NIES GOSAT PROJECT NEWSLETTER

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DEC.2010

Center for Global Environmental Research
celebrates the 20th Anniversary.

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/

CONTENTS

NEWS

Level 3 FTS Global Greenhouse Gases Distribution Released to General Users

- Kenji Hayashi, NIES GOSAT Project Office

On November 30, 2010, the GOSAT Project started the distribution of two of new FTS SWIR Level 3 data products to the general users. These products are based on the data obtained in the SWIR[1] bands of the Fourier Transform Spectrometer (TANSO-FTS) of "IBUKI." The following Level 3 data products are on release this time.

FTS SWIR Level 3 global CO_2 distribution (SWIR)
FTS SWIR Level 3 global CH_4 distribution (SWIR)

These aforementioned Level 3 products store the monthly global distribution of

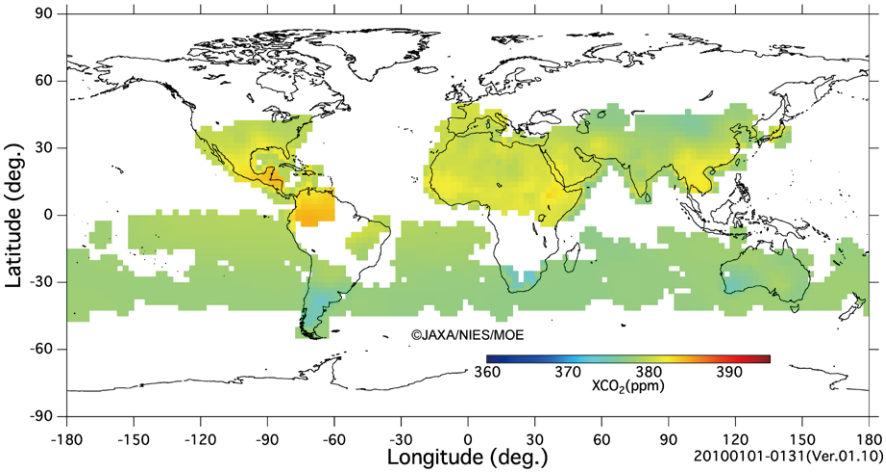


Image 1. FTS SWIR Level 3 global CO_2 distribution for January 2010.

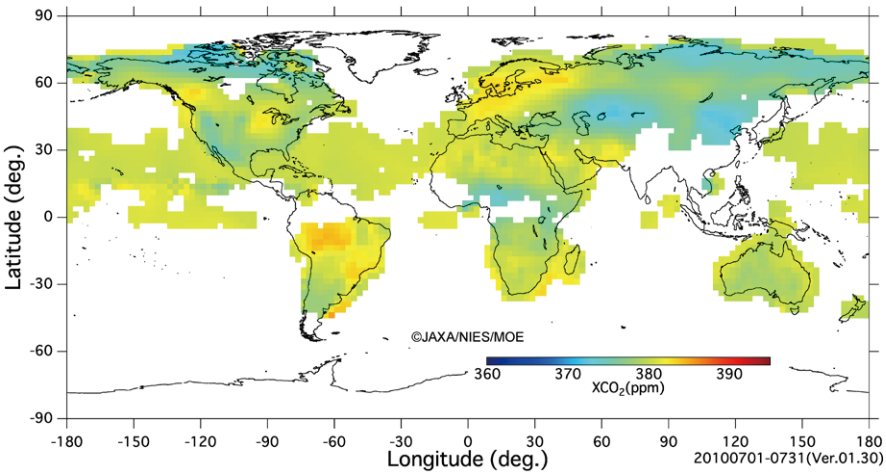


Image 2. FTS SWIR Level 3 global CO_2 distribution for July 2010.

1 **SWIR** stands for Short-Wavelength InfraRed. SWIR radiations are detected in the bands 1,2, and 3 of FTS.

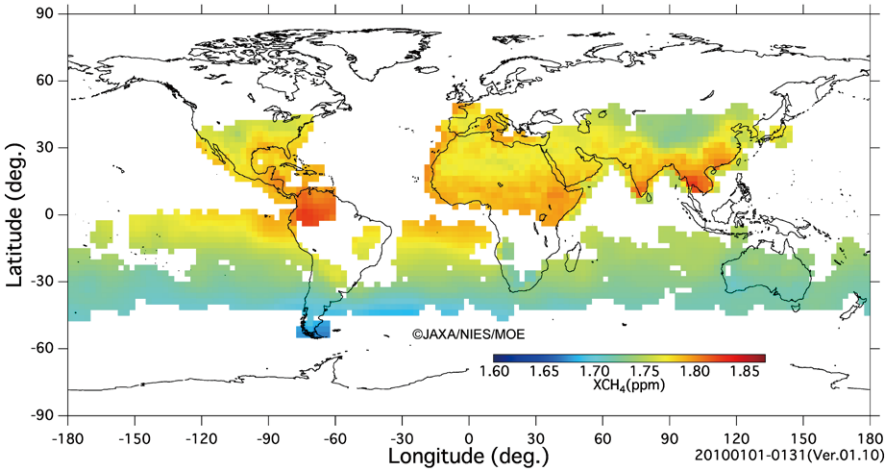


Image 3. FTS SWIR Level 3 global CH_4 distribution for January 2010.

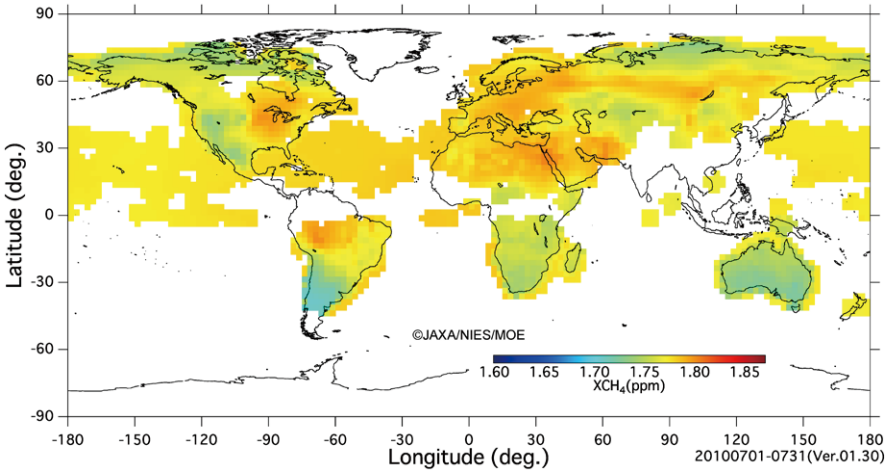


Image 4. FTS SWIR Level 3 global CH_4 distribution for July 2010.

carbon dioxide (CO_2) and methane (CH_4) calculated from the FTS SWIR Level 2 column-averaged mixing ratios of CO_2 and CH_4. In this calculation process, the whole globe is divided into a grid 2.5 degrees of latitude and longitude, and the value for each grid is estimated using the Kriging[2] method so that the variance of concentrations with the neighboring grids is relatively smooth. If the nearest observation point is more than 500 km away from a grid, the grid contains blank value (white in the images). The products also contain statistics, for example, the number of observation points and average in the grids.

FTS Level 3 data products' version numbers correspond with those of the FTS Level 2 data products. The relationships between the version numbers and observation periods are noted below.

- Ver. 01.10 : April 2009, June 2009, July 2009, October 2009, November 2009, December 2009, and January 2010, February 2010
- Ver. 01.20 : August 2009, September 2009, and March 2010
- Ver. 01.30 : April ~ October 2010

Image 1~4 are the rendered images of Level 3 CO_2 and CH_4 global distribution (SWIR) for the months of January and July 2010.

For the future, the Level 3 data products will be released in a few days after every time the Level 2 data products are released.

You can search, order, and download these two FTS Level 3 data products at the GOSAT User Interface Gateway (GUIG) once registered as a general user. Before using the products, please read the product description on "FTS L3" carefully. The product description on "FTS L3" can be found when you log into GUIG, and click on "ATBD, Product Format Descriptions, Product Description, Results of Validation" under the Documents section of the Selection Menu (Top menu).

2 **Kriging** is a statistical method to estimate a fair possible value at an unobserved location from the values at nearby observed locations.

NEWS

Report: the 54th Symposium on Space Science and Technology in Japan

- Hiroshi Watanabe, NIES GOSAT Project Office Manager

The 54th Symposium on Space Science and Technology was held from November 17 to 19, 2010 at the Shizuoka Convention & Arts Center "GRANSHIP," and I participated in the GOSAT related session held in the afternoon of 18th. Eight lectures and a panel discussion on GOSAT were held during this session entitled "GOSAT 'IBUKI's Contribution for the Global Environmental Issues."

The lectures covered a wide range of subjects, including abstract topics such as the relationship between the global warming and the GOSAT Project, and the future prospect for the GOSAT Project, as well as specific topics such as the details on the GOSAT data products. There were eight lecturers at the session; Senior Fellow Taroh Matsuno and Group Leader Michio Kawamiya of the Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Professor Teruyuki Nakajima of The University of Tokyo, Fellow Takashi Moriyama, GOSAT Mission Manager Masakatsu Nakajima, and Researcher Kei Shiomi of the Japan Aerospace Exploration Agency (JAXA), Professor Gen Inoue of the Research Institute of Humanity and Nature (RIHN) and I from NIES. For my lecture entitled "Current Status of GOSAT Higher-level Products," using examples of the products, I explained the GOSAT higher-level products that NIES has been processing, producing, and distributing.

A broad range of issues was talked about during the panel discussion. The topics included the issues on the accuracy of the GOSAT data products, on the number of retrieved data being small and only limited areas being covered, on the progress in the application of data to climate models, on promoting the domestic data usage as well as contribution and cooperation in the international community, and on a prospective successor for GOSAT. Not only the lecturers but also NIES GOSAT Project Leader Tatsuya Yokota in the audience joined the active debate during the panel discussion.

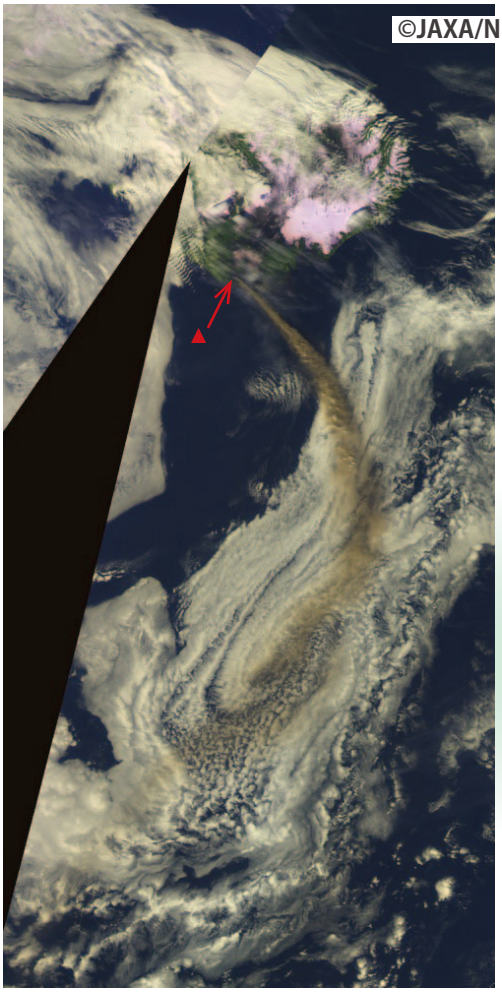
The Shizuoka Convention & Arts Center, "GRANSHIP."

SPECIAL FEATURE

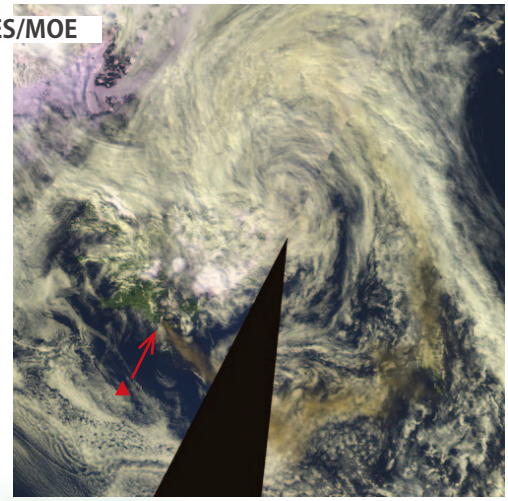
2010 THROUGH THE EYES OF "IBUKI"

- Nobuyuki Kikuchi,
Specialist,
NIES GOSAT Project Office

In this issue and in February 2011 issue, NIES GOSAT PROJECT NEWSLETTER is going to bring you what "IBUKI" saw happening to our planet Earth during the year 2010. This issue is on the natural phenomena observed by "IBUKI"'s Cloud and Aerosol Imager (TANSO-CAI). In the February issue, we are going to talk about the global greenhouse gases concentrations observed by the Fourier Transform Spectrometer (TANSO-FTS).

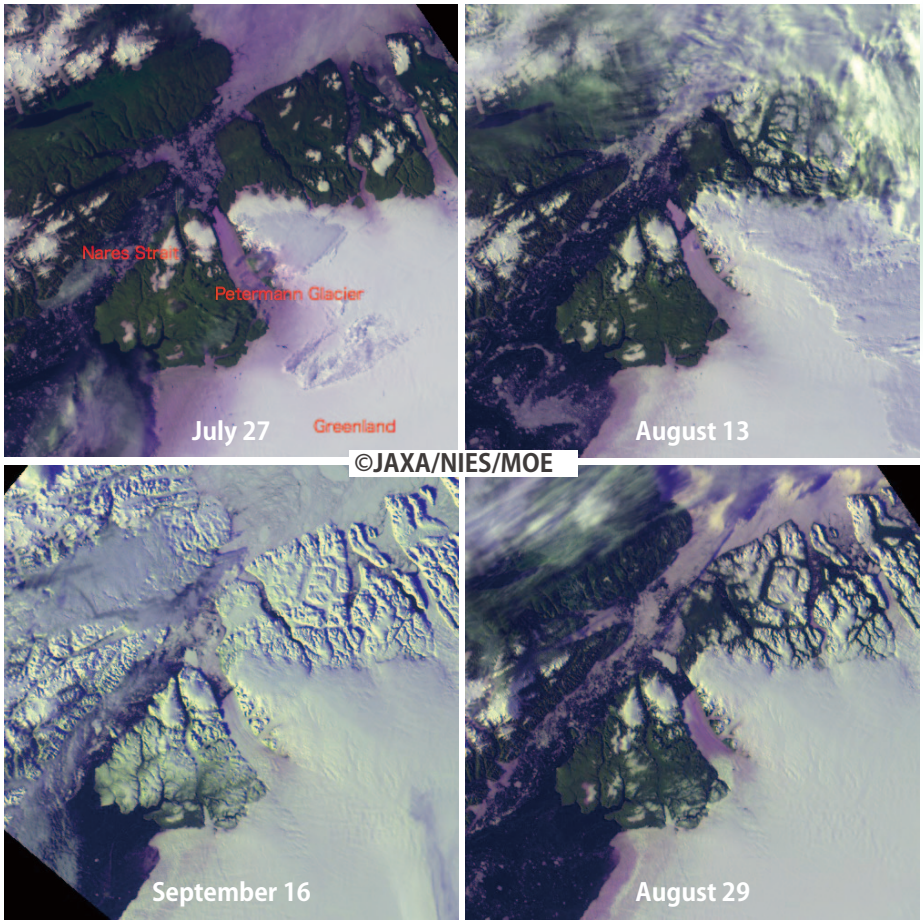


The red arrow indicates the location of the volcano.



Volcano Eruption in Iceland

The volcanic eruption on April 14, 2010 in the glacier region of Eyjafjallajökull in Iceland had a great impact on people's activities such as causing the entire shutdown of airports in Europe. Responding to the request, the GOSAT Project provided "IBUKI"'s data on the volcano eruption to the government of United Kingdom. The volcano remained active until May, but owing to the wind direction, the volcanic plume went to the Atlantic ocean, and it caused airport shutdowns only in limited areas such as in Spain. (Left image) A long arch shaped stream of volcanic plume (brown colored) can be seen in the image acquired on May 8, 2010. (Right image) A stream of the plume sucked in by a swirl of low-pressure is visible in the image acquired on May 13, 2010.



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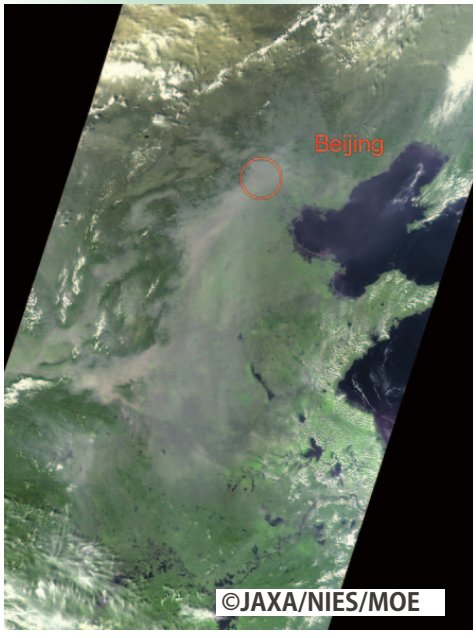
Drifting Iceberg Greenland

In the summer of 2010, there were news reports on a giant iceberg starting to drift away from Greenland. It was possible to see how it was happening in the images acquired by "IBUKI." (Left top) No iceberg is formed yet on July 27. (Right top) An iceberg can be seen separated from the Petermann Glacier and starting to drift away on August 13. (Right bottom) The iceberg moved onto the Nares Strait on August 29. (Left bottom) The iceberg broken into pieces, and is half the size on September 16.

2010 THROUGH THE EYES OF "IBUKI"

Smog in China

On October 9, a smog covers the entire North China Plain, from Beijing in the north along the Hwang Ho (the Yellow River) into the inland China. It is not always this hazy, but it was after a week of stable atmosphere and the smog remained still in the area.



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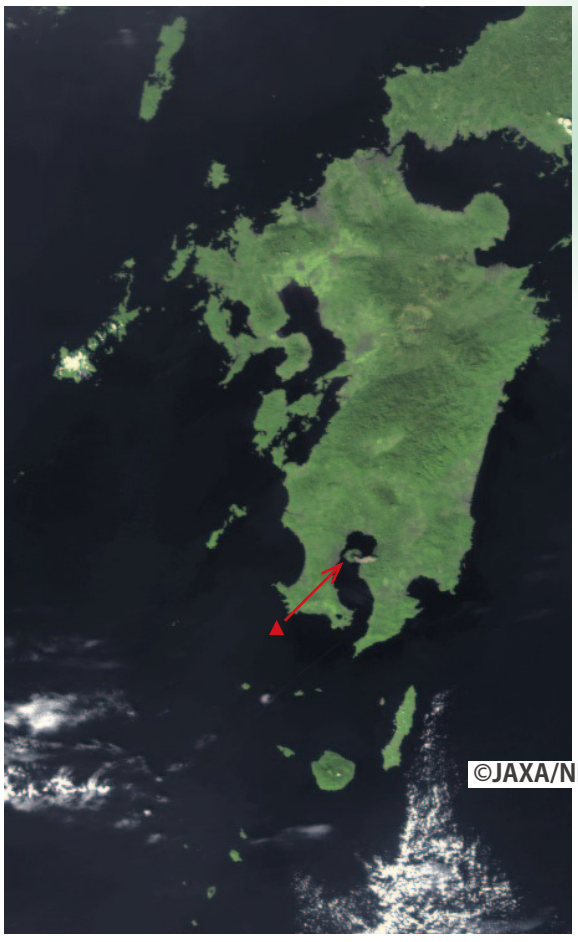
Volcanic Activities of Sakurajima Japan

The Sakurajima volcano in Japan has been active this year. A volcanic eruption on March 17 was spotted by "IBUKI." (Sakurajima area is enlarged in the image on the right.)



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The red arrow indicates the location of the volcano.

GOSAT INTERVIEW

A Series: "IBUKI"'s PI Interviews

No.5

DR. RICHARD ENGELEN

Researcher

European Centre for Medium Weather Forecasts

GOSAT Project solicits research proposals from scientists worldwide through the research announcements (RA) with a purpose to promote the use of GOSAT data as well as to integrate some of the important outcomes brought about by these selected researchers into the routine processing of the GOSAT observational data. This year, the Third GOSAT RA was released and the application was just closed on November 8, 2010. The project is currently reviewing the research proposals. For this issue, we are going to introduce one of such researchers who were selected after the First GOSAT RA, Dr. Richard Engelen of the European Centre for Medium-Range Weather Forecasts. Dr. Engelen is working on research entitled "Application of GOSAT data in a 4D-Var data assimilation system in combination with other greenhouse gas observations to better estimate CO_2 and CH_4 fluxes." (Interviewer: NIES GOSAT Project Tatsuya Yokota. Interviewed on September 7, 2010 in Oxford, UK.)

Yokota (Y): You are now with the European Centre for Medium-Range Weather Forecasts (ECMWF), and working on the 4D-Var data assimilation[1] of satellite data. You are trying to assimilate not only GOSAT data, but also AIRS[2] and IASI[3]. At first, I would like to know how you got interested in the data assimilation.

Engelen (E): Well, I went to Utrecht University in the Netherlands where I studied meteorology and physical oceanography, and a little bit on atmospheric chemistry. I received my master's degree in Atmospheric Science, and then I started my PhD there in the same department. My PhD was on using satellite data to measure ozone (O_3) using the thermal infrared. I was using the TOVS[4] at the time. I developed a new algorithm for that.

Then, I moved to the United States, to Colorado State University (CSU) in 1996. I moved to CSU initially as a post-doc and then stayed as a research associate. There I worked with Professor Graeme Stephens[5], and did various things with remote sensing; looking at humidity, at clouds etc. At some point, I started working on observing CO_2 with satellites. This was around 2000 or 2001.

In 2002, I moved to ECMWF. There, I was working on a small project, COCO[6]. We were looking at CO_2 and how we could use satellite data to estimate surface fluxes. Then, after COCO, we started the Global and regional Earth-system (Atmosphere) Monitoring using Satellite and in-situ data (GEMS)[7] project, which was led by Dr. Tony Hollingsworth. He passed away three years ago, but he is remembered as the driving force behind GEMS and later MACC[8].

1 **4D-Var Data Assimilation** is a method that uses observations to constrain a model simulation. 4D-Var uses all the observations within a certain assimilation time window to adjust the initial conditions such that the model simulation fits the observations within the assumed error statistics.

2 **Atmospheric InfraRed Sounder (AIRS)** is a high spectral resolution spectrometer that measures atmospheric temperature and humidity, and land and sea surface temperature. It is installed on Aqua satellite, and launched in May 2002. The instrument is designed to support climate research and improve weather forecasting.

3 **Infrared Atmospheric Sounding Interferometer (IASI)** is an instrument unit of MetOp, a series of European meteorological satellites. IASI measures infrared radiation emitted from the surface of the Earth to derive data on humidity and temperature profiles in the troposphere and lower stratosphere, as well as some of the chemical components playing a key role for climate monitoring and atmospheric chemistry. The first model was launched on METOP-A satellite in October 2006.

4 **TIROS Operational Vertical Sounder (TOVS)** is equipped on TIROS series of the U.S. polar orbiting satellites of National Oceanic and Atmospheric Administration (NOAA). TOVS consists of three instruments: High Resolution Infrared Radiation Sounder (HIRS), the Microwave Sounding Unit (MSU) and the Stratospheric Sounding Unit (SSU). (MSU and SSU have been replaced with improved instruments on newer satellites.) Each instrument measures radiation emitted by the Earth to estimate the total amount of O_3 in the earth's atmosphere.

5 **Professor Graeme Stephens** is currently the University Distinguished Professor at the Department of Atmospheric Science at Colorado State University.

6 **COCO** was a project funded by EU. Its aim is to use measurements from the satellite missions to monitor carbon dioxide levels in the atmosphere.

7 **Global and regional Earth-system (Atmosphere) Monitoring using Satellite and in-situ data (GEMS)** is a EU-funded project developing comprehensive monitoring and forecasting systems for trace atmospheric constituents important for climate, air quality, an UV radiation with a focus on Europe. The project concluded in May 2009.

8 **Monitoring Atmospheric Composition and Climate (MACC)** is the project that continues the operation and improvement of the system developed during

E: GEMS was a large European project. It was not only looking at greenhouse gases but also aerosols and reactive gases, using data assimilation together with modeling experts. Then GEMS moved into the MACC project. Both projects are very large European projects. MACC currently has 45 partners. We acquire a wide range of observational data, and use it in the ECMWF global data assimilation system. I look after the greenhouse gases data assimilation.
Y: Do you look at them on a global scale or for special regions?
E: Global with an extra focus on Europe.

Y: What is your major interest in the data assimilation?
E: I have been interested in seeing how we can use satellite data to improve our assimilation of O_3, clouds, and greenhouse gases. What we get from satellites is a wealth of information, but it is not easy to use.

Y: You are a GOSAT Research Announcement Principal Investigator. What do you think about the present GOSAT data?
E: I think it is progressing well. I think everyone was a little bit too optimistic at the beginning about how quickly you would get good results, but I know it takes time and effort for new measurement techniques to keep moving forward. I think that is still the case. We are not there yet, but it is going in the right direction. I think that is very important.

Y: I hear you are using the thermal infrared spectra from GOSAT data. How are the CO_2 and CH_4 concentrations?
E: We haven't been using the thermal infrared yet because of some calibration problems. So we will wait for that, but we have experience with AIRS and IASI so it shouldn't be too difficult to use the GOSAT data as well.

Y: Do you now mainly use the IASI data?
E: AIRS and IASI are the main satellite instruments for carbon dioxide (CO_2) and for methane (CH_4) we use SCIAMACHY[9]. One thing we also started looking into is how we can use in-situ data in our system together with the satellite data.
Y: What kind of in-situ data?
E: At the moment, we look at the continuous CO_2 data from a few European stations that we get from the Infrastructure for Measurements of the European Carbon Cycle (IMECC)[10] project. We would like to assimilate as many different data products as possible.

Y: Will you be at the European Geosciences Union General Assembly next year? I am expecting by that time you can access the GOSAT thermal infrared data.
E: That will be nice if we can get that to work. We can look at it and compare it to IASI and AIRS.

Y: Another issue is to assimilate GOSAT data or to identify the bias info. Is it one of the MACC project topics?
E: Yes, when we think the retrieval products for CO_2 and CH_4 are at a stage where they will improve our assimilation, then we will assimilate them together with AIRS and IASI. But at the moment we just monitor them, we compare with our model, to assess the quality and possible biases. Then, we will assimilate them. We are looking forward to get the satellite data in our system.

Y: Are you going to use other satellite data such as OCO-2[11] and CarbonSat[12] in the future?
E: Yes. We will look at the retrieval products in the same way as for GOSAT. We will compare with what we already have, and then if we think it is adding information, we will start assimilating them.

Y: Finally, I would like to ask about your expectation for GOSAT.
E: I just hope that in the next year or so, we will get to the point where we can start assimilating the data together with the other instruments we have. That should improve the quality of our own products. In MACC we have the atmospheric data assimilation as a first step, and as the second step we look at the fluxes. Hopefully, we will get to see improved flux estimates as well.

Y: I see. Thank you for your time today.

GEMS. MACC provides data records on atmospheric composition for recent years, data for monitoring present conditions and forecasts of the distribution of key constituents for a few days ahead. MACC combines the atmospheric modeling with Earth observation data to provide information services covering European air quality, global atmospheric composition, climate, and UV and solar energy.

9 **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.

10 **Infrastructure for Measurements of the European Carbon Cycle (IMECC)** is a project that aims to build the infrastructure for a coordinated, calibrated and accessible dataset for characterizing the carbon balance of Europe.

11 **Orbiting Carbon Observatory 2 (OCO-2)** is a satellite dedicated to studying atmospheric CO_2, a replacement model for the OCO. It is being developed by NASA and is scheduled to be launched in February 2013.

12 **CabonSat** is a satellite prepared under the scientific lead of the Institute of Environmental Physics of the University of Bremen. It is selected as one of missions for the Earth Explorer Opportunity Missions of ESA, and the launch is scheduled in 2018. Carbonsat's scientific objectives are to globally measure the concentration of CO_2 and CH_4, and expected to assume the tasks of SCIAMACHY and GOSAT.

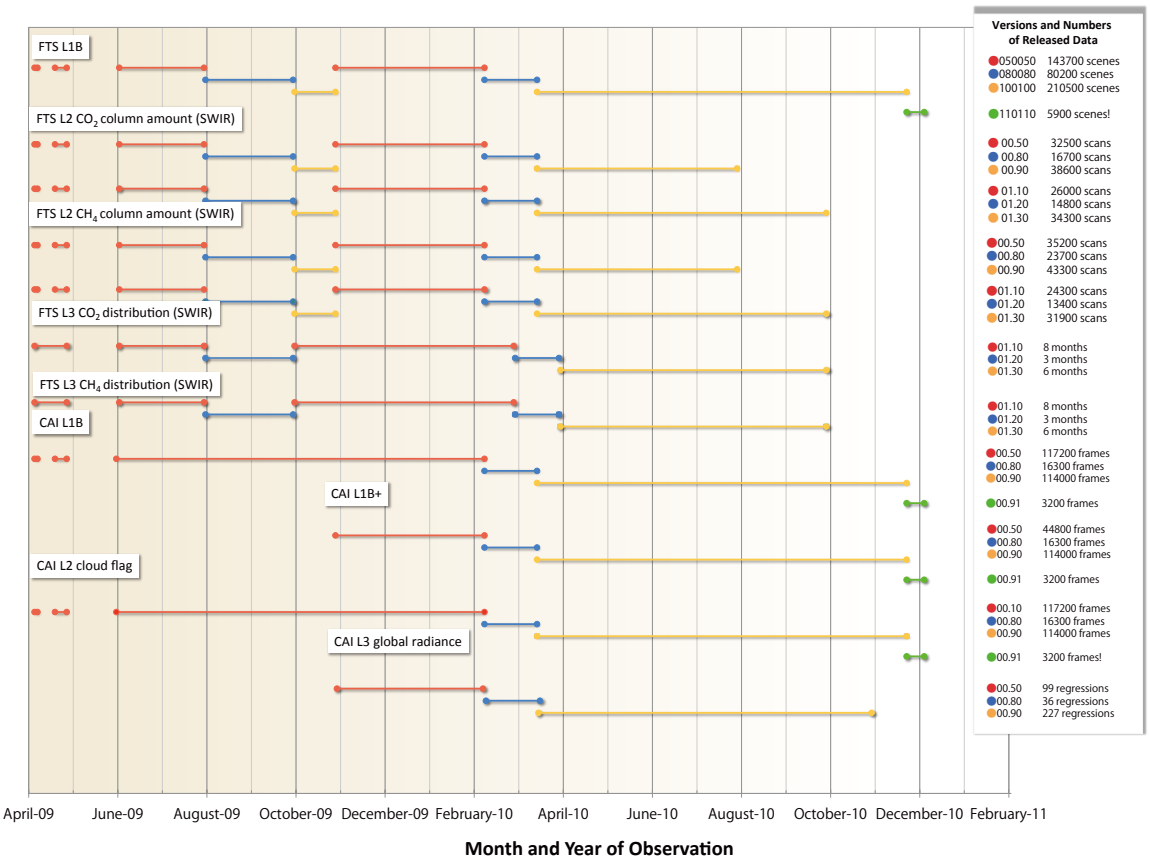
DATA PRODUCTS UPDATE

Data Processing Status Update from GOSAT Project Office

— Fumie Kawazoe, Specialist, NIES GOSAT Project Office

Observation Period and Versions of Publicly Released Data

As of December 6, 2010



Here we report an update on data processing status for late November and early December 2010. We have released the upgraded version of the FTS L1B observed after November 24. The changes in the new version of the FTS L1B are 1) the accuracy of TIR processing is improved, 2) the influence of delay mismatch is corrected, and 3) the method of saturation judgment is improved. With this upgrade, other products have been upgraded as well. With the FTS SWIR L2, a minor bug of the High Speed Computation of Radiative Transfer program is corrected. With the CAI data products, the only change is the version names, and there is no actual change of the content. For the new version numbers of products, please refer to "Observation Period and Versions of Publicly Released Data" above. On November 30, we have also released the FTS L3 of CO_2 and CH_4 global distribution (SWIR). You can view the rendered images of global distribution, "FTS SWIR L3 (XCO2)" and "FTS SWIR L3 (XCO2)" at the "Gallery" section in the GOSAT User Interface Gateway (http://data.gosat.nies.go.jp/).

The number of registered general users reached 930 as of December 6, 2010.

PUBLISHED PAPERS

Field of Research : Data Processing Algorithm

Name of Journal : Journal of Quantitative Spectroscopy and Radiative Transfer (Volume 112, Issue 3, February 2011, pages 531-539)

Title : Measurements of self-broadening and self-induced pressure-shift parameters of the methane spectral lines in the 5556-6166 cm^{-1} range

Authors : O.M. Lyulin, V.I. Perevalov, I. Morino, T. Yokota, R. Kumazawa, T. Watanabe

CALENDAR

2011/01/31
Sending out the notices of results for the Third Research Announcement.

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