GOSAT いぶき IBUKI
NIES GOSAT PROJECT NEWSLETTER
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CONTENTS

Group photo of the 5th GOSAT RA PI Meeting held at Yokohama Symposia

NEWS

Report : The 5th GOSAT RA PI Meeting

Chairperson, GOSAT RA Selection and Evaluation Committee (RA Committee)
Professor Haruhisa Shimoda of Research Institute of Science and Technology at Tokai University

The meeting was held at the Industry & Trade Center near Yamashita Park in Yokohama, Japan, on May 27, 28 and 29 morning, followed by the 9th International Workshop on Greenhouse Gas Measurements from Space (see another report) held on 29 afternoon, 30 and 31, which unusually came after the RA PI meeting, also at the same place. The venue was Yokohama Symposia, a conference hall with a view, on the 9th floor of the building. The participants were 56 including Principal Investigators (PIs) and Co-Investigators (Co-Is), and 96 in total, including the staff from the National Institute for Environmental Studies (NIES), the Japan Aerospace Exploration Agency (JAXA), and the guests from the National Aeronautics and Space Administration (NASA) and others.

The meeting started with the plenary session for 1 hour from 9:30 a.m. on the first day, followed by sessions on calibration, validation, algorithms, modeling, data application, and closing session in that order; after the data application session, discussions were also held in working groups for 1.5 hours.

The plenary started with the greeting remarks from Deputy Director Takuya Nomoto of Research and Information Office, Global Environment Bureau at Ministry of the Environment, Japan, and myself, the host of the meeting. They were followed by reports on current status of GOSAT project: "Brief report on the GOSAT science team activity" (Prof. Gen Inoue, GOSAT science team chief scientist), "Report on GOSAT recent operation" (Kei Shiomi, JAXA), and "Data processing status and review of RA users' privileges" (Masataka Ajiro, NIES). The session closed with "Summary of action items from the 4th RA PI Meeting" (Masataka Ajiro, NIES).

Two researchers gave presentations in the calibration session: "Characterization of micro vibration effect to spaceborne-FTS on orbit" (Hiroshi Suto, JAXA) and "GOSAT TIR band inter-calibration with satellite


Some views from the venue


Oral Presentation

infrared sensors" (Dr. Jonathan Gero, the University of Wisconsin-Madison).

The validation session saw 15 presentations: 5 used ground-based high-resolution FTSs (mainly TCCON data); 4 were related to observation with validation instruments (including lidar); 3 made comparison with other satellites' data; 1 made comparison with in-situ data; 1 reported on water vapor isotope; and the last 1 was on retrieval algorithm development that seemed to belong rather to algorithm session.

The algorithm session had 11 presentations reporting retrievals of 3 latest results of CO_2, 1 water vapor isotope, 3 trace gases (CO_2, CH_4, ozone, etc.) from TIR, 1 aerosol from CAI, 2 aerosol from O_2 A band, and the last 1 was on the algorithm development status for Chinese satellite TanSat*1.

In the following model session, there were 13 presentations consisting of: flux inversions of 5 on CO_2, 2 on CH_4, and 2 on both, 1 CO_2 flux comparison between inverse models (almost all of inverse models adopt data assimilation), 1 on correlation with atmospheric pollutants, 1 on comparison with vegetation model, and 1 on comparison with flux measurement using tower. About one year has passed since L4 product was provided to RA researchers, however, there seems to be large differences in the estimated CO_2 fluxes between models. Lack of good validation measure is one reason for the status quo.

The last was the application session with 9 presentations, 3 of which targeted on regional trend of greenhouse gases (CO_2 and CH_4): other 3 were on large point sources of CO_2 such as biomass burning*2, volcanoes, mega cities, and power plants: the rest were 1 on a source of aerosol, 1 on radiative forcing, and 1 estimating phenology*3 from CAI.

Thereafter discussions were held in 3 working groups of SWIR, TIR, and flux estimation, summaries of which were briefly reported at the closing session: topics at SWIR working group were on the possibility of a little bias change in SWIR retrieval result depending on the scanning direction when the latest FTS L1B V160.160 were used, the necessity of comparing results of pre-/post-screening to clarify the difference between retrieval algorithms, and the possibility study of multi-angle observation.

TIR working group discussed mainly the calibration accuracy of the L1B product; the latest V160.160 seems to have larger error than V150.151 at some wavelength regions; inter-calibrations with other satellites are now done only at around 40 degree or very high latitude, however, additional ones are required at other latitudes, especially at tropical area; SHIS (airborne-FTS) should be considered. Other topics are synergy use of SWIR with TIR spectra, simultaneous retrieval of HDO and CH_4, etc. Also, there is a comment for GOSAT-2: keeping the TIR band is welcome, but high calibration accuracy is required.

Flux estimation group discussed how to validate L4 product, which included comparing L4B data with independent profile data (CONTRAIL*4, HIPPO*5, NOAA*6 aircraft, etc.), providing flux averaging kernel, comparing the L4A data with other independent flux estimates. Also it was announced that CH_4 L4 data would be released to RA users from NIES in near future.

Below is my summing up of the 5th PI meeting as a whole, almost the same as the last one.

(1) The improved quality of L2 product by NIES, ACOS, etc. now enabled the full-scale scientific application including inverse modeling,

(2) However, its data accuracy is yet left to be validated in the regions of high reflectance and high latitude due to the uneven distribution of TCCON sites,

(3) Retrieval and validation need to be expedited for TIR using latest L1 data because of insufficient retrieval on the product,

(4) Inverse models have still large differences between themselves, which should be responded with estimation of any factor(s) constituting the difference and proved what is going on now.

*1 TanSat is a Chinese satellite for CO_2 observation, whose launch is planned in 2015.

*2 Biomass burning means vegetation burning as of forests or agricultural wastes which is discernible from fossil fuel burning in observation by its GHG component fraction such as CO concentration.

*3 Phenology is the study to research the temporal changes of plants and animals' seasonal phenomena and their relation with climate.

*4 Comprehensive Observation Network for TRace gases by AIrLiner is a project to measure CO_2 from passenger aircrafts while they are operating in the air. An instrument to collect air samples and an instrument to measure CO_2 concentration in the atmosphere continuously are installed in the cargo room of JAL (Japan Airlines) aircrafts.

*5 the HIaper Pole-to-Pole Observations is a project to observe greenhouse gases and collect their samples including CO_2 at different heights in the atmosphere approximately pole-to-pole using Hiaper, an aircraft developed by US NCAR (National Center of Atmospheric Research) specifically for environmental research.

*6 National Oceanic and Atmospheric Administration is an organization of the US Department of Commerce focusing on research and study of ocean and atmosphere.

ANNOUNCEMENT

Accepting Applications of GOSAT RA#6

NEWS

Report : IWGGMS-9

Rajesh Janardanan, Research Associate,
Center for Global Environmental Research, NIES

The ninth International Workshop on Greenhouse Gas Measurements from Space (IWGGMS-9) was held at Yokohama, Japan from May 29 to 31, 2013, hosted by the Japan Aerospace Exploration Agency (JAXA), the National Institute for Environmental Studies (NIES) and the Ministry of the Environment, Government of Japan. The agenda of the series of IWGGMS has been to discuss and present the status and advancement in the techniques and methodologies for observation of greenhouse gases in the atmosphere using space-borne and allied instruments. The venue this time was Yokohama Symposia amidst the busy avenues of Yokohama, provided with a very pleasing ambience for serious discussions for two and half days.

The first day started with welcome speeches by the NIES President, Dr. Akimasa Sumi and Director Hiroshi Tsujihara of Research and Information Office, Global Environment Bureau at Ministry of the Environment, Japan, followed by a short recap of the history of IWGGMS by Dr. Tatsuya Yokota. The first day had presentations about the dedicated satellites missions like GOSAT, SCIAMACHY*1, CarbonSat*2, OCO-2*3, TanSat*4 etc. There were reports on the comparison of different satellites, their subsequent developments and novel techniques.


Poster Session

The second day had a session on future space-borne missions of GreenHouse Gas (GHG) measurements, their potential and the possibilities to improve the quality of GHG estimates. After the presentation of more than thirty posters, sessions on “calibration/in-situ measurements/applications”, “algorithm” and “GHG results and comparison” were held. Some of the presentations gave technological approaches and the rest on scientific findings based on them. There were ample representation of the various algorithms for retrieval of GHGs, the different instruments onboard various satellites and their inter-comparison to give the attendees an overview of their capabilities.


Participants at IWGGMS-9

Presentations on inverse modeling started as the last session of the second day and extended to the whole of third day with special focus on CO_2, CH_4, large point source, and regional emissions. This was the single largest session under a main title, which dealt with various aspects of inverse modeling related to GHGs. Inversion results of CO_2 fluxes using GOSAT XCO_2 observation and the inter-comparison of estimates using various GOSAT products were presented. Some of the reports presented evaluation of inverted fluxes over different homogenous regions like grassland, geographic regions like tropics, Eurasia and south Asia. There were some interesting discussions on emission estimates from large point sources including mega cities, which attracted an overwhelming enthusiasm among researchers working on carbon emission related issues.

After the very eloquent sessions and discussions during these two and half days, the meeting came to an end on 31 May. The closing address was delivered by Prof. Inoue, GOSAT science team chief scientist. He evaluated there were remarkable progress in modeling and reports on modeling increased than previous years. He opined that in coming few years the community would have more satellites and it would improve our understanding about regional carbon cycles also. The programme ended with the concluding remarks by Dr. Tatsuya Yokota.

The IWGGMS-9 provided a very good venue for young researchers to get better insight into various aspects which need to be unveiled next, by interacting with scientists who have been working in this field for quite a long time and participating all through the nine meetings. The announcement of the venue and date of the next meeting is pending decision.

*1 SCanning Imaging Absorption spectroMeter for Atmospheric CartograpHY is the sensor mounted on the ESA satellite Envisat, which was in operation from March 2002 to April 2012.
*2 Carbon Monitoring Satellite is planned and led mainly by Bremen University in the ESA's Earth exploration project, targeting at global observation of CO_2 and CH_4 concentrations, to be launched in 2018.
*3 Orbiting Carbon Observatory 2 is a CO_2 observing satellite of the US to be launched in 2014.
*4 Please refer to *1 of page 2.


Group photo of the IWGGMS-9

GOSAT PEOPLE Series: Supporting GOSAT Project (4)

Big Stagehands in Higher Level Data Processing

Masataka Ajiro, GOSAT Project Office Manager,
Center for Global Environmental Research, NIES

The National Institute for Environmental Studies (NIES) assumes many roles in GOSAT project; development and improvement of retrieval algorithm for greenhouse gases' concentration using *IBUKI* and auxiliary data: higher level data processing: validation of data products: data provision to worldwide users: flux estimation by atmospheric models, etc. Let us introduce the people and their activities who are responsible for development and maintenance of the system for higher level *IBUKI* data processing and its related systems.

Higher level data processing of *IBUKI* data

Higher level data processing, level 2 processing specifically, can be simply described as "to extract meaningful information such as carbon dioxide (CO_2) and methane (CH_4) concentrations from the data observed by *IBUKI* ". TANSO-FTS, the greenhouse gas observing sensor on-board *IBUKI*, observes sunlight reflected on the ground surface and atmosphere, and their thermal radiation as well. The observed data are transformed into spectra (level 1B data) by the Japan Aerospace Exploration Agency (JAXA). The spectra are the mixture of noise and information containing concentrations of greenhouse gases, from where meaningful information should be extracted. Some data can be inadequate to be used because of observation conditions like cloudy sky. It's the key point for successful retrieval to sort out data of good quality out of the mixture with accuracy as better as possible.

We make full use of various resources to extract information from observed data. They are auxiliary data indispensable for higher level processing of observed data, programs (algorithms) to process these data, computers to run the programs, storage*1 to save the output, etc. These resources are combined appropriately for GOSAT data processing system, where greenhouse gases' concentrations (level 2 data) are retrieved, global distribution of greenhouse gases and their flux (level 3/ level 4 data) are estimated, and these output are organized easy to use (data product) or easy to understand (visualization) for users. It is Fujitsu FIP and other companies' engineers that develop this GOSAT data processing system.

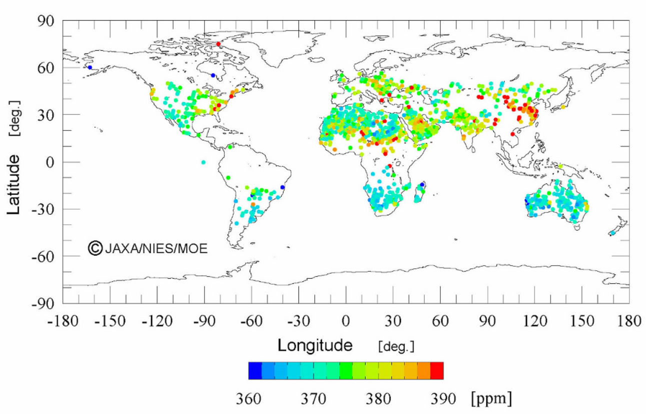
From the start of system development to the launch of GOSAT

System development at NIES for higher level data processing and data provision started in January 2007, which was about 2 years before the launch in January 2009. That was extremely short compared to the previous development of ground system for satellites at NIES, which usually took 5 to 6 years. At first, we took up the function to nominally fetch required auxiliary data, i.e., meteorological data and other satellites' observation data, to process the GOSAT data. Also we prepared substitutional data beforehand to keep nominal operation considering various cases where those auxiliary data were unavailable. Development of data processing programs (algorithms) were shared between NIES, JAXA, GOSAT science team and us, system development engineers. But the thing was a bit more complex; there were more than 100 programs to run on the system, which were to be connected and work as a whole, and also they were run on different machines of supercomputers in NIES and the University of Tokyo besides the computer in GOSAT Data Handling Facility (DHF). They had to work in corporation with each other.

Plenty of time was also required to adjust and decide the interface specification with those data providing facilities, research institutes, computer resource providing facilities. It happened once that the improvement in level 2 processing algorithm brought significant reduction in data processing time, which affected computer power assignment in Information Technology Center of the University of Tokyo, and we had to renegotiate how many computers to use.

We cleared many issues encountered during the short period of system development time and came the launch in January, the initial checkout in April 2009.

The initial checkout and ensuing revision work



XCO_2 (Column averaged dry air mole fraction)
(uncalibrated data)

The first level 1 data were sent to GOSAT DHF from JAXA in April 2009. At first, we confirmed if each processing program worked as specified, and if not, the causes were analyzed for specification adjustment/confirmation with JAXA, program replacement, or parameter adjustment until all worked well. We were located downstream of the satellite, ground system, and JAXA, which means that our system was affected by those upstream ones and it took more than 1 month to get to generation of CO_2/ CH_4 concentration data after solving the incidental difference between real data and previous assumptions. After many repeated adjustments, data plotted on the map for 9 days of late April showed beautifully approximate compliance with existing ground-based observations, i.e., the concentration distribution was high in the Northern and low in the Southern hemisphere, though it was relatively lower as a whole. That was the moment when we believed in the capability of global observation by *IBUKI* (fig. above).

Level 2 data product was published in February 2010, about 1 year after the launch. The product repeated improvement and level 4 product was released to the general public in December 2012, which was the initially set goal of publishing flux estimate reached at last under 4 years' effort after starting observation.

Meanwhile, our system was being improved in general handling various issues as algorithm improvement, faster processing, etc. When the Great East Japan Earthquake attacked, all the system stopped due to interruption of electrical power supply at NIES and its complete recovery took 1 month confirming data corruption and data consistency. NIES supercomputer was stopped for a long time due to ensuing save power measures, which brought hastily arranged program importing task from the supercomputer to DHF.

The system improvement is going on

Now it's an age of shale gas which was known long time but thought to be unprofitable, however, it found its way to the business owing to recent technologies. The same thing may happen to GOSAT data: those data which were considered inadequate to analyze can be used for higher level data processing by technological progress such as algorithm upgrading or system revision. The system development team is always making steady effort for utilizing precious past data, improving yield ratio for coming observation data, eventually maximizing the outcome of GOSAT project, even at this point of time when more than 4 years have passed since the launch.

Engineers developing/maintaining GOSAT data processing system at NIES (front row from left, **Dr. Nobuta**, **Mr. Kawasaki**, **Mr. Ishihara**, **Ms. Nakamura**; back row from left, **Ms. Forsyth**, **Mr. Ishihama**, **Mr. Miyasaka**, **Mr. Ikegami**, **Mr. Kasai**, **Mr. Kojima**)

*1 Storage is an external device to keep data/program on the computer system. There are various types of them such as hard disk drive, magnetic tape, etc.

PUBLISHED PAPERS

Field of Research: carbon balance estimation, atmospheric transport models
Name of Journal: Geophysical Research Letters (Volume 40, pages 1252–1256, 2013)
Title: Error statistics of Bayesian CO_2 flux inversion schemes as seen from GOSAT
Authors: F. Chevallier, C. W. O'Dell

Field of Research: carbon balance estimation, atmospheric transport models
Name of Journal: Atmospheric Chemistry and Physics (Volume 13, pages 4349–4357, 2013)
Title: Towards constraints on fossil fuel emissions from total column carbon dioxide
Authors: G. Keppel-Aleks, P. O. Wennberg, C. W. O'Dell, D. Wunch

Field of Research: data application
Name of Journal: Proceedings of the Royal Society B (Volume 280, 20130171, 2013)
Title: Forest productivity and water stress in Amazonia: observations from GOSAT chlorophyll fluorescence
Authors: J.-E. Lee, C. Frankenberg, C. van der Tol, J. A. Berry, L. Guanter, C. K. Boyce, J. B. Fisher, E. Morrow, J. R. Worden, S. Asefi, G. Badgley, S. Saatch

Field of Research: data application
Name of Journal: Geophysical Research Letters (Volume 40, pages 2378–2383, 2013)
Title: Reduced carbon uptake during the 2010 Northern Hemisphere summer from GOSAT
Authors: S. Guerlet, S. Basu, A. Butz, M. Krol, P. Hahne, S. Houweling, O. P. Hasekamp, I. Aben

Field of Research: data processing algorithm, validation
Name of Journal: Atmospheric Measurement Techniques (Volume 6, pages 1533–1547, 2013)
Title: Improvement of the retrieval algorithm for GOSAT SWIR XCO_2 and XCH_4 and their validation using TCCON data
Authors: Y. Yoshida, N. Kikuchi, I. Morino, O. Uchino, S. Oshchepkov, A. Bril, T. Saeki, N. Schutgens, G. C. Toon, D. Wunch, C. M. Roehl, P. O. Wennberg, D. W. T. Griffith, N. M. Deutscher, T. Warneke, J. Notholt, J. Robinson, V. Sherlock, B. Connor, M. Rettinger, R. Sussmann, P. Ahonen, P. Heikkinen, E. Kyrö, J. Mendonca, K. Strong, F. Hase, S. Dohe, T. Yokota

Field of Research: carbon balance estimation, atmospheric transport models
Name of Journal: Atmospheric Chemistry and Physics (Volume 13, pages 5697–5713, 2013)
Title: Estimating regional methane surface fluxes: the relative importance of surface and GOSAT mole fraction measurements
Authors: A. Fraser, P. I. Palmer, L. Feng, H. Boesch, A. Cogan, R. Parker, E. J. Dlugokencky, P. J. Fraser, P. B. Krummel, R. L. Langenfelds, S. O'Doherty, R. G. Prinn, L. P. Steele, M. van der Schoot, R. F. Weiss

INTERVIEW

A Series: "IBUKI"'s PI Interview

No.9

Dr. Claude Camy-Peyret

CNRS Emeritus Scientist,
Co-chairman of IASI Sounding Science Working Group

Dr. Claude Camy-Peyret visited Japan this May to attend the 5th GOSAT RA PI Meeting and IWGGMS-9 as an RA PI. This interview was held at the opportunity, where he talked about his career as a researcher since his youth, contacts with Japan, his expectation on GOSAT, etc., looking back on his various activities in more than 40 years.

(Interviewer: T. Yokota, NIES GOSAT Project)

Yokota (hereafter **Y**): Thank you for coming here. Today I would like to ask you several questions. You are involved in many satellite projects, so at first, please tell us on your scientific background.

Claude Camy-Peyret (hereafter **C**): I was recruited by CNRS*1 in October 1970 and I started as a young researcher in a lab which was doing high resolution infrared spectroscopy, both on the experimental and the theoretical side. I quickly started my first analyses of Fourier transform spectra recorded with the high resolution spectrometers designed and built by P. Connes and his students. This was the time when the first interferograms*2 with more than 10^6 points where recorded and the FFT*3 algorithm was just being available. Magnetic tapes were used for storing the interferograms and we would wait six hours to get one spectrum from these 10^6 points. My first spectroscopic analysis was on a molecule called methyl iodide CH_3I. Then I switched quickly to the spectroscopy of water vapor (H_2O), and for a significant period of my research career I worked on the spectra of H_2O and its isotopes from the far infrared to the visible. I worked on high temperature flame spectra recorded by Fourier transform spectroscopy in emission, analyzing the highly excited vibrational and rotational states of H_2O. I became then a specialist of the theory of asymmetric rotors. H_2O is one of the best examples of this type of molecules called the XY_2 asymmetric tops*4: O_3, NO_2, H_2S and SO_2 are of this same type. I did a lot of work on the infrared spectra of all these species recording and assigning the spectra and performing the theoretical analysis.

Y: Is it the time when you have been involved in HITRAN*5 or GEISA*6?

C: Yes, in the early 1970s. It was the beginning of the HITRAN infrared spectroscopic database. In 1972, I visited AFCRL*7 (the name at this time; now AFGL*7) in Hanscom Field, Massachusetts, USA. It was later called AFGL and the first issue of the database was not disseminated publicly because of defense applications. It became openly available in 1974. I contributed to the production of improved or new line parameters for H_2O, O_3, NO_2, H_2S, SO_2... and I was later co-author of several papers describing the successive versions of HITRAN. The GEISA database came later in France for atmospheric and planetary applications.

Y: When I visited your office in Paris and I remember you had a big laboratory and also you had an instrument named LPMA*8. Could you tell us more on your work with Fourier transform instruments?

C: I was interested in the applications of molecular spectroscopy to atmospheric science because I realize quickly the importance of using the best line parameters

*1 CNRS (le Centre National de la Recherche Scientifique, French National Centre for Scientific Research in English) is the largest fundamental science agency in Europe.

*2 Interferogram is a pattern of light intensity obtained as a result of the following steps: i) split incident light into two beams using the beam splitter, ii) change one of the path lengths of the two split beams, and iii) merge the two beams by letting them interfere with each other.

*3 FFT (Fast Fourier Transformation) is a fast Fourier transform method to process digital signals on a computer, which is used to transform interferogram into spectra.

*4 XY_2 asymmetric tops means a molecule with the shape of inverted V, atom X on its top and 2 atoms Y at its feet. It has no symmetry around any of the 3 main rotational axes, from which the name came.

*5 HITRAN (HIgh resolution TRANsmission) is a database on absorption lines' locations, intensities, etc. of gas molecules, and developed by U.S. Air Force's laboratories since 1973. Its 2012 edition contains 7,400,447 absorption lines for 47 different gas molecules. Each datum includes transition wavenumber, line intensity, Lorentzian halfwidths, and lower-state energy etc.

*6 GEISA (Gestion et Etude des Informations Spectroscopiques Atmosphériques) is a database developed by CNRS, similar in kind as HITRAN above.

*7 AFCRL stands for Air Force Cambridge Research Laboratory, AFGL for Air Force Geophysics Laboratory, both of which are laboratories of the US Air Force.

*8 LPMA (Limb Profile Monitor of the Atmosphere) is a Fourier transform infrared spectrometer based on solar occultation technique*9.

*9 (see next page)

for atmospheric remote sensing. I went to Kitt Peak*10 in the 1980s and I was one of the early users of the Fourier transform spectrometer there, with which I performed the first measurements of NO_2 from the ground using the sun as the source during the day and using the moon as the source during the night. The infrared micro-window for NO_2 which is now used everywhere in the NDACC*11 network was first identified at that time. I managed to get my first Fourier transform instrument which was a Bomen DA2, and I began to use it for atmospheric applications. I then worked part time in the lab and part time doing field measurements. My growing interest in atmospheric measurements started with NO_2 in that case, but I realized that it would be interesting to fly my instrument under a balloon. My first balloon instrument was called LPMA for Limb Profile Monitoring of the Atmosphere. This solar occultation Fourier transform instrument was collecting the infrared radiation with a sun-tracker or heliostat (in French) from a stratospheric gondola with azimuth control, thus producing vertical profiles of atmospheric constituents. At that time, I was doing in parallel the preparation of the campaigns, the balloon measurements and the analysis of the spectra. I was quickly involved in the early polar ozone projects in Europe, since we had a very strong stratospheric ozone program in the beginning of the 90s.

Y: Was this your first relation with the Japanese programme?

C: When I began the cooperation with Japan, I was trying to do not only solar absorption spectroscopy but also thermal emission nadir sounding. I was involved in 1989 in the early proposal of IASI*12, which was discussed during the "Colloque de prospective du CNES*13". This is held every 4 years, and the French space agency is inviting scientists and engineers to propose and examine future space missions. It was the time when the idea of an infrared medium resolution Fourier transform spectrometer was proposed for measuring temperature and water vapor profiles (but also ozone and other trace gases). In fact the project really started in 1996, and I have been involved since that time with the IASI project as chairman of what we call the ISSWG, the IASI Sounding Science Working Group. This materialized with the launch of the IASI instrument ten years later in 2006. Being involved in the early IASI, I heard about the Japanese experiment IMG*14 of Professor Haruhisa Shimoda who was also proposing this type of instrument and I contacted him at that time to check if we could detect HNO_3, in the IMG spectra, a weak feature around 12 μm partially covered by a strong water vapor line.

Y: And with the ADEOS*15 project which started from 1982…

C: Yes, I was working on the IMG data with Sébastien Payan, my student at that time. With my links with Japanese scientists and with my own solar occultation instrument, I decided to contact Sasano-san, the PI of the ILAS*16 project, and I prepared with him and more specifically with Hiroshi Kanzawa, the validation campaign for ILAS and for ILAS-II*16. We did two balloon campaigns for these two missions, and it's a pity that ILAS-II on ADEOS-II*15 did not last long. But we did interesting balloon measurements from Esrange/Kiruna in Northern Sweden, and we produced good validation papers.

Y: And I heard from Prof. Kanzawa of Nagoya University that you two were leading the team campaign.

C: Yes, we were campaign leaders and responsible to organize the balloon flights and to optimize measurements during the over paths of ADEOS and later ADEOS-II. Then I became more and more involved in the thermal infrared nadir looking spectra, and I changed the LPMA instrument into what we called IASI-balloon. The IASI program was going well, so we were able to get spectra in the same type of geometry and with a resolution similar to what IASI would achieve later. The first flight of IASI-balloon was from Kiruna in 2001 and at that time I was working on the retrieval of H_2O, CH_4, CO and N_2O. In 1996 I became director of LPMAA*17, the lab called "Laboratoire de

*9 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.

*10 The Kitt Peak National Observatory (KPNO) is a US astronomical observatory site located on Kitt Peak of the Quinlan Mountains, Arizona.

*11 NDACC (Network for the Detection of Atmospheric Composition Change) is a global network of 70 or more sites to observe atmospheric composition of stratosphere and upper troposphere.

*12 IASI (Infrared Atmospheric Sounding Interferometer) is a sensor mounted on the European meteorological satellites MetOp to measure infrared radiation from the ground surface to acquire humidity-, temperature distribution at troposphere/lower stratosphere, and chemical component data which are important for climate monitoring, global change, and atmospheric chemistry. The first model was launched on-board MetOp-A in October 2006.

*13 CNES (Centre National d'Etudes Spatiales, National Centre for Space Studies in English) is the French government space agency established in 1961.

*14 IMG (Interferometric Monitor for Greenhouse Gases) is a Fourier transform spectrometer to observe infrared spectra, mounted on ADEOS for the purpose of greenhouse gas observation.

*15 ADEOS/ADEOS-II (ADvanced Earth Observing Satellite) are Japanese satellites with the objective to acquire data of global environmental changes such as the greenhouse effect, ozone layer depletion, tropical rain deforestation, and abnormal climatic conditions, launched in 1996/2002. Nicknames are *MIDORI* / *MIDORI-II*.

*16 ILAS/ILAS-II (Improved Limb Atmospheric Spectrometer) are Japan's first atmospheric observing sensors to monitor and research the ozone layer in the polar stratosphere developed by Ministry of the Environment of Japan. They were installed on ADEOS (*MIDORI*) / ADEOS-II (*MIDORI-II*).

*17 LPMAA (Laboratoire de Physique Moléculaire pour l'Atmosphère et l'Astrophysique, Molecular Physics Laboratory for the Atmosphere and Astrophysics in English) is a joint laboratory of Pierre-and-Marie-Curie University and CNRS.

Physique Moléculaire pour l'Atmosphère et l'Astrophysique". I spent 12 years from 1996 to 2008 as director of this laboratory, and even in this position I was still enjoying balloon campaigns and participating in some of the laboratory experiments using infrared diode lasers for line shape studies including non-Voigt profiles.

Y: All of them were studies for IASI?

C: Not only! For example, with my LPMA instrument, and in relation with ILAS, which had a 765 nm molecular oxygen channel, I did one balloon flight covering this O_2 A-band and I published one paper on O_2 and the $^{18}O^{16}O$ isotope. We showed that there was a disagreement in the positions of the weak lines. I was then involved in GOSAT. I had been in contact with you, Yokota-san, for ILAS and I was interested in GOSAT because it was focused on greenhouse gases. I was wanting to look not only in the thermal infrared for temperature sounding using the CO_2 lines, but also trying to get the amount of CO_2 in the atmosphere using the short wave infrared. So with my balloon team and support from CNES, we had 2 other balloon campaigns from Kiruna in the configuration called "SWIR-balloon".

Y: You are one of these GOSAT RA PIs.

C: When there was the first research announcement for GOSAT, I put forward a proposal to JAXA/NIES with Sébastien Payan and with other partners from NOVELTIS*18 with whom I am working. I am working in close cooperation with them and with CNES, within the MicroCarb*19 project. As a scientist I am advising them and helping to support retrieval algorithms for this new proposed satellite mission for measuring CO_2 from space. And this is directly related to the retrieval of GOSAT spectra. Also we want to use the GOSAT data to prepare the operation chain for MicroCarb.

Y: What do you think about the present GOSAT status?

C: I think it's a very successful mission and it's the first one really measuring CO_2, (in addition to CH_4). So the GOSAT status is extremely good. It's also the first mission which has demonstrated the use of the high resolution oxygen A-band for aerosols and that's quite useful, because this is constraining the air mass factor*20. Even though we "see" the column of CO_2, we don't really capture the full column because scattering effects are slightly modifying the effective optical path in the atmosphere. The aerosol effect must be modeled and one should continue to make progress in using at best the combination of TANSO-FTS SWIR bands. GOSAT is providing high quality data and improvements have been made on several problems that have been corrected (like the non-linearity in TANSO-FTS band 1). Other smaller effects can be corrected. I would like to continue to have access to these spectra to check their quality and how it varies in time (or not). I am also interested in the solar spectra which are recorded through the diffuser plate of TANSO-FTS.

Y: OK. So what is the expectation or recommendation on the future of GOSAT and GOSAT-2?

C: I wish that GOSAT will operate long enough and I hope that the quality of GOSAT spectra and products will still improve. I strongly recommend that efforts are made to improve the quality of the level 1B product. Now we have GOSAT-2 in mind, and I think it's a good idea to add CO at 2.3 μm, for correlating anthropogenic and natural sources of CO and CO_2. Even though I mentioned above my interest in NO_2, other sensors are measuring NO_2 like OMI*21, and TROPOMI*22 and Sentinel-5*23. I would then say it's more interesting to put the efforts in improving the quality of the TIR data (I insist in maintaining the TIR channel, but you could reduce the band width because you don't need to cover the full TIR and we know that the noise of GOSAT above 1400 cm^{-1} is increasing). So we could reduce the band pass, just covering the region between 700 cm^{-1} to 1400 cm^{-1}. That would be sufficient in the TIR for CO_2, O_3, CH_4, and N_2O (all greenhouse gases). The spectral resolution is good enough, but with a better radiometric quality in the TIR, one could really perform synergistic TIR-SWIR measurements, because if you have 2 identical footprints, one can do level 1-level 1 retrievals since one see the same surface on the ground.

Y: OK. Thank you for your time.

*18 NOVELTIS is a French private company developing technologies in the field of space-borne Earth Observation.

*19 MicroCarb is a French GHG observing satellite launching in 2018.

*20 Air mass factor is the value of observation optical path length divided by the vertical length from the atmospheric top to the ground. The optical path length varies when scattered by aerosol.

*21 OMI (Ozone Monitoring Instrument) is an ozone observing sensor mounted on the satellite Aura of NASA.

*22 TROPOMI (TROPOspheric Monitoring Instrument) is a Dutch imaging spectrometer under development to observe O_3, CH_4, CO_2 using spectra from UV to SWIR to be launched on-board Sentinel-5 Precursor in 2014.

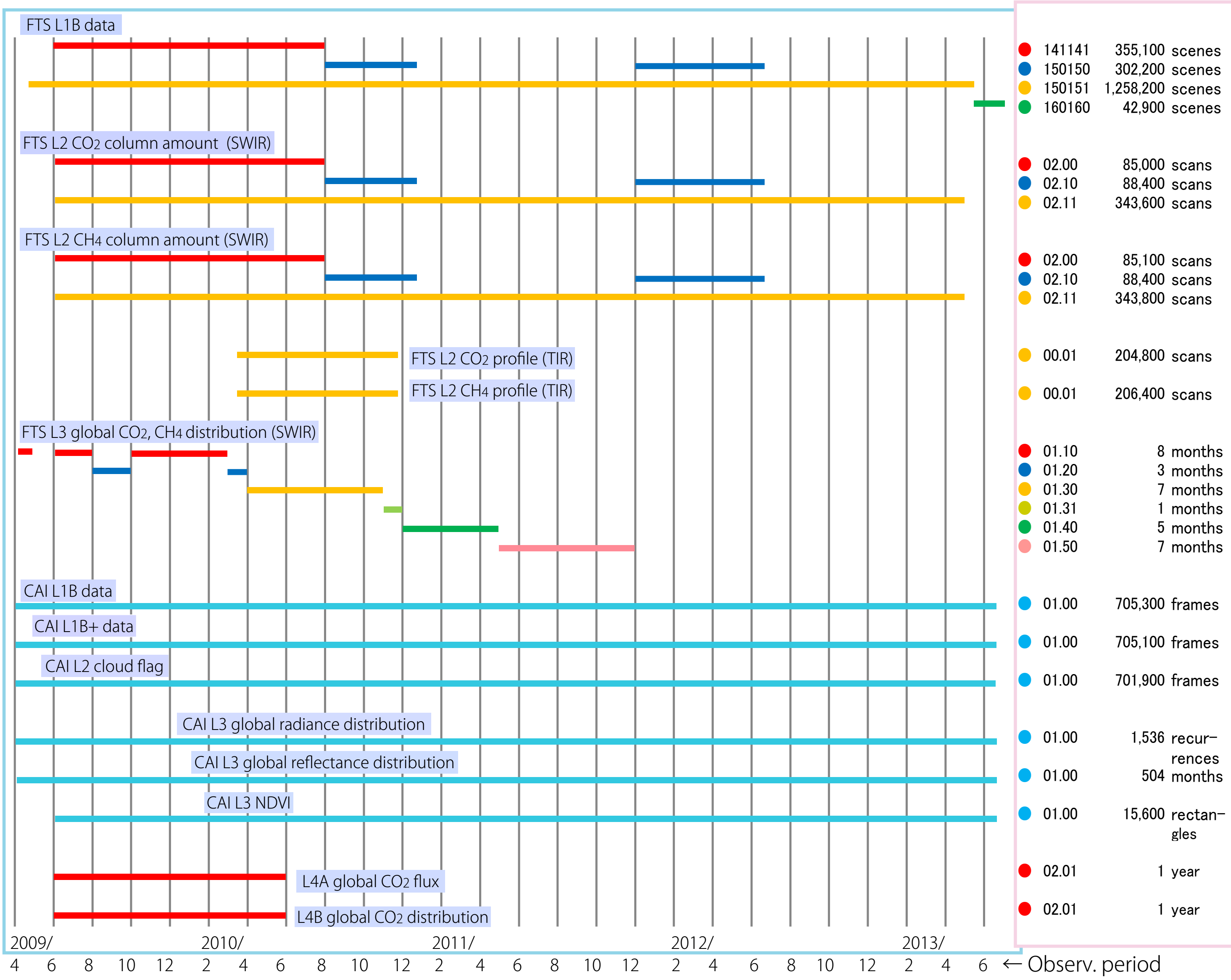
*23 Sentinel-5 is a satellite to observe atmospheric components to be launched in 2020 as part of Sentinel project by ESA aiming at multi-satellite observation of land, ocean, and atmosphere.

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 July 4, 2013



The chart above is as of July 4, 2013. The latest processed and released on are: FTS L1B in upgraded V160.160 (for more detail, please refer to Descriptions of TANSO-FTS Level 1B Product Updates (V160.160) on GUIG; CAI L1B/L1B+/L2 cloud flag/L3 global radiance and reflectance distribution, and NDVI in V01.00. The version names of FTS L2 CO_2/CH_4 column amount (SWIR) will be changed into V02.20 according to the FTS L1B upgrade.

Reprocessing of all past data has been completed for FTS SWIR L2 V02.11, CAI L3 global radiance distribution V01.00, and FTS field-of-view image.

Data provision ended for old versions of FTS L1B data: V050.050 - V130.130, CAI L3 global radiance distribution: V00.50 - V00.92, CAI L3 global reflectance distribution: V00.91 - V00.92.

The number of registered users is 1494 as of July 4, 2013.

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