NIES GOSAT PROJECT NEWSLETTER

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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/

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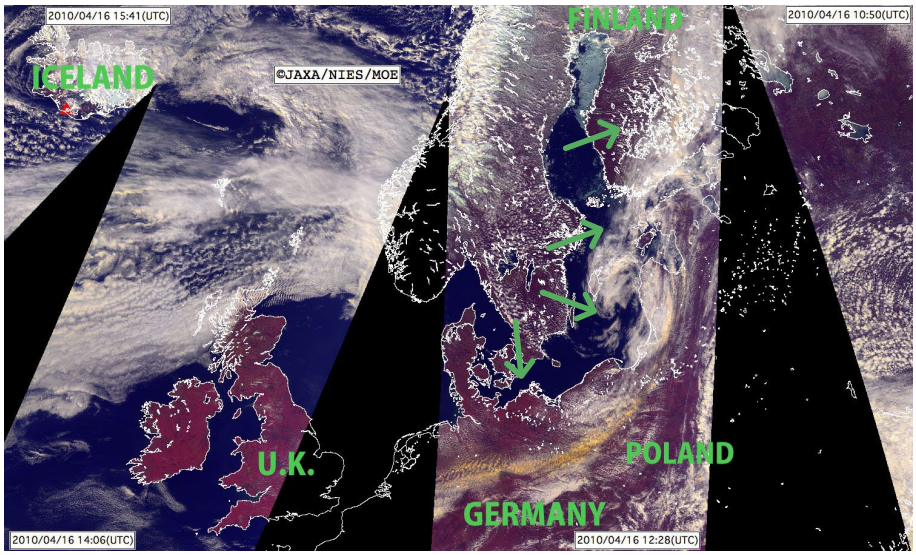


Image 1. Made from four CAI L1B data products observed when "IBUKI" flew over Russia~Europe four times on April 16, 2010 (Japan Standard Time). Blue = Band 1, Green = Band 2, Red = Band 3

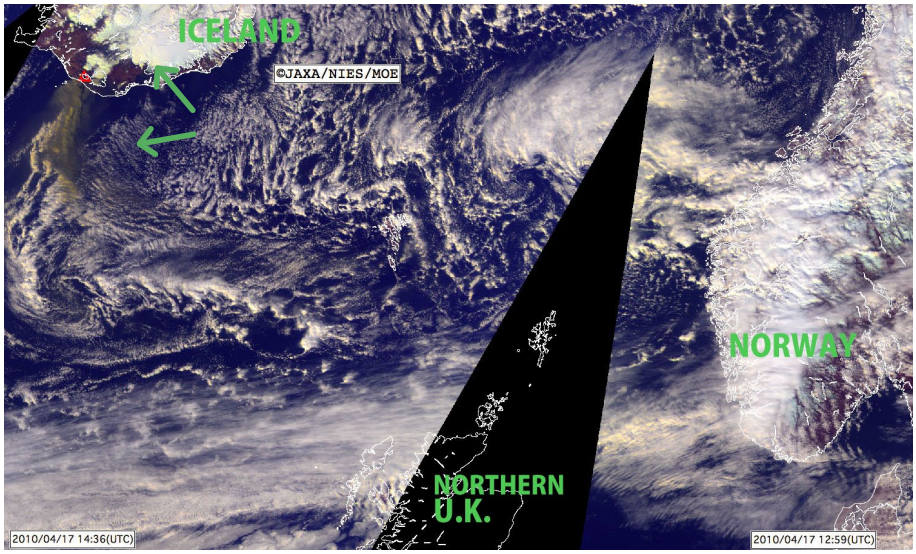


Image 2. Made from three CAI L1B data products observed when "IBUKI" flew over Europe three times on April 17, 2010 (Japan Standard Time). Blue = Band 1, Green = Band 2, Red = Band 3

IMAGE OF THE MONTH

ICELAND
—VOLCANO ERUPTION AND SPREADING VOLCANIC PLUME

On April 14 and 17, large scale eruptions occurred in the glacier region about 100 km southeast of Reykjavik, the capital city of Iceland, after the intermittent volcanic activities observed since March 2010. As the volcanic plume of these eruptions reached the large areas in Europe, many European countries took emergency measures such as cancellation of commercial passenger flights and shutdown of airports. Here we report IBUKI's observation of volcanic eruptions in Iceland and the spreading volcanic plume.

Image 1 is a color composite image of CAI L1B data products on April 16, 2010, two days after an eruption, taken over Russia and Europe. A red triangle indicates the location of the erupting volcano, and black regions are the areas where "IBUKI" could not observe. Clouds, snow, and sea ices are shown in white, terrestrial vegetation in red, and volcanic plume in yellow. In the bottom-center of Image 1, yellow spreading volcanic plume can be seen over northern Germany, Poland, and Finland.

Image 2 is a color composite image of CAI L1B data products from April 17, 2010 over Europe. There appears some volcanic plume caused by an eruption on 17th spreading southwards from southern Iceland to the ocean close-by, then changing its direction to the east.

There was a request from the government of United Kingdom to the Ministry of Foreign Affairs of Japan for the observation data to check the status of the volcanic plume as well as to validate their prediction model. Responding to the request, Ministry of the Environment (MOE), Japan Aerospace Exploration Agency (JAXA), and NIES provided the observation data over Europe from April 15, 2010 to April 29, 2010 after some image processing and mapping.

More images of Icelandic volcano eruptions observed by "IBUKI" can be seen on NIES GOSAT Project website.

"IBUKI"'s web page on the Icelandic volcano eruptions:
http://www.gosat.nies.go.jp/eng/related/201004.htm

GOSAT NEWS

A New Ground-based High-resolution Fourier Transform Spectrometer Now Installed at NIES!

—Isamu Morino, Senior Researcher, Satellite Remote Sensing Research Section, Center for Global Environmental Research (CGER), NIES

During March 25 and 31, 2010, a new ground-based high-resolution Fourier Transform Spectrometer (FTS, Bruker IFS 125 HR) was delivered and installed at NIES, and adjustments were performed. After a pilot run of the atmospheric observation, the routine observation was started on April 8, 2010.

At NIES GOSAT Project, validation is being carried out to evaluate the uncertainty of concentrations of green house gases or other information retrieved from the GOSAT data. The validation is an indispensable task for a GOSAT data product to be used for scientific purposes. Measuring the direct solar radiation that has been affected by the absorption of the greenhouse gases in Earth's atmosphere using a ground-based high-resolution FTS is one the most effective observation methods for validation. For this reason, there is a network of the ground-based high-resolution FTSs, named Total Carbon Column Observing Network (TCCON), and currently such observations are carried out in more than ten locations worldwide.

A high-resolution FTS (Bruker IFS 120 HR) was installed in 2001 at the Climate Change Research Hall at NIES, and the routine observation using this instrument has been conducted since then. In 2009, an observation that follows TCCON protocol was initiated for GOSAT validation. And it was approved as one and only TCCON observation site in Asia after an airborne observation exam in January 2009 that proved its observation results to be consistent with the other major TCCON sites. However, it has been ten years since the existing observation instrument was installed, and it was not able to fully follow the TCCON observation protocol with its aged measurement and control system. The newly installed FTS realized much improved signal-to-noise ratio and observation efficiency. A lot is expected for this new FTS in the GOSAT validation process.

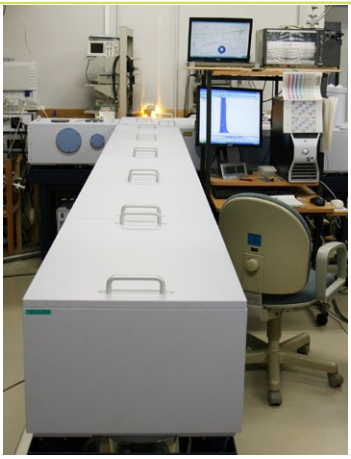


Image 1. The new FTS (Bruker IFS 125 HR) has been conducting a routine observation after a series of adjustments were performed. The sunlight brought in from the solar tracker on the rooftop shines on the gold-coated mirror in the upper middle of the image. (April, 14, 2010)

Image 2. A part of high-resolution FTS is being brought in. (March 25, 2010) Photo: Isamu Morino.

GOSAT NEWS

On Installing the GOSAT Research Computation Facility (GOSAT RCF)

— Tsuneo Matsunaga, Chief, Office for Global Environmental Database, CGER, NIES
Kaduo Hiraki, NIES Fellow, Office for Global Environmental Database, CGER, NIES

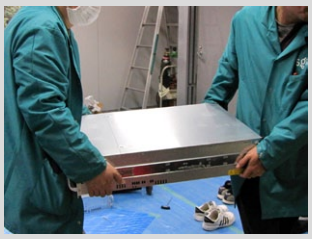
NIES GOSAT Project has newly installed a dedicated large-scale computer of its own, "GOSAT Research Computation Facility" (GOSAT RCF) in the end of March 2010 to further promote the GOSAT related research.

GOSAT RCF features 320 CPUs (Central Processing Unit, Intel Xeon E5530 (2.4GHz, 4 cores)) and 320 GPGPUs (General-Purpose computing on Graphics Processing Units, NVIDIA Tesla C1060) and its total theoretical peak performance (double precision floating point number) reaches 37 TFLOPS[1]. GOSAT RCF also features a large capacity disk system with an actual capacity of 100 Tera Byte (RAID6) to hold the data in the computing process.

On the other hand, a massive amount of electricity that a large-scale computer consumes has been considered problematic in recent years. In an effort to achieve lower energy consumption, GOSAT RCF features not only GPGPU that is of high performance per energy consumption, but also silicon disks that do not run on motors (except for the large capacity disk system and some of the servers), energy-efficient rack-mount cooling systems, and a monitoring function to halt CPUs if they are detected inactive for a certain period of time.

Additionally, the installation of the atmospheric radiative transfer program and the atmospheric transport program, that are very important in the GOSAT data processing, and their optimization at the GOSAT RCF are being carried out as the discussions with software developers and users are continued. As soon as these softwares are ready, the GOSAT's large data processing and other numerical simulations are scheduled to start.

1 Further improvement of the performance is expected as the update of the GPGPU is scheduled during the first half of 2010.



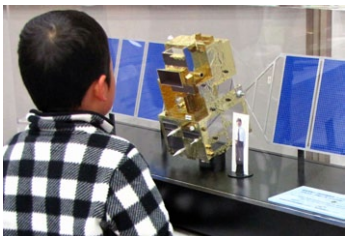
(left)A view inside GOSAT Research Computation Facility. (right top) At the beginning of GOSAT RCF construction work. (right middle and bottom) Computing nodes are brought in and stored on the racks one by one.

GOSAT NEWS

NIES Spring Environmental Lecture Report

At the lecture "Let's look at the Earth breathing from satellite!" by NIES GOSAT Project Leader Tatsuya Yokota.

CGER Office for Global Environmental Database Chief Tsuneo Matsunaga explains the global observation data including "IBUKI."



One-sixteenth scale model of "IBUKI."

On April 17, 2010, as a part of the National Science and Technology Week, NIES introduced some main research facilities and our daily research achievements to the general public. At the lecture, "Let's look at the Earth breathing from satellite!" by NIES GOSAT Project Leader Tatsuya Yokota, "IBUKI"'s undisclosed facts were told, including the viewing of a video recorded from the rocket at the moment "IBUKI" was released into the orbit. Curious questions from participants such as "How much does this project cost?" excited the lecture room. (Answer: From the development to the launch, it cost approx. 350 million US dollars.) At the exhibition, "Get to know about Greenhouse Gases Observing Satellite "IBUKI" (GOSAT)," a popular question was "How does a satellite measure greenhouse gases?" Researchers directly answered such questions by using an observation instrument (similar to the sensor onboard "IBUKI") on display. We appreciate 350 people visited the Climate Change Research Hall where the "IBUKI" lecture and exhibit were held despite the out-of-season snow in the morning.

GOSAT INTERVIEW

A Series: "IBUKI"'s PI Interviews

No.3

DR. CHRISTIAN FRANKENBERG

Scientist
Jet Propulsion Laboratory, California Institute of Technology, USA

GOSAT Project hosted the Second Annual Research Announcement Principal Investigator Meeting (RA PI Meeting) in Kyoto from January 28 to January 29, 2010. At this meeting, 133 people including the PIs of selected RAs and the related researchers from 18 countries around the world gathered and had intensive discussions.

For this issue we introduce one of the PIs from the first RA, Christian Frankenberg of Jet Propulsion Laboratory. (Interviewer: NIES GOSAT Project Yokota Tatsuya. Kyoto, Japan. January 29, 2010.)

Yokota : Thank you for coming here. I remember you went to Heidelberg University, and you were with Netherlands Institute for Space Research (SRON), and then, you just moved to National Aeronautics and Space Administration (NASA)[1] last week. I would like to ask you about your birthplace and the history of your research works, and also about your major achievement for Scanning Imaging Absorption Spectrometer for Atmospheric Cartography (SCIAMACHY) [2]. Also, I would like to ask about your impression on the present GOSAT data and the expectation in the future as well.

Frankenberg : Ok, I was born in 1976 in Bad Honnef, Germany, close to Bonn, the former capital. I studied Geoecology at the

1 JPL is a federally funded research and development facility managed by the California Institute of Technology for NASA.

2 SCIAMACHY is a passive remote sensing spectrometer observing backscattered, reflected, transmitted or emitted radiation from the atmosphere and Earth's surface. The instrument flies on board European Space Agency's ENVISAT satellite, which was launched on March 1, 2002.

GOSAT INTERVIEW continued

University of Bayreuth, which is in the southern part of Germany.

Yokota : Geoecology?

Frankenberg : Geoecology. It is kind of an interdisciplinary study. My focus was in physical and chemical aspects of the atmosphere. I had a good impression from my summer school of Environmental Physics in Heidelberg (two week summer school, one week dedicated to Atmospheric Chemistry and Physics, and the other week to Soil Physics), I started my doctoral program in Heidelberg University. I think it was in 2002 roughly. They had some open work on the SCIAMACHY shortwave infrared channels, but it was more or less an open topic; just do something with the shortwave infrared channels. The topic of my thesis wasn't really strictly defined at the beginning but evolved in the course of my studies. There, I actually started focusing on methane (CH_4) retrievals from SCIAMACHY, also switching to a wavelength range that was not really planned for the CH_4 retrievals, a region that's now being used by GOSAT actually. I also did some work on CO from SCIAMACHY during my doctoral program.

Yokota : What was your role in the retrieval? Did you develop a new code?

Frankenberg : Yes, I actually developed a new code at the Heidelberg group because they come more from the Differential Optical Absorption Spectroscopy (DOAS) background, an algorithm not fully suitable for near-infrared retrievals. Mine is rather a simple approach, compared to the GOSAT retrieval, that completely ignores scattering, but it still tries to properly model the atmosphere in the best sense that you can do without any scattering properties. Then, we actually used the concurrent CO_2 measurement as a proxy for the light path which in turn enabled the first global CH_4 retrievals from SCIAMACHY, because this largely eliminated uncertainties in the light-path distribution in the observed ground-scene. You can imagine that for SCIAMACHY, with a ground-pixel size of 60 by 30 kilometers, you hardly have any completely cloud free scene, so you need a proxy for the light path. Then, at the end of my studies, I applied for a personal fellowship from the Dutch Science Foundation (NWO). Then, after my doctoral program in Hidelberg, I started working for the Netherlands Institute for Space Research (SRON) in Utrecht. Now, I have been there for more than three years, and just started at Jet Propulsion Laboratory (JPL) in mid January. Now, I hope to be able to focus my work on GOSAT.

Yokota : So your research works in Heidelberg University, SRON, and JPL, all are in the same area?

Frankenberg : It is kind of in the similar area. During my doctoral program I was doing more work for carbon monoxide as well. At my time at SRON, I also did some work on the characterisation of CH_4 spectroscopy.

Yokota : So, your role in JPL is for OCO-2?

Frankenberg : Right now, I will be in the ACOS team also, to help understand the data product. There are already many people in the algorithm development. I will also try to get some CH_4 into the ACOS team because right now it's focused on CO_2.

Yokota : What is your major interest? In the retrieval code, climate change, greenhouse gas monitoring, changing variation or comparison?

Frankenberg : It's hard to say because my studies are interdisciplinary, so I do not fully focus on algorithm development, and I do not fully focus on the interpretation. I try to bridge the gap a little bit. I have a hybrid interest. It is often quite important to know a little bit of both worlds, retrieval and scientific interpretation.

Yokota : Do you have some special area where you have a focus on in the world?

Frankenberg : Asia probably is the most exciting area. This is where I think the most changes are happening now and can be expected to be happening in the future. It is the most uncertain region also because many of these ground based measurements that are established in Europe or North America or in Japan are not really apparent in the main-land of the Asia, in the emerging nations like China and India. These are the two most densely populated places with almost half the people worldwide living in this area.

Yokota : I'd like to ask you about your impression on the present GOSAT data.

Frankenberg : I have to admit that I didn't fully spend a lot of time working on the GOSAT data, but even when I look at the data, it is a huge improvement in terms of spectral resolutions that you can identify individual lines, and the spatial resolution which is quite important. Just from this point of view, you can actually expect a huge improvements over SCIAMACHY. When we see what we have achieved with SCIAMACHY already, I am actually quite confident that there will be nice results coming out of GOSAT spectra. It is such a vast variety of spectra and data that GOSAT provides, that it probably will take quite some time until the full potential of GOSAT will be exploited.

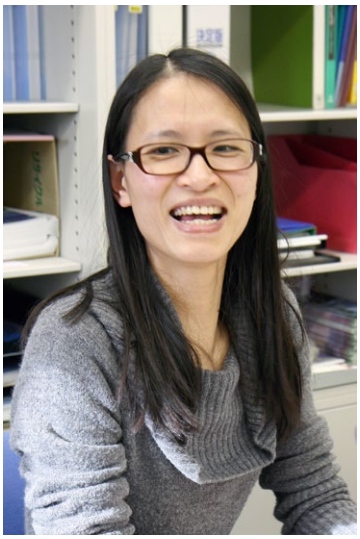
Yokota : Do you have some requests or expectation in GOSAT data near future?

Frankenberg : It would be nice, of course, if some calibrations were directly implemented in the Level 1B. Or some calibration products that the end user does not have to apply all the calibrations on their own would be nice. One unified kind of calibration scheme that is easy to implement for everybody, that would be an ideal case, I think.

SMALL AHA! OF THE MONTH

SCIAMACHY is not only an abbreviation for Scanning Imaging Absorption Spectrometer for Atmospheric Cartography, but it is also a Greek expression, which means *chasing or hunting shadows*, and is equivalent to do the impossible task.

Reference : The SCIAMACHY Book on SCIAMACHY website.
http://www.sciamachy.org/



GOSAT INTERVIEW

DR. HA TRAN

Researcher,
Laboratoire Inter-universitaire des Systemes Atmosphériques
Centre National de la Recherche Scientifique, France

NIES GOSAT Project invited Dr. Ha Tran from Laboratoire Inter-universitaire des Systemes Atmosphériques (LISA), Université Paris 12 and the Centre National de la Recherche Scientifique (CNSR) in France for discussions on one of the important aspects of the radiative transfer calculation in GOSAT data processing, the line-mixing effect, with NIES GOSAT algorithm team and GOSAT Data Handling Facility team from March 9 to March 19, 2010. (Interviewer: GOSAT Project Tatsuya Yokota)

Yokota: Thank you for coming here to our institute. Today, I would like to ask you some questions on your personal history etc. Firstly, where were you born?

Tran: I was born in Thai Binh, Vietnam. I finished my master's studies at Hanoi National University of Education in 2000. Then, I came to France for my doctoral degree. First, I spent one year for my master's degree in molecular physics, and then I studied for my doctoral degree at University of Franche-Comte in Besançon for three years. I finished my doctoral degree in 2004. I had two years of postdoc at LISA, Université Paris 12. Then, I spent one year as an assistant professor at Laboratoire de Physique Moléculaire pour l'Atmosphère et l'Astrophysique (LPMAA) at Université Paris 6. I got my permanent position at LISA in 2007 in the group of Dr. Jean-Michel Hartmann and Dr. Jean-Marie Flaud.

Yokota: Dr. Flaud? He is the key person for the High-resolution Transmission Molecular Absorption Database (HITRAN)[1] and Management and Study of Atmospheric Spectroscopic Information (Gestion et Etude des Informations Spectroscopiques Atmosphériques, GEISA)[2].

Tran: Yes, he is the director of the laboratory as well and we are in the same group.

Yokota: When you were in university and went to Paris, what kinds of molecule spectroscopy were you involved with?

Tran: I was interested in the spectral line shape of molecules of the atmosphere for example CO_2, O_2, and many other molecules present in the atmosphere.

Yokota: What is the motivation to study molecular physics and spectroscopy?

Tran: Hmm, good question. I love physics. And I also met some people like Dr. Jeanine Bonamy and Dr. Daniel Robert when I was in Besançon. They have the "French school" of molecular physics, especially in "line shape" theory in Besançon and then I had very good professors who made me love molecular physics and spectroscopy.

Yokota: Have you ever been involved with satellite sensor projects?

Tran: When I was at LPMAA, I worked with Dr. Claude Camy-Peyret and Dr. Sébastien Payan, and they had a project with the Centre National d'Etudes Spatiales (CNES), a satellite project, Tropospheric composition and Air Quality (TRAQ), but unfortunately, it did not work. In fact, I am not really involved in satellite projects, but more in spectroscopy in laboratories.

Yokota: Are you going to continue your work in molecular spectroscopy?

Tran: Yes, and currently, with Dr. Jean-Michel Hartmann we plan to develop some models of line shape including line mixing and velocity effects by using molecular dynamic simulations for example

Yokota: I think it's a very important field. Very many researchers have demands and requests for new data.

Tran: For understanding, this is important. Application (of the data) is the most important, of course, but understanding the process is very important, too.

Yokota: What is your expectation and impression of the GOSAT Project here?

Tran: Very huge. "IBUKI" is the first satellite devoted to greenhouse gases measurement with high resolution, so I think that data and spectra provided by "IBUKI" motivate us for our spectroscopy studies. The aim of GOSAT is to measure greenhouse gases amounts in our atmosphere with very high precision then we need very accurate line parameters and line shape. So, I am very pleased to be invited by you here.

Yokota: Well, thank you for coming here. I hear this is your first visit to Japan. What do you think about Japan?

Tran: I really like it. For me, Japan is very modern, but also it is very traditional and Japanese people are very kind and polite. I hope I can visit some shrines or monuments this weekend in Tokyo... (Dr. Tran visited some shrines during her weekend in Tokyo, and says she appreciated that experience very much.)

Line shape: Measured by a high-resolution spectrometer, sunlight that traveled through the atmosphere has absorption lines because the gas molecules in the atmosphere such as CO_2 absorb the light at certain wavenumber. In the actual atmosphere the absorption lines are broadened because of the Doppler effect and collisions with other gas molecules. The shape of absorption lines including such effect of broadening is called "line shape."

Line mixing: When an absorption line is far from the other lines, the line shape can be approximated by an analytical function. However, when absorption lines are close to each other, the shape can differ from the shape overlaid using these analytical functions. The effect that generates this difference is called "line mixing." Because of line mixing, the absorption is less prominent at the wings of the absorption lines.

TANSO-FTS measures the sunlight at a high-spectral resolution. If the data is analyzed ignoring line mixing, there will be errors in the retrieved column amounts of greenhouse gases. This is the reason why it is important to employ very accurate information on line shape and line mixing in the GOSAT data analysis.

—Yukio Yoshida NIES Special Researcher,
Satellite Remote Sensing Research Section, CGER, NIES

1 HITRAN is a database on absorption lines' locations, intensities, etc. of gas molecules, and developed by U.S. Air Force's laboratories since 1973. Its 2008 edition contains 2,713,968 absorption lines for 39 different gas molecules. Each datum includes transition wavenumber, line intensity, Lorentzian half-widths, and lower-state energy etc.

2 GEISA is a database developed by CNRS since 1976. Its 2009 edition contains 3,807,997 absorption lines for 50 different gas molecules.

DATA PRODUCTS UPDATE

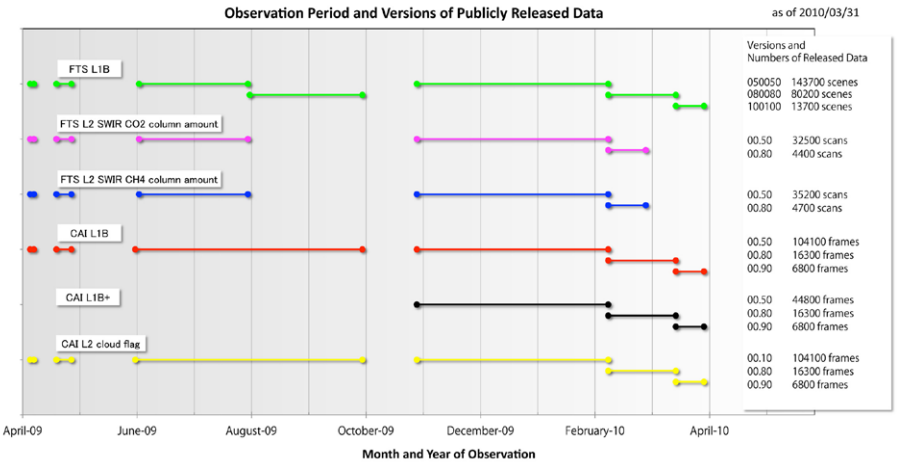
Data Processing Status Update from GOSAT Project Office

— Fumie Kawazoe, Specialist, NIES GOSAT Project Office

Here we report an update on data processing status for the month of March, 2010.

Continued from February, the data before March 16, 2010, were processed as V080080 for FTS L1B, as V00.80 for CAI L1B, L1B+, and L2 cloud flag, and all of these data products are available to the public. The data after March 16, 2010, were processed as V100100 for FTS L1B, and as V00.90 for CAI L1B, L1B+, L2 cloud flag, and these are all available to the public.

As for FTS L2 SWIR CO_2 and CH_4 column amounts, the data from February were processed as V00.80 and are available to the public. The data between March 1 and 16, are being processed as V00.80, and then after March 16 as V00.90. The number of the registered general users reached 707 as of April 8, 2010.



INFORMATION

Presentations at Domestic Academic Conferences

NIES GOSAT Project members will be attending several domestic academic conferences held in May to report the research achievements.

Name of Academic Conference	Location	Date	Title	Presenter/Author
15th International Workshop on Atmospheric Science from Space using Fourier Transform Spectrometry (ASSFTS15)	Nara Women's University, Nara, Japan	5/11-13	Retrieval of column abundances of carbon dioxide and methane from GOSAT observational data.	Tatsuya Yokota
The 10th Symposium on Molecular Spectroscopy	Guraduate School of Science and Engineering, Tokyo Institute of Technology Tokyo, Japan	5/14-15	Observation of greenhouse gases using the Fourier Transfer Spectrometer onboard GOSAT(Greenhouse gases Observing Satellite) and its data validation.	Isamu Morino
The Meteorological Society of Japan 2010 Spring Meeting	National Olympics Memorial Youth Center Tokyo, Japan	5/23-26	A high-resolution global inventory of fossil fuel CO_2 emission derived using a global power plant database and satellite-observed nightlight data.	Tomohiro Oda (author) Shamil Maksyutov (presenter)
The 48th Spring Conference of the Remote Sensing Society of Japan	National Institute of Advanced Industrial Science and Technology (AIST) Tsukuba, Japan	5/27-28	Current status of GOSAT data processing and distribution.	Hiroshi Watanabe

CALENDAR **other future events**

2010/05/02-07 Presentation at the EGU General Assembly 2010 held in Vienna, Austria.
2010/05/31-06/07 Presentation at the Network for the Detection of Atmospheric Composition Change Infrared Working Group (NDACC IRWG) • Total Carbon Column Observation Network (TCCON) Meeting held in Wollongong, Australia.
2010/06/14-15 Presentation at the 32nd Review of Atmospheric Transmission Models Meeting held in Lexington, Massachusetts, USA.
2010/06/16-18 Presentation at the11th Biennial HITRAN Conference (with 10th ASA Conference) held at Harvard-Smithsonian Center for Astrophysics, Cambridge, USA.

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email : gosat_newsletter@nies.go.jp
website : http://www.gosat.nies.go.jp/eng/newsletter/top.htm
address : 16-2 Onogawa, Tsukuba-City, Ibaraki, 305-8506 Japan
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