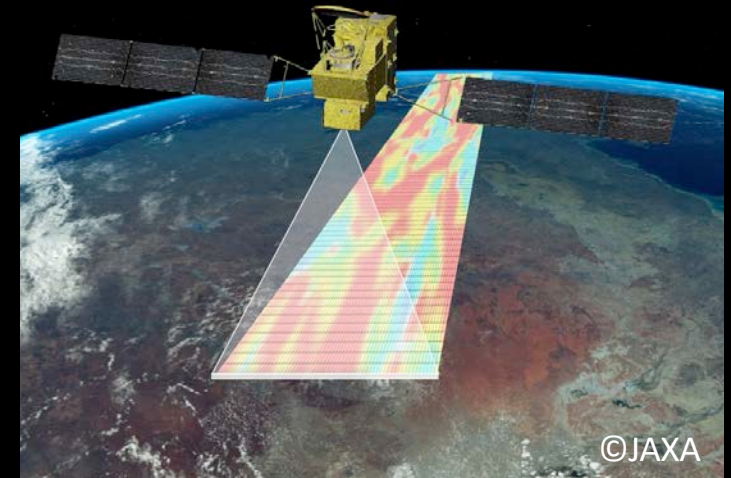


Update on GOSAT series (1, 2 and GW)



Hiroshi Tanimoto, Tsuneo Matsunaga, Isamu Morino, Takafumi Sugita
National Institute for Environmental Studies, Japan



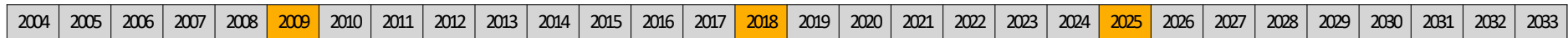
Ministry of the Environment
Government of Japan



MEXT

MINISTRY OF EDUCATION,
CULTURE, SPORTS,
SCIENCE AND TECHNOLOGY-JAPAN

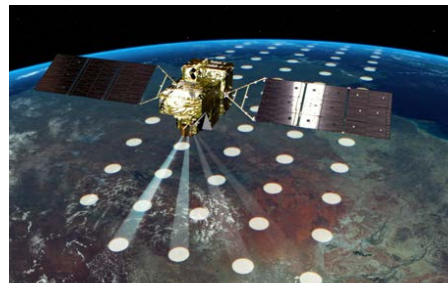
GOSAT series satellites



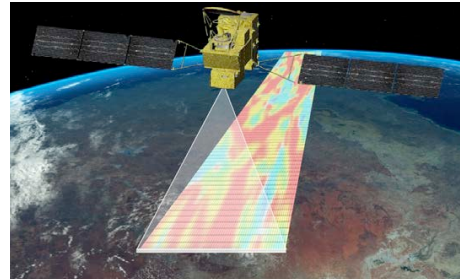
GOSAT



GOSAT-2

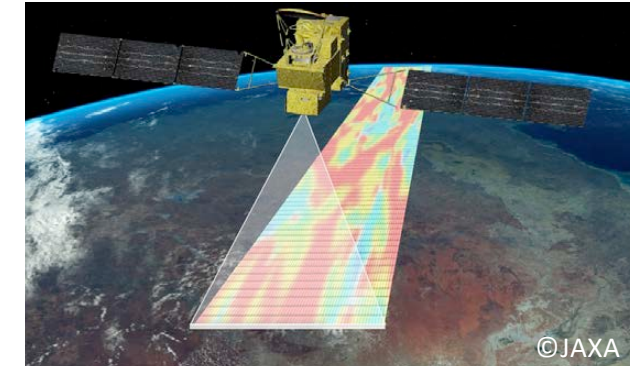
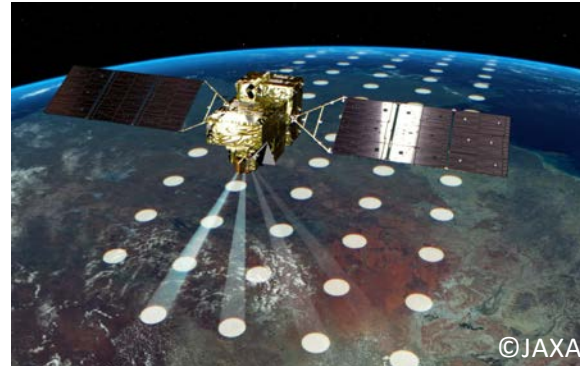


GOSAT-GW



- **JAXA** is responsible for the launch, L0 and **L1** including **calibration** (in-orbit and ground)
- **NIES** for **L2** (and higher **research** products) including **validation** and data distribution
- Collaboration agreements with foreign space agencies – NASA, ESA, CNES, DLR, and **SRON, BIRA, EUMETSAT (new)**
- Science Teams by Japanese scientists – mainly universities – for GOSAT 1 and 2
- Research Announcement for GOSAT 1 and 2

GOSAT, GOSAT-2, and ... GOSAT-GW



	GOSAT	GOSAT-2	GOSAT-GW
Launch / lifetime	2009 / 5 years	2018 / 5 years	2025 / 7 years
Satellite mass / power	1.75 t / 3770 W	1.8 t / 5000 W	2.6 t / 5300 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 - TANSO	FTS-2 - TANSO-2	Grating - TANSO-3
Major targets	CO ₂ , CH ₄ (Full Physics, Proxy)	CO ₂ , CH ₄ , CO (Full Physics, Proxy)	CO ₂ , CH ₄ , NO ₂ (Full Physics, Proxy, DOAS, Matched Filter)
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	911 km (Wide Mode) or 90 km (Focus Mode)
Footprint size, nadir	10.5 km	9.7 km	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)

GOSAT series - mission requirements

- Monitoring of whole atmosphere global-mean concentrations of GHGs
- Verification of national (or country-specific) anthropogenic emissions inventory of GHGs
- Detection of GHGs emissions from large emission sources, such as megacities, power plants, etc



Japan

GOSAT, GOSAT-2

OCO-2

GOSAT-GW

CO2M

Swath
Nadir pixel size 10-km diameter

10 km
2.3 x 1.3 km²

911 km (wide-mode)
10 x 10 km² (wide-mode)

250 km
2 x 2 km²

Tokyo

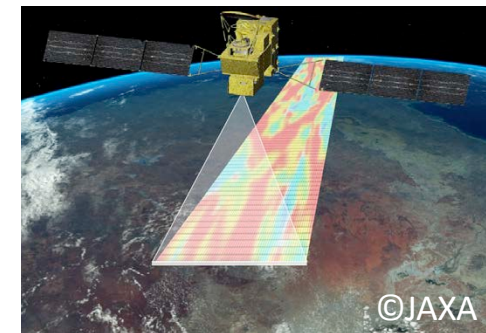
Swath
Nadir pixel size 10-km diameter

10 km
2.3 x 1.3 km²

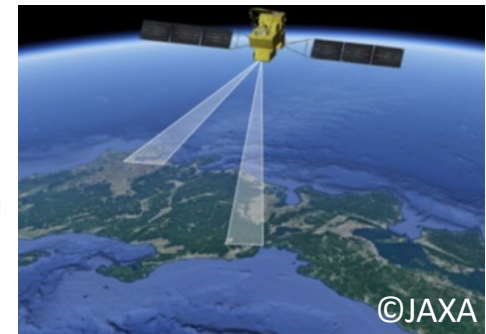
90 km (fine-mode)
3 x 3 km² (fine-mode)

250 km
2 x 2 km²

Wide mode



Focus mode



Updates Today

- **Mission status** – GOSAT-1, GOSAT-2, GOSAT-GW
- **Calibration** – Lunar calibration, Railroad Valley (RRV) vicarious campaign led by JAXA
- **Products** – preliminary L1B (JAXA) and initial L2 (NIES)
- **Validation** – GHG-NO₂ urban sites in Japan, [new India sites](#), cargo ship-aircraft over oceans, IAGOS NO₂
- **Tokyo-FC airborne campaign** – NASA, NIES, and JAMSTEC joint efforts in March 2026
- **Coordinated Observations** – JPL OCO-3 SAM, Methane Air, Tokyo-FC, TexAQS
- **International Collaboration** – IMEO/MARS, EUMETSAT-Copernicus

Status of GOSAT and GOSAT-2

Partly by Kei Shiomi (JAXA)

- **GOSAT: Nominal after FTS restart**

- FTS obs. suspended - Dec18, 2025 – Feb04, 2026 (Safety mechanism activation by overcurrent mis-detection)
- JAXA L1 V300.301 parameter version-up of the TIR DC offset table
- NIES L2 V03.05; ACOS L2 V11 (Chris O'Dell and Tommy Tayler)

- **GOSAT-2: Nominal**

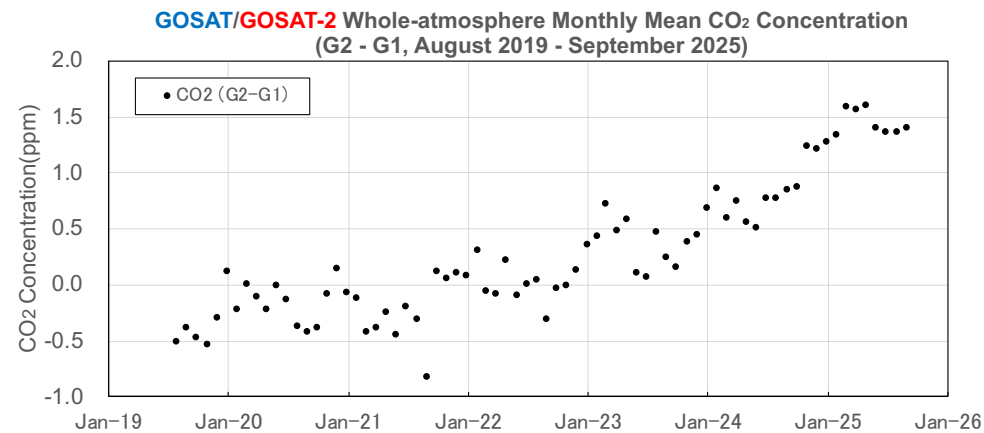
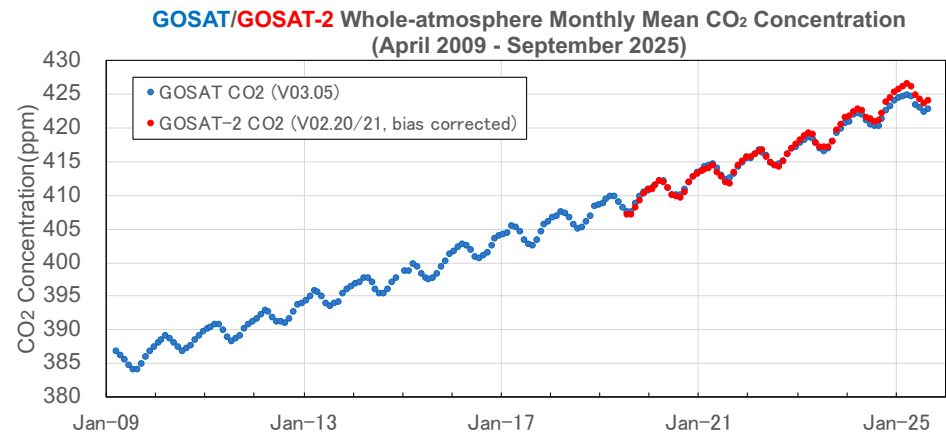
- FTS-2 Band1 radiometric response recovered up to 15% by Feb 2026 than the V230 expected radiance
- JAXA L1 V240.240 version-up of the SWIR RDF
- NIES L2 V02.20/21

- **GOSAT-GW: Initial cal/val phase**

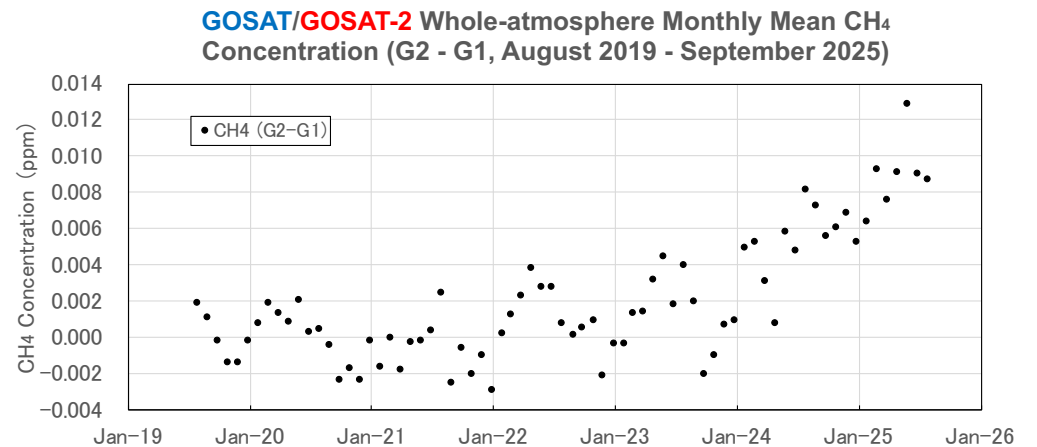
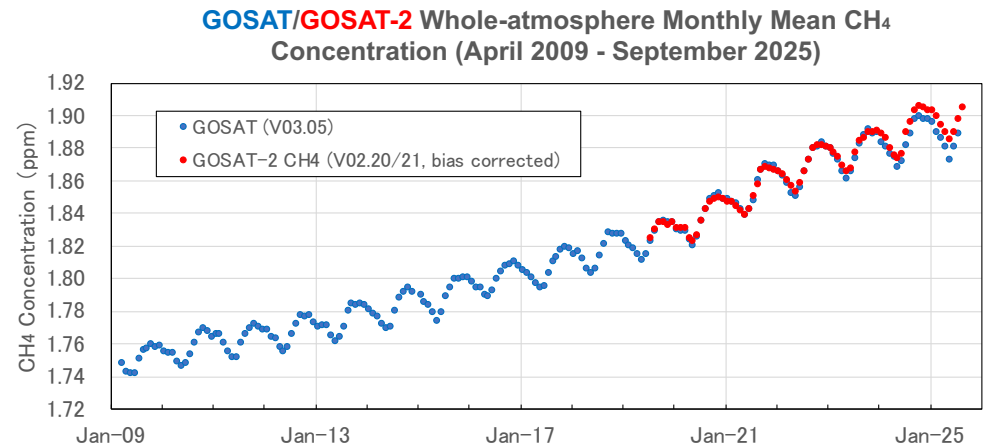
- TANSO-3: Observation started on July14, 2025; JAXA L1 V001
- RRV campaign in summer/autumn, 2025; summer 2026
- JAXA L1 V002 updates: wavelength, wide-mode radiance conversion, binning map
- JAXA L1 V100 updates in April: radiance degradation, wavelength, bad pixels, (good geometry)
- JAXA L1 V101 updates scheduled in July, after the JAXA's Review in June

GOSAT and GOSAT-2 Consistency

GOSAT-2 – GOSAT-1, CO₂



GOSAT-2 – GOSAT-1, CH₄

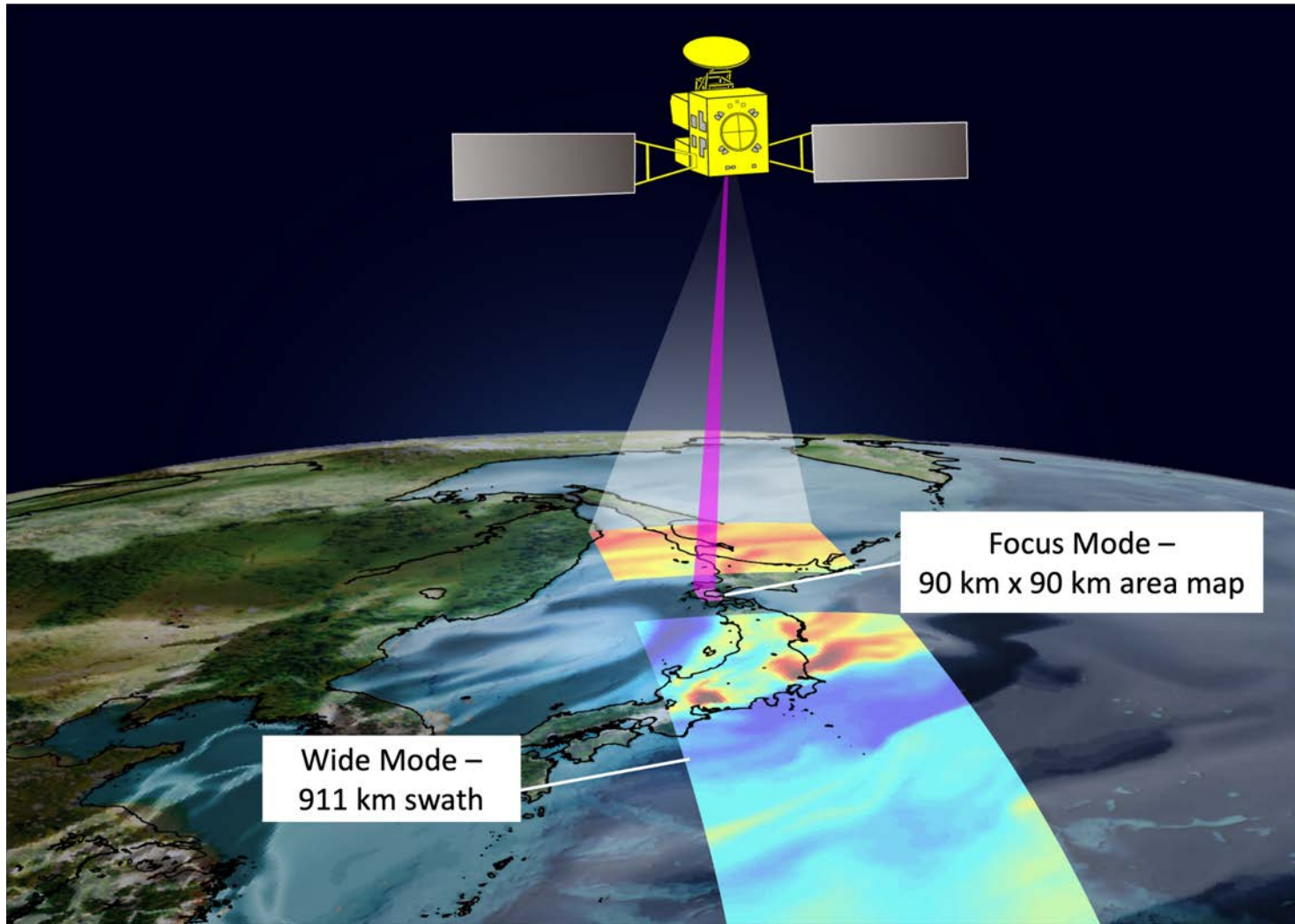


Successful launch of GOSAT-GW in June 2025



- The GOSAT-GW satellite was launched at 1:33:03 am Japan time on 29th June at Tanegashima Space Center with the 50th H-IIA rocket, the last vehicle of the H-IIA series

Focus mode makes high spatial resolution footprints



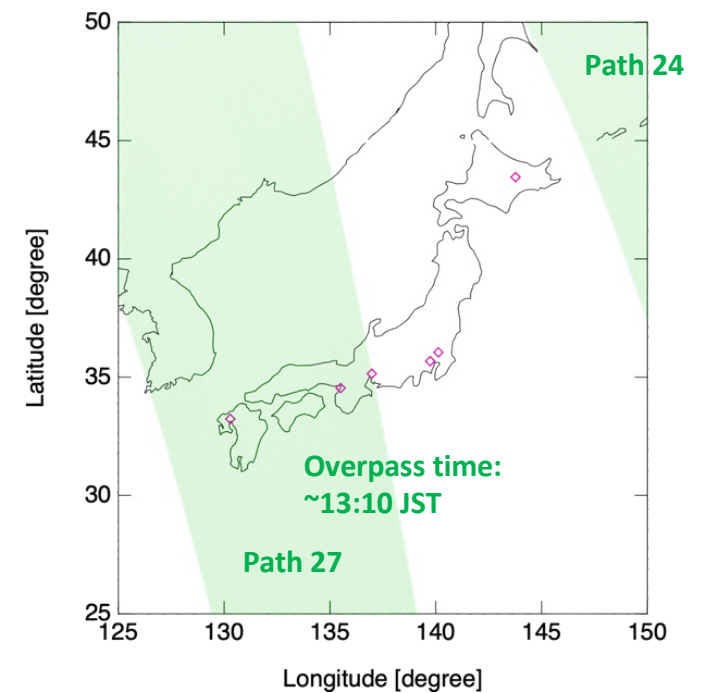
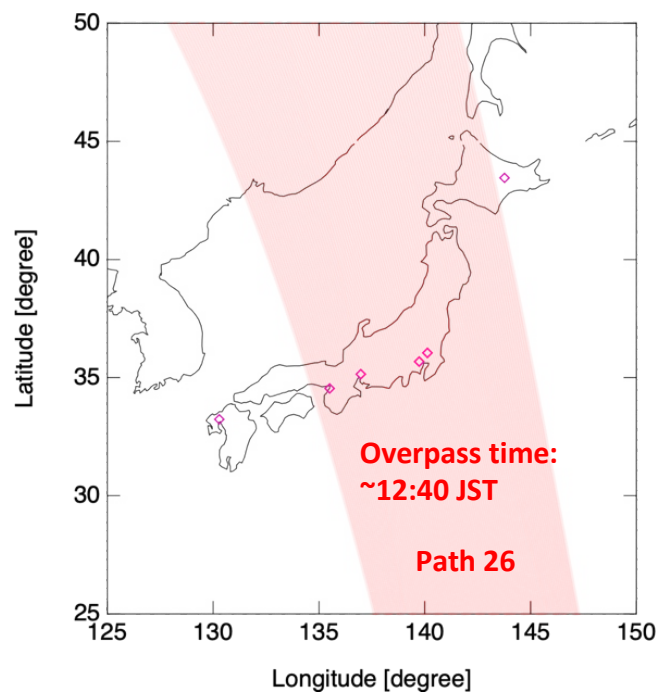
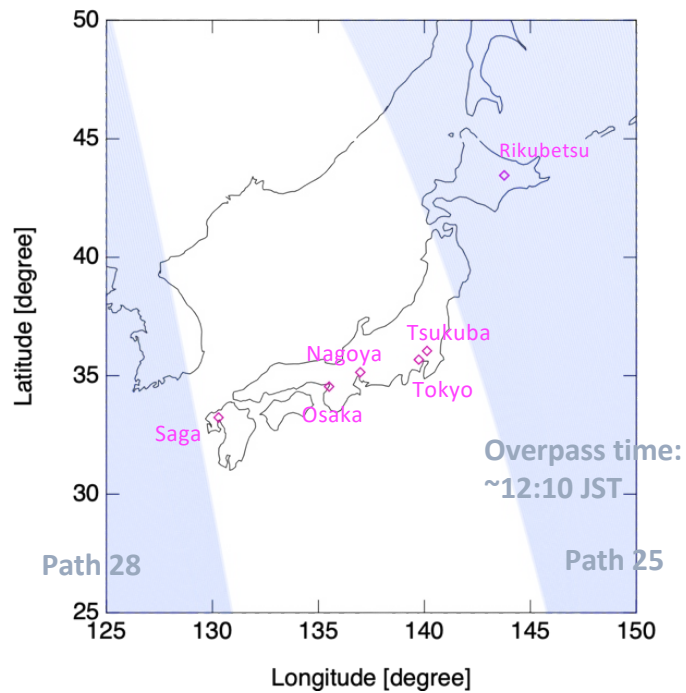
Focus Mode

- Target area $\approx 90 \text{ km} \times 90 \text{ km}$
- Footprint $\approx 1 - 3 \text{ km}$
- Push-broom, AT/CT Pointing Func.
- Optional, upon request

Wide Mode

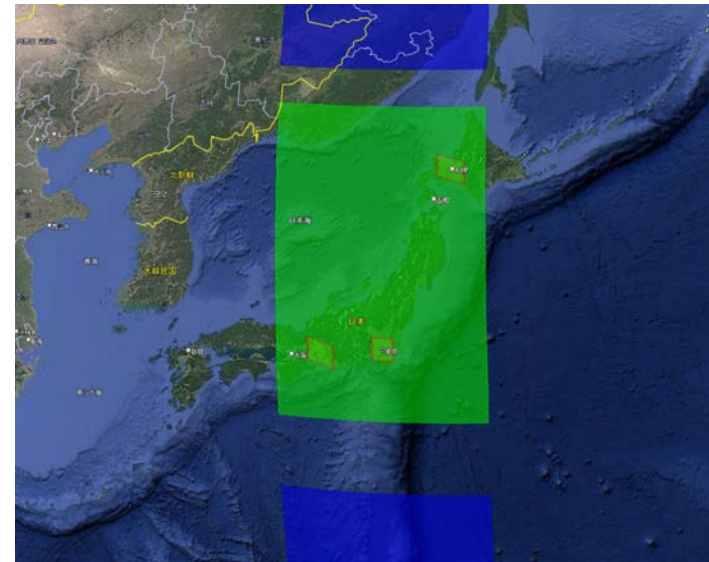
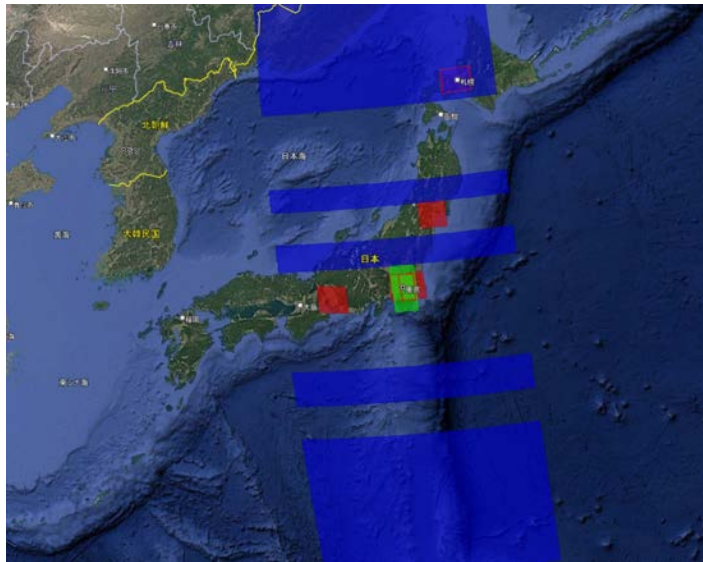
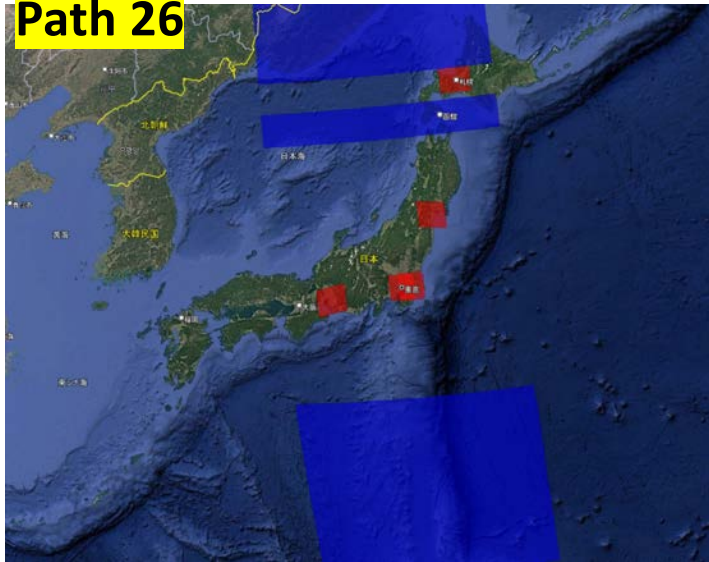
- Wide swath $\approx 911 \text{ km}$
- Footprint $\approx 10 \text{ km}$
- Push-broom, No AT/CT Pointing
- Standard operation

GOSAT-GW Overpasses

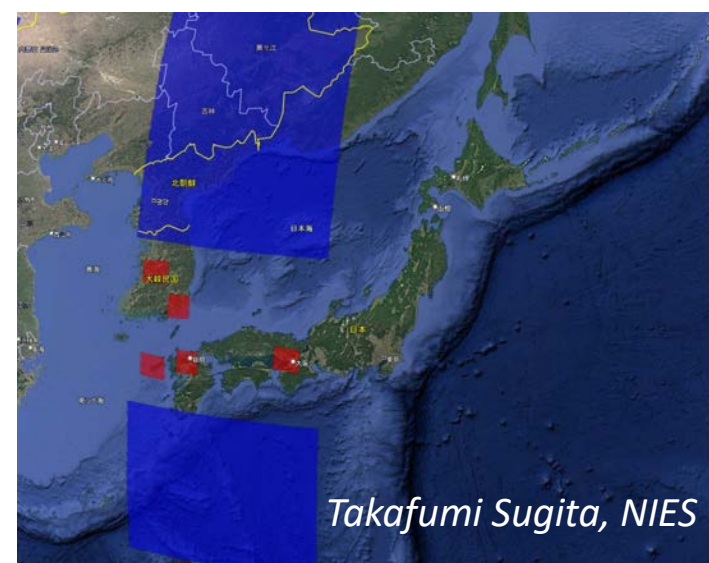
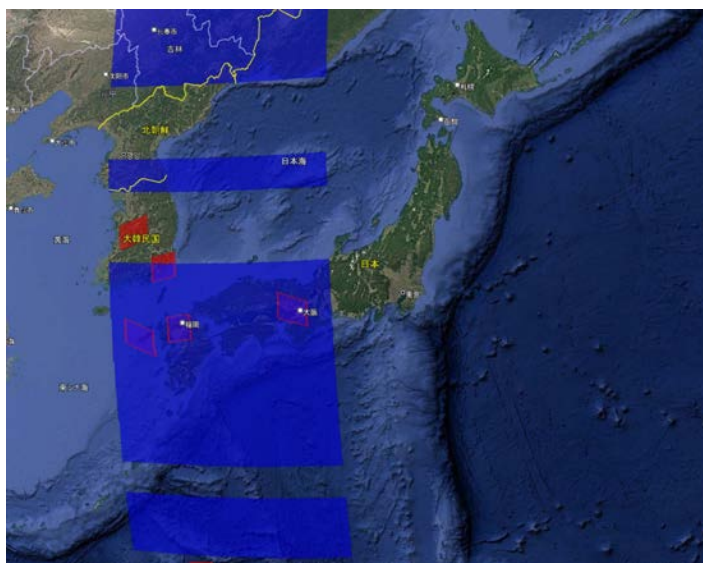
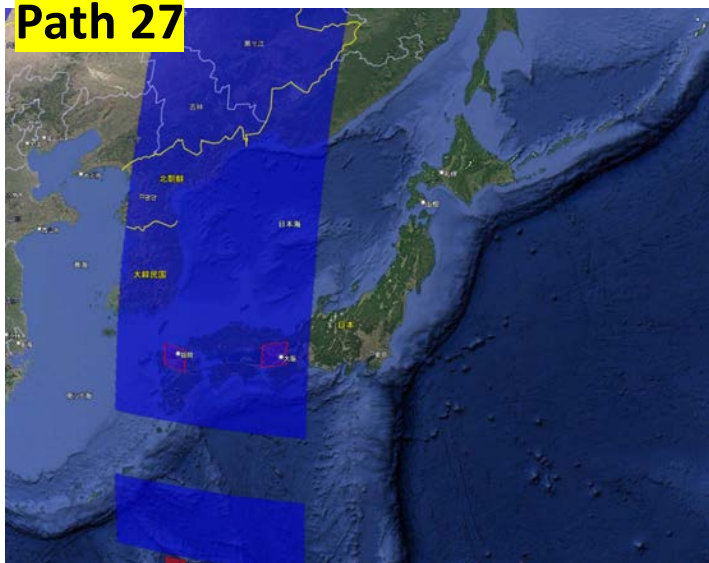


Sun	Mon	Tue	Wed	Thu	Fri	Sat
3/1	3/2	3/3	3/4	3/5	3/6	3/7
3/8	3/9	3/10	3/11	3/12	3/13	3/14
3/15	3/16	3/17	3/18	3/19	3/20	3/21
3/22	3/23	3/24	3/25	3/26	3/27	3/28
3/29	3/30	3/31	4/1	4/2	4/3	4/4

Path 26



Path 27

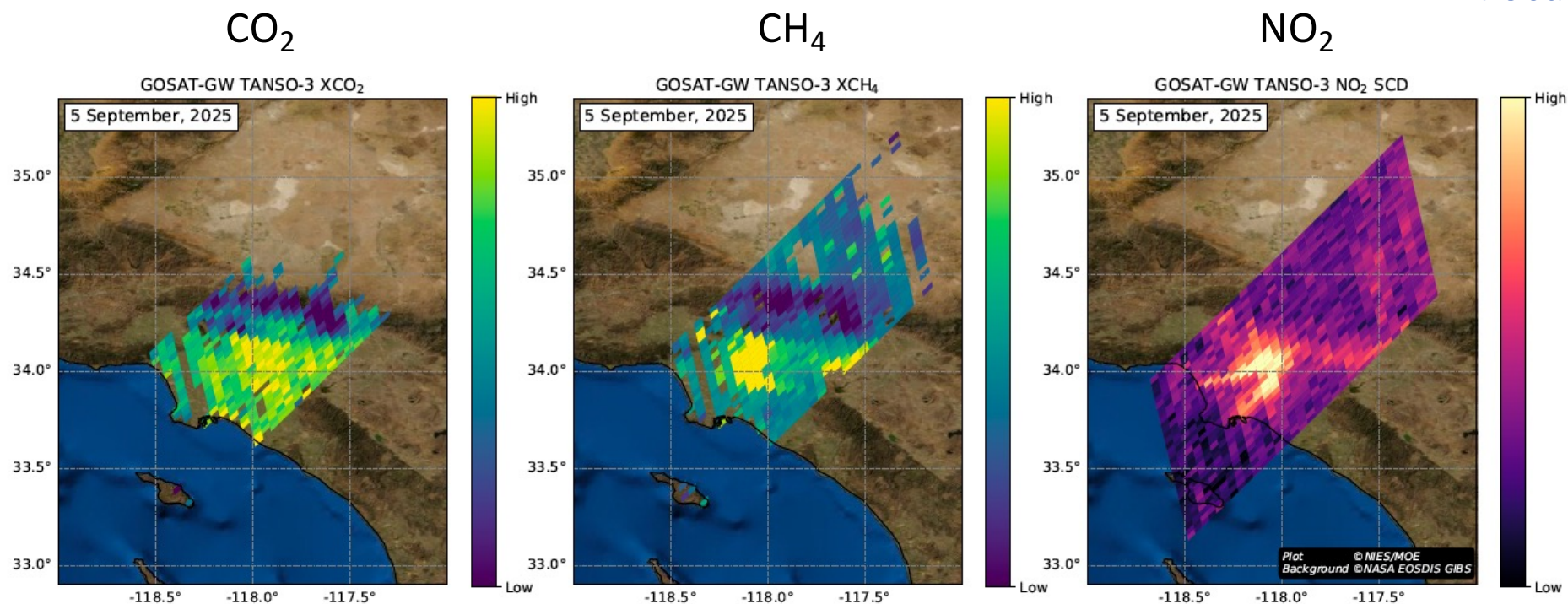


Takafumi Sugita, NIES



First results of co-located CO₂, CH₄, and NO₂ from GOSAT-GW

Focus Mode



Yu Someya, Tamaki Fujinawa, Hyunkwang Lim, NIES

!! CAUTION !! Initial analysis based on preliminary data



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FTIR sites

Worldwide NDACC-IRWG TCCON stations



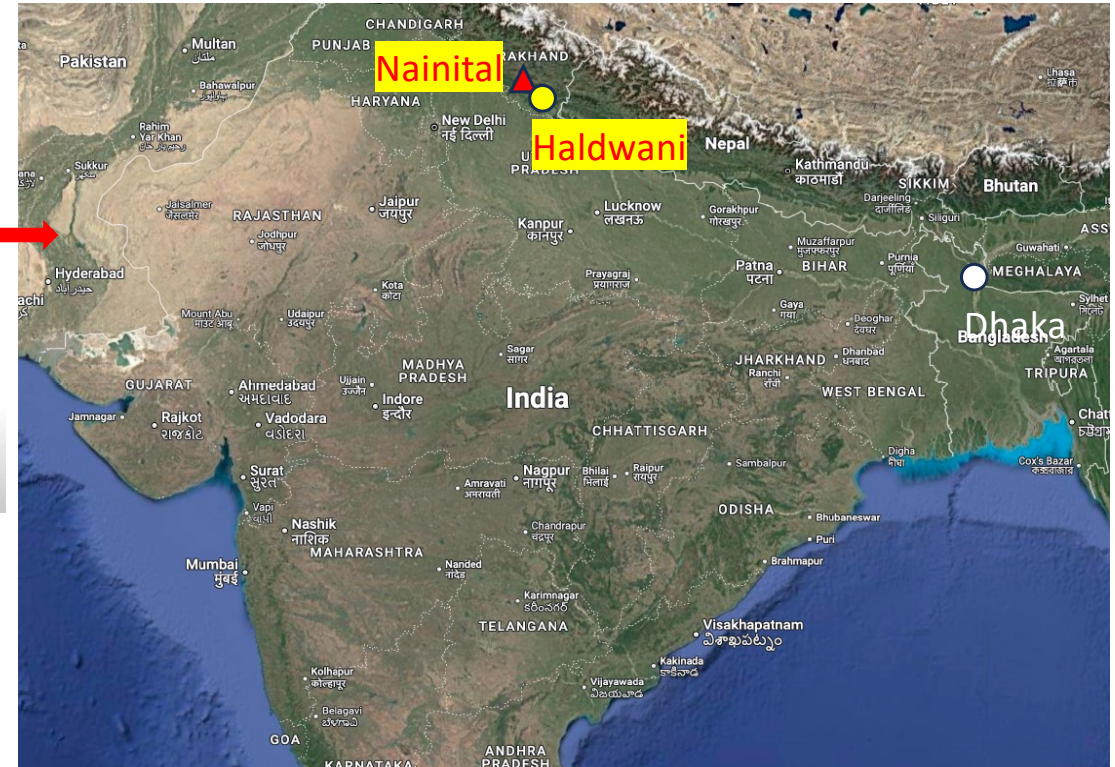
Worldwide COCCON stations



- Year-long observations of columnar CO₂ and CH₄ using EM27 were made during September 2015 – July 2016. However, they were discontinued and not yet recovered.
- Joint collaboration between NIES (Isamu Morino), BIRA-IASB (Mahesh Kumar Sha and Martine De Maizière) and Indian Institutes (IISER, Kolkata, IISER-Bhopal and PRL- Ahmedabad) following a discussion at the IRWG/TCCON/COCCON annual meeting in Spa, Belgium, June 2023

Mahendar Rajwal, NIES

Pandora sites



Only two Pandonia Network sites in India

- Nainital and Haldwani since January 2024 (ARIES: Manish Naja)
- In collaboration with Jim Crawford (NASA Langley) and Hiroshi Tanimoto (NIES)
- Three more Pandoras will be shipped and installed in India

Mahendar Rajwal, NIES

New TCCON, COCCON, and NDACC FTS sites in India

Isamu Morino, NIES

IISER-Kolkata



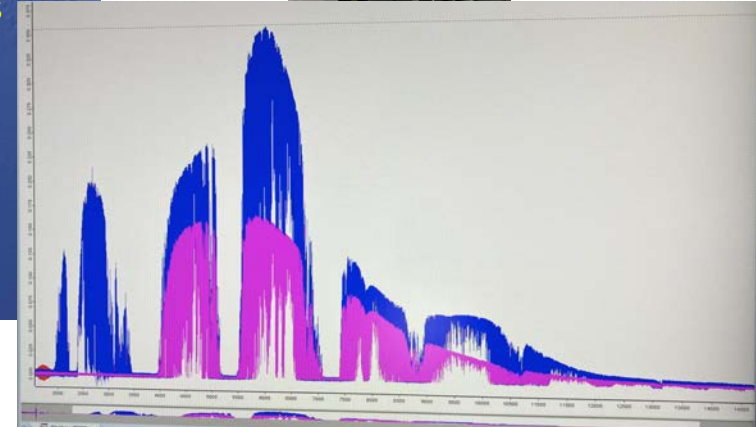
PRL-Ahmedabad



Roof of the building at PRL



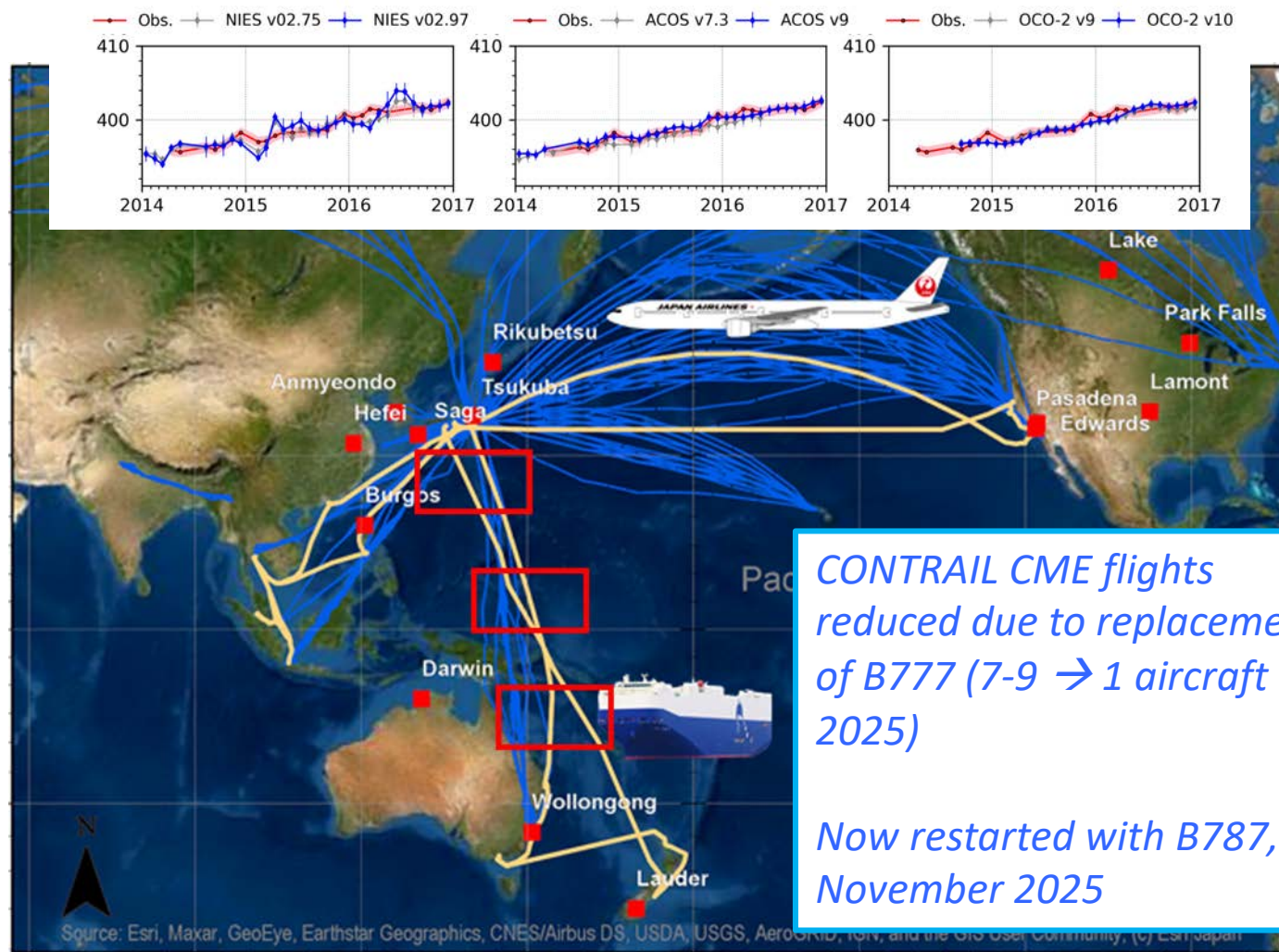
Roof of the building and the observatory at IISER-Bhopal



We have started the new ground-based FTS measurement project focusing on India with the aim to have the first ones starting in 2026 as one of the **GOSAT-GW validation activities**.

NIES (Morino), BIRA-IASB (Sha, De Mazière, Desmet, Kumps, Langerock, Boonants, Vigouroux), IISER-Kolkata (Ray, Banerjee), IISER-Bhopal (Pillai, Kumar), PRL (Gadhavi)

Integrated ship-aircraft evaluation of XCO₂ over open oceans



- Application to other Pan-Pacific areas – **North Pacific, Southeast Asia**
- Application to other species such as **CH₄ and CO**
- Application to other areas of open oceans such as the **Atlantic**, where **in situ (continuous) GHG data from IAGOS** will be available
- Extension of the record in a **timely manner** and providing to the community as **operational products**

*Mueller et al.,
ACP 2021, AMT 2023*

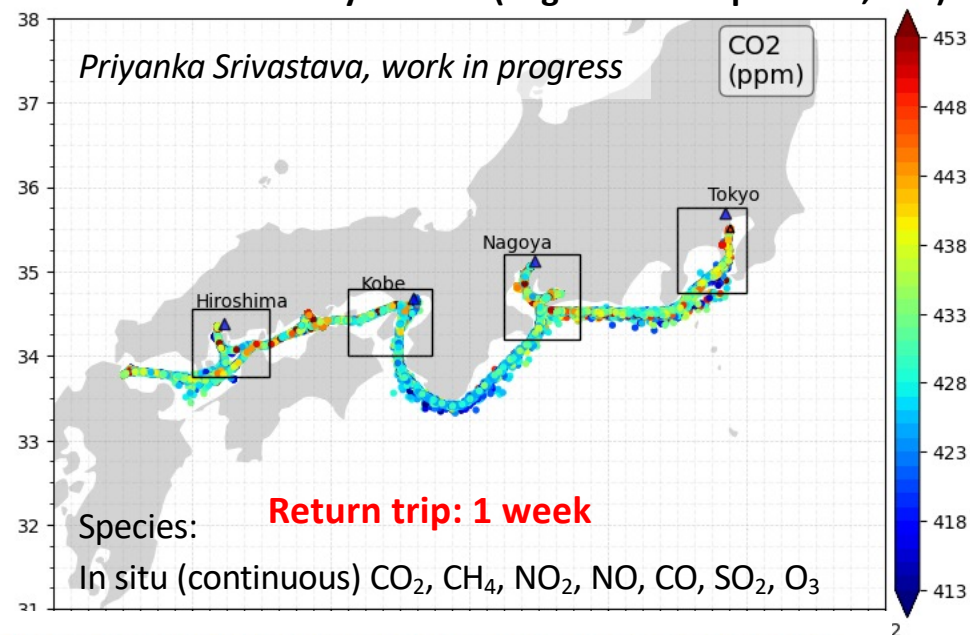
*Astrid Mueller, Hiroshi Tanimoto,
Takafumi Sugita, Prabir Patra et al.*

Cargoship-based EM27/Sun & DOAS



- Satellite validation
- Continuous emission monitoring
- Plume transects from point sources

Vehicle carrier "Nichiyu Maru" (Kagoshima Senpaku Co., Ltd.)



Towards routine shipborne measurements of columnar CO₂, CH₄, CO, and NO₂: a case study for tracking regional-scale emission patterns

Vincent Enders^{1,2}, Astrid Müller³, Matthias Max Frey^{3,4}, Frank Hase⁴, Ralph Kleinschek¹, Marvin Knapp^{1,5}, Benedikt Löw¹, Isamu Morino³, Shin-Ichiro Nakaoka³, Hideki Nara³, Hiroshi Tanimoto³, Sanam N. Vardag^{1,6}, Karolin Voss¹, and André Butz^{1,6}

¹Institute of Environmental Physics (IUP), Heidelberg University, Heidelberg, Germany

²Institute of Materials Chemistry, TU Wien, Vienna, Austria

³National Institute for Environmental Studies (NIES), Tsukuba, Japan

⁴Institute of Meteorology and Climate Research (IMKASF), Karlsruhe Institute of Technology (KIT)

⁵Harvard John A. Paulson School of Engineering and Applied Sciences, Harvard University, Cambridge

⁶Heidelberg Center for the Environment (HCE), Heidelberg University, Heidelberg, Germany

Correspondence: André Butz (andre.butz@uni-heidelberg.de), Hiroshi Tanimoto (tanimoto@nies.go.jp)

AMT, April 2026



The Tokyo Field Campaign (**Tokyo-FC**) is a collaborative airborne field campaign with the overarching goal to validate products retrieved by Japan's latest satellite instrument, Global Observing SATellite for Greenhouse gases and Water cycle (GOSAT-GW), launched in June 2025.



Tokyo FC – Airborne validation campaign for GOSAT-GW

- Since the launch of GOSAT in 2009, Japan and the United States have worked closely together
- Multiple satellites: GOSAT, GOSAT-2, GOSAT-GW, OCO-2, OCO-3 (ISS), TEMPO
- International collaboration and leadership in CEOS (Committee Earth Observation Satellite)
- Hiroshi Tanimoto (NIES) and Emma Knowland (NASA)—Previously Barry Lefer (NASA) as co-chairs of CEOS AC-VC along with Ben Veihelmann (ESA)
- NASA aircraft observations in Asia: KORUS-AQ 2016, ASIA-AQ 2024

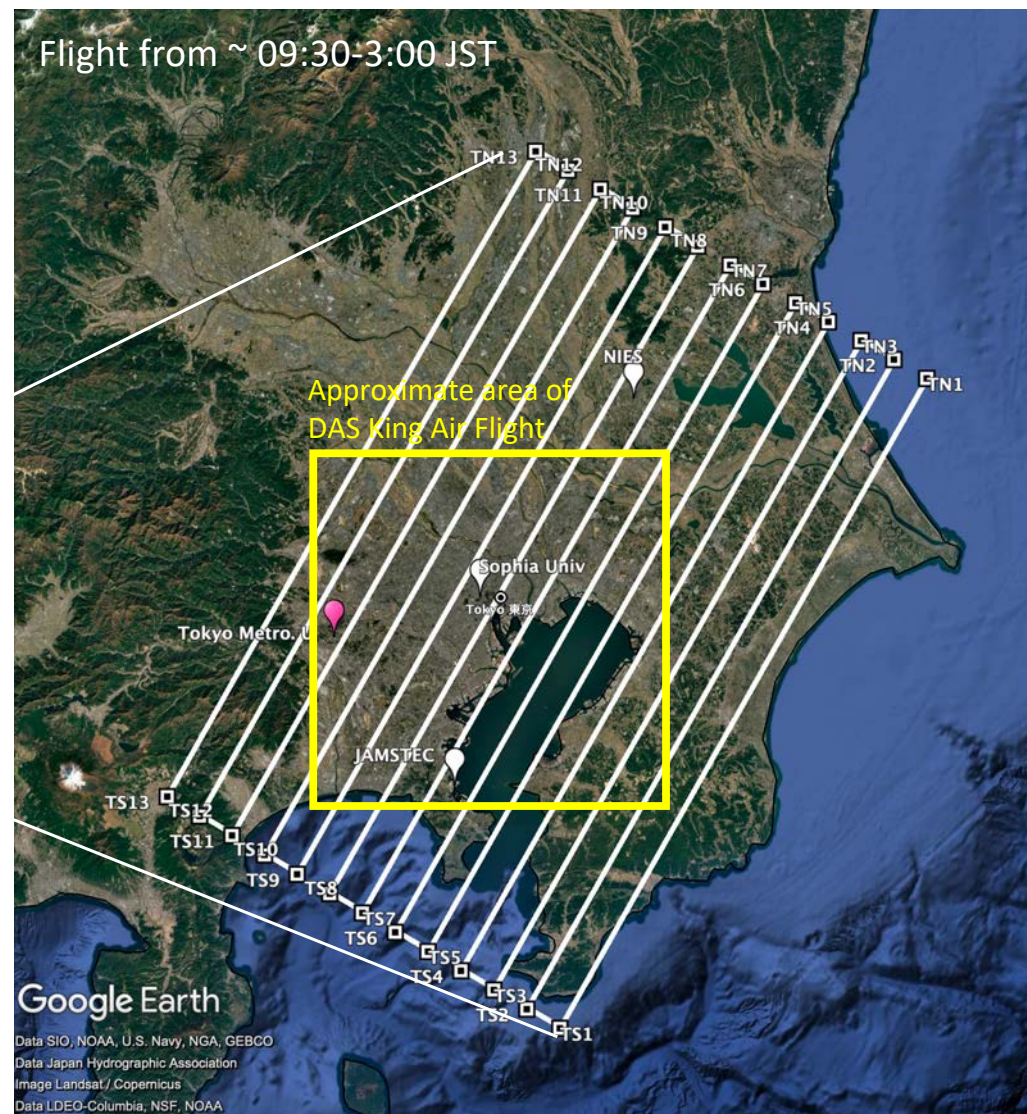
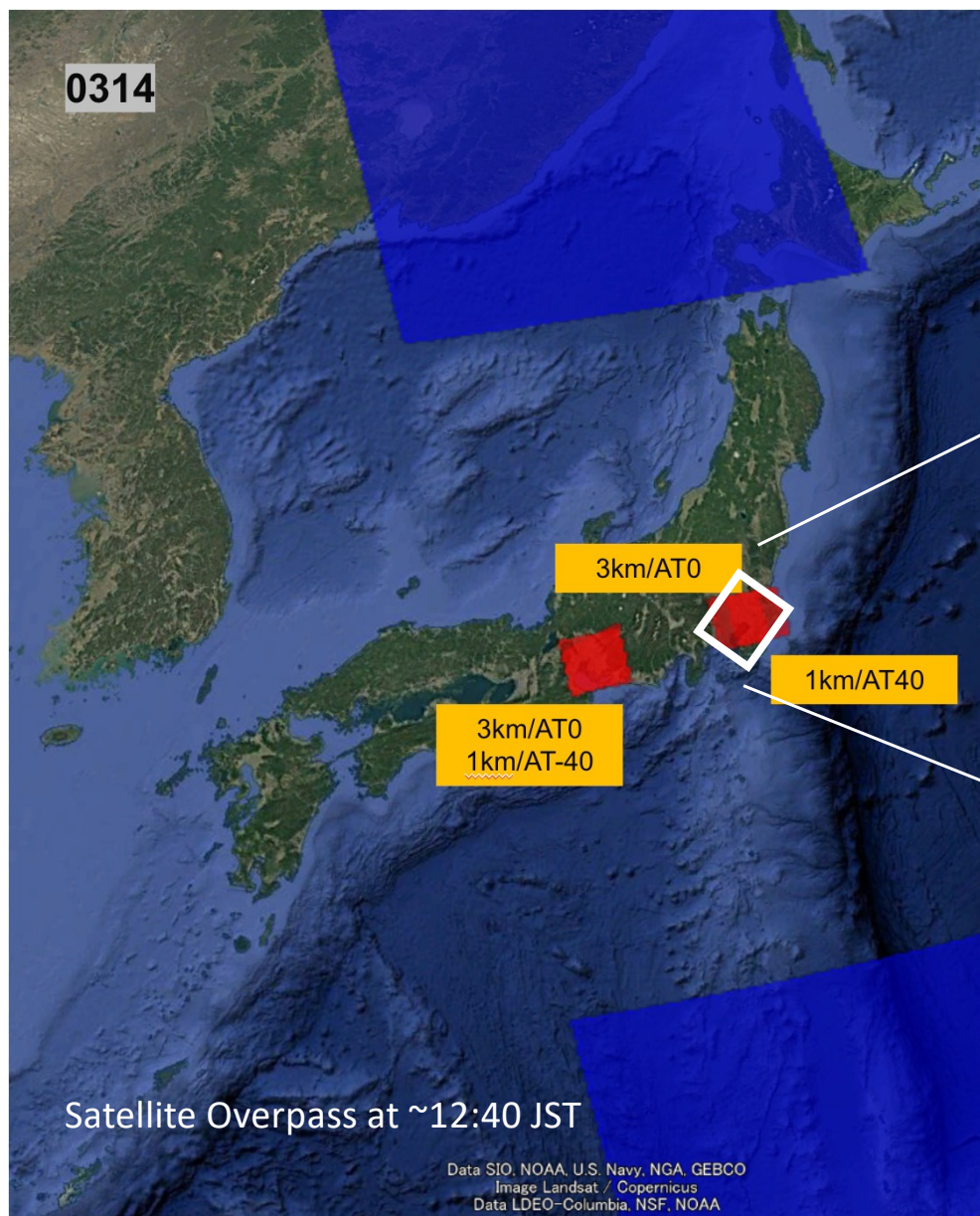
Laura Judd, NASA Langley



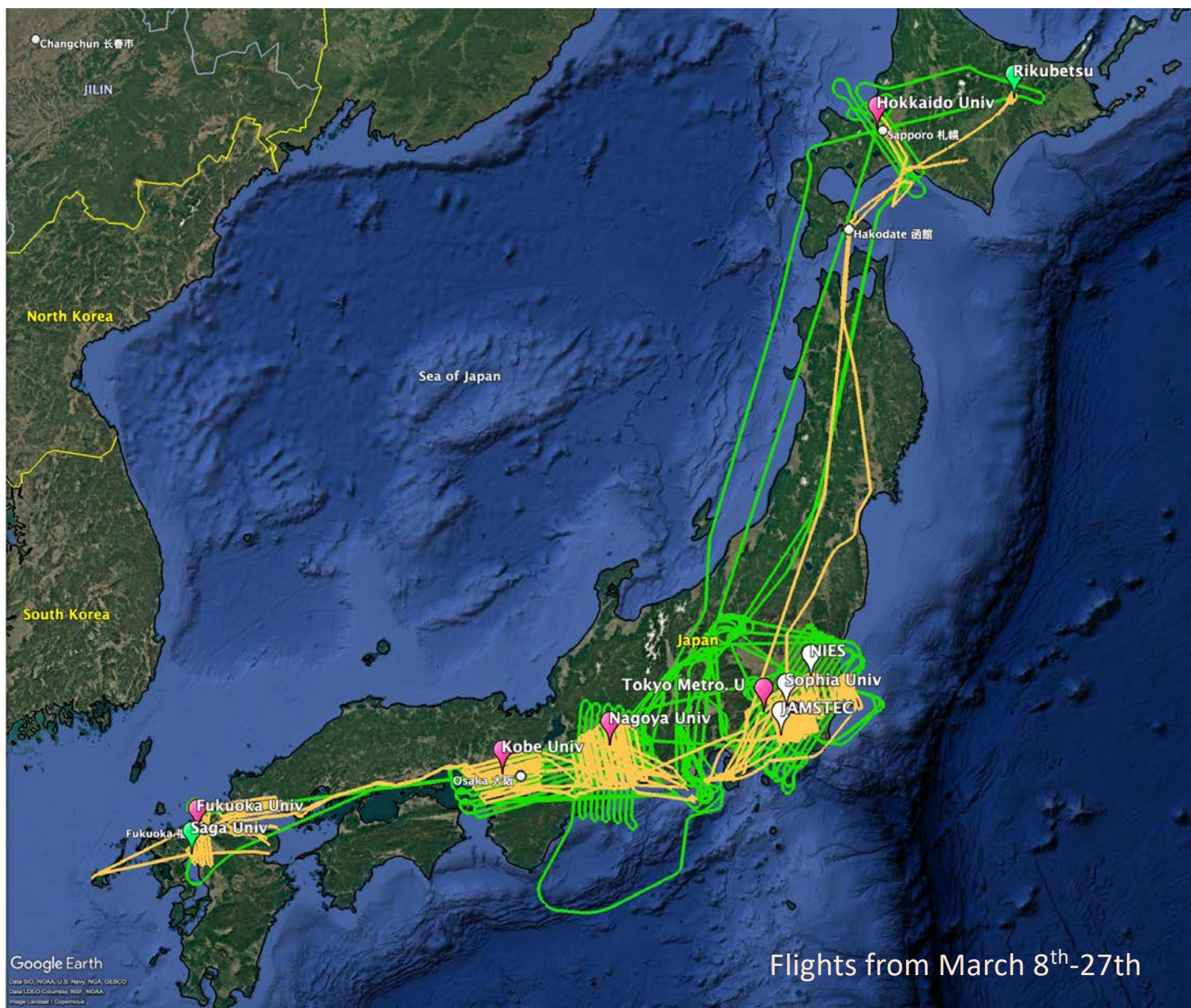
Hiroshi Tanimoto, NIES



Barry Lefer, NASA



Laura Judd, NASA Langley



Green lines: G-III Flight Lines
(~54+ flight hours)

Yellow lines: DAS King Air Flight Lines

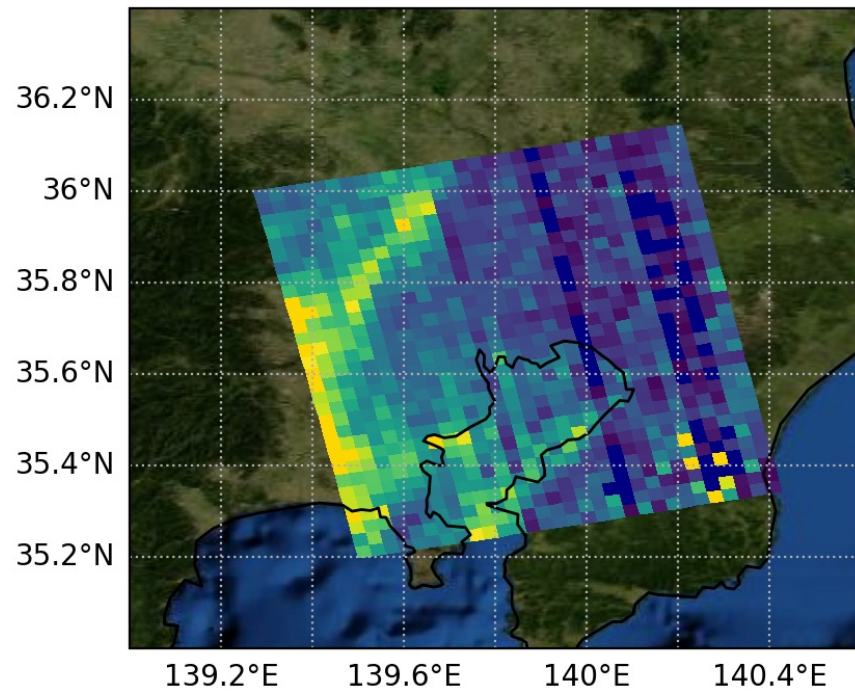
Flight hours were optimized to fly over ground sites, known strong emission sources, and coinciding with GOSAT-GW overpasses:

- Ground sites shown by labeled balloons
- GOSAT-GW Coincidences included (focus/wide):
 - 2 Hokkaido
 - 3 Tokyo
 - 4 Nagoya
 - 2 Osaka
 - 1 Fukuoka/western Japan

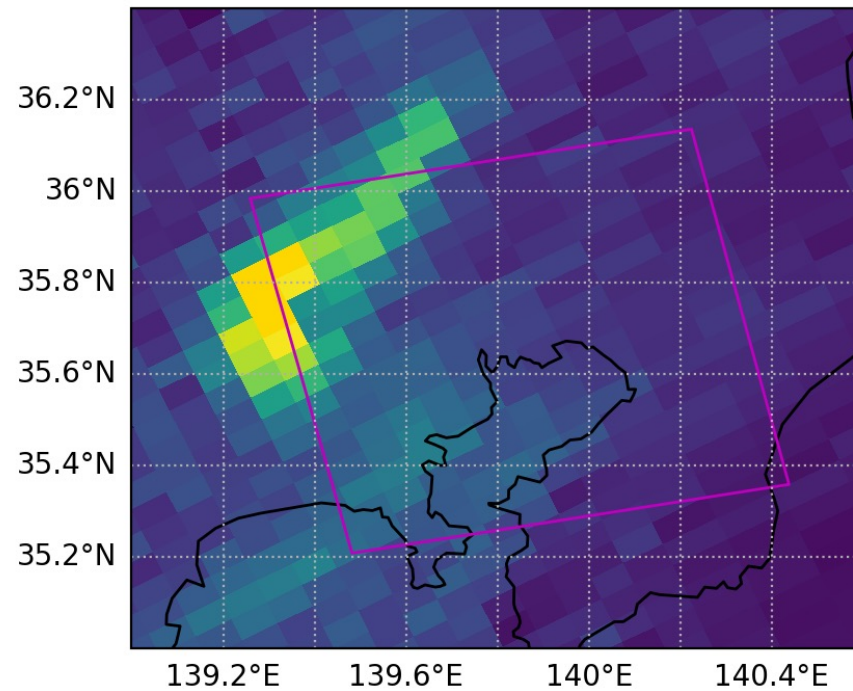
Laura Judd, NASA Langley

GOSAT-GW captured the extent of the fire plume, similarly to the Gold standard satellite for NO₂, TROPOMI

March 14th at 12:40 JST
GOSAT-GW trop VCD



March 14th at 13:33 JST
TROPOMI trop VCD



Laura Judd, NASA Langley

Pmolec. cm⁻²

Data courtesy of Tamaki Fujinawa NIES



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<https://gosat-gw.nies.go.jp/en/>