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CONTENTS

NEWS	Report: COP18	01
GOSAT PEOPLE		
	A Series: Supporting GOSAT Project (2)	03
	- Big Stagehands in Level 1 Processing	
ANNOUNCEMENT		
	9th IWGGMS to be held in late May	04
PUBLISHED PAPERS		04
DATA PRODUCT UPDATE		05



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: COP18

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From Nov. 26 to Dec. 8, 2012, COP18/CMP8⁽¹⁾ was held in Doha of Qatar, located on Arabian Peninsula (Photo 1). Qatar's land is a bit smaller than the half of Sardegna, Italy, populated with 1 million and 700 thousand people (as of 2011), major part of which consists of foreign workers (only 300 thousands are Qatari); the country is encouraging various industries now to break away from the Oil-Gas-dependent economy.

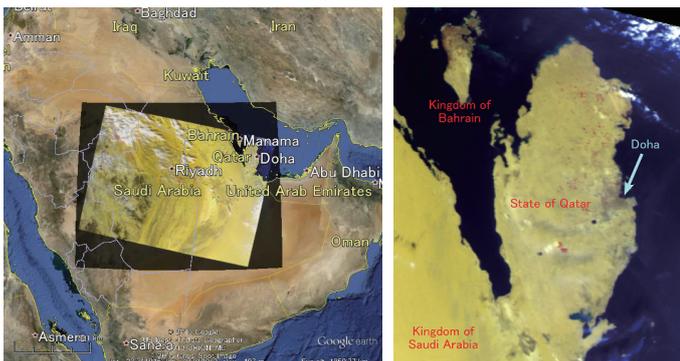


Photo1 The image is generated from CAI L1B+ data (R: G: B = band3: band2: band1) captured on Dec. 2, 2012 (in COP18 period), and overlaid on Google Earth. Brown dots in the center and north-east of the right photo show irrigation agriculture.

NIES (National Institute for Environmental Studies) has joined the conference with an exhibition booth since the 10th as an NGO⁽²⁾ to introduce the latest research activities on global warming and climate change. GOSAT project has been one of the main features of NIES, appealing its significance and achievement. This is to report how I attended and introduced the latest outcomes of the project as a member of GOSAT-2 Project Preparation Team and

how the conference looked like.

The conference took place at QNCC (Qatar National Convention Center) 10km away from new Doha urban area filled with lines of modern buildings (Photo 2 bottom). During the period, free shuttle buses were commuting between hotels in the city and QNCC for the attendees' convenience, however, they took 30 to 40 minutes forth and 60 to 120 minutes back, because we from NIES stayed in old urban area (Photo 2 top), a bit away from QNCC. The traffic was generally slow, but the main reason for longer time the way back was the bus route, picking riders at all sites of events hosted by Qatar. That would be a best operation to serve random arrival of way-back commuters.



Photo2 Old (top) and new (bottom) urban area of Doha

QNCC was as large as Tokyo Big Sight but with much playful spirit found, for example, in an enormous spider *objet* and a pond paved with LED tubes set in the conference hall (Photo 3), exhibit area, and connecting space in between, adding some taste to its inorganic atmosphere.

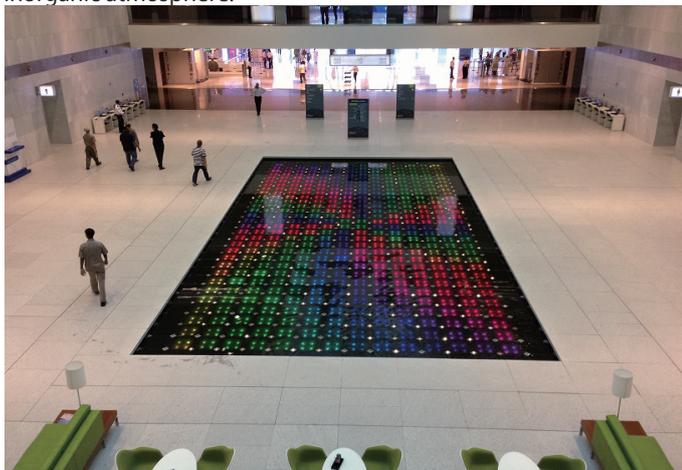


Photo3 An *objet* in QNCC paved with LED tubes

Attendees had to go through security check as at airports to enter, where everyone was scanned and identified with a picture ID card issued on pre-registration for qualification and attending period. The site was divided into 5 zones for meetings, delegations, exhibits, media, and restaurants. We, NGO, were allocated to exhibits zone where NIES and ESA (European Space Agency) were the only two organizations of over 200 NGOs worldwide to feature remote sensing. The US, a tough presenter, sent NASA to the delegations' zone, not to the exhibits zone, taking this opportunity to show its activities extensively.

Attendees from NIES left Narita on Nov. 24 to arrive in Doha the next day, staying until Dec. 4 to work on publicity. Our exhibit focused on "What is GOSAT?", "What is the GOSAT's possible contribution to our global society?", and "What are the present and future GOSAT data products and how can our society be changed by them?" to explain after consulting with Dr. Yokota, GOSAT Project Leader, and Dr. Matsunaga, GOSAT-2 Project Preparation Team Deputy Leader, to assume majority of the visitors to be more policy-related than science-minded, who knew not much of remote sensing. We put up a poster explaining the outline of GOSAT and a tapestry of GOSAT borrowed from JAXA (Japan Aerospace Exploration Agency) on the wall most visible to the visitors' flow, and explained L2 (CO₂ and CH₄ column-averaged mixing ratios) and L4 (global CO₂ flux) data product on two LCD monitors on the table. We also prepared 700 CDs^(*) including GOSAT materials to distribute to the visitors.

NIES booth collected many visitors to distribute more than 100 CDs every day, being very successful throughout the period (Photo 4). 20% of visitors had already known GOSAT and many of the rest were interested when they were explained the significance and activities of GOSAT and came up with questions of "What are the flux of my county or local region?" or "How have we been affected by our own CO₂ emission, as I myself am a member of the delegation from an oil-producing country?", and so on. I supposed

they wanted to understand the real status of social change and environmental deterioration they perceived by using the scientific measure of GOSAT. When I referred to the value of broader ground-based observation network, TCCON^(*) for example, some delegates from African government proposed the possibility of construction in their country. When I told that GOSAT data products were not fine enough at present to tell the status of a county or a specific region of their interest but we would figure out a way in the future, they showed great expectation.

There was a common question made by young visitors, especially from African countries: Can I study at NIES as a student? "NIES is an institute and can't accept students if not as researchers; we have no class curriculum" was my answer, grinding my teeth,

I am personally convinced of three things now; we should show the significance and outcomes of GOSAT more in where policy-related people gathers and should continue effort to increase supporters; should create a new system in cooperation with JICA and universities to accept those young visitors above, who are strong buds to be GOSAT supporters; should have not only the standpoint of observation but of "assessing" the policies executed to realize low-carbon society which requires global cooperation. GOSAT project is surely able to carry out these challenges.

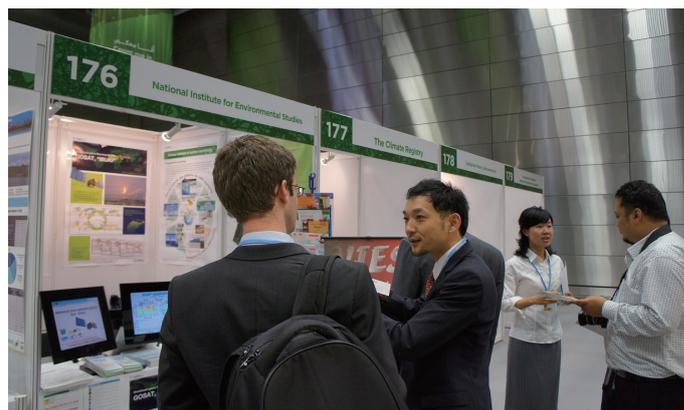


Photo4 Endo at NIES booth answering visitors' questions

COP19 will be held in Warsaw, Poland, in 2013. We sincerely hope GOSAT supporters to increase around the world through our publicity activities in COP.

*1 COP18: 18th session of the Conference of the Parties to the United Nations Framework Convention on Climate Change / CMP8: 8th session of the Conference of the Parties serving as the Meeting of the Parties to the Kyoto Protocol. Official site: <http://unfccc.int/2860.php> (in English, Spanish, French)

*2 NGO: Non-Governmental Organization

*3 Pamphlet included in the distributed CD can be seen or downloaded at "GOSAT Project/Download GOSAT Pamphlet", and related additional leaflet is available at "Leaflet"; both are on http://www.gosat.nies.go.jp/index_e.html.

*4 TCCON: Total Carbon Column Observing Network is a network of the ground-based high-resolution FTS observations. Currently, its observations are carried out in more than 20 locations worldwide. TCCON's column-averaged volume mixing ratios of greenhouse gases are used for validating greenhouse gases observation by satellites and other carbon cycle studies.

*5 JICA : Japan International Cooperation Agency



GOSAT PEOPLE A Series: Supporting GOSAT Project (2)

Big Stagehands in Level 1 Processing

Kei Shiomi, Earth Research Observation Center / Shinichi Fukagawa, Mission Operations System Office,
Japan Aerospace Exploration Agency



What is Level 1 processing of *IBUKI* data?

IBUKI, the Greenhouse gases Observing SATellite (GOSAT), launched on Jan. 23, 2009, is equipped with 2 sensors: Fourier Transform Spectrometer TANSO-FTS (hereafter FTS), and the cloud and aerosol imager TANSO-CAI (hereafter CAI). Level 1 processing for the observation data acquired by these sensors is handled by Japan Aerospace Exploration Agency (JAXA).

Observation data, FTS data for example, is stored as electric signal of optical interference pattern acquired by FTS. GOSAT data processing system in JAXA transforms the pattern into spectra of observed light by Fourier transformation. This process is called Level 1 processing and the data storing the spectra is called Level 1B data (Figure 1).

Level 1 data processed by JAXA is the base of higher-level processing at National Institute for Environmental Studies (NIES): generation of Level 2 data product (CO₂/CH₄ column-averaged mixing ratios) and Level 3 and 4 data product (global distribution and flux).

The optical interference pattern is affected by the micro-vibration of on-orbit *IBUKI* or minimal characteristics of parts in sensors and circuits, which create noise in spectra. The noise correction and quality check of observation data are important at Level 1 processing.

As 1% change in CO₂ concentration is represented as only 0.3% change of spectra at most, we always pursue the precision increase of Level 1 processing to ensure 0.3% relative precision for radiance.

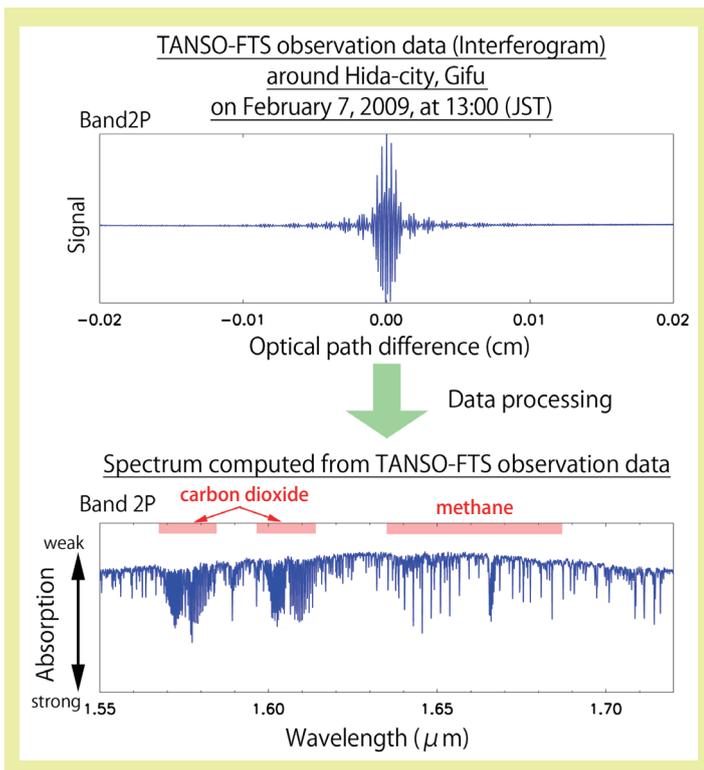


Figure1 Schematic of Level 1 processing

Level 1 process development and First Light

Expectations people had on *IBUKI* were very great because the first commitment period of Kyoto Protocol was to start in 2008, and NASA's Orbiting Carbon Observatory (OCO), a powerful competitor of GOSAT, was planned to launch also in 2008.

JAXA had just started the development of GOSAT in March 2005, and the target launch date was set on August 2008 under the watchword "Launch GOSAT before OCO!" Actual launch date was January 2009, however, the development process was shortest ever, never experienced in the past. (OCO was launched in February 2009, but could not go into orbit because of fairing^(*) separation failure.) Also ground equipment had to be developed on time. Only 2 persons were assigned in JAXA then, who anyway started to design and develop the ground equipment under cooperation of related engineers in 2004.

TANSO sensors were also under development on a very tight schedule to make as better sensors as possible, which made the sensor development group kept away from organizing design information and minimal characteristics of each sensor or circuit required for designing Level 1 processing algorithm.

How on earth can we prepare L1 algorithm on time for the launch!

Technical information required for the development of Level 1 processing algorithm was not prepared enough, however, a design team was organized in NEC who was in charge of sensor development, and started work in February 2006.

Design information required to be embedded in Level 1 correction process was gradually collected along with the progress of sensor development, but the team had to wait for the complete set of necessary information until September 2008, only 4 months before the launch.

To compress the process development period, we asked the team to develop minimal necessary part of algorithm for launch and test before launch, and we managed to be ready for January 2009 launch.

The first event after the launch was to process the First Light (the first observation) data. We acquired FTS SWIR spectra and CAI image data on February 7, 2009, and FTS TIR spectra on March 12, 2009, to release to general public. Processing of data and image took quite a long time in the operation room in cooperation with engineers. Our chests really swelled anticipating the coming success of GOSAT when praised by researchers around the world, "Beautiful spectra!"

JAXA started to send Level 1 data to NIES on April 23, 2009, at last after repeated revision of algorithm to meet the starting time to check each item of the satellite and sensors. That was really the time of being on the edge of our seats.



Photo1 Engineers involved in data and image processing of the First Light (front row from left, Mr. Imanaka, Ms. Kataoka, Ms. Higuchi; back row from left, Mr. Kowata, Mr. Mitomi, Mr. Kato)

Improvement of Level 1 processing after launch

Level 1 processing is still improving by continuous calibration and validation for better data quality in cooperation with researchers in Japan and around the world, such as those in NIES, NASA/JPL, etc.

In calibration, difference in radiance spectra of Level 1 data between GOSAT and other satellites (AIRS, for example) is analyzed; in validation, difference in retrieved CO₂ concentration between GOSAT and ground-based observation data is analyzed; these analyses are used to estimate causes of difference rooted in sensor characteristics. The estimated causes are checked their correctness on design

documents or engineering models of sensors, because TANSOs are on-orbit. When the causes are proved, algorithm is studied for the correction.

These works are handled by a team including engineers who developed sensors, because that cannot be executed only by engineers in ground equipment, This quiet dedication supports much further improvement of Level 1 data precision.



Photo2 Engineers working on Level 1 algorithm development and precision improvement (from left, Mr. Kondo, Mr. Suzuki, Mr. Yamamoto, Mr. Nagatsuka, Mr. Yoshida, Mr. Nakamura; in square windows from left, Ms. Kasai, Mr. S. Iguchi, Mr. M. Iguchi, Mr. Miyahara, Mr. Tamagawa)

*1 A structure located at the top of a rocket to protect things inside such as a satellite from vibration, heat, etc., at the launch. 

ANNOUNCEMENT

9th IWGGMS to be held in late May

 The 9th IWGGMS (International Workshop on Greenhouse Gas Measurements from Space) is going to be held as shown right.

This workshop intends to assess the latest science and technologies in spaceborne measurement of greenhouse gases, addressing new findings by the current and past missions (GOSAT, AIRS, SCIAMACHY, TES, IASI, etc) as well as the next-generation missions (OCO-2, TanSat, GOSAT-2, CarbonSat, microCarb, etc).

Admission is free. See URL below for more details.

<https://www.w5ss.com/IWGGMS-9/>

Date/Time: May 29(Wed) afternoon - 31(Fri), 2013

Venue: Yokohama Symposia, Industrial Trade Center 9F, 2 Yamashita-Cho, Naka-Ku, Yokohama-city, 231-0023 Japan
<http://www.yokohama-cci.or.jp/symposia/> (Japanese only)

Key Deadlines:

Abstract Due: **March 31(Sun), 2013 (JST)**

Registration Deadline*: **May 7(Tue), 2013 (JST)**

*Deadline for participants who need to obtain invitation letters for entry visa application is **March 20(Wed), 2013 (JST)**. 

PUBLISHED PAPERS

Field of Research: data processing algorithm

Name of Journal: Atmospheric Measurement Techniques
(Volume 6, pages 263-274, 2013)

Title: Water vapor isotopologue retrievals from high-resolution GOSAT shortwave infrared spectra

Authors: C. Frankenberg, D. Wunch, G. Toon, C. Risi, R. Scheepmaker, J.-E. Lee, P. Wennberg, J. Worden

Field of Research: data processing algorithm, validation

Name of Journal: Applied Optics
(Volume 52, pages 1339-1350, 2013)

Title: Simultaneous retrieval of atmospheric CO₂ and light path modification from space-based spectroscopic observations of greenhouse gases: methodology and application to GOSAT measurements over TCCON sites

Authors: S. Oshchepkov, A. Bril, T. Yokota, Y. Yoshida, T. Blumenstock, N.M. Deutscher, S. Dohe, R. Macatangay, I. Morino, J. Notholt, M. Rettinger, C. Petri, M. Schneider, R. Sussman, O. Uchino, V. Velasco, D. Wunch, D. Belikov

Field of Research: data application

Name of Journal: Atmospheric Chemistry and Physics
(Volume 13, pages 1771-1780, 2013)

Title: A joint effort to deliver satellite retrieved atmospheric CO₂ concentrations for surface flux inversions: the ensemble median algorithm EMMA

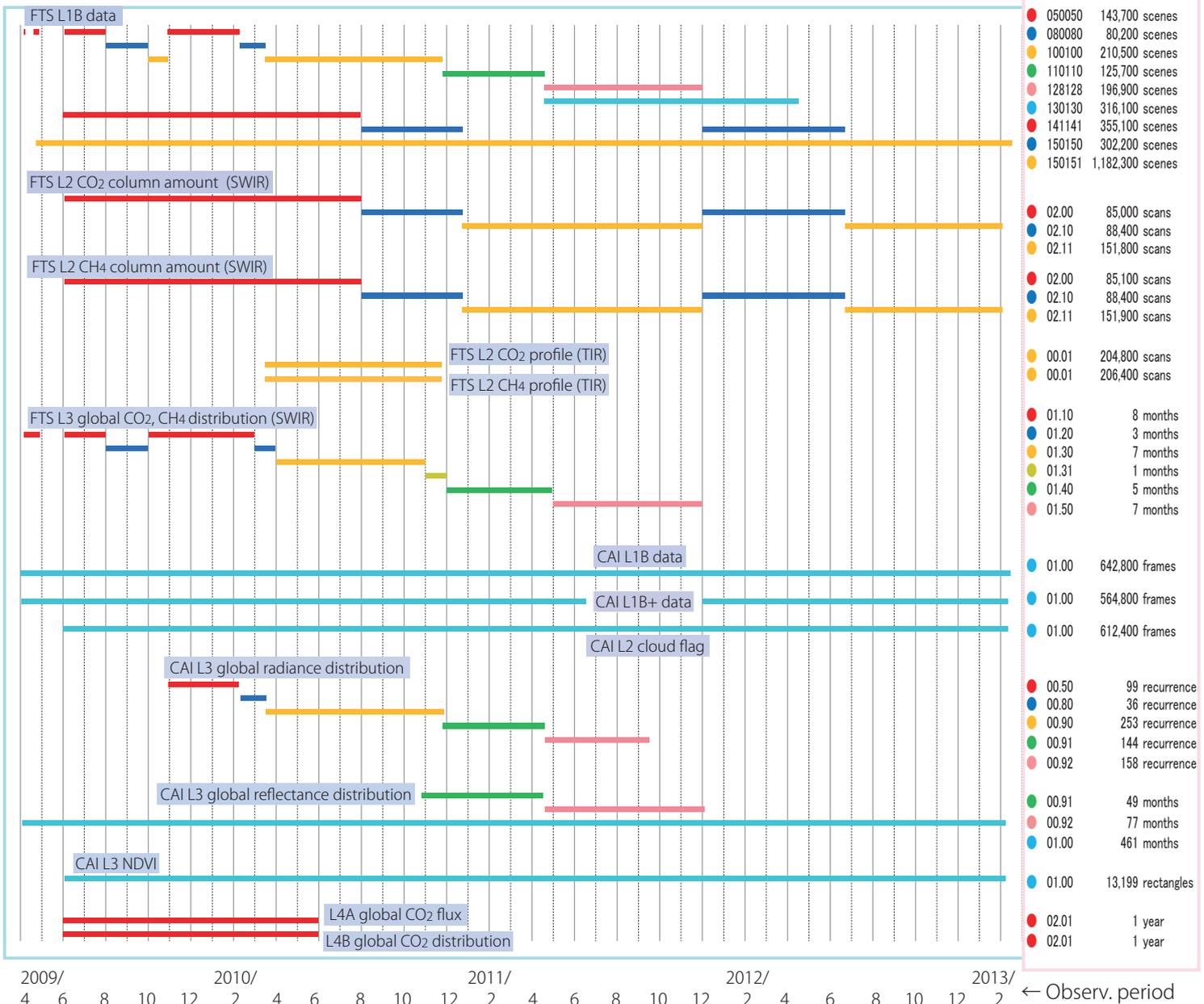
Authors: M. Reuter, H. Bösch, H. Bovensmann, A. Bril, M. Buchwitz, A. Butz, J.P. Burrows, C.W. O'Dell, S. Guerlet, O. Hasekamp, J. Heymann, N. Kikuchi, S. Oshchepkov, R. Parker, S. Pfeifer, O. Schneising, T. Yokota, Y. Yoshida

DATA PRODUCTS UPDATE

Data Processing Status Update from GOSAT Project Office

Fumie Kawazoe, Specialist, NIES GOSAT Project Office

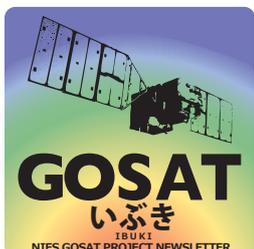
Observation Period and Versions of Publicly Released Data As of February 15, 2013



🌱🌱 The chart above is as of February 15, 2013. The latest processed and released on are: FTS L1B in V150.151; CAI L1B/L1B+/L2 cloud flag /L3 global reflectance distribution/NDVI in V01.00; FTS L2 CO₂/CH₄ column amount (SWIR) in V02.11.

FTS L1B has been completed its reprocessing in V150.151 over the whole observation period, while CAI L1B+ is still under reprocessing in V01.00.

The number of registered users is 1389 as of Feb. 14, 2013. 🌱🌱



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