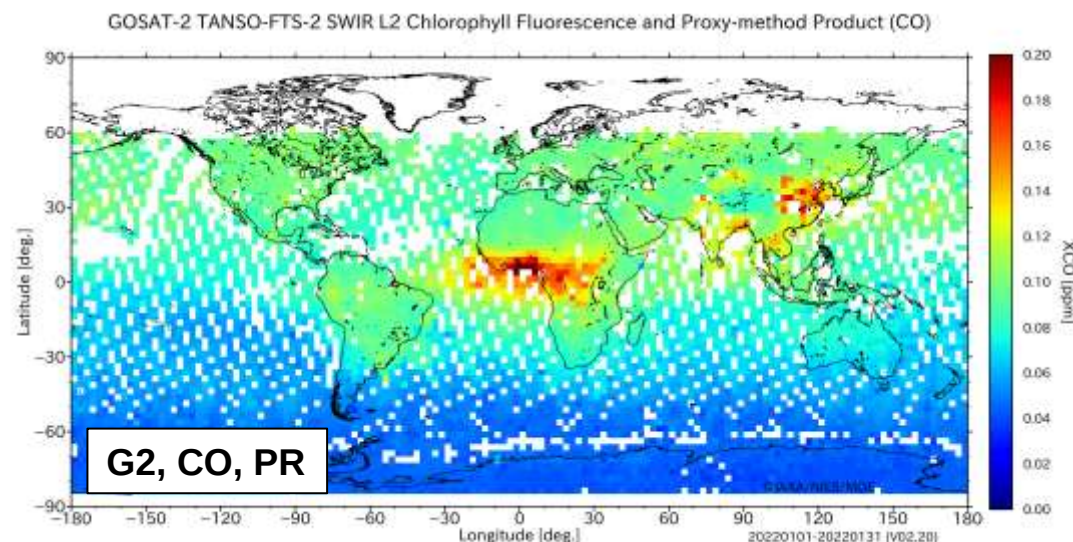
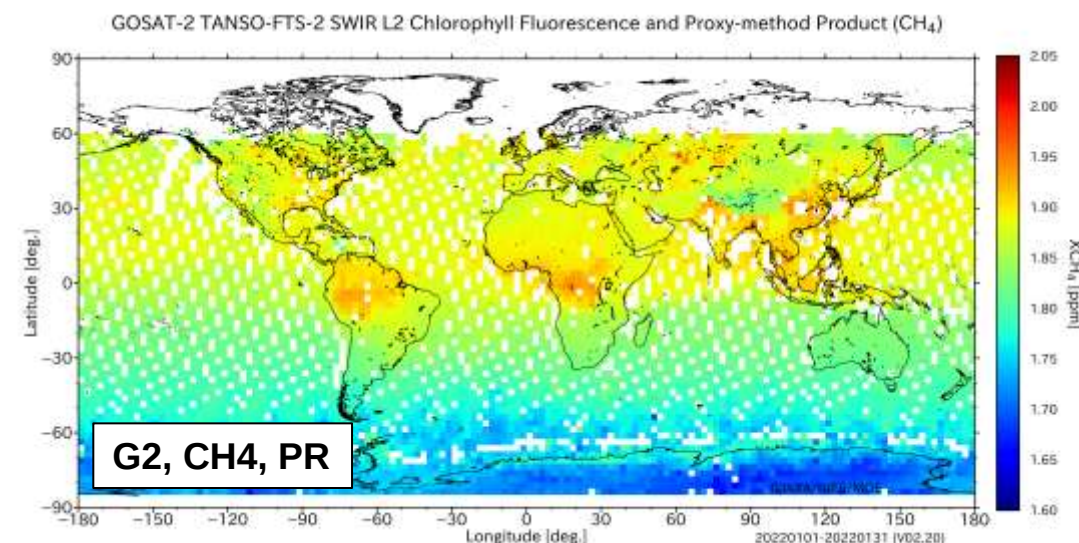
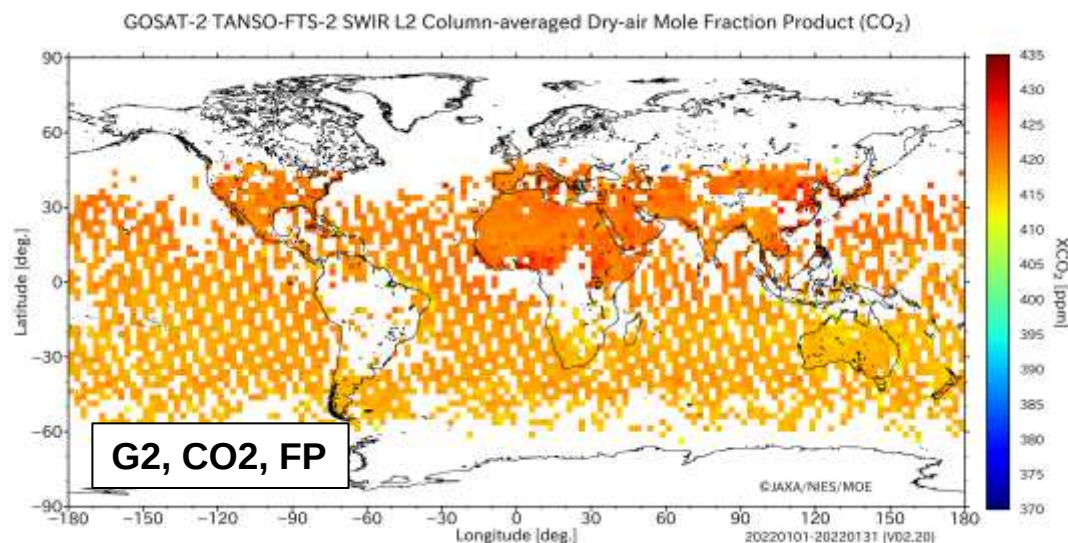


IWGGMS-21 Session 1: Status and results from current missions

Status of NIES GOSAT and GOSAT-2 Projects (Tsuneo Matsunaga, NIES)



GOSAT-2 XCO₂, XCH₄,
and XCO maps
(V02.20) from January
2022 to December 2023

Status of NIES GOSAT and GOSAT-2 Projects



Tsuneo Matsunaga, Isamu Morino, Yukio Yoshida, Makoto Saito, Hibiki Noda, Hirofumi Ohyama, Yu Someya, Tazu Saeki, Yosuke Niwa, Hiroshi Tanimoto, Akihide Kamei, Fumie Kawazoe, Yukitomo Tsutsumi, Jiye Zeng, Shamil Maksyutov, Rajesh Janardanan, Fenjuan Wang, and Lorna Nayagam

Satellite Observation Center
National Institute for Environmental Studies

IWGGMS-21 Presentations from NIES (1/3)

Oral (10)

Day 1, Session 1: Status and results from current missions / Session 2: Status and plans of future missions

Matsunaga, Status of NIES GOSAT and GOSAT-2 Projects

Tanimoto, The greenhouse gas observation mission with Global Observing SATellite for Greenhouse gases and Water cycle (GOSAT-GW): Updates

Yashiro, Interface with users of GOSAT-GW TANSO-3 observation: observation requests, product downloads, and acquisition of information

Day 2, Session 4: Calibration and validation

Morino, Status and upcoming plans of ground-based FTS measurements for evaluating space-based greenhouse gas measurements and carbon cycle studies at the National Institute for Environmental Studies

Day 3, Session 5: Global to regional flux estimates and validation

Niwa, Inverse analysis with in-situ/flask and GOSAT observations to disentangle regional and sectoral emission contributions to the surge of atmospheric CH₄ for 2020-2022

Day 3, Session 8: Stakeholder needs and engagement

Tanimoto, Development of the Japan Greenhouse Gas Center and its stakeholder engagement

IWGGMS-21 Presentations from NIES (2/3)

Oral (10)

Day 3, Session 5: Global to regional flux estimates and validation

Maksyutov, Regional carbon sink estimates by NTFVAR inverse model with surface and satellite observations

Maity, Investigating anomalous growth of atmospheric CO₂ in 2023-2024 using GOSAT XCO₂-constrained inverse modeling

Day 4, Session 5: Global to regional flux estimates and validation

Wang, Methane Budgets of East, Southeast and South Asia (2010-2021): An Inversion Inter-Comparison for Asia (MICA)

Day 4, Session 7: Multi-species observations/modeling and GHG-AQ synergy

Mueller, Towards shipborne emission monitoring and satellite validation of CO₂, CH₄, CO, and NO₂ through simultaneous columnar and in situ observations

IWGGMS-21 Presentations from NIES (3/3)

Poster (12)

Day 1:

Yoshida, Latest topics about the GOSAT-2 SWIR L2 products

Ohyama, Validation plan for GOSAT-GW TANSO-3 Level 2 products

Tsusumi, Validation of the latest GOSAT series L2 products

Janardanan, Localized CO₂ enhancements observed by the GOSAT satellite and their relation to country-level anthropogenic emissions

Day 2:

Saito, Global carbon dioxide and methane flux estimates based on GOSAT-2 observations

Nayagam, Quantifying Indian terrestrial biospheric CO₂ flux using observations from ground-based network and GOSAT

Tohjima, Global carbon budgets estimated from atmospheric O₂ and CO₂ observations in the western Pacific over a 20-year period

Day 3:

Bisht, High resolution CO₂ simulation over Kanto region in Japan

Yang, Urban CO₂ simulations for the Greater Tokyo Area based on high-resolution modeling and comparison with tower observation network

Fujinawa, Retrieval algorithm development for TANSO-3 NO₂ product

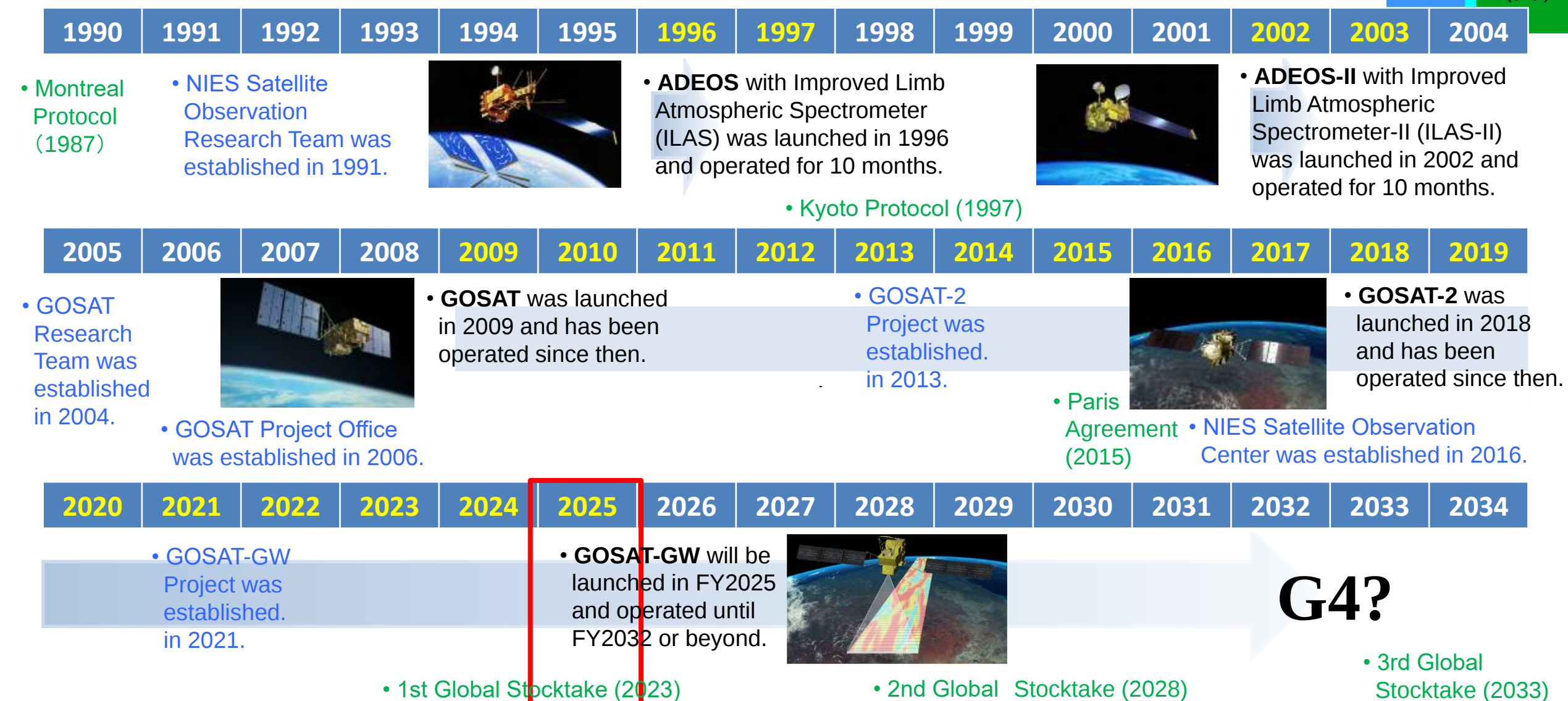
Yamashita, Development Of A Simple NO_x Emission Estimation Method Using Satellite Observations And A Chemistry-Transport Model

Lim, Development Of A Simple NO_x Emission Estimation Method Using Satellite Observations And A Chemistry-Transport Model

Earth Observation Satellite Projects at NIES:

ADEOS/ILAS, ADEOS-II/ILAS-II, GOSAT, GOSAT-2, and GOSAT-GW/TANSO-3

(FY)



G4?

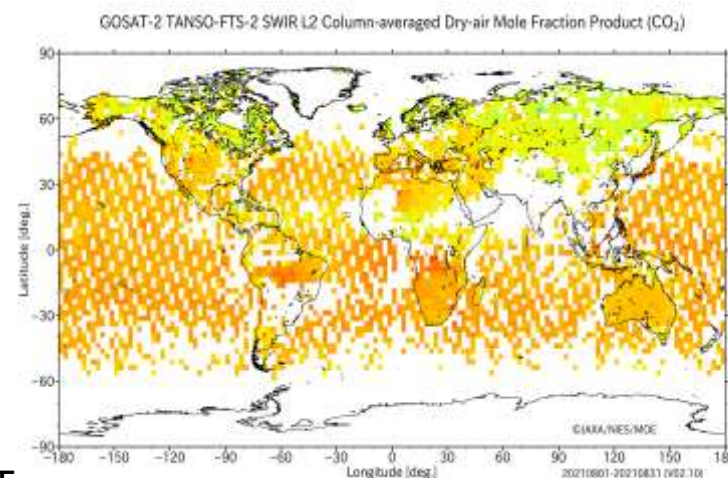
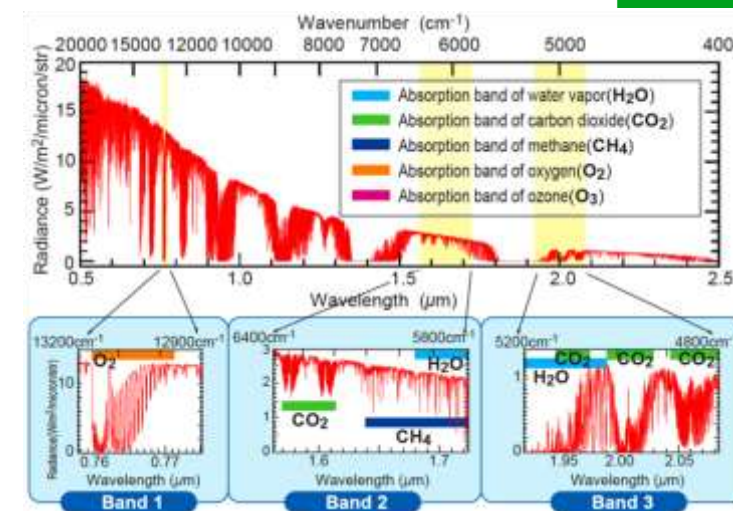
What is GOSAT Series?

■ Japanese earth observation satellite series measuring atmospheric concentrations of greenhouse gases for **more than 16 years**

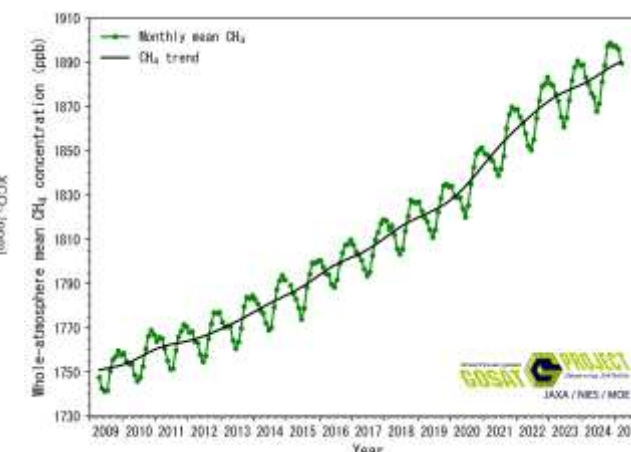
- **GOSAT (2009 -)**
Fourier transform spectrometer (FTS)
for CO₂ and methane (CH₄)
- **GOSAT-2 (2018 -)**
FTS-2 for CO₂, CH₄, and carbon monoxide (CO)
- **GOSAT-GW (June 2025 -)**
Grating imaging spectrometer (TANSO-3)
for CO₂, CH₄, and nitrogen dioxide (NO₂)

■ Organizations

- Joint projects by MOE, NIES, and JAXA
- NIES is responsible for generation, validation, distribution, and archiving of gas concentration and flux data
- Science Teams by domestic scientists
- Collaboration agreements with foreign space agencies such as NASA, CNES, DLR, and ESA.
- Participation of overseas researchers via GOSAT Series RA



GOSAT-2 FTS-2 SWIR L2 XCO₂ Map of August 2021
(V02.10, Full Physics)



GOSAT Whole-atmosphere Monthly
Mean CH₄ Concentration
(April 2009 – March 2025)

GOSAT FTS SWIR and GOSAT-2 FTS-2 SWIR L2 Products

GOSAT FTS SWIR

Public Release

V3.00 and V03.05 (bias corrected)

In preparation

V03.10 and V03.10 (bias corrected)

GOSAT-2 FTS-2 SWIR

Public release

V02.00

V02.10

With bias correction equations
A priori variance-covariance matrix
for CO₂ profile was modified

RA release

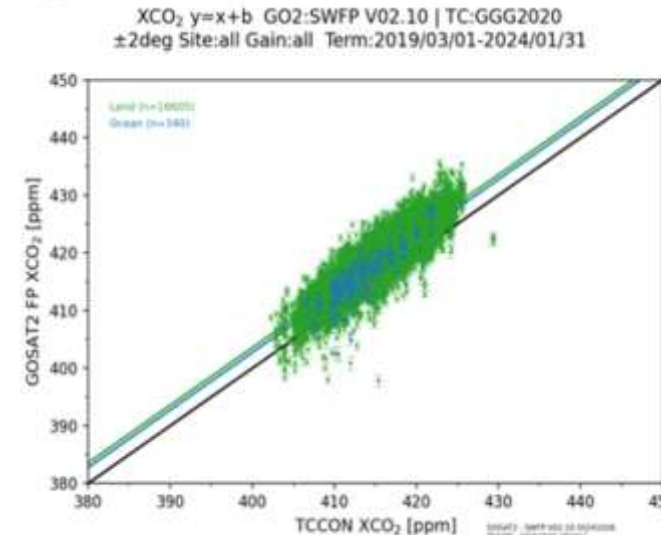
V02.20/V02.21

JRA-55 => JRA-3Q

Future release

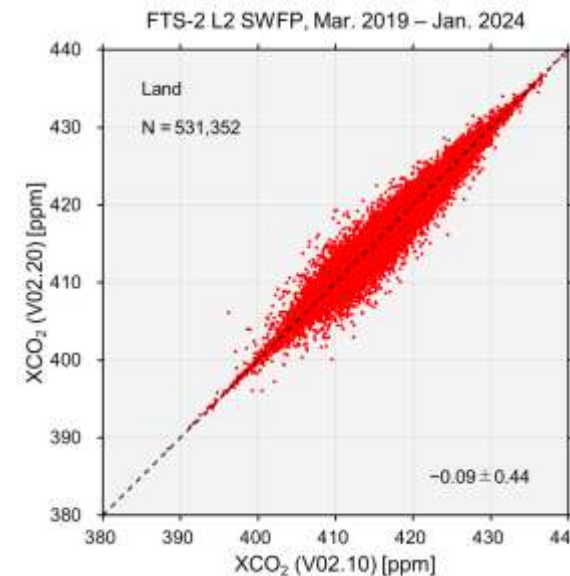
V02.30?

New L1B and/or other bug fixes



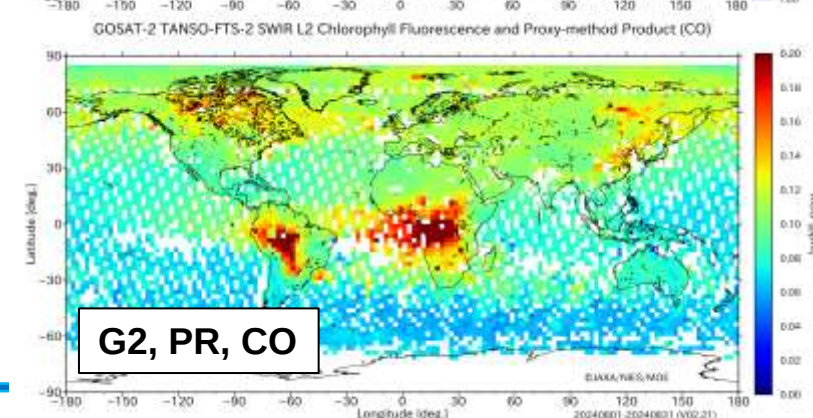
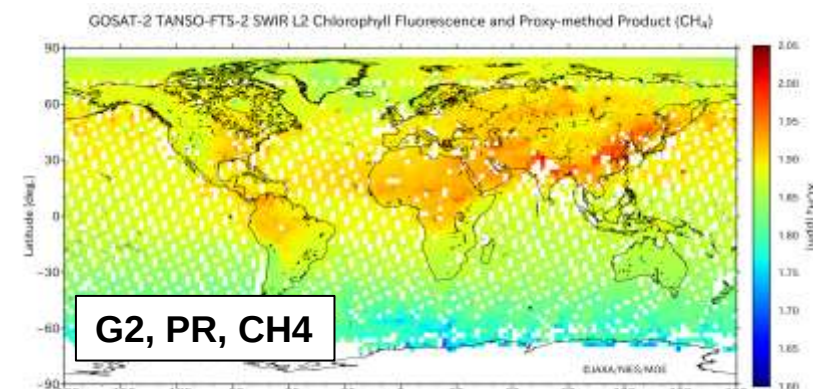
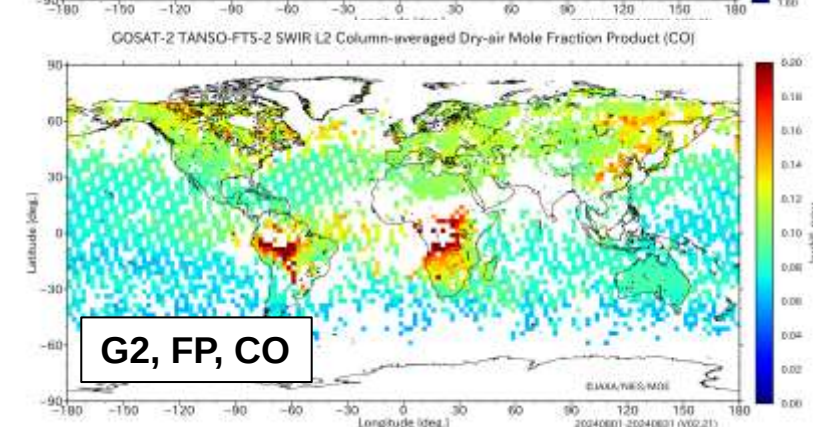
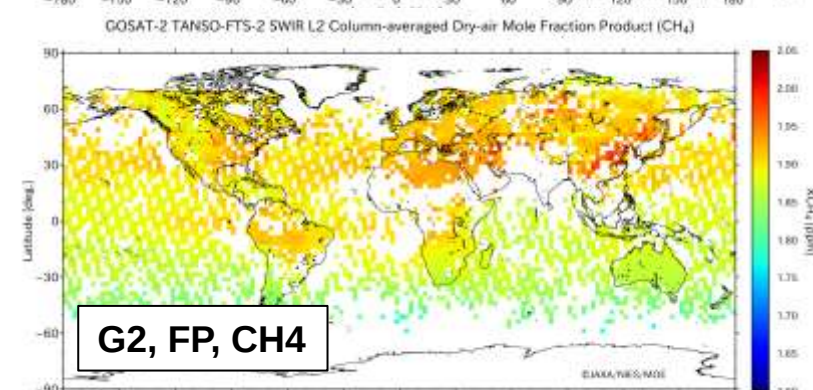
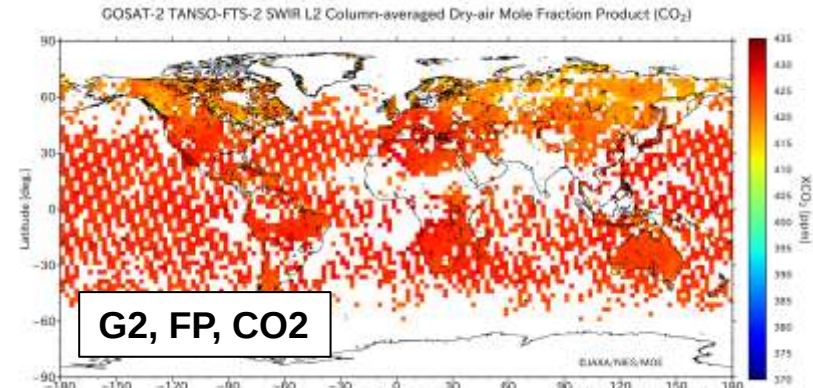
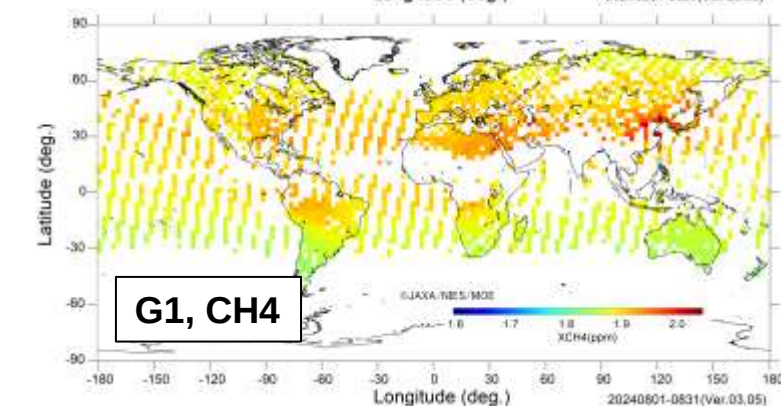
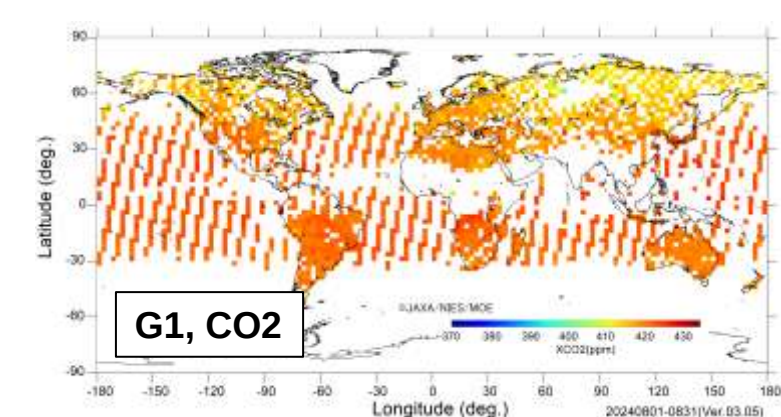
FTS-2 SWFP
Land XCO₂
V02.10 – TCCON
= 3.19 ± 2.06 ppm
(2019 – 2024, ± 0.1 deg.)

https://prdct.gosat-2.nies.go.jp/documents/pdf/ValidationResult_FTS-2_L2_SWFP_ver0210_en_00.pdf

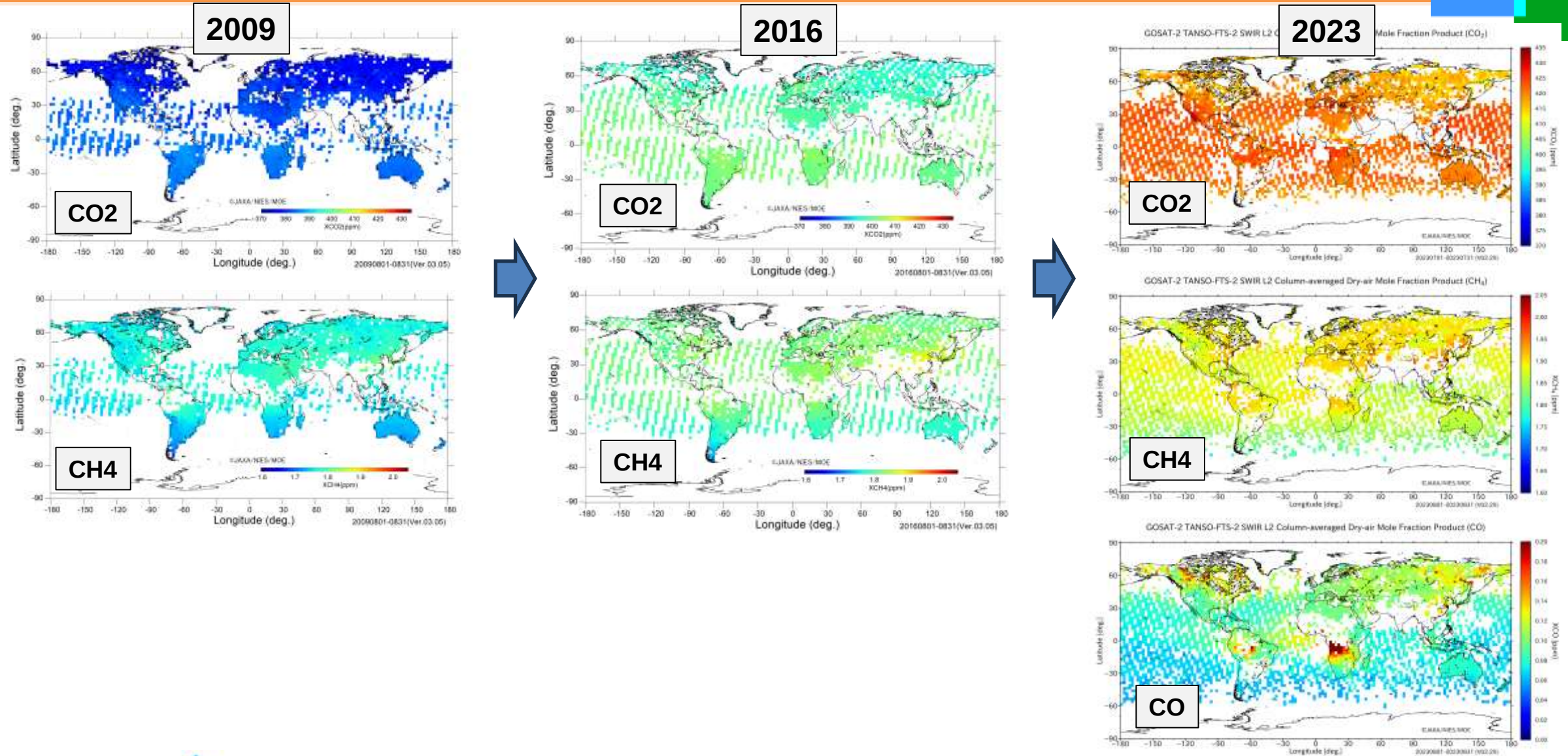


FTS-2 SWFP
Land XCO₂
V02.20 – V02.10
= -0.09 ± 0.44 ppm

GOSAT FTS SWIR (V3.05) and GOSAT-2 FTS-2 SWIR L2 (V2.21) Maps (August 2024)



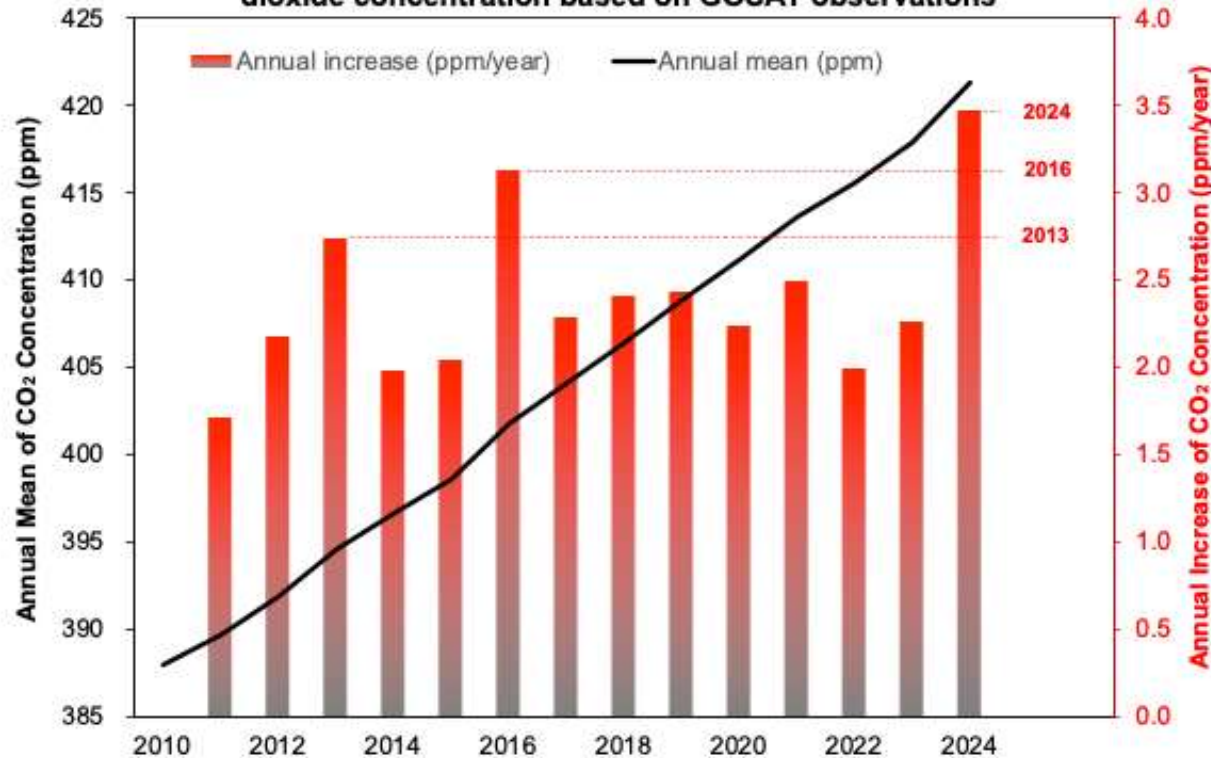
GOSAT(2009 and 2016) and GOSAT-2 (2023) August Maps of XCO₂, XCH₄, and XCO



GOSAT Whole-atmosphere Mean Concentrations of CO₂ and CH₄: Annual Mean and Annual Increase

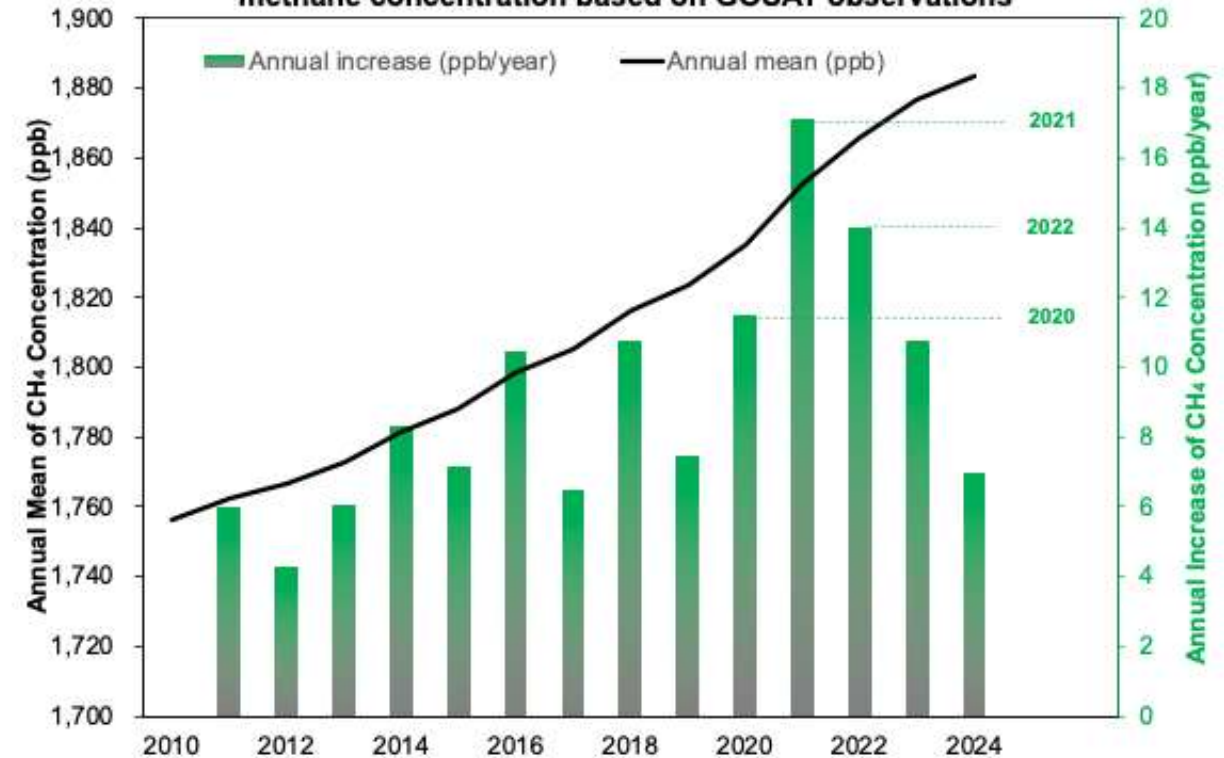
See Niwa et al.
and Maity et al.
on Day 3

Annual mean and annual increase of whole-atmosphere mean carbon dioxide concentration based on GOSAT observations



GOSAT annual mean CO₂ concentration and its annual increase from 2023 to 2024 were highest in the past 15 years.

Annual mean and annual increase of whole-atmosphere mean methane concentration based on GOSAT observations



GOSAT annual mean CH₄ concentration in 2024 and its annual increase from 2020 to 2021 were highest in the past 15 years.

<https://www.nies.go.jp/whatsnew/20250214/20250214-e.html>

<https://www.nies.go.jp/whatsnew/20220323/20220323-e.html>

2016 – 2022 CH₄ Inversion Using Surface, Airborne, and GOSAT Data (Niwa et al., accepted)

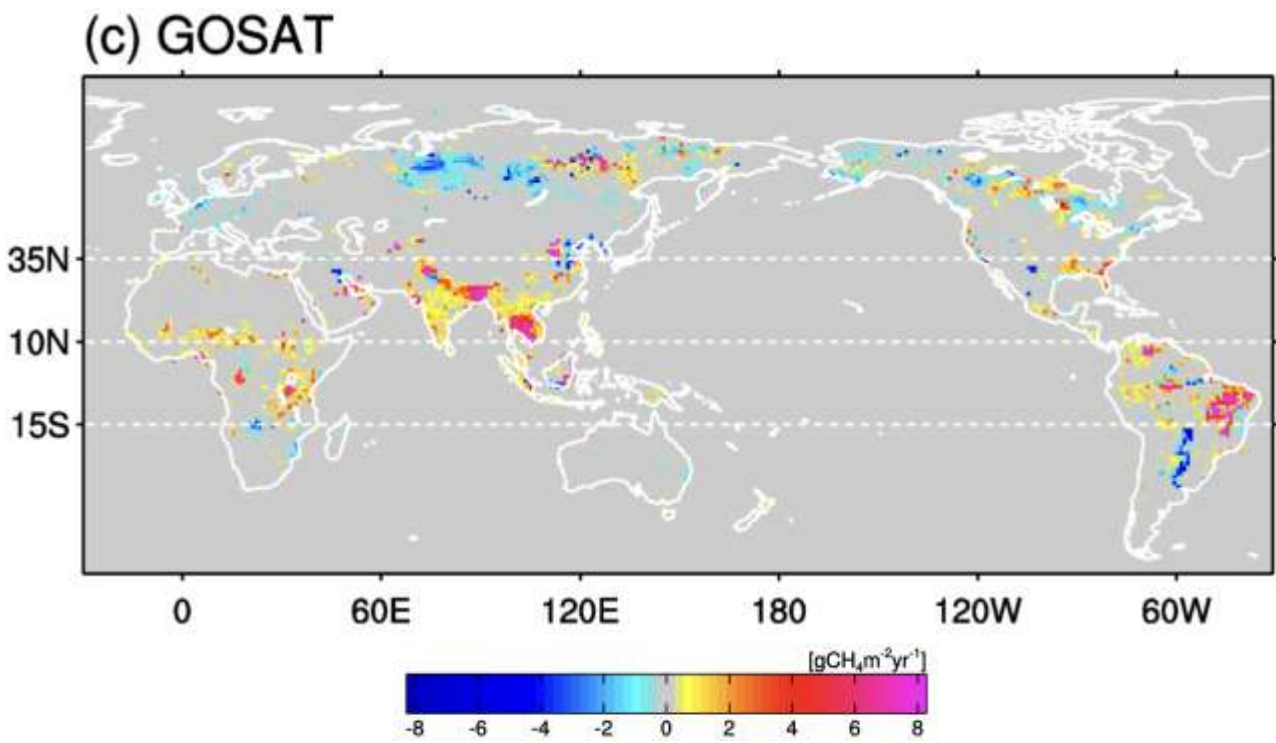


Figure 4c Spatial patterns of the total net CH₄ emissions increase (ΔfCH₄) from 2016–2019 to 2020–2022 in the GOSAT inversion.

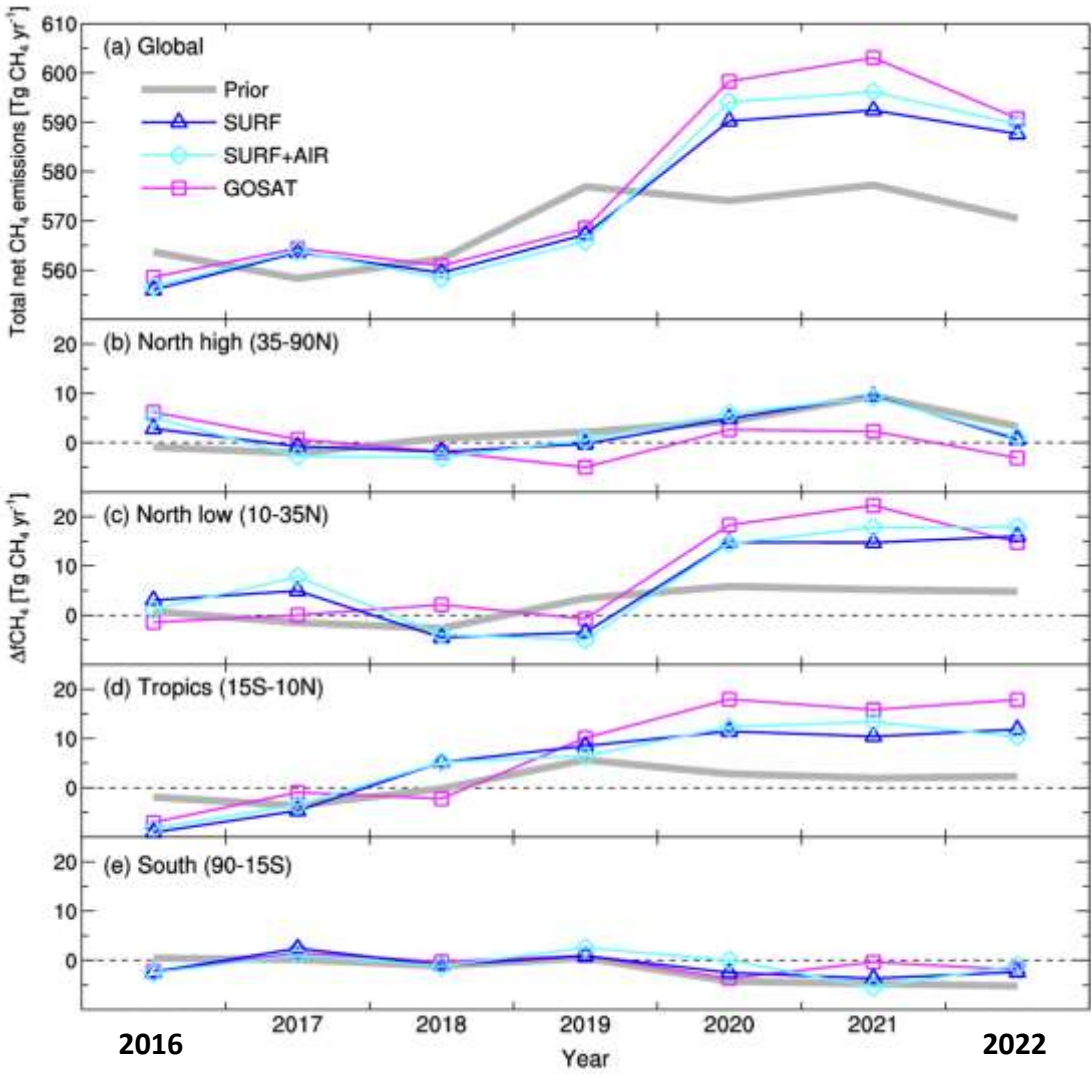


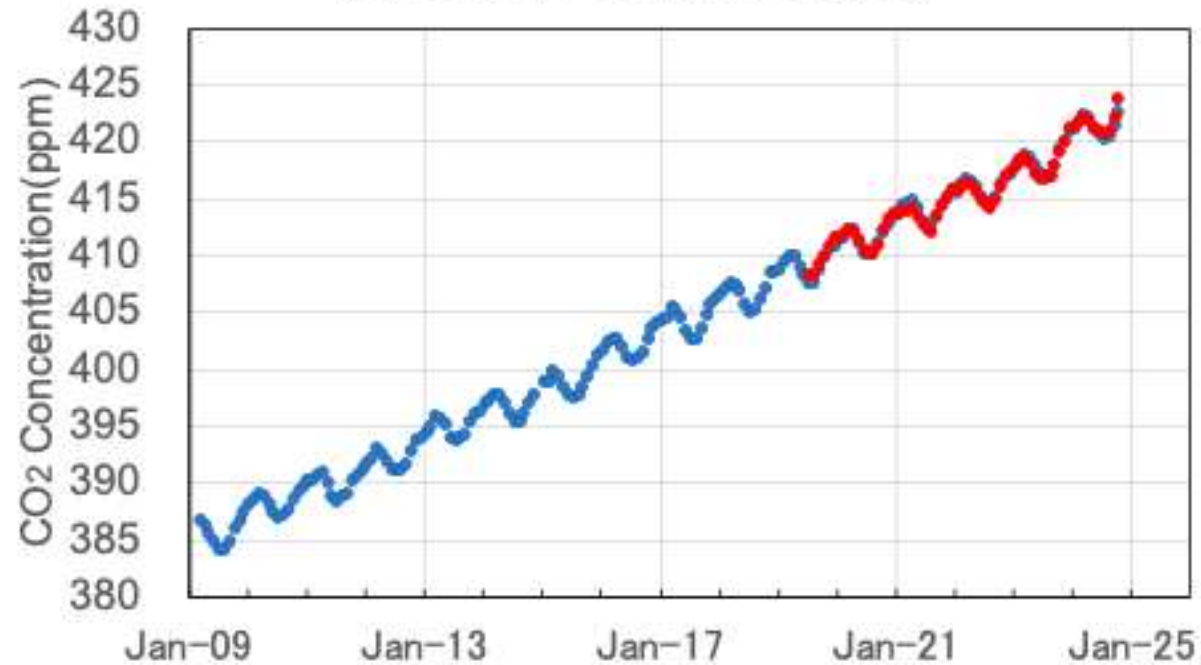
Figure 5 Year-to-year variations of total net CH₄ emissions

Increase of emissions from Wetland in Tropics and Agri + Waste in North Low were significant.

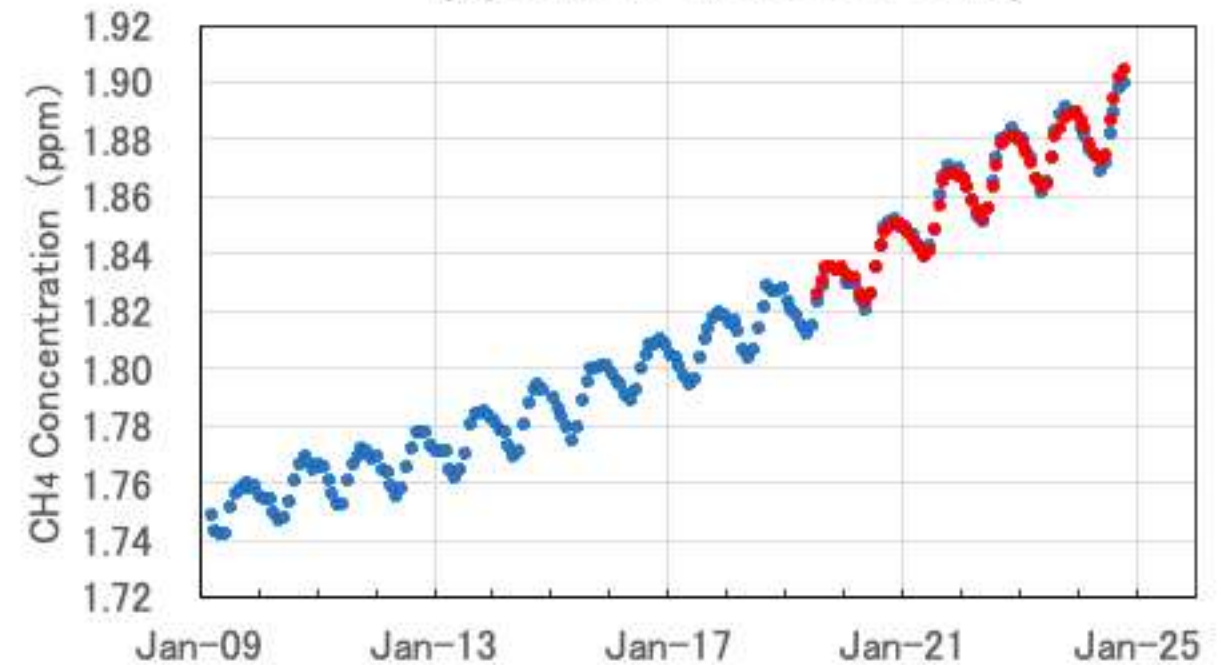
<https://egusphere.copernicus.org/preprints/2024/egusphere-2024-2457/>

GOSAT (2009 – 2024) and GOSAT-2 (2019- 2024) Whole-atmosphere Monthly Mean CO₂ and CH₄ Concentrations

GOSAT/GOSAT-2 Whole-atmosphere Monthly Mean CO₂ Concentration
(April 2009 - November 2024)



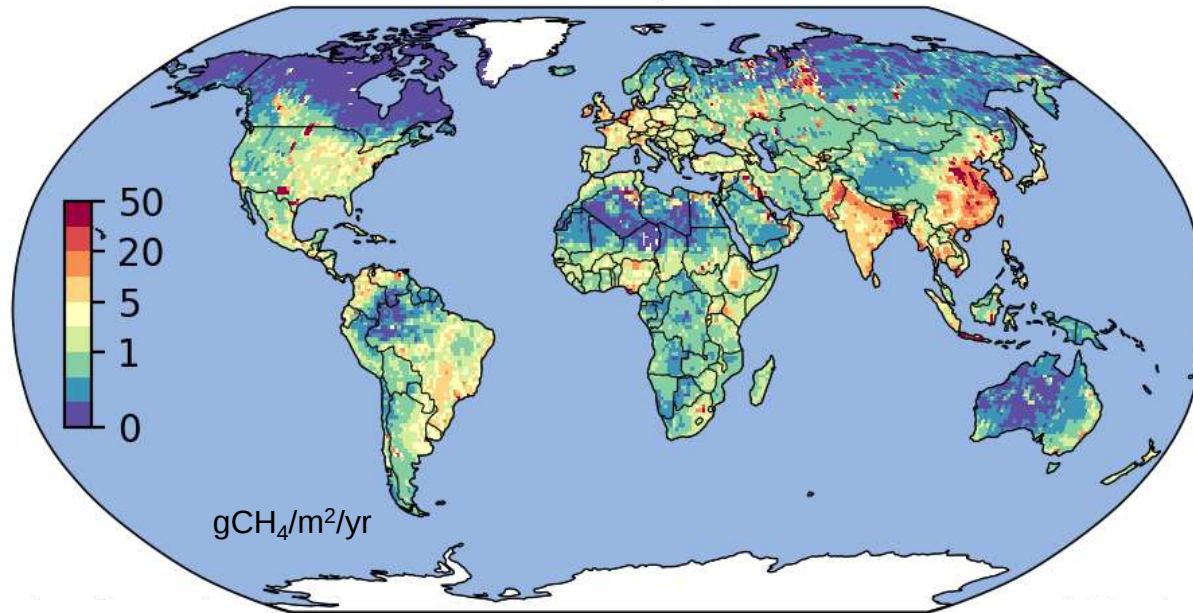
GOSAT/GOSAT-2 Whole-atmosphere Monthly Mean CH₄ Concentration
(April 2009 - November 2024)



GOSAT-2 data (V02.20/V02.21) are adjusted to GOSAT data (V03.05) using linear equations derived from regression analyses of 2019 – 2024 data.

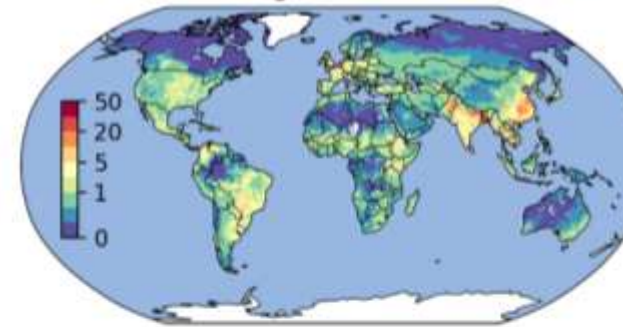
2009-2020 Global Methane Flux Maps Derived from GOSAT Inversion

Total Anthropogenic

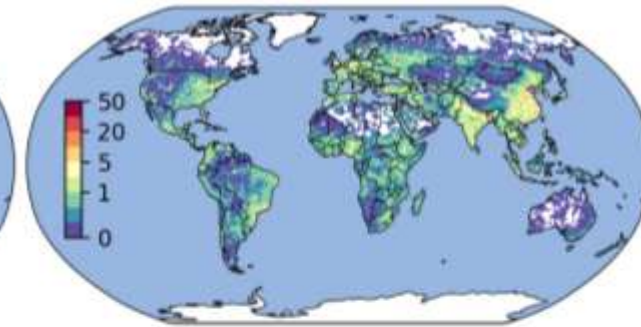


- Janardanan et al., ERL (2024)
High-resolution NTFVAR inversion (0.2 x 0.2 deg.)
using GOSAT and ground-based observation data
- “Natural” = “Wetland”
- “Total Anthropogenic”
= “Agriculture” + “Waste” + “Biomass Burning”
+ “Coal” + “Oil & Gas”
- Prior = EDGAR6 + GFED 4.1 + Saunois et al. (2020) for wetlands

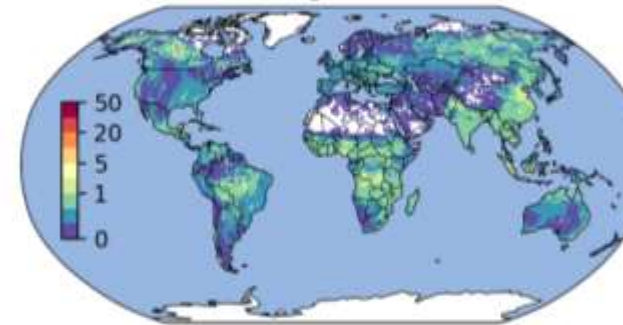
Agricultural



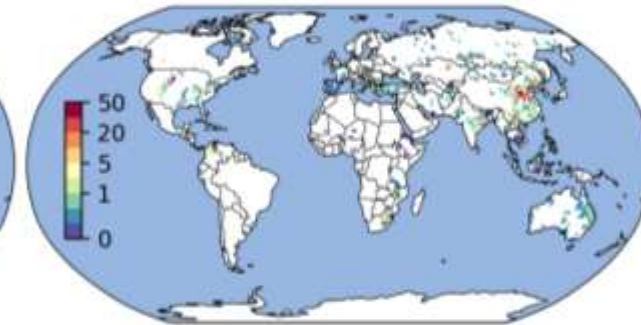
Waste



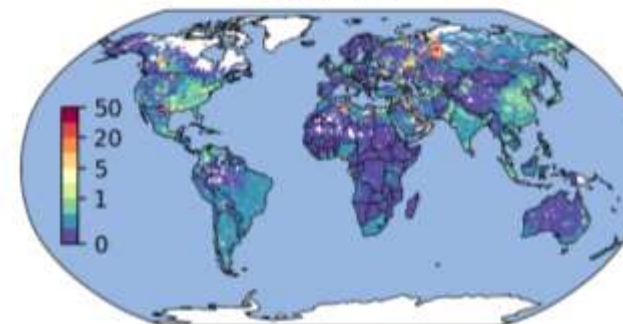
Burning Biomass



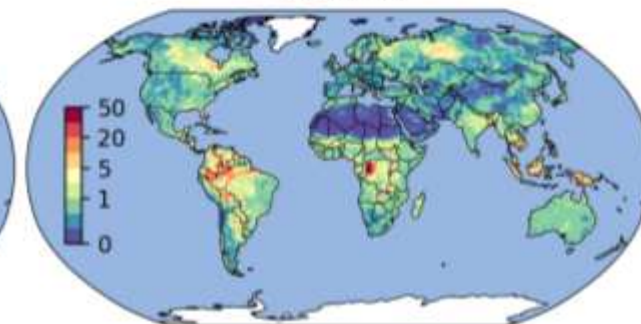
Coal



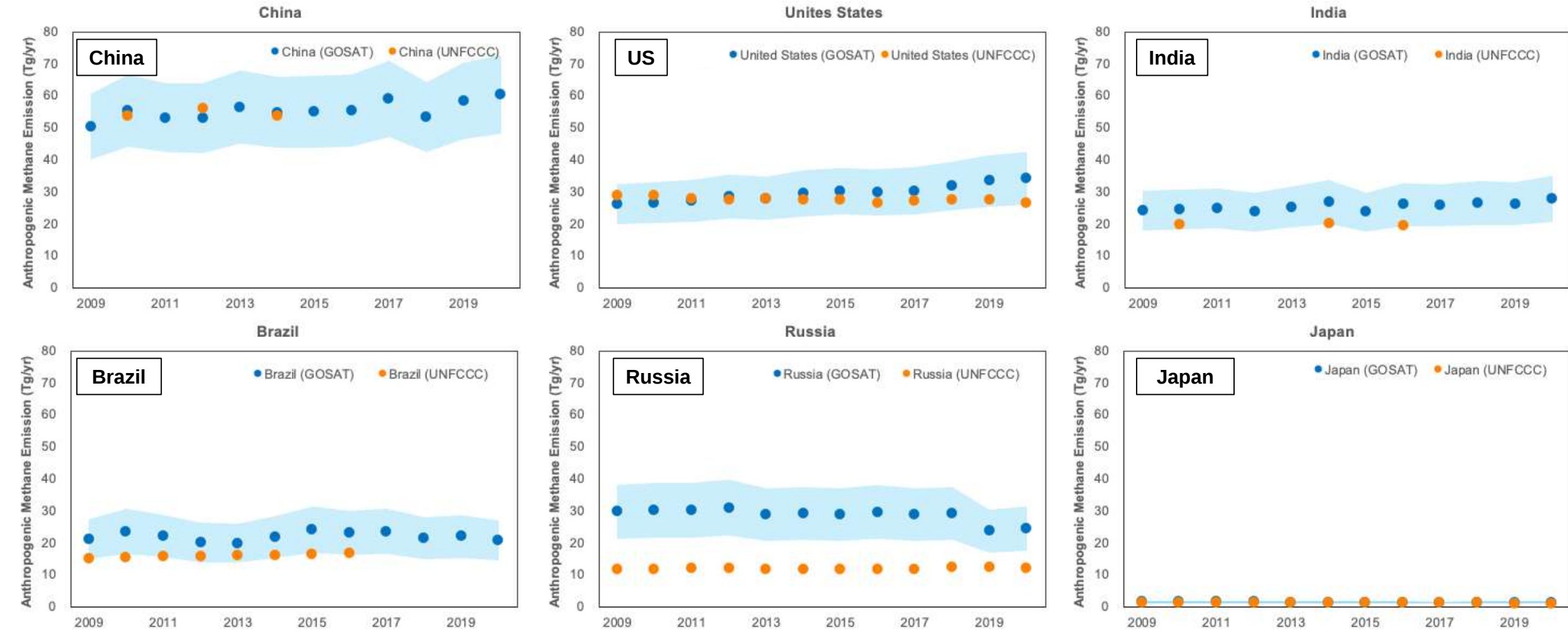
Oil & Gas



Wetlands



2009 – 2020 National Anthropogenic Methane Emissions Derived from GOSAT Data (UNFCCC COP29, November 2024)

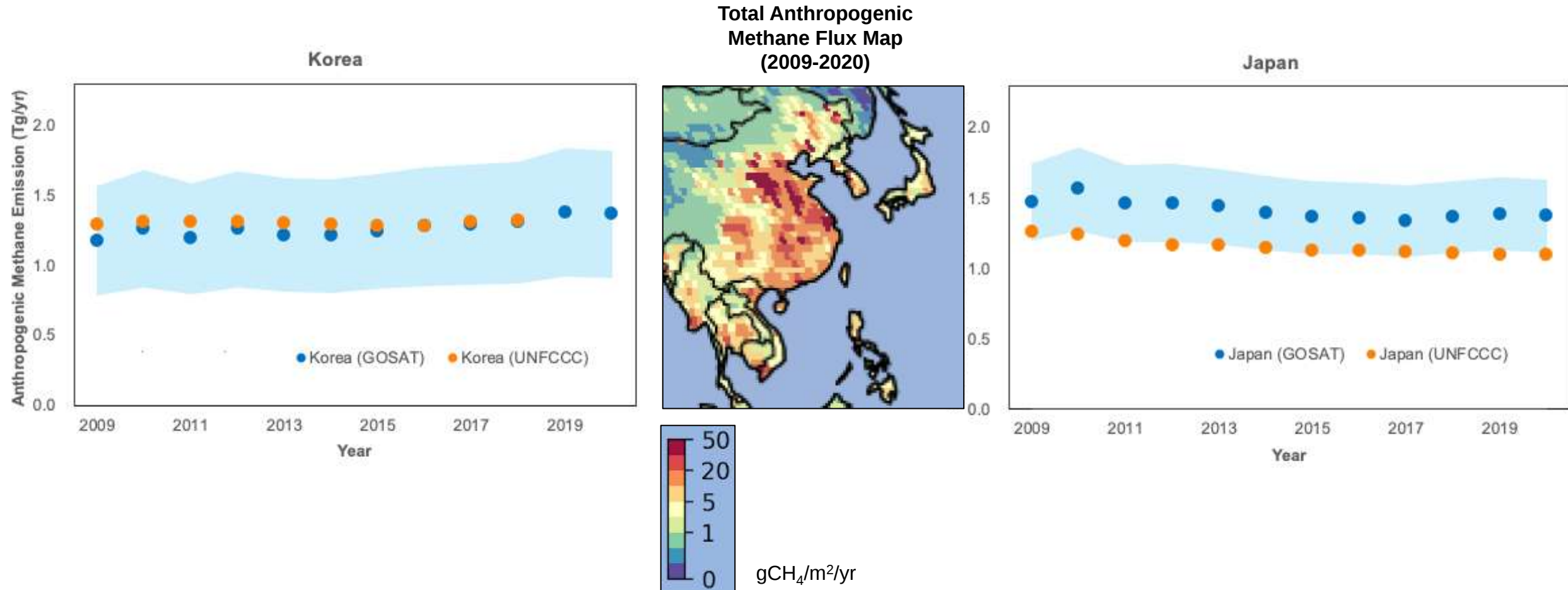


Anthropogenic methane fluxes from inversion analyses of GOSAT data (Janardanan et al. 2024) and UNFCCC Data

<https://esd.nies.go.jp/ghg-information/>

2009 – 2020 Anthropogenic Methane Emissions (Korea and Japan)

Derived from GOSAT Data



Anthropogenic methane fluxes from inversion analyses of GOSAT data (Janardanan et al. 2024)
 UNFCCC Data (<https://unfccc.int/topics/mitigation/resources/registry-and-data/ghg-data-from-unfccc>)

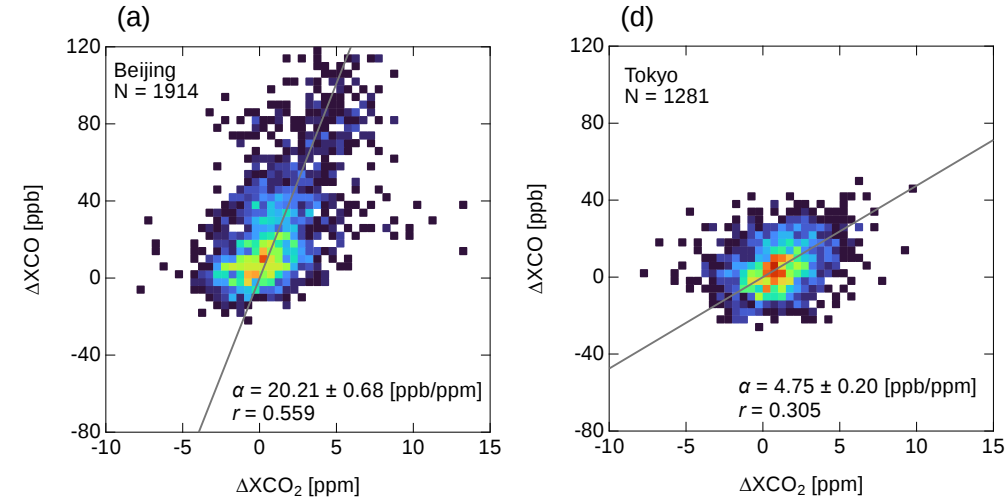
Estimation of CH₄ and CO emissions in megacities by using simultaneous GHGs and air pollutant observations by GOSAT-2 (Ohshima et al., ERL, 2024)

ENVIRONMENTAL RESEARCH LETTERS

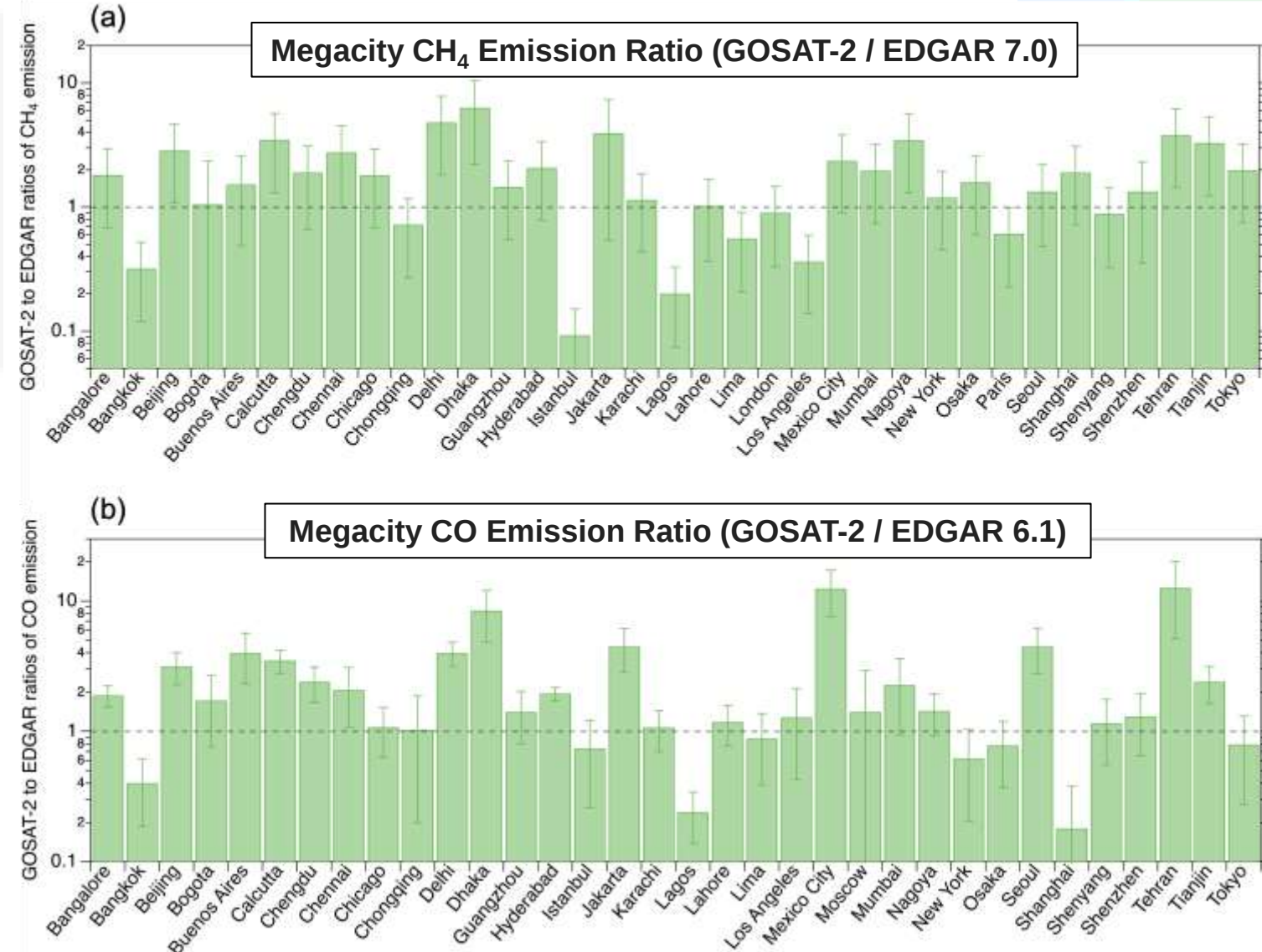
LETTER

CH₄ and CO emission estimates for megacities: deriving enhancement ratios of CO₂, CH₄, and CO from GOSAT-2 observations

Hirofumi Ohshima*, Yukio Yoshida and Tsuneo Matsunaga



ΔXCO vs ΔXCO₂ plots for Beijing and Tokyo.

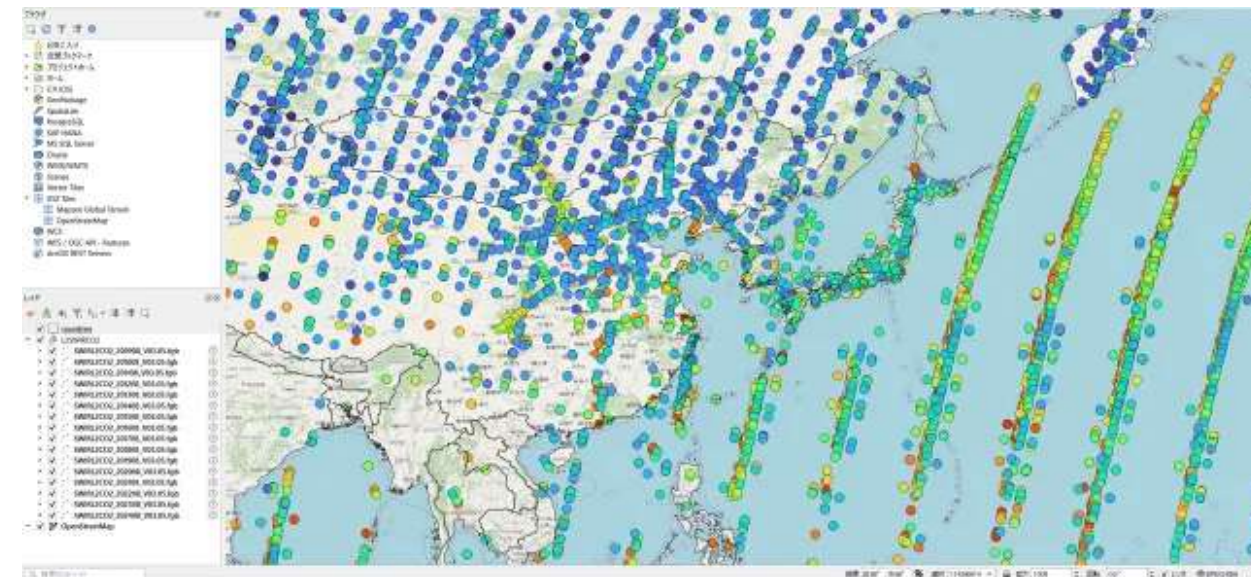


<https://iopscience.iop.org/article/10.1088/1748-9326/ad89e0>

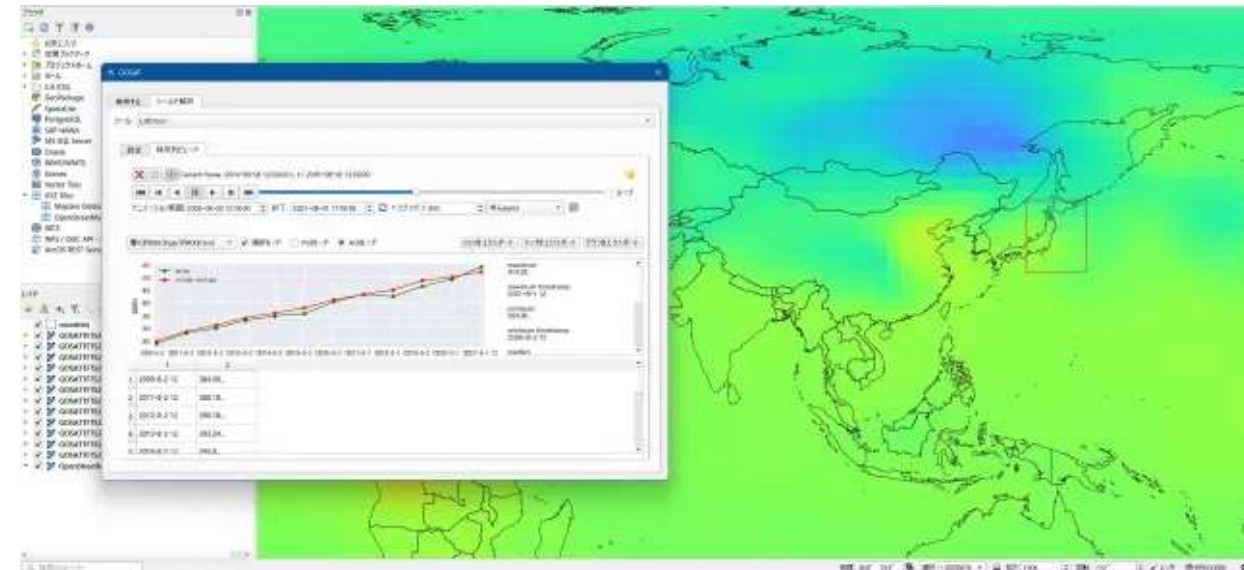
GOSAT and GOSAT-2 data are now available via Tellus QGIS plugin and API

<https://www.tellusxdp.com/en-us/>

- ✓ Tellus is a cloud-based satellite data platform originally funded by Japanese Ministry of Economy, Trade, and Industry. Tellus extension to GOSAT is supported by MOE and NIES.
- ✓ From March 2025, the most of L2, L3, and L4 GOSAT / GOSAT-2 data can be obtained and analyzed using QGIS plugin and API provided by Tellus.
- ✓ Tellus system is now automatically downloading latest GOSAT and GOSAT-2 data.
- ✓ A simple online visualization environment, Tellus Traveler, is also provided.



Global Point Cloud 2D Observation Data Visualization Tool (L2 SWIR)



Global Mesh 3D Analysis Data Visualization Tool (L4B)

Thank you for your attention

Contact

matsunag@nies.go.jp

Website

<https://www.nies.go.jp/soc> (Satellite Observation Center)

<https://www.gosat.nies.go.jp> (NIES GOSAT Project)

<https://www.gosat-2.nies.go.jp> (NIES GOSAT-2 Project)

<https://gosat-gw.nies.go.jp> (NIES GOSAT-GW Project)

GOSAT and GOSAT-2 standard products are freely available from

GOSAT Data Archive Service (GDAS: L1B, L2, L3, L4)

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

GOSAT-2 Product Archive (L1B, L2, L4)

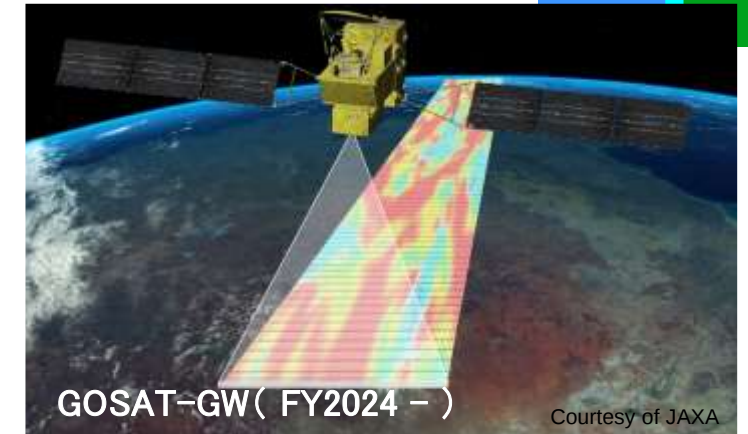
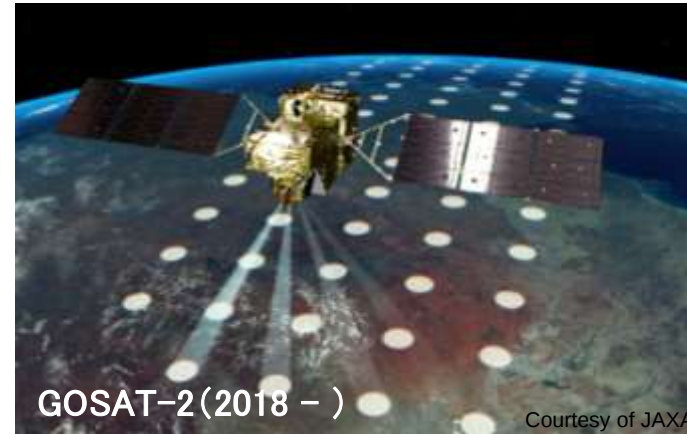
<https://prdct.gosat-2.nies.go.jp>

From 2025 or later, GOSAT-GW TANSO-3 standard products will be freely available
from

GOSAT-GW TANSO-3 Product Archive (G3PA: L1B, L2)

(URL: TBD)

Specifications of GOSAT, GOSAT-2, and GOSAT-GW



	GOSAT	GOSAT-2	GOSAT-GW
Launch / lifetime	2009 / 5 years	2018 / 5 years	FY2025 / 7 years
Satellite mass / power	1.75 t / 3770 W	1.8 t / 5000 W	2.9 t / 5200 W
Orbit	666 km, 3 days, 13:00, descending	613 km, 6 days, 13:00, descending	666 km, 3 days, 13:30, ascending
Spectrometer	FTS	FTS-2	TANSO-3 (Grating)
Major targets	CO₂, CH₄	CO ₂ , CH ₄ , CO	CO ₂ , CH ₄ , NO₂
Spectral bands	0.7 / 1.6 / 2 μm + TIR	0.7 / 1.6 / 2 μm + TIR	0.45 / 0.7 / 1.6 μm
Spectral Resolution (Sampling interval)	0.2 cm⁻¹, (≈ 0.01 nm @ 0.7 μm, ≈ 0.05 nm @ 1.6 μm)		< 0.5 nm @ 0.45 μm, <0.05 nm @ 0.7 μm, < 0.2 nm @ 1.6 μm
Swath	Discrete, 1 – 9 points	Discrete, 5 points	Selectable, 911 km (Wide Mode) or 90 km (Focus Mode)
Footprint size, nadir	10.5 km	9.7 km	Selectable, 10 km (Wide Mode) or 1 – 3 km (Focus Mode)
Pointing	±20 / ±35 deg (Along Track/Cross Track)	±40 / ±35 deg (AT/CT) Intelligent Pointing	± 40 / ± 34.4 deg (AT/CT)
Other instruments	CAI (Cloud and Aerosol Imager)	CAI-2 (Cloud and Aerosol Imager 2)	AMSR3 (Advanced Microwave Scanning Radiometer 3)