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NIES GOSAT PROJECT NEWSLETTER

CONTENTS

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

New Versions of Level 2 Data Products Now Released to the General Users

- Akira Yuki, NIES GOSAT Project Office

GOSAT Project upgraded two Level 2 standard data products, and started to offer the new versions to the general users on August 24, 2010. The new versions are available for FTS Level 2 CO_2 column amount[1] (SWIR) and FTS Level 2 CH_4 column amount (SWIR).

Starting with this version upgrade, the version numbers are of format V01.xx (xx are numbers). According to the relationship definition shown in table 1, the data products are offered as V01.10, V01.20, V01.30[2].

There are three notable differences between the new and old versions of Level 2 standard data products.

1 The number of molecules of a gas in a column of atmosphere from the ground to top.

2 Each of the three versions corresponds to the version of input data, Level 1B 050050, 080080, 100100.

Table 1. The relation between the observational periods and version numbers of FTS SWIR Level 2 standard data products.

Version Numbers	Observation Periods
V01.10	2009/04/06 ~ 2009/04/08
	2009/04/20 ~ 2009/04/28
	2009/06/03 ~ 2009/07/31
	2009/10/29 ~ 2010/02/08
V01.20	2009/08/01 ~ 2009/09/30
	2010/02/08 ~ 2010/03/16
V01.30	2009/10/01 ~ 2009/10/29
	2010/03/16 ~ current

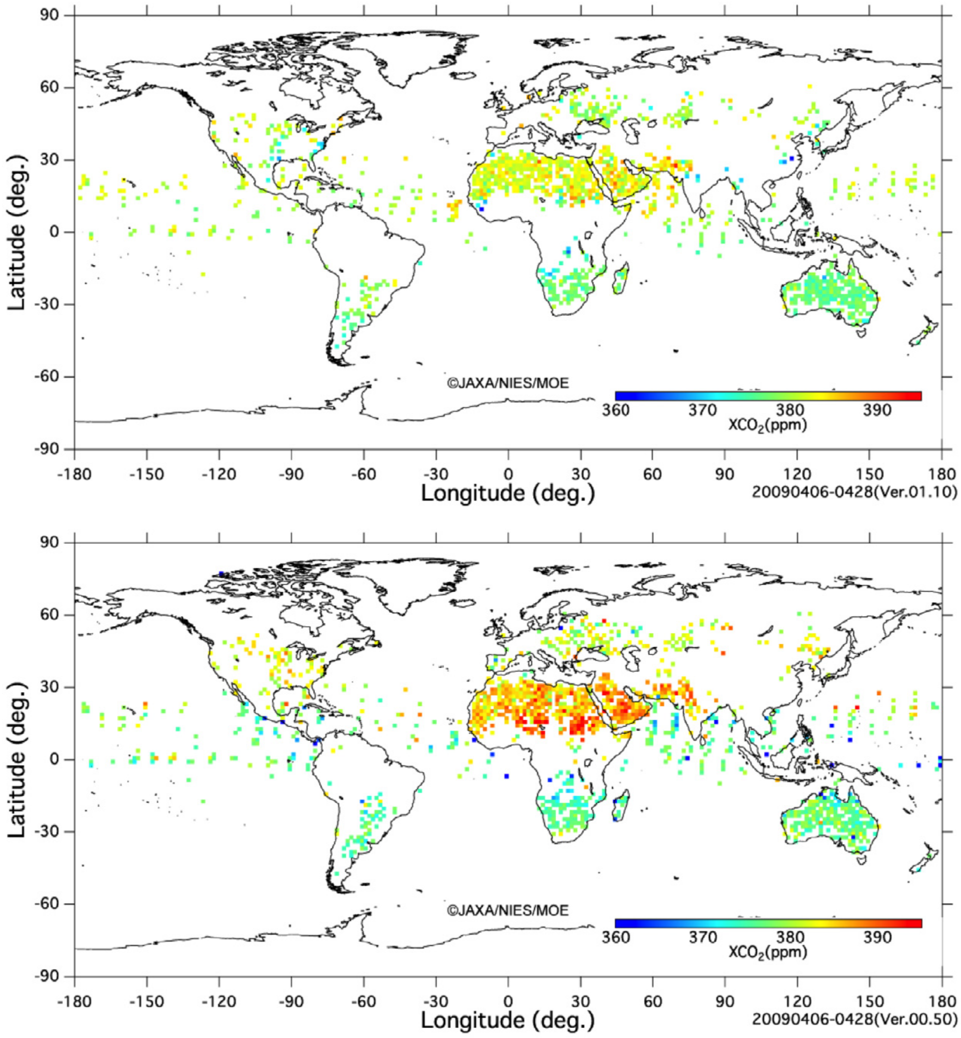
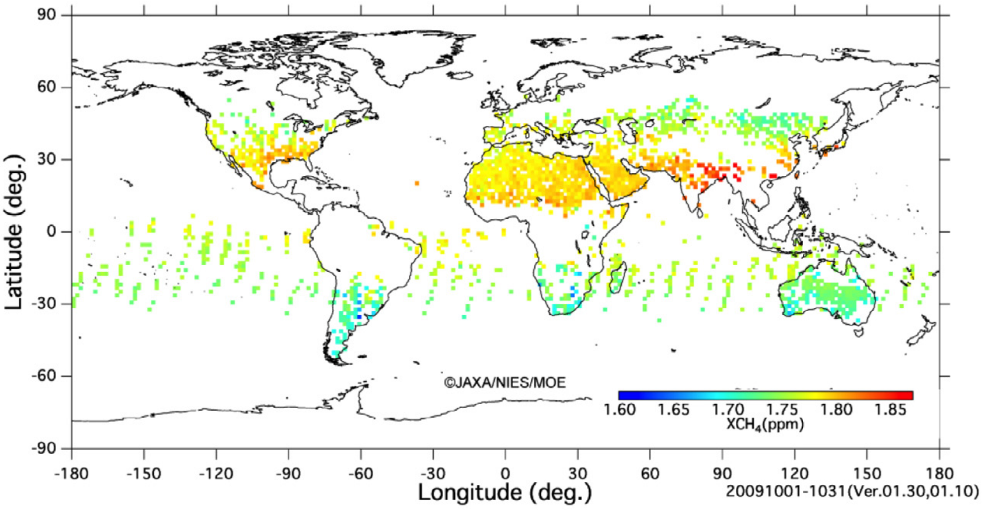
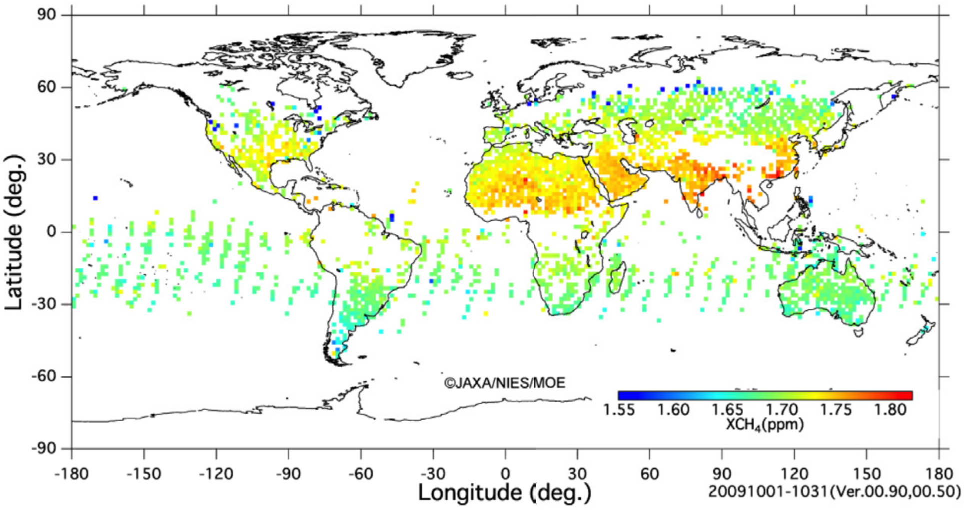


Figure 1. Global maps of the CO_2 column-averaged volume mixing ratios in 1.5 deg mesh for the month of April 2009, which were created from the FTS-SWIR Level 2 CO_2 column-amount data. (Top: The new version (V01.10), Bottom: The old version (V00.50)) In the new version, many of abnormal high concentrations over Sahara and Arabian peninsula are relieved. The number of retrieved data of the new version is smaller than that of the older version.

Figure 2. Global maps of the CH_4 column-averaged volume mixing ratios in 1.5 deg mesh for the month of October 2009, which were created from the FTS-SWIR Level 2 CH_4 column-amount data. (Top: The new version (V01.30), Bottom: The old versions (V00.90, V00.50))

* The range of color scale in the new versions of the global distribution of XCH_4 averaged over 1.5 deg mesh shown in Figure 2 is shifted to higher direction by 0.05 ppm than the case of the old versions. The number of retrieved data of the new version is smaller than that of the older version.





The first difference is that in the new versions, many of abnormal high concentrations over Sahara and Arabian peninsula seen in old versions are relieved (Figure 1). The second is, the concentrations of methane (CH_4) as the column-averaged mixing ratios[3] are higher overall (Figure 2).

The reasons for these improvements are the three following major changes in the methods of calculation (algorithms); the use of O_2 A band[4], change of absorption line parameters, and degradation correction. Details on these changes will be described in "Algorithm Theoretical Basis Document for GOSAT TANSO FTS SWIR."

The third difference is that the number of retrieved and released data products is smaller (Figure 1 and 2). Before releasing the FTS SWIR Level 2 standard data products, the quality of data is always checked after the retrieval process. If the data products do not meet these standards, they are not released. In the new version, the quality checklist has been revised and check items are added, and the quality criteria were also revised, and this resulted in smaller number of data products to be offered. One example of revisions is that the 2-micron Band Scattering Material Determination[5] is refined. All the quality check items are listed in "Important Notes on the Use of FTS SWIR Level 2 Data Products (Version 01.xx) for General Users." [6]

In this version upgrade, we revised and made additions to the quality checklist, and now we offer smaller number of data products that are of better quality.

These new versions of two Level 2 standard data products are available at GOSAT User Interface Gateway (GUIG)[7] for everyone once registered as a general user.

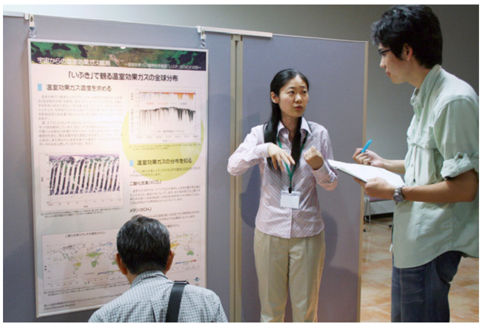
3 The column-averaged mixing ratio of a gas is the column amount of the gas devided by column amount of dry air.

4 O_2 A band is an absorption band that exists around wavelength range of 0.76 μ m that absorbs O_2. Since the band 1 of TANSO-FTS observes the wavelength range including this O_2 A band, the band 1 is often referred to as the O_2 A band. In the old version, abnormal high concentrations of gases near the areas with aerosols could be seen. It is possible to reduce the impact of aerosols if the column-averaged volume mixing ratios of CO_2 and CH_4 are estimated by dividing CO_2 and CH_4 column amounts retrieved from band 2, with the column amount of dry air retrieved from band 1.

5 A method to detect the existence of scattered substances in the atmosphere such as thin clouds called cirrus clouds that can cause erroneous estimations of greenhouse gases concentrations. Data from observation points affected by these scattered substances will not be processed.

6 Important Notes on the Use of FTS SWIR Level 2 Data Products (Version 01.xx) for General Users:
https://data.gosat.nies.go.jp/GosatWebDds/productorder/distribution/user/V01XX_FTS_L2_gu_en.pdf

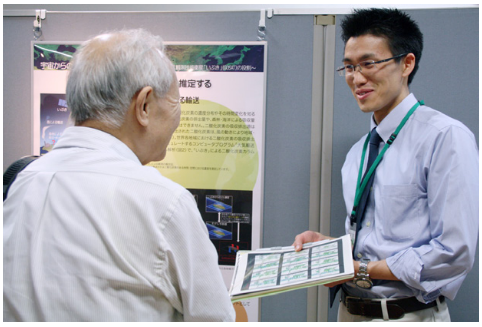
7 GOSAT User Interface Gateway (GUIG) : http://data.gosat.nies.go.jp



宇宙からの
温室効果ガス観測
シンポジウム

SYMPOSIUM
ON
GREENHOUSE GASES MEASUREMENT FROM SPACE

Photos: (top) The lectures.
(middle and bottom) During the exhibition
(Photos by Yuki Tanaka)

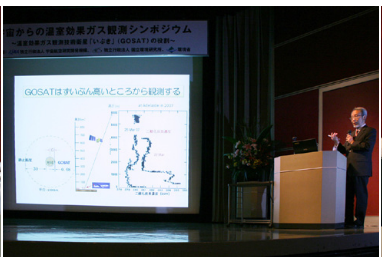


NEWS **"Symposium on Greenhouse Gases Measurement from Space - A Role of Greenhouse Gases Observing Satellite "IBUKI" (GOSAT) -" Hosted by GOSAT Project**

- Yuki Tanaka, Specialist, NIES GOSAT Project Office

The GOSAT Project hosted "Symposium on Greenhouse Gases Measurement from Space - A Role of Greenhouse Gases Observing Satellite "IBUKI" (GOSAT) -" held at the KOKUYO Hall in Tokyo on August 25, 2010. As many as 298 people visited the event, and it was a great opportunity for the GOSAT Project to introduce "IBUKI" and the greenhouse gases measurement from space to a wide range of audience. The GOSAT Project Office would like to thank everyone who attended the event.

In the first part of the program, the significance of "IBUKI" from multiple approaches was talked about in the lectures by Dr. Chiaki Mukai, an astronaut and space medicine researcher at Japan Aerospace Exploration Agency (JAXA), an environmental journalist, Professor Hiromichi Yokoyama of Shukutoku University, and the Chief Scientist of GOSAT Science Team, Professor Gen Inoue of Research Institute for Humanity and Nature. Following the lectures, JAXA GOSAT Mission Manager Masakatsu Nakajima gave a presentation 'like a physics class' on "IBUKI"'s observation mechanism. Then, the NIES GOSAT Project Manager Tatsuya Yokota introduced "IBUKI"'s data products. From the GOSAT Project's close partners, NASA's Jet Propulsion Laboratory, Dr. David Crisp took a part in the event and gave a video lecture.



Photos (from left) Dr. Chiaki Mukai of JAXA, GOSAT Science Team Chief Scientist Professor Gen Inoue of RIHN, Professor Hiromichi Yokoyama of Shukutoku Univ.

The second part of the symposium was the exhibition and "IBUKI" specialists (about 20 members including researchers and staff) interacted with visitors to explain about earth observation from space, research using the observational data, how to download "IBUKI"'s data products.

The entire event was recorded by Necovideo Visual Solutions and live-streamed on multiple websites. If you missed the event, now the videos of entire event are available to watch on Necovideo Visual Solution's website.

The videos of "Symposium on Greenhouse Gases Measurement from Space - A Role of Greenhouse Gases Observing Satellite "IBUKI" (GOSAT) -"NIES GOSAT Project on Necovideo Visual Solutions website.
http://nvs-live.com/achievements/20100825gosat.html

(Photo by Yuki Tanaka)

Continued from July issue, NIES GOSAT PROJECT NEWSLETTER is focusing on The Remote Sensing Society of Japan (RSSJ), an academic society with the objective of advancement of remote sensing and its applications. In this issue, we are going to bring you an interview with the newly appointed (May 2010) President Shuichi Rokugawa.

President Rokugawa is a professor at the Department of Technology Management for Innovation, Graduate School of Engineering, the University of Tokyo, specialized in exploration and monitoring technology using electromagnetic wave and elastic wave.

President Rokugawa currently works on research and development on the following themes; the conservation of living environment in Asian delta regions, a method to distinguish suitable sites for forestation and to estimate the effect of forestation using satellite data, and a method using a ground penetrating radar to measure the carbon sequestration of soil and root systems of trees that are difficult to estimate. From the viewpoint of a researcher as well as an educator of remote sensing, we asked what he thinks of GOSAT Project. (Interviewer: NIES GOSAT Project Tatsuya Yokota. May 27, 2010.)

INTERVIEW

The Remote Sensing Society of Japan (RSSJ) President

SHUICHI ROKUGAWA

Professor,
Department of Technology Management for Innovation
Graduate School of Engineering,
The University of Tokyo

Yokota (Y): Thank you very much for taking your time for this interview today. You have just been appointed President of The Remote Sensing Society of Japan (RSSJ), and I would like to know how you feel about leading the society from now on.

Rokugawa (R): I think it is such a great honor, but at the same time I feel anxious about fulfilling all the duties, especially under the current circumstances. (There have been talks on transforming the organization from "general incorporated association" to "public interest incorporated association.") I hope to do my best to live up to the expectations of my supportive colleagues.

Y: You have been devoted to RSSJ for a long time, and you know the A to Z. I am certain that you will lead the society to where it needs to be.

For this interview, first I would like to ask where you are originally from, and how you became involved in the current research.

R: I was born in Nakano city in Nagano prefecture. It is about half-an-hour train ride from the capital of Nagano, and it is at the foot of Shiga Heights. I went to Nagano High School there, and went on to the University of Tokyo.

I became a member of male choir there. Since I was spending most of my time for these club activities during my liberal arts years, I really did not think about what to pursue after that. When I had to decide my major, I chose resource development engineering. It is more like earth science but different from geophysics, and I think I was more interested in how to apply science to human society. At that time, it was not really a popular field of study.

Then, I went on to pursue exploration engineering, and I can say this is where I met remote sensing. The first thing I was involved with happened to be the Synthetic Aperture Radar (SAR)[1]. I was intrigued by the idea of looking at the whole globe, and fascinated by how data processing creates a picture of faraway things like holography and makes it visible just like magic. Since then, I have been involved with various aspects of resources observation.

Around the same time, an earth-observing sensor ASTER[2] project was started in Japan, and I became a part of it as a young researcher. Through this experience, I was able to learn what it is to be a part of an international project, in other words, fun and difficult aspects of it. It was very dynamic and exciting, and kept

1 **Synthetic Aperture Radar (SAR):** An active microwave sensor that transmits a microwave and detects the wave reflected back by objects to observe the topographical features, such as land cover type, undulations, roughness and slopes at high resolution. By processing data acquired by observing reflected waves of one object at different locations while the sensor travels on a satellite or an airplane, it is possible to get information on the object at high-resolution that was only possbible with big antenae. It is not affected by weather conditions, it creates pictures of geographical features, forrests, ocean waves, and ocean ice regardless of time of a day.

2 **Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER)**: An advanced optical sensor with 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).

me involved in it for a long time. So, this is how it all started.
Y: The satellites (sensors) you have used are SAR and ASTER?
R: I have used the old Landsat[3], as well as GFO[4], AMSR[5], and ASTER. I have used ILAS[6] as well. As for SAR, I now use PALSAR[7].

Y: What do you mean by resource exploration? Do you have specific targets like oil or minerals?
R: By exploration, of course I do not mean the resources can be found by the satellites directly. Such resources can be looked for based on the information provided by these satellite data. With minerals, if you examine the state of metamorphism or composition of rocks on the land surface, you can get some information on the resources that appears on the ground surface as an outline survey.

Y: I know that you are not only a researcher but also an educator at the University of Tokyo. From an educator's point of view, how do you describe today's students learning about remote sensing?
R: I might be wrong, but I think students nowadays are seeking something very practical, and also skills that can be advantage to getting a job. It is a long way to get to the ultimate targets from these observations or data, so it is more difficult than I expected to communicate the values of such observations. I think what is exciting is to grasp the state of the earth, but when people think about the benefits of mankind, these days they tend to be more business-minded and realistic. So, I feel I have difficulty explaining these values. There should be education or study that is about getting an overview, in other words, looking at the whole view, not just focusing on details.

Y: I feel that there is a connection between what you have talked about and how we process data to extract or visualize information that otherwise we would not get from the GOSAT observational data as they are. Could you tell us what impression you have on the current GOSAT project?
R: As I mentioned, these earth observation data do not create practical values right away. With that said, it is important that the observation is done as a part of mechanism that reveals some kind of logic on what goes on in the whole system. In the case with GOSAT, as it continuously looks at the whole globe, it intends to get the global picture of greenhouse gases concentration and aerosols in a systematic sense. If you consider the international trend, I believe it is an important point of view in terms of giving an adequate explanation to complex matters.

Y: What do you expect in GOSAT from here on? Could you give us some suggestions?
R: I think, it is still difficult to reflect the results in practice such as in policymaking, or for 'the benefit of human kind.' How do we communicate with people outside science? I think more efforts should be made to appeal to broader audience to bring awareness of its significance and for better understanding.
Another thing you should be alert is that in this "environmental era," these data will be used for economic purposes, such as ultimately for trade in CO_2 emissions. This means scientific evidence will be more important. GOSAT project has a range of validation programs, but you need to make sure this aspect is fully covered. You need a validation program that takes into account that basically these data will be applied to various fields such as business. There is a possibility that it will have a much bigger impact in the world than what the original researchers imagined. I am not saying you should take responsibility of the data, but you should proceed with the project with a sense that the quality and integrity of data at each step, and so on should be assessed completely.

Y: You mean the project should ensure the objectivity of information, and the data should be indisputable.
R: Right. I believe these two aspects, a power to appeal to bring awareness and the objectivity of the data are very important.
Y: Thank you very much.

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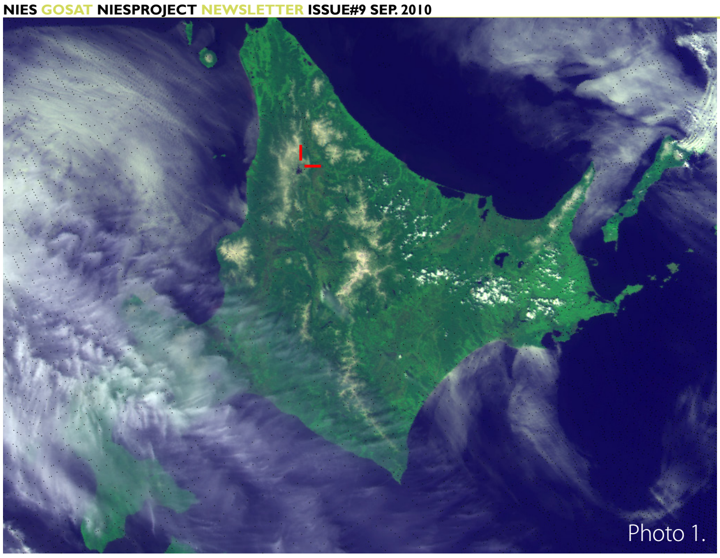
3 **Landsat:** A series of Earth Resources Technology Satellites jointly managed by NASA and U.S. Geological Survey. The first Landsat was launched in 1972, and the seventh and latest was launched in 1999. (The launch of the eighth Landsat is scheduled after December 2012.) It is often said a pioneer of the earth observing satellites. The satellites have carried optical sensors such as, Multi-Spectral Scanner (MSS), Thematic Mapper (TM), and its improved version, Enhanced Thematic Mapper Plus (ETM+).

4 **GFO:** Geosat Follow-On is a U.S. satellite launched on February 10, 1998. Sensors on the satellite were a water vapor radiometer and a radar altimeter, providing the distance from the satellite to sea surface with an accuracy of 3.5cm. It stopped its operation in October 22, 2008. (Currently, the launch of GFO-2 is scheduled in 2014.)

5 **Advanced Microwave Scanning Radiometer (AMSR):** A microwave sensor for the purpose of obtaining water-related physical parameters such as profiles of atmospheric temperature and humidity, clouds and precipitation, net radiation, snow and sea ice, sea-surface temperature, oceanic primary production, and soil water. It can continue observation day and night, regardless of the weather, and without being interrupted by clouds. Installed on ADEOS-II satellite, it was launched in 2002 and stopped its operation in 2003. The same sensor named AMSR-E was launched in 1999 on NASA's Aqua satellite and continues its observation.

6 **Improved Limb Atmospheric Spectrometer (ILAS):** Japan's first atmospheric observing sensor to monitor and research the ozone layer in the polar stratosphere developed by Ministry of the Environment of Japan. It was installed on Advanced Earth Observing Satellite (ADEOS, "MIDORI") and launched in August 1996.

7 **Phased Array type L-band Synthetic Aperture Radar (PALSAR):** A microwave sensor developed based on JERS-1 SAR (Japanese SAR made in 90s) with improved functions and performance. With an ability to analyze the geological structure at the accuracy of a few centimeters, it is expected to contribute to resource exploration and development, observation of vegetation, classification of land use. It is also possible to correspond to emergency observation requests at the time of natural disasters. It is mounted on Advanced Land Observing Satellite (ALOS) and was launched in January 2006.



AHA! OF THE MONTH

"Moshiri" Ground-Based Observation Site for "IBUKI" Validation

- Nobuyuki Kikuchi Specialist, NIES GOSAT Proejct Office

There are two ground-based observation sites for validation of "IBUKI" in Japan. One of them is at NIES in Tsukuba, and the other is Moshiri Observatory of Solar-Terrestrial Environment Laboratory of Nagoya University.

Moshiri is located by Lake Shumarinai in the upstream region of Uryu River, a side stream of Ishikari River in Hokkaido, the northernmost prefecture of Japan. Lake Shumarinai is an artificial lake stemmed by Uryu Dam constructed in 1943. Photo 1. is an image acquired on May 18, 2010 by CAI on "IBUKI," and the location of Moshiri is indicated by the two red marks. There was some snow left even in May, and in the wintertime it marks as low as 30 degrees Celsius below zero. Ranching and farming are the primary industries, and Soba noodles and Kumazasa Tea are the local specialties.

Moshiri Observatory (Photo 2.) was established in 1963, and various kinds of observation have been conducted there ever since.

Among these observations, the following are relevant to "IBUKI"'s validation; the observation of carbon dioxide (CO_2) and methane (CH_4) column amounts using FT-IR Spectrometer (Fourier Transform InfraRed Spectrometer), the observation of clouds and aerosols using a LIght Detection And Ranging (LIDAR), and the observation of aerosols using the Sky Radiometer. The other observations include the following; observation of VLF radiation[1] from thunders, measurement of column amounts of CO_2 and Ozone (O_3) in the stratosphere using a visible spectrometer, observation of low-latitude aurora using a 630 nm photometer. In the past, it used to be the receiving end of satellite observation of VLF emission, and used to observe O_3 within 20 km altitude using ozone sondes.

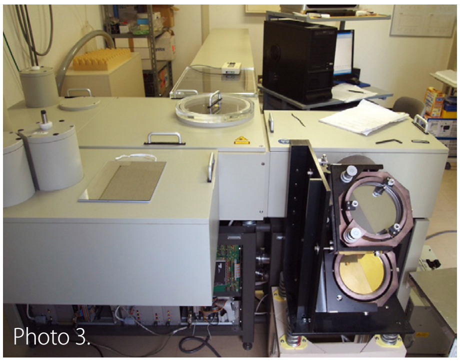
1 Very low frequency radiation (VLF radiation) is a kind of electric waves of frequency between 1 and 30kHz from the ionosphere and the magnetosphere. Phenomenon such as chorus and hiss are known.

Associate Professor Tomoo Nagahama of Nagoya University is mainly in charge of the observation using the FTIR Spectrometer for validation of "IBUKI." The concentrations of CO_2 and CH_4 are measured by spectroscopic observation of the light between wave number range of 5500 cm-1 and 10500 cm-1 using IFS 120HR (BRUKER)(Photo 3). The instrument is installed inside, but a sun tracker (Photo 4) outside takes in sunlight using a mirror.

On the other hand, Professor Takashi Shibata of Nagoya University leads the observation using the LIDAR. The instrument (Photo 5) emits laser pulses (at the wave number 532 nm and 1064 nm) towards the sky, then a telescope gathers and measures the light that comes back after being scattered by molecules, aerosols, and clouds in the air. The distance to the aerosols and clouds can be calculated from the time the light took to come back to the ground. The amount of substance is estimated from the number of returned light pulses.

The observation using the Sky Radiometer (Photo 6) was initiated by NIES. The Sky Radiometer measures direct and scattered solar radiation. Then, the optical depth, the particle-size distribution, and the absorption coefficient of aerosols can be estimated from the distribution of brightness in the sky by radiative calculation.

Using the data observed by FTIR Spectrometer, it is possible to validate the accuracy (variability and bias) of concentrations of CO_2 and CH_4 measured by "IBUKI"'s TANSO-FTS. It is also possible to examine the possible error factors of "IBUKI," using the data on aerosols and cirrus clouds observed by the LIDAR and the Sky Radiometer.



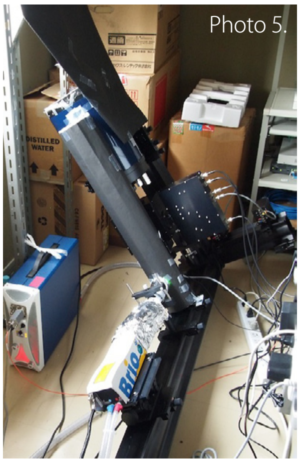


Photo 1. A CAI image of Hokkaido obtained on May 18, 2010. Where the two red marks cross is the location of Moshiri. Blue=Band 1, Green=Band 3, Red=Band 2.
Photo 2. An overview of Moshiri Observatory, Solar-Terrestrial Environment Laboratory, Nagoya University.
Photo 3. FTIR Spectrometer
Photo 4. A mirror on sun tracker
Photo 5. LIDAR
Photo 6. Sky Radiometer
(Photos by Nobuyuki Kikuchi)

DATA PRODUCTS UPDATE

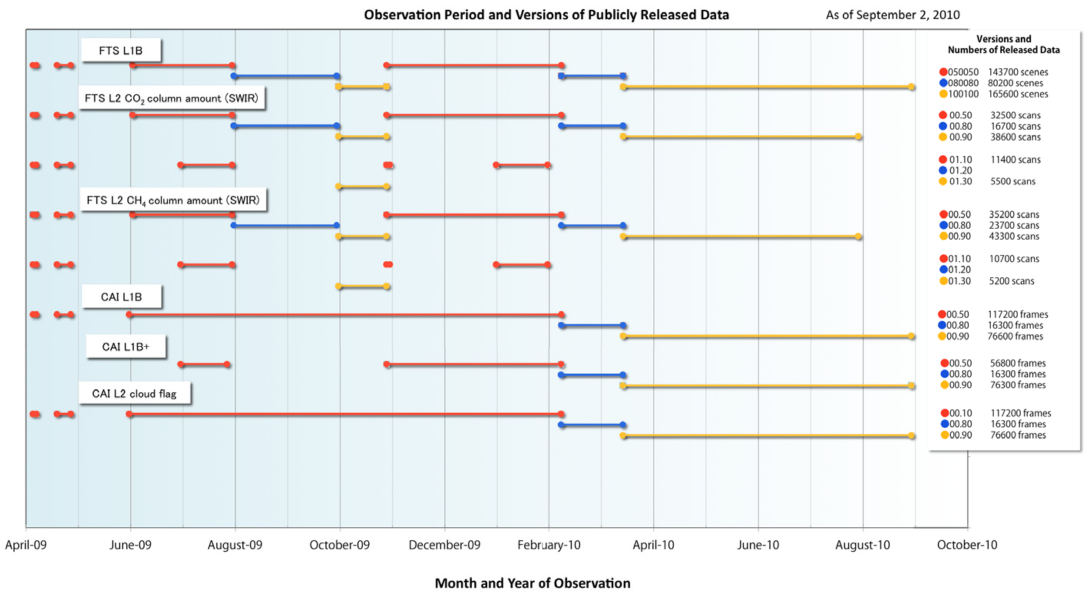
Data Processing Status Update from GOSAT Project Office

- Fumie Kawazoe, Specialist, NIES GOSAT Project Office

Here we report an update on data processing status for the months of late August and early September 2010.

We are processing the V100100 of the FTS L1B data products, V00.90 of the CAI L1B, L1B+, and L2 cloud flag data products. As reported in August issue, now we offer the upgraded versions (V01.10, V01.20, V01.30) of FTS L2 SWIR CO_2 and CH_4 column amount data products. Further details on this upgrade are explained in the article on page 1, "New Versions of Level 2 Data Products Now Released to the General Users." The monthly global maps of column-averaged volume mixing ratios created with the new versions are also available in "Gallery" at the GOSAT User Interface Gateway (http://data.gosat.nies.go.jp). From here on, we will continue to release the upgraded versions of data products after June 2009 until now.

The number of registered users reached 883 as of September 10, 2010.



CALENDAR

2010/10/11-14
Participation at the SPIE Asia-Pacific Remote Sensing 2010 held in Incheon, Korea.

2010/10/27-29
Participation at the Meteorological Society of Japan's 2010 Autumn Meeting held in Kyoto, Japan. There will be a special topic session for GOSAT: Utilization studies of the greenhouse gas observing satellite (GOSAT) "IBUKI."

2010/11/2
Lecture at the lecture meeting: - "Let's Think about Environmental Issues from Scientific Points of View" held at the Institute of Statistical Mathematics in Tokyo, Japan.

PUBLISHED PAPERS

Name of Journal：Atmospheric Chemistry and Physics (Volume 10, Number 16, Aug 2010, pages 7659-7667)
Title：CO_2 column-averaged volume mixing ratio derived over Tsukuba from measurements by commercial airlines
Authors : M. Araki, I. Morino, T. Machida, Y. Sawa, H. Matsueda, H. Ohyama, T. Yokota, and O. Uchino

Name of Journal：Journal of Quantitative Spectroscopy & Radiative Transfer (Volume 111, Issue 15, October 2010, pages 2211-2224)
Title：GOSAT-2009 methane spectral line list in the 5550–6236 cm^{-1} range
Auhtors : A.V. Nikitin, O.M. Lyulin, S.N. Mikhailenko, V.I. Perevalov, N.N. Filippov, I.M. Grigoriev, I. Morino, T. Yokota, R. Kumazawa, T. Watanabe

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