouse Gases (WDCGG))

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 the month of June 2010. Continued from May, FTS L1B data were processed and released as V100100; and CAI L1B, L1B+, and L2 cloud flag were processed and released as V00.90. We have been working on the quality check process for the FTS L2 SWIR CO_2 and CH_4 column amounts data, and the data for the month of March was released along with "Important Notice." The observation period between March 1 and March 16 are available for search and download as V00.80, and between March 16 and March 31 as V00.90. "Important Notice" can be found on "Important Notices on monthly FTS L2 SWIR Product" page. Please read carefully before using the product. (GUIG/ Product & Service/ User Authentication/ Selection Menu/ Important Notices on monthly FTS L2 SWIR Product) FTS L2 SWIR data observed after April 2010, as well as during August, September, and October 2009 are planned to be released as soon as possible. The number of registered users reached 826 as of July 9, 2010.



ANNOUNCEMENT The Third Research Announcement to Start Soon!

The GOSAT Project will organize the third Research Announcement (RA) in late August 2010. Eligible applicants are independent researchers or researchers affiliated with research institutions, educational organizations, government institutions, or private companies that aim to use the GOSAT data for non-profit and peaceful purposes. Open to applicants of all nationalities. Even if you have been selected as the principal investigator (PI) at the first or the second RA, you are encouraged to apply for the third RA with a different research theme. Details of the third RA will be available on our homepage on the release date. For those who would like to have better understanding of what the RA is, please refer to the first and the second RA at the website below.

Information on the First and the Second RA:
http://www.gosat.nies.go.jp/eng/proposal/proposal.htm

PUBLISHED PAPERS

Name of Journal: Atmospheric Measurement Techniques (Volume 3, Number 4, July 2010, pages 909-932)

Title: The inter-comparison of major satellite aerosol retrieval algorithms using simulated intensity and polarization characteristics of reflected light

Authors: A. A. Kokhanovsky, J. L. Deuzé, D. J. Diner, O. Dubovik, F. Ducos, C. Emde, M. J. Garay, R. G. Grainger, A. Heckel, M. Herman, I. L. Katsev, J. Keller, R. Levy, P. R. J. North, A. S. Prikhach, V. V. Rozanov, A. M. Sayer, Y. Ota, D. Tanré, G. E. Thomas, and E. P. Zege

CALENDAR

2010/08/09-12
Participation at the International Society for Photogrammetry and Remote Sensing (ISPRS) Technical Comission VIII Symposium held in Kyoto, Japan.

2010/08/25
GOSAT Project is hosting "The Greenhouse Gases Observation from Space Symposium" in Tokyo, Japan.

2010/Late August
Release of the third Research Announcement.

2010/09/05-09
Participation at the 2010 Meeting of Japanese Federation of Statistical Science Associations (Japan Statistical Society the 78th Meeting) held in Tokyo, Japan.

2010/09/07-11
Participation at the 21st International Conference on High Resolution Molecular Spectroscopy-POZNAN2010 held in Poznań, Poland.

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