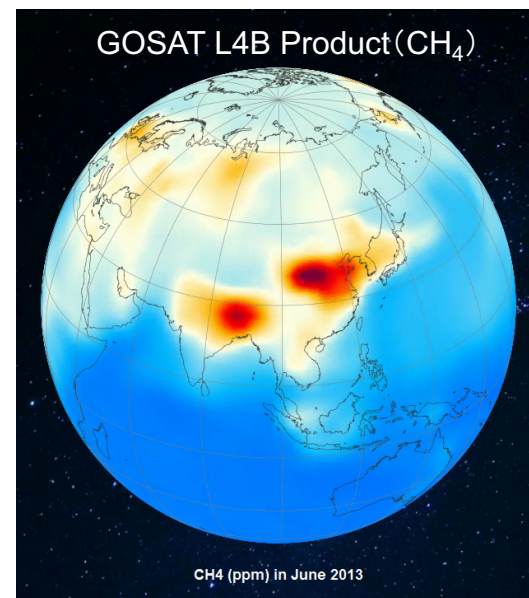
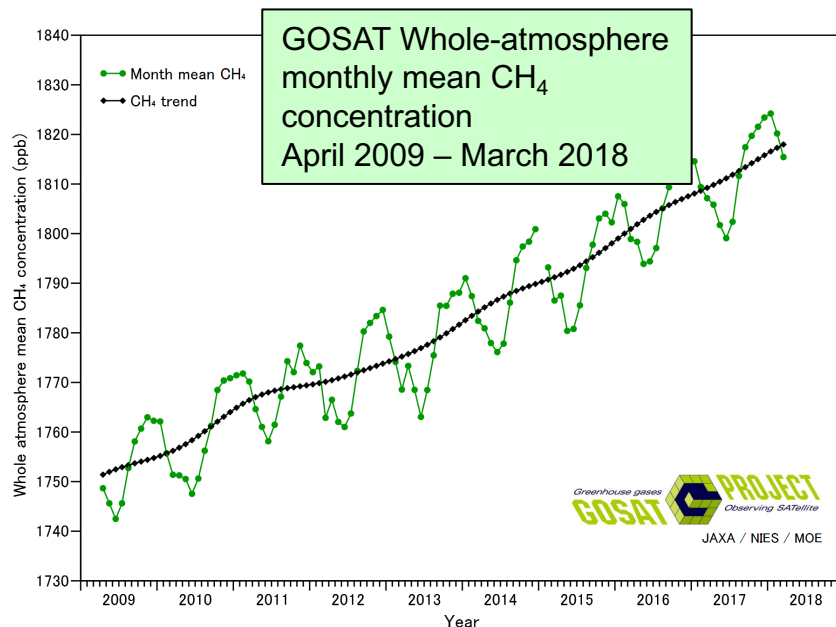


# Recent Progress of GOSAT Project and Preparation for GOSAT-2 at National Institute for Environmental Studies

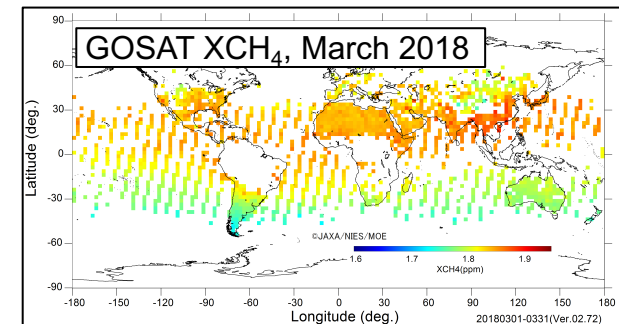
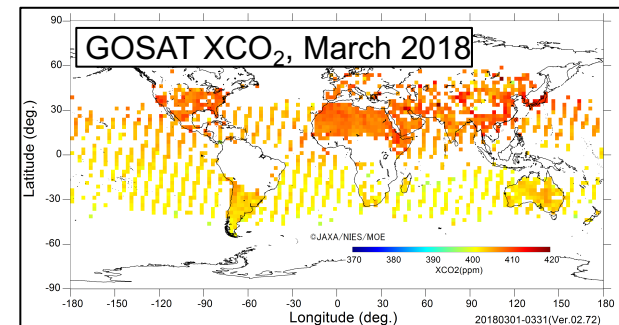


Tsuneo Matsunaga, Akihide Kamei, Shamil Maksyutov, Isamu Morino,  
Yukio Yoshida, Makaoto Saito,  
Hibiki Noda, Hirofumi Oyama, Fumie Kawazoe,  
Yukio Terao, **and Osamu Uchino**

# GOSAT Product Distribution from GDAS

[https://data2.gosat.nies.go.jp/index\\_en.html](https://data2.gosat.nies.go.jp/index_en.html)

- FTS Level 1B Spectral Radiance Product
  - V210.210 April 2009 – Present  
(except Jan. 2012 – Mar. 2018)
  - V205.205 April 2009 – January 2018
  
- FTS SWIR Level 2 Gas Column Amount  
(CO<sub>2</sub>, CH<sub>4</sub>, H<sub>2</sub>O)
  - V02.72 April 2009 – March 2018  
Generated from L1B V210  
Public release in Fall, 2018?
  - V02.8X
  - Bias-corrected L2 products
    - V02.45/46 February 2015 – August 2015
    - V02.35/36 June 2014 – December 2014
    - V02.25/26 April 2009 – May 2014
    - V02.75 (in preparation)
  
- Level 4 Global Flux and Concentration
  - CO<sub>2</sub>, V02.05 June 2009 – October 2015
  - CH<sub>4</sub>, V01.03 June 2009 – September 2013



# Release of GOSAT FTS SWIR Level 2 Product V02.72 (December 2017)

- Changes of source products and other input data
  - FTS Level 1B V161.160/V161.161 => V201.202
  - CAI Level 1B V01.00 => V02.00
  - CAI Level 2 Cloud Flag V01.00 => V02.00
  - Instrument Line Shape Function => ILSF2015
  
- Changes in preprocessing
  - Observation Time Correction
  - Observation Position Correction
  - Degradation Correction (update of the correction factors)
  - Polarization Synthesis Process
  
- Changes in data screening
  - L1 Quality Evaluation
  - CAI Cloud Determination
  - CAI Coherent Test
  - Land/Sea Mask Revision
  
- See

[https://data2.gosat.nies.go.jp/doc/documents/ReleaseNote\\_FTSSWIRL](https://data2.gosat.nies.go.jp/doc/documents/ReleaseNote_FTSSWIRL)

2 V02.72 en.pdf for more details.

# TCCON Validation Summary of GOSAT FTS SWIR Level 2 V02.72 Product

- GOSAT – TCCON Match-up
  - $\pm 30$  minute and  $\pm 2$  degree (latitude and longitude)
  - $\approx 25$  TCCON sites, April 2009 – August 2017
  - XCO<sub>2</sub>, N  $\approx 5835$  (Land, H), 791 (Land, M), 65 (Ocean, H)
- The GOSAT Level 2 XCO<sub>2</sub> data is **lower** than the TCCON data by  $\sim 0.10$  % (**0.38 ppm**) and the standard deviation of the Level 2 XCO<sub>2</sub> data is  $\sim 0.55$  % (**2.2 ppm**).
- The GOSAT Level 2 XCH<sub>4</sub> data is **lower** than the TCCON data by  $\sim 0.19$  % (**3.4 ppb**) and the standard deviation of the Level 2 XCH<sub>4</sub> data is  $\sim 0.72$  % (**13.0 ppb**).
- The GOSAT Level 2 XH<sub>2</sub>O data is **lower** than the TCCON data by  $\sim 2.5$  % (**98 ppm**) and the standard deviation of the Level 2 XH<sub>2</sub>O data is  $\sim 20.8$  % (**418 ppm**).

by Osamu Uchino, NIES

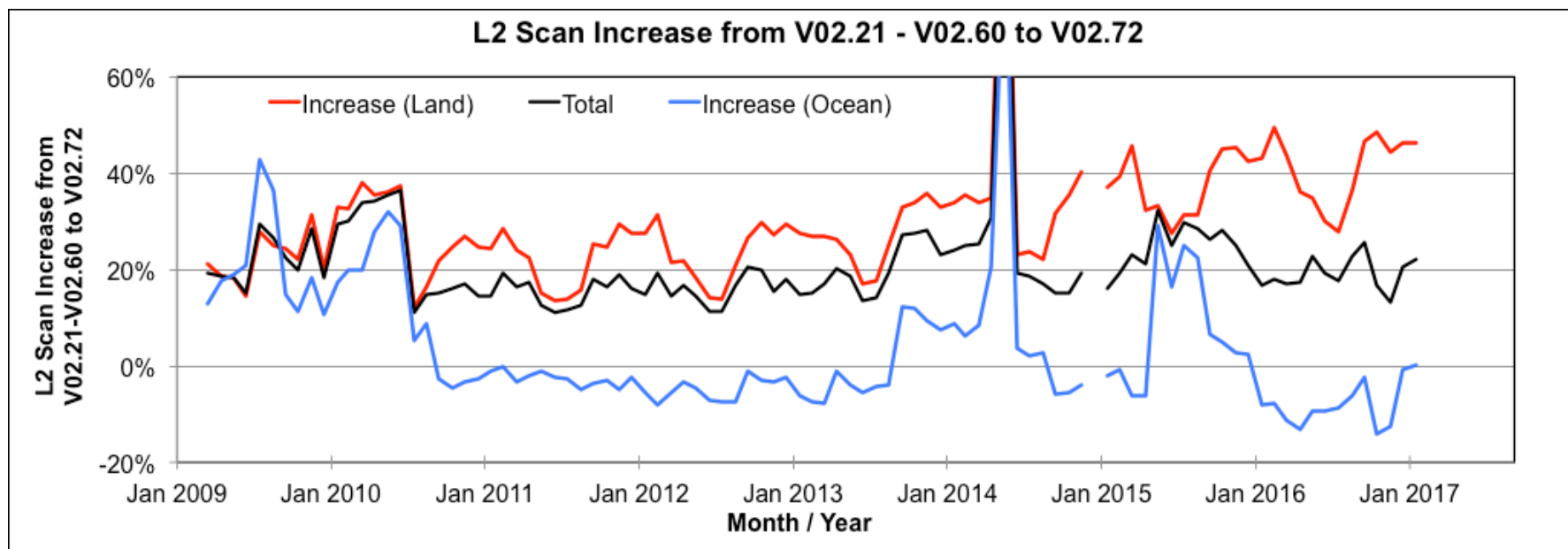
Details will be presented at 10<sup>th</sup> GOSAT RA PI Mtg on Friday.

Also see [https://data2.gosat.nies.go.jp/doc/documents/ValidationResult\\_FTSSWIRL2\\_V02.72\\_GU\\_en.pdf](https://data2.gosat.nies.go.jp/doc/documents/ValidationResult_FTSSWIRL2_V02.72_GU_en.pdf)



# FTS SWIR L2 Scan Increase from V02.21 - V02.60 to V02.72

Period	Increase (Land)	Increase (Land, H)	Increase (Land, M)	Increase (Ocean)	Total
2009-2017	28%	30%	23%	1%	20%
2009	23%	23%	22%	20%	22%
2010	26%	28%	22%	7%	22%
2011	21%	23%	16%	-3%	15%
2012	22%	23%	19%	-4%	16%
2013	26%	28%	20%	0%	20%
2014	36%	39%	27%	6%	26%
2015	36%	38%	31%	7%	25%
2016	39%	42%	31%	-8%	19%



# Release of Bias Corrected FTS SWIR L2 Product (October 2017)

- Empirical bias correction equations are applied to GOSAT FTS SWIR L2 V02.21 – V02.40 (April 2009 – August 2015)
  - Biases are estimated by linear combinations of AOT,  $\Delta P_s$ , Albedo at  $O_2$  band obtained by FTS SWIR L2 processing and Airmass.
  - Coefficients in linear equations are determined by regression of TCCON and GOSAT data.

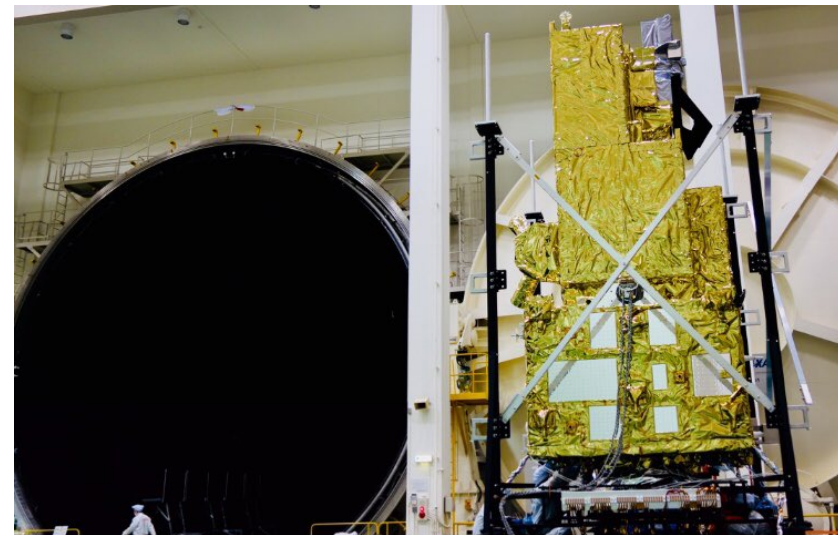
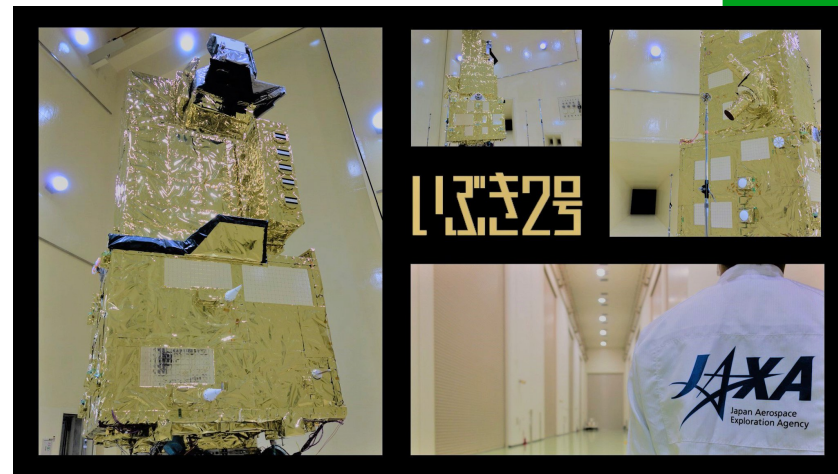
$$XCO_2^{\text{Bias-corrected}} = XCO_2 + C_1(AOT - \overline{AOT}) + C_2(\Delta P_S - \overline{\Delta P_S}) + C_3(\text{Airmass} - \overline{\text{Airmass}}) + C_4(\text{Albedo}_{O_2} - \overline{\text{Albedo}_{O_2}}) + C_5$$

$$XCH_4^{\text{Bias-corrected}} = XCH_4 + C_1(AOT - \overline{AOT}) + C_2$$

- Difference between TCCON and GOSAT ( $\approx$  Bias) are substantially reduced.  $XCO_2$  SD of differences are also reduced (10 ~ 20 %).
  - $XCO_2$ , Land :            -1.5 ~ -0.8 ppm    => -0.1 ~ 0.0 ppm
  - $XCO_2$ , Ocean :           -2.2 ~ -1.8 ppm   => 0.0 ppm
  - $XCH_4$ , Land :            -9 ~ -6 ppb        => -0.4 ~ -0.3 ppb
  - $XCH_4$ , Ocean :            1 ~ 4 ppb           => 0.0 ppb
- See [https://data2.gosat.nies.go.jp/doc/documents/ReleaseNote\\_FTSSWIRL2\\_V02.x5-V02.x6\\_en.pdf](https://data2.gosat.nies.go.jp/doc/documents/ReleaseNote_FTSSWIRL2_V02.x5-V02.x6_en.pdf)

# Status of GOSAT-2 Project

- GOSAT-2 is now being assembled and tested at JAXA Tsukuba Space Center.
- Ground data systems for GOSAT-2 at JAXA and NIES are being developed and tested.
- Japanese version of “GOSAT Data Policy” was simplified / modified to cover GOSAT-2. English version is almost completed.
- GOSAT-2 will be launched by H-IIA rocket from JAXA Tanegashima Space Center in FY2018.



[https://twitter.com/ibuki2\\_jaxa](https://twitter.com/ibuki2_jaxa)

# GOSAT-2 Product List (Level 1 and CAI-2 Level 2)

Level	Sensor	Product Name	Main Contents	Category	Unit	Format
L1A	CAI-2	TANSO-CAI-2 L1A Product	Uncorrected digital value	Internal	CAI-2 scene	HDF5
	FTS-2	TANSO-FTS-2 L1A Product	Interferogram	Internal	FTS-2 scene	HDF5
L1B	CAI-2	GOSAT-2 TANSO-CAI-2 L1B Product	Radiance	Standard	CAI-2 frame	HDF5
	FTS-2	TANSO-FTS-2 L1B Product	SWIR/TIR common information and FOV monitor camera image	Internal	FTS-2 scene	HDF5
			SWIR spectra before radiance conversion ( $V/cm^{-1}$ ) SWIR spectra after radiance conversion ( $W/cm^2/str/cm^{-1}$ )	Standard	FTS-2 scene	HDF5
			TIR spectra after radiance conversion ( $W/cm^2/str/cm^{-1}$ ) TIR spectra after radiance conversion and finite IFOV correction ( $W/cm^2/str/cm^{-1}$ )	Standard	FTS-2 scene	HDF5
L2	CAI-2	GOSAT-2 TANSO-CAI-2 L2 Cloud Discrimination Product	Integrated clear-sky confidence level, cloud status bit data	Standard	CAI-2 frame	HDF5
		GOSAT-2 TANSO-CAI-2 L2 Aerosol Property Product	Aerosol optical thickness, soot volume fraction, Ångström exponent, PM2.5	Standard	CAI-2 frame	HDF5

Products for calibration are not included.

# GOSAT-2 Product List (FTS-2 Level 2 and Level 4)

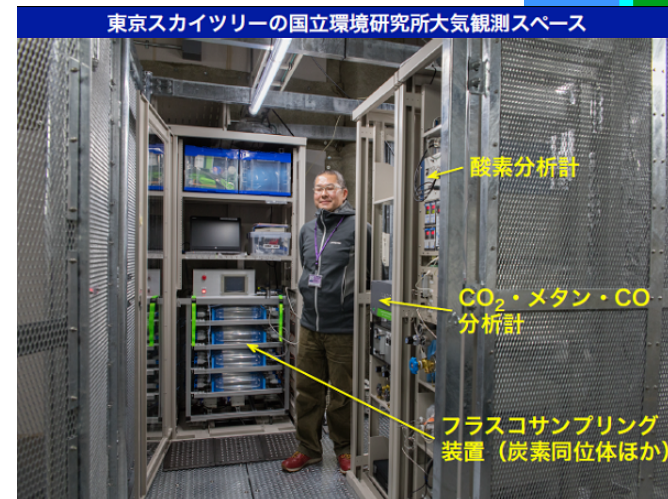
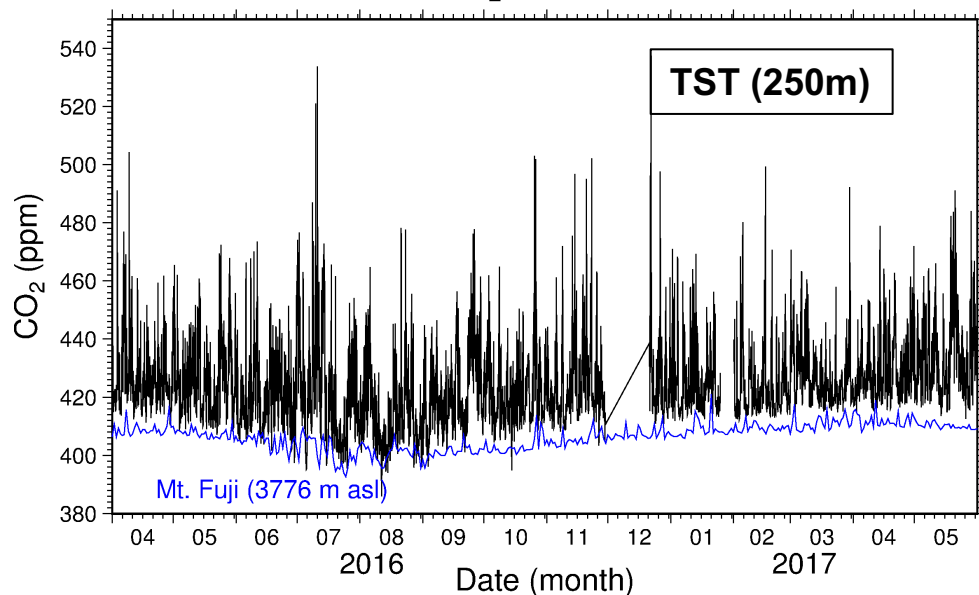
Level	Sensor	Product Name	Main Contents	Category	Unit	Format
L2	FTS-2 SWIR	GOSAT-2 TANSO-FTS-2 SWIR L2 Chlorophyll Fluorescence and Proxy-method Product	Solar Induced chlorophyll fluorescence, XCH <sub>4</sub> <sup>*</sup> , XCO <sup>*</sup> <sup>*</sup> By proxy method	Standard	Daily	HDF5
		GOSAT-2 TANSO-FTS-2 SWIR L2 Column-averaged Dry-air Mole Fraction Product	XCO <sub>2</sub> <sup>**</sup> , XCH <sub>4</sub> <sup>**</sup> , XCO <sup>**</sup> , XH <sub>2</sub> O <sup>**</sup> <sup>**</sup> By full-physics method	Standard	Daily	HDF5
	FTS-2 TIR	GOSAT-2 TANSO-FTS-2 TIR L2 Cloud and Aerosol Property Product	Cloud flags (by each method), optical thickness, cloud particle type	Standard	Daily	HDF5
		GOSAT-2 TANSO-FTS-2 TIR L2 Temperature and Gas Profile Product	Vertical profiles of temperature, CO <sub>2</sub> , CH <sub>4</sub> , and H <sub>2</sub> O	Standard	Daily	HDF5
		GOSAT-2 TANSO-FTS-2 TIR L2 Temperature and Gas Profile Research Product	Vertical profiles of temperature, CO <sub>2</sub> , CH <sub>4</sub> , H <sub>2</sub> O, O <sub>2</sub> , and N <sub>2</sub> O	Research	Daily	HDF5
L4		GOSAT-2 L4A Global CO <sub>2</sub> Flux Product	CO <sub>2</sub> surface flux	Standard	TBD	TBD
		GOSAT-2 L4A Global CH <sub>4</sub> Flux Product	CH <sub>4</sub> surface flux	Standard	TBD	TBD
		GOSAT-2 L4B Global CO <sub>2</sub> Distribution Product	Vertical profile of CO <sub>2</sub> concentrations	Standard	TBD	TBD
		GOSAT-2 L4B Global CH <sub>4</sub> Distribution Product	Vertical profile of CH <sub>4</sub> concentrations	Standard	TBD	TBD



# Atmospheric Measurements at Tokyo Skytree (TST) for GOSAT-2 Validation



TST CO<sub>2</sub> (1-hr average)



- Licor Li-840A / PICARRO G2401 for continuous in-situ measurements of CO<sub>2</sub>, CH<sub>4</sub>, and CO concentrations (March 2016/January 2017)
- Oxizilla for continuous in-situ measurements of O<sub>2</sub> concentrations (February 2017)
- Air samplings using 2.5L since July 2016 for concentrations of CO<sub>2</sub> (NDIR), CH<sub>4</sub> and CO (GC-FID), N<sub>2</sub>O and SF<sub>6</sub> (GC-ECD), <sup>13</sup>CO<sub>2</sub> (MAT-252 and 253), and <sup>14</sup>CO<sub>2</sub> (NIES-CAMS).

(Terao et al., GGMT, 2017)

(Press release in July 2017)



# Agreements among NIES, JAXA, ESA, CNES, and DLR (Dec. 2017)



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Press Release  
December 13th, 2017

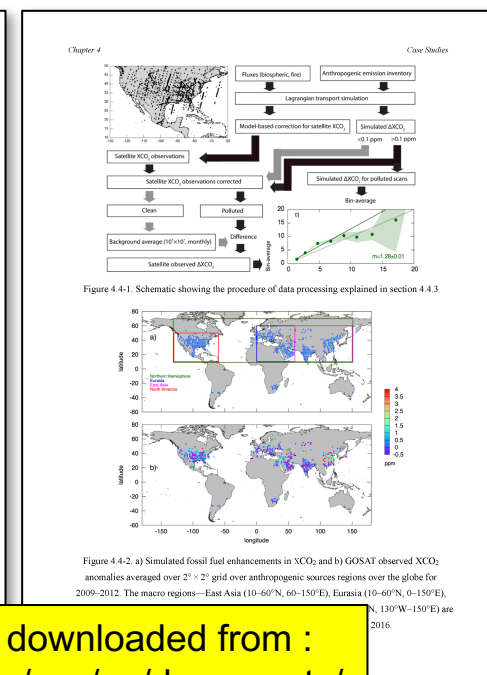
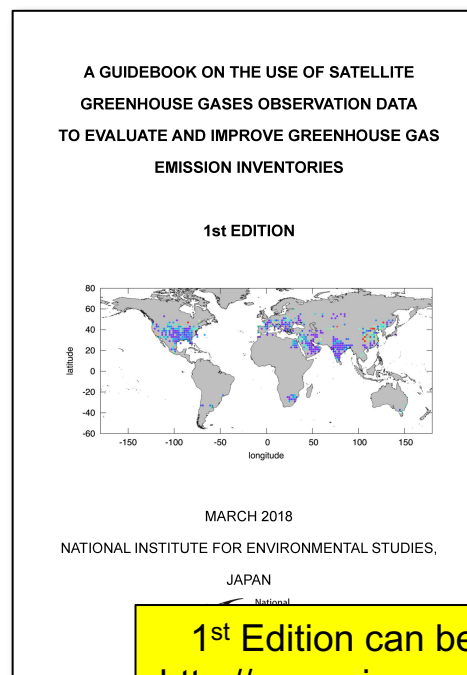
National Research and Development Agency, Japan Aerospace Exploration Agency  
National Research and Development Agency, National Institute for Environmental Studies

**Agreements signed with the European Space Agency (ESA), the Centre National d'Etudes Spatiales (CNES), and the German Aerospace Center (German: Deutsches Zentrum für Luft und Raumfahrt, abbreviated DLR) concerning the Cooperation in the Remote Sensing of Greenhouse Gases and Related Missions**



# About Guidebook

- ✓ To promote the use of satellite GHG data and contribute to **2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.**
- ✓ Schedule
  - Draft edition = Oct. 2017
  - Open review = Nov. 2017 - Feb. 2018
  - 2<sup>nd</sup> Expert Mtg = Feb. 2018
  - 1<sup>st</sup> edition = Mar. 2018
  - WGIA, India = July, 2018
- ✓ New guidebook title : “Guidebook on the Use of Satellite Greenhouse Gases Observation Data to Evaluate and Improve Greenhouse Gas Emission Inventories”



1<sup>st</sup> Edition can be downloaded from :  
<http://www.nies.go.jp/soc/en/documents/>

# IWGGMS-14 Poster Presentations

## by NIES GOSAT/GOSAT-2 Project Members

- (A2.8) **H. Ohyama**,  
Toward improvement of the retrieval algorithm for GOSAT TANSO-FTS SWIR
- (A3.1) **I. Morino**  
Philippines TCCON Project: Result on One-year Measurements and Future
- (B2.2) **Y. Yoshida**  
Progress status of the GOSAT and GOSAT-2 SWIR L2 retrievals
- (B5.8) **T. Saeki**  
Implications of Overestimated Anthropogenic CO<sub>2</sub> Emissions on East Asian and Global Land CO<sub>2</sub> Flux Inversions
- (B5.9) **H. Oshio**  
Radiance offset correction for observing SIF from GOSAT and inter-satellite comparison of the derived SIF
- (B5.10) **H. M. Noda**  
Seasonal changes in SIF in a warm-temperate evergreen coniferous forest in Japan
- (C5.7) **A. Tsuruta**  
Towards global and regional methane budgets estimated by high spatial resolution atmospheric inverse model with GOSAT retrievals

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# Thank you for your attention.

## Contact

matsunag@nies.go.jp, soc-info@nies.go.jp

## Website

<http://www.nies.go.jp/soc/en/>

<http://www.gosat.nies.go.jp/en/>

<http://www.gosat-2.nies.go.jp>

GOSAT standard products are freely available from

**GOSAT Data Archive Service**

<https://data2.gosat.nies.go.jp>