

# ISSUE # 15 MAR. 2011

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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/>

## NEWS Report: The 1st International Workshop on GOSAT Data Utilization

- NIES GOSAT Project Leader Tatsuya Yokota

🍀🍀🍀 First of all, I would like to convey our deepest condolences to all the victims of the Great East Japan Earthquake. In the afternoon of March 11, 2011, the National Institute for Environmental Studies, the Japan Aerospace Exploration Agency, and the Ministry of the Environment were hosting the 1st International Workshop on GOSAT Data Utilization at the International Congress Center EPOCHAL TSUKUBA in Japan. The workshop had to be closed due to the earthquake that occurred halfway through the presentations. I would like to express my sincere apology to those who traveled all the way for this workshop.

The earthquake happened during the presentation by Dr. Julia Marshall of Max Planck Institute (Germany). The strong shaking lasted for quite some time, and then the ceiling lights went off. Soon after the venue was closed for safety check, and it was impossible to proceed with the workshop.

The purpose of this workshop was to promote the "IBUKI" data utilization mainly for the carbon cycle model studies by reviewing the current understandings and issues and discussing the possibility of future cooperation. Unfortunately, this workshop was suspended halfway, but I hope to have another opportunity in the near future.



Dr. David Crisp of the NASA Jet Propulsion Laboratory gives a presentation before the earthquake at the 1st International Workshop on GOSAT Data Utilization. Photo: courtesy of JAXA/RESTEC.

Details on the 1st International Workshop on GOSAT Data Utilization :

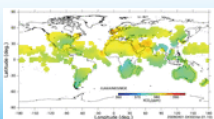
<http://www.restec.or.jp/?p=11103>

The agenda for the 1st International Workshop on GOSAT Data Utilization :

[http://www.restec.or.jp/wp-content/uploads/2011/03/Agenda\\_20110307.pdf](http://www.restec.or.jp/wp-content/uploads/2011/03/Agenda_20110307.pdf)



**DATA  
AND  
IMAGES  
ARE HERE.**



**GOSAT USER INTERFACE GATEWAY**

### ANNOUNCEMENT from NIES GOSAT PROJECT

The GOSAT User Interface Gateway (GUIG), the website where you can search and download GOSAT data products, is partially restored after being down due to the Great East Japan Earthquake that occurred on March 11, 2011. We apologize to all the GUIG users for the inconvenience that this incident has caused. For more details, please refer to the page 6.

## NEWS

## Validation of "IBUKI" Data Products and Development of Next-generation Satellite Sensors

- Shuji Kawakami, Associate Senior Engineer and Daisuke Sakaizawa, Invited Researcher of Earth Observation Research Center, Japan Aerospace Exploration Agency in cooperation with the participants at the 2011 aircraft observation campaign



Photo 1. On the airplane, the writer (Sakaizawa) warming up the window with a hairdryer to keep it from being fogged. Photo: Diamond Air Service Inc. (DAS)

🍋🍋🍋 It has been two years since "IBUKI" started the observation of atmospheric greenhouse gases from space. Meanwhile, we have been checking the quality of its data. Another important task for us has been to work on the development of future satellite sensors that will meet the higher needs of data users. Along with the operational calibration and validation of "IBUKI" data, the members at the Earth Observation Research Center (EORC) at the Japan Aerospace Exploration Agency (JAXA) are doing research on instruments for carbon dioxide (CO<sub>2</sub>) measurement using lasers as a possible candidate for the next-generation satellite (photo 1 and 2).

JAXA's EORC, in collaboration with the NIES GOSAT Project, conducted an aircraft observation for validation of "IBUKI" data (photo 3). We measured the atmospheric greenhouse gases concentrations (CO<sub>2</sub> and methane) in Tsukuba area using an instrument on airplane and a ground-based high-resolution Fourier Transform Spectrometer at the same time when "IBUKI" passed over the vicinity.

Previously, the aircraft observations were conducted in August 2009 and February 2010. This year marked our third aircraft observation campaign. The observations were held on January 28, 31, and February 3 and 7 in clear weather typical of Kanto Plain in winter. In favor of "IBUKI," this enabled us to acquire data sets on days with different amount of aerosols. Validating the "IBUKI" data in consideration of these aerosol data is expected to help improve the precision of observational data in the future. Since the further details on validation of "IBUKI" data (and on the aircraft observation in February 2010) are already covered in the article, "the Airborne Observation for the GOSAT Data Product Validation" in the NIES GOSAT PROJECT NEWSLETTER ISSUE#3 MAR. 2010, this article will report on the instruments for CO<sub>2</sub> measurement using lasers (photo 1 and 2).

The advantage of an instrument for CO<sub>2</sub> measurement using lasers on satellite is that it has a light source on the instrument itself. Unlike the observation using the sunlight, the data can be obtained consistently regardless of season or latitude with a laser instrument, and it has an advantage especially when it is observing the high-latitude regions. It only needs one sensor to acquire observational data both during the day and night. Since the lasers emit very fine beams, they are less likely to be interfered by the clouds and aerosols compared to GOSAT sensors. This year, the concentrations were measured over the areas where the high anthropogenic CO<sub>2</sub> emissions can be expected such as the Tokyo Bay area and the nearby industrial area (photo 4), and over suburban area such as northern Kanto (from Kumagaya to Tsukuba) to check if the actual data reflect the contrast of different amounts of CO<sub>2</sub> emissions.

The instrument used for this aircraft observation outputs the continuous near-infrared laser lights. These laser lights are set at the wavelengths where the absorption of CO<sub>2</sub> occurs the most and least. These lights are emitted towards the ground and the absorption by CO<sub>2</sub> in diffuse lights that come back is measured to estimate the CO<sub>2</sub> amounts in the atmosphere. The instrument has become as precise as "IBUKI" sensors now, and the data can be compared to the "IBUKI" data. We are expecting to develop a sensor that is three times more accurate than "IBUKI"'s sensor based on this technology.

During this aircraft observation period, research groups at the National Institute of Information and Communications



Photo 2. The laser instrument for CO<sub>2</sub> measurement installed on the airplane. The instrument measures the amount of CO<sub>2</sub> between the airplane and the ground by emitting the near-infrared laser light through the window and by receiving the diffused light that comes back after being reflected on the ground with a telescope. Photo: Daisuke Sakaizawa



Photo 3. Members participated in the aircraft observation (the airplane in the back was used for the observation) at the headquarters of DAS in Aichi, Japan. Photo: DAS



Photo 4. The Kashima Industrial Zone seen from the airplane during the observation. Photo: Tomoaki Tanaka

Technology and the Tokyo Metropolitan University also measured the CO<sub>2</sub> concentration in Tokyo using other laser instruments, the Differential Absorption Light Detection And Ranging (DIAL). Their instruments were set at the wavelength different from ours, and used the pulsed laser light. As such, the three groups measured the vertical profile in the troposphere and the column amount of CO<sub>2</sub> in the atmosphere. We hope to continue our collaboration in research to establish a next-generation measurement method.

As for us, now we will analyze the results of observation to validate "IBUKI" data, and at the same time continue our research for the next-generation satellite sensor.



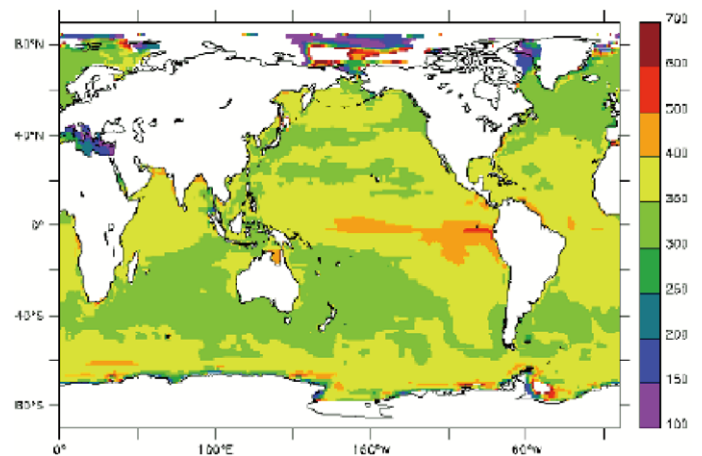
## NEWS

# Global Oceanic Emission and Absorption Maps of CO<sub>2</sub> Gas Using Model Simulations and Assimilation

- Vinu Valsala, Research Associate,  
and Shamil Maksyutov, Chief  
Biogeochemical Cycle Modeling and Analysis Research Section, CGER, NIES

Partial pressure of carbondioxide in equilibrium with the surface ocean waters (pCO<sub>2</sub>) is a key parameter that determines the absorptions and emissions of carbondioxide gas (CO<sub>2</sub>) by the ocean. A positive (negative) difference of pCO<sub>2</sub> between the atmosphere and ocean (i.e.  $\Delta pCO_2$ ) will cause an absorption (emission) of CO<sub>2</sub> gas by the ocean. Therefore, a global map of pCO<sub>2</sub> is required to calculate the total oceanic absorptions and emissions of CO<sub>2</sub> gas. The oceanic pCO<sub>2</sub> values varies from region to region depending on the surface ocean temperature and biogeochemical<sup>\*1</sup> parameters.

We have developed an ocean model to calculate the surface ocean pCO<sub>2</sub>. The model operations are based on ocean general circulation, biogeochemical dynamics and data assimilation<sup>\*2</sup> of the surface ocean pCO<sub>2</sub> measurements. The image shows the mean value of surface ocean pCO<sub>2</sub> (from 1996 to 2004) based on our model calculations. The units are in  $\mu\text{atm}$ <sup>\*3</sup>. According to our calculations, in most regions, the global ocean pCO<sub>2</sub> ranges between 250  $\mu\text{atm}$  and 600  $\mu\text{atm}$ . The difference between the modeled pCO<sub>2</sub> and the pCO<sub>2</sub> of the atmosphere (which is assumed as a mean value of 368  $\mu\text{atm}$ ) is used to calculate the net exchange of CO<sub>2</sub> gas between the ocean



The mean value of surface ocean pCO<sub>2</sub> (from 1996 to 2004) based on the new model calculations (units:  $\mu\text{atm}$ ).

and the atmosphere. The net exchange (which is an absorption of CO<sub>2</sub> gas from the atmosphere to the ocean) is estimated as 1.45 Peta<sup>\*4</sup> grams of carbon per year.

GOSAT L4 algorithm requires the global emission and absorption maps of CO<sub>2</sub> gas by the ocean for the inverse calculations of CO<sub>2</sub> sources and sinks. The above map of the modeled pCO<sub>2</sub> (which is created on monthly time-scale) is used to find the monthly maps of emissions and absorptions of CO<sub>2</sub> gas by the ocean. The data set is also extended to the period for which the GOSAT retrievals are available (i.e. 2009 and onwards) and will be used for the inverse calculations of CO<sub>2</sub> sources and sinks in the GOSAT L4 processing.



\*1 e.g. dissolved inorganic carbon in the ocean, pH value of ocean water, alkalinity etc.

\*2 a mathematical technique to optimally estimate the model parameters (e.g. pCO<sub>2</sub>)

\*3 read as "micro atmosphere"

\*4 1 Peta = 10<sup>15</sup>

## INTERVIEW

JAMSTEC Japan Agency  
for Marine-Earth Science and Technology

Principal Scientist

DR. TAROH  
MATSUNO

**Yokota (Y):** Thank you very much for taking time for us today. Dr. Matsuno, you have been supporting us as a member of the satellite observation evaluation committee at the Ministry of the Environment even before the start of the GOSAT Project. First, I would like to ask you about your career as a researcher from the days as a graduate student.

**Matsuno (M):** For a long time I have been interested in weather, so I decided to study meteorology. Recently, I realized that I have been a researcher for more than 50 years. I finished my undergraduate program in 1957 and I became a professor at the University of Tokyo in 1984, which is about 25 years ago, so I would say that I spent the first half doing solely research, and the latter half I worked as a research leader etc.

When I became a professor, I thought we had to develop models as

tools for climate research such as global warming. In fact, I had been wanting it for a long time. At that time, people from Japan such as (current Senior Meteorologist at the Princeton University) Syukuro Manabe and (current Professor Emeritus at the University of California, Los Angeles)

**28 years to found a  
atmospheric research  
institute**

Akio Arakawa were world's leaders in the field of modeling research in the United States, but we did not have computers for that in Japan. We also needed a specialized organization or research institute, but we did not have that either. I thought I needed to make efforts to change the situation.

In fact, back in the 1960s when the National Center for Atmospheric Research (NCAR) was founded in the U.S., we Japanese meteorologists were saying, "isn't it nice to have an organization like that in Japan?" and university faculties had a meeting to discuss the possibility of creating such a facility.

**Y:** Is that true? When was this?

**M:** It was around 1963, and I participated in this effort. We drafted a plan for an organization like a Japanese version of NCAR. The Kyoto University submitted a budget request to the government in 1972, but it was never accepted for many reasons including the nation's fiscal situation back then. So, we had to give up the idea. Since I was involved in this activity, I continued to think that we had to do something in Japan, reminding that it is Japanese pioneers who were leading the world. In time, the performance of Japanese computers became comparable with others in the world in 1980s, so I thought I just had to found an organization.

At the same time, in 1970s and 80s I was involved in the research on ozone ( $O_3$ ) layer issues from early days because then I was studying dynamics of the stratosphere. In 1972, I was already involved in the project to investigate effects of nitrogen oxide emissions from supersonic planes on the  $O_3$  layer, one of the first of  $O_3$  depletion issues. Since I was familiar with this subject and I also knew Dr. Manabe's work well, I began to think that the 'global warming' would be a very big issue soon or later, and we should have a research system ready to handle it by ourselves.

**Y:** At the NIES, I remember you were on the advisory board for the Improved Limb Atmospheric Spectrometer (ILAS), a sensor for  $O_3$  layer observation. Is this because you were studying the stratosphere?

**M:** Yes, I think that is possible. Before I was appointed to a professor in 1984, I had been working in a rather theoretical studies on the fluid dynamics. However, I recognized the importance of numerical modeling as the future direction so I asked (current Professor at the Integrated Research System for Sustainability Science) Akimasa Sumi to come to the University of Tokyo and began modeling research together. Then, as I supposed, the Vienna Convention for the Protection of the Ozone Layer was adopted in 1985, then in 1987, the Montreal Protocol was adopted. Immediately, environmental problems became serious issues in Japan. It is hard to imagine now, but before then, people had little interest in such issues in Japan. It is a little bit similar to the skeptics of global warming now. Some chemistry professors wrote in magazines, "That's a lie. Chlorofluorocarbon has nothing to do with ozone-hole." So, after this sudden change of people's awareness for environmental issues, I was convinced that the global warming problem would be next without doubt, and I proposed the Ministry of Education, Science, Sports and Culture creating a new research institute. As a result, the Center for Climate System Research<sup>\*1</sup> in the University of Tokyo was founded in 1991 at last after 28 years since I had it in my mind.

<sup>\*1</sup> **The Center for Climate System Research** was integrated into the Atmosphere and Ocean Research Institute (AORI) at the University of Tokyo in 2010.

**Y:** You have been working as an advisor at the GOSAT briefing sessions. What is your current impression on GOSAT?

**M:** I feel that I requested the project to be a very difficult one. In 1999, I was assigned a position in the Space Activities Commission because they wanted a meteorologist in the group. The committee evaluated a sensor proposed by NIES and JAXA (then NASDA) that was later named SOFIS. It was immediately after the Kyoto Protocol in 1997, so the word "Kyoto Protocol" was mentioned frequently during the presentation given by the proposer who was an administrator of the Ministry of Environment. It was a solar occultation<sup>2</sup> sensor which could not make observations frequently enough or observe the atmosphere below an altitude of 5 km. So, I questioned if it was really possible for this sensor to contribute to the Kyoto Protocol. The presenter was not able to answer my question, so it had to be evaluated again. In the next committee meeting, (current Director of Center for Global Environmental Research (CGER)) Yasuhiro Sasano answered my question, and said "No, that is not possible." He stated the importance of CO<sub>2</sub> measurement and his intention to apply the O<sub>3</sub> measurement technique to the CO<sub>2</sub> measurement without mentioning the Kyoto Protocol.

**Y:** Is this when they decided to redesign the GOSAT sensors?

**M:** No, not yet. We decided to proceed with the old model at this point. I said it is ok if everyone understands that this CO<sub>2</sub> measurement is not intended to contribute to the Kyoto Protocol right away, but that its purpose is technical study.

**M:** However, in time, then Director Gen Inoue of CGER (and current Chief Scientist of the GOSAT Science Team) started saying, "This proposal is not relevant in the current situation." I think he probably thought that the satellite would not be useful in the international community if it were for studying the technology just because it was difficult to achieve the goal right away. I also think that he just thought, "We have to try!"

**Y:** Well, that is possible. He is a person with great

<sup>2</sup>**Solar occultation technique** is to observe direct sunlight that slices through the atmosphere each time a satellite makes an orbit. On the other hand, "IBUKI" employs a **nadir-looking method**. It is a method to observe sunlight reflected on the ground or the direct light coming from the Earth by pointing downward on the ground.



power of action.

**M:** So, this is when the plan was changed. At that time, I thought it was impressive that the chair of the Program Evaluation Committee ordered the re-evaluation of the project, including the review of the observation method from the scratch despite the planning and some part of the production had already started by then. I believe the manufacturing contractors had started their work.

**Y:** Yes. The engineering model of the sensor was built already. I don't think anything like this ever happened before.

**M:** We had to organize another working group to discuss observation methods again. This is the background how the Research and Promotion Committee for the Greenhouse Gases Observing Satellite Project was founded.

**Y:** I was a member of the working group under this committee, so I participated in the discussion, too.

**M:** Then, finally it was decided that the sensor should be nadir-looking.

**Y:** If you compare what you expected then and the current GOSAT, what do you think?

**M:** I feel like we may have made a request too difficult to respond

**Y:** It indeed was difficult, but by directly involved in the project, I think so many things have been made clear by the actual data and it is interesting.

**M:** Of course, it must be. The observation with a solar occultation sensor could have been interesting scientifically, but in the CO<sub>2</sub>-conscious time like this, what we can see from the nadir-looking sensor must be by far interesting. Moreover, this is the first attempt of its kind around the world.

**Y:** What are your thoughts on the future direction of the GOSAT Project?

**M:** I hear that the Differential Absorption LIDAR (DIAL) is on the list for a future CO<sub>2</sub> observation sensor. I think an intensive research should be done on various methods. The reason why I

supported the thermal infrared observation for the current GOSAT was also because of its broad range of observation. I don't think it would be difficult to handle it if we followed the basics of data assimilation method as adopted by the European Centre for the Medium-Range Weather Forecast. Though, I am not sure if we can retrieve the data that we really need like the distribution of CO<sub>2</sub> in the lower layers.

**Y:** I can imagine coming across many new findings as we combine different methods.

**M:** I also think that the observations using CO<sub>2</sub> sondes might become popular and semi-routine.

**Y:** I believe that Dr. Inoue is also working to develop CO<sub>2</sub> sonde kits.

**M:** There are observations using airplanes and towers. The sondes lie between these two methods in character, so it will be great if more groups use sondes for CO<sub>2</sub> observations.

**Y:** Sondes are very convenient. The observations can be done in any weather, and the clouds don't interfere with the results either.


**M:** I think it would be a good idea to combine these methods. The coverage of satellite observation is massive. It covers the entire globe regardless of whether it is over the land or ocean. It is difficult to cover all requirements by the satellite observation. I hope that there is such a system that integrates these different methods.

**Y:** Right. There are always advantages and disadvantages to any method.

**M:** I think someone should start making daily or weekly weather charts of CO<sub>2</sub>. As you may know, Dr. Akimoto (Director Hajime Akimoto of the Atmospheric Composition Research Program at JAMSTEC) is working on chemical weather forecasting. The very CO<sub>2</sub> or CH<sub>4</sub> version of the weather chart is probably possible in five or ten years. All in all, it is the best to combine everything including towers, sondes, and airplanes.

**Y:** Right. We have to collaborate with different types of observations with a broader point of view, not just satellites.

**M:** I think many people in the world were waiting to see how well this satellite works. That tells how difficult this satellite was. I think it has come a long way to become a reality.

**Y:** I appreciate your continuing support for the project. There still is a long way ahead of us before achieving the final goal. 

DATA PRODUCTS UPDATE

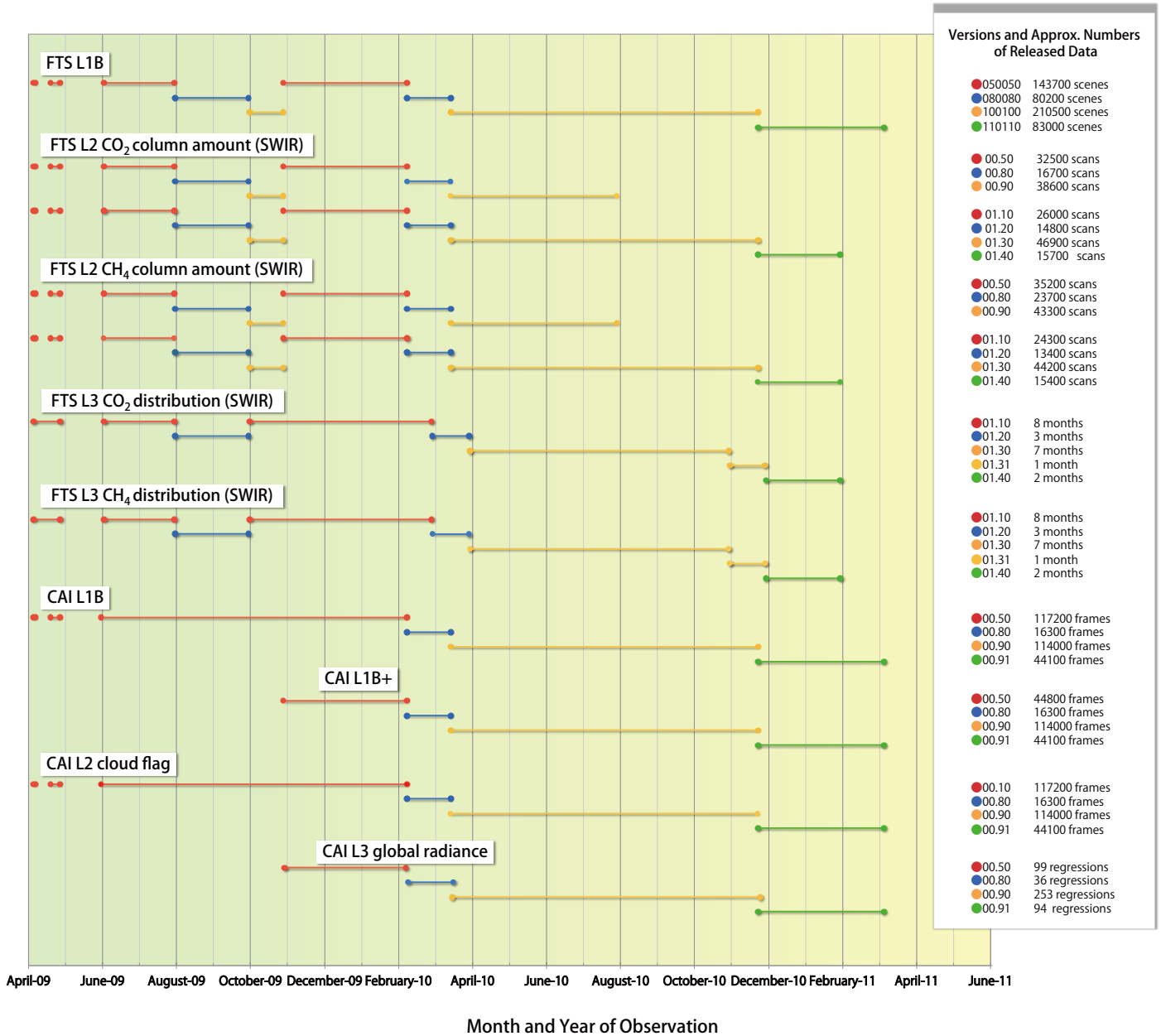
# Data Processing Status Update from GOSAT Project Office

- Fumie Kawazoe

Specialist, NIES GOSAT Project

Observation Period and Versions of Publicly Released Data

As of March 8, 2011



🌐🌐🌐 The GOSAT User Interface Gateway (GUIG), the website where you can search and download GOSAT data products, is partially restored on April 1, 2011, after having been down due to the Great East Japan Earthquake that occurred on March 11, 2011. We apologize to all the GUIG users for the inconvenience that this incident has caused.

We have started processing the data acquired after March 11 as the data processing system is resumed its in operation. We are going to resume processing the V110110 of the FTS L1B data products, V00.91 of the CAI

L1B, L1B+, L2 cloud flag data products, and L3 global radiance distribution products, and V01.40 of the FTS L2 CO<sub>2</sub> and CH<sub>4</sub> column amount (SWIR) data products.

Before using the data products, please make sure to check the "Important Notes at Releasing" and "Product Format Descriptions" under the "ATBD, Product Format Descriptions, Product Description, Results of Validation" section of GUIG. The number of registered users reached 1009 as of March 8, 2011.



? **IBUKI QUIZ** ?

**Q1**

Which of the following items is not observed by "IBUKI"?

- 1) greenhouse gases
- 2) clouds and dust
- 3) temperatures of world's major cities

**Q2**

The CO<sub>2</sub> concentration around the time when its routine observation was first started was around 315 ppm (at Mt. Mauna Loa in Hawaii). About how much is the CO<sub>2</sub> concentration now?

- 1) 320ppm
- 2) 355ppm
- 3) 390ppm

**Q3**

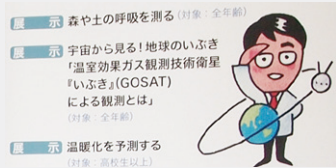
Which of the following items weighs about the same as "IBUKI"?

- 1) large passenger car.
- 2) tour bus.
- 3) bicycle



**Q4**

Who is the model of this image on an ad board at the NIES Summer Openhouse?

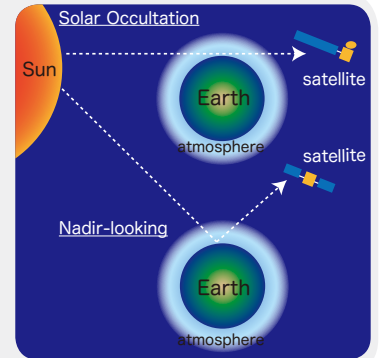


- 1) NIES GOSAT Project Leader Tatsuya Yokota
- 2) GOSAT Science Team Chief Scientist Gen Inoue
- 3) NIES GOSAT Project Office Manager Hiroshi Watanabe

**Q5**

Which of the following techniques does "IBUKI" employ to measure the CO<sub>2</sub> and CH<sub>4</sub> in the earth's atmosphere?

- 1) solar occultation technique
- 2) nadir-looking method



Some of the answers can be found in this issue or the previous issues of NIES GOSAT PROJECT NEWSLETTER.

Please send us an email with your name and answers as well as comments or request for the newsletter at: [gosat\\_newsletter@nies.go.jp](mailto:gosat_newsletter@nies.go.jp) (Due: April 29, 2011). We will give the right answers to those who send us emails!

**PUBLISHED PAPERS**

**Field of Research:** Carbon balance estimation, atmospheric transport models

**Name of Journal:** Geoscientific Model Development (Volume 3, Number 4, Pages 1737-1781)

**Title:** Mass-conserving tracer transport modelling on a reduced latitude-longitude grid with NIES-TM

**Authors:** D. Belikov, S. Maksyutov, T. Miyasaka, T. Saeki, R. Zhuravlev, and B. Kiryushov

**CALENDAR**

**2011/05/16-18**

Participating in the 7th International Workshop on Greenhouse Gases Measurement from Space held at the University of Edinburgh, in Edinburgh, Scotland, UK.

**2011/05/19-20**

Hosting the 3rd GOSAT Research Announcement Principal Investigator Meeting held at the John McIntyre Conference Centre in Edinburgh, Scotland, UK.

**ANNOUNCEMENT**

NIES GOSAT PROJECT NEWSLETTER welcomes letters from our readers.

We appreciate your opinions,

"I want to read articles on ..."

"... was really interesting." etc.

We also appreciate opinions or contributions from people involved in the GOSAT Project.

Please feel free to contact : [gosat\\_newsletter@nies.go.jp](mailto:gosat_newsletter@nies.go.jp).

Thank you for supporting the newsletter.

- Yuki Tanaka, editor

