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

Hiroshi Tanimoto, *Science and Application Lead*
Tsuneo Matsunaga, *Project Management Lead*

National Institute for Environmental Studies, Japan

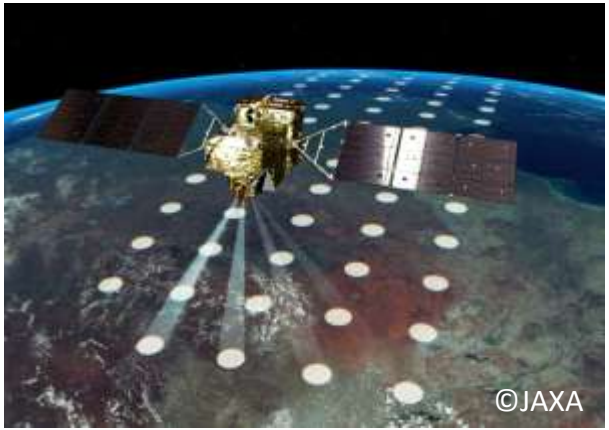
with
Takafumi Sugita, Hisashi Yashiro, Isamu Morino, Makoto Saito, Hirofumi Ohyama, Satoshi Inomata, Kohei Ikeda, Yu Someya, Tamaki Fujinawa, Yukio Yoshida, Yosuke Yamashita, Astrid Müller, Matthias Frey, Hyunkwang Lim, Tazu Saeki, Nobuko Saigusa, Yugo Kanaya, Takashi Sekiya, Prabir Patra, Masayuki Takigawa, Masahiro Yamaguchi, Jagat Bisht, Yasko Kasai, Tomohiro Sato

National Institute for Environmental Studies (NIES)
Japan Agency for Marine-Earth Science and Technology (JAMSTEC)
National Institute of Information and Communications Technology (NICT)

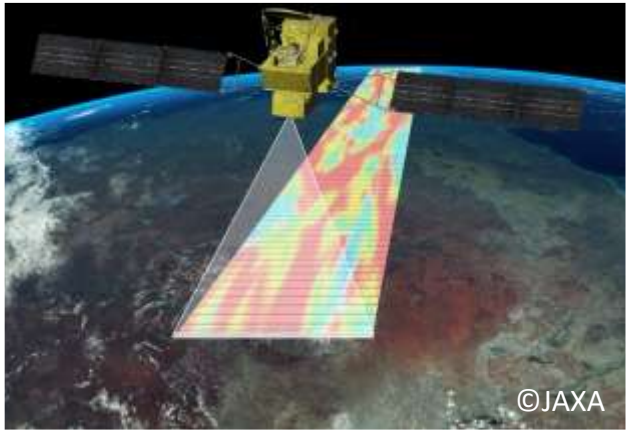
GOSAT, GOSAT-2, and … GOSAT-GW

GOSAT 2009 --

GOSAT-2 2018 --



GOSAT-GW 2025 --



- TANSO-3 funded by MOEJ, AMSR3 (Advanced Microwave Scanning Radiometer 3) by MEXT
- JAXA is responsible for launch, L0 and L1; NIES for L2 (and higher research products)

TANSO-3 sensor onboard GOSAT-GW

Tanimoto et al.
Progress in Earth and Planetary Science (2025) 12:8
https://doi.org/10.1186/s40645-025-00684-9

Progress in Earth and Planetary Science

RESEARCH ARTICLE Open Access

The greenhouse gas observation mission with Global Observing SATellite for Greenhouse gases and Water cycle (GOSAT-GW): objectives, conceptual framework and scientific contributions

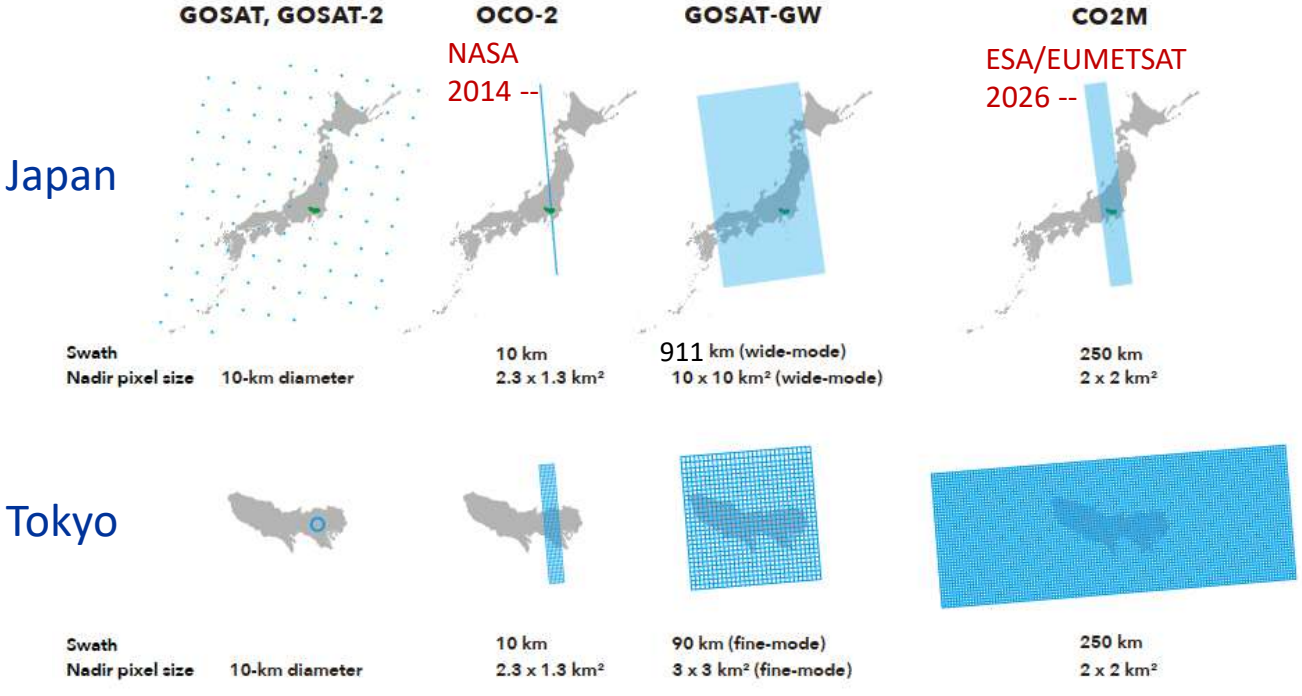
Hiroshi Tanimoto[1*], Tsuneo Matsunaga[1], Yu Someya[1], Tamaki Fujinawa[1], Hirofumi Ohyama[1], Isamu Morino[1], Hisashi Yashiro[1], Takafumi Sugita[1], Satoshi Inomata[1], Astrid Müller[1], Tazu Saeki[1], Yukio Yoshida[1], Yosuke Niwa[1], Makoto Saito[1], Hibiki Noda[1], Yousuke Yamashita[1], Kohei Ikeda[1], Nobuko Saigusa[1], Toshinobu Machida[1], Matthias Max Frey[1], Hyunkwang Lim[1], Priyanka Srivastava[1], Yoshitaka Jin[1], Atsushi Shimizu[1], Tomoaki Nishizawa[1], Yugo Kanaya[2], Takashi Sekiya[2], Prabir Patra[2], Masayuki Takigawa[2], Jagat Bisht[2], Yasko Kasai[3] and Tomohiro O. Sato[3]

	GOSAT-GW
Launch / lifetime	FY2025 / 7 years
Satellite mass / power	2.9 t / 5200 W
Launcher	H-IIA rocket
Orbit	666 km, 13:30, ascending
Repeat cycle	3 days (44 cycles/3days)
Spectrometer	TANSO-3 (Grating) by Mitsubishi Electric
Major targets	CO_2 (FP), CH_4 (FP, Proxy), NO_2 (QDOAS)
Spectral bands	0.45 / 0.7 / 1.6 μm
Spectral Resolution (Sampling interval)	< 0.5 nm @ 0.45 μm, <0.05 nm @ 0.7 μm, < 0.2 nm @ 1.6 μm
Swath	911 km (Wide Mode) or 90 km (Focus Mode)
Footprint size, nadir	10 km (Wide Mode) or 1–3 km (Focus Mode)
Pointing	± 40 / ± 34.4 deg (AT/CT) for Focus Mode

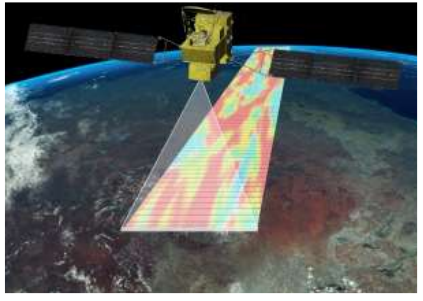
Tanimoto et al., Prog. Earth Planet. Sci., 2025

GOSAT-GW 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 (>6.5 Mt CO2/yr), etc



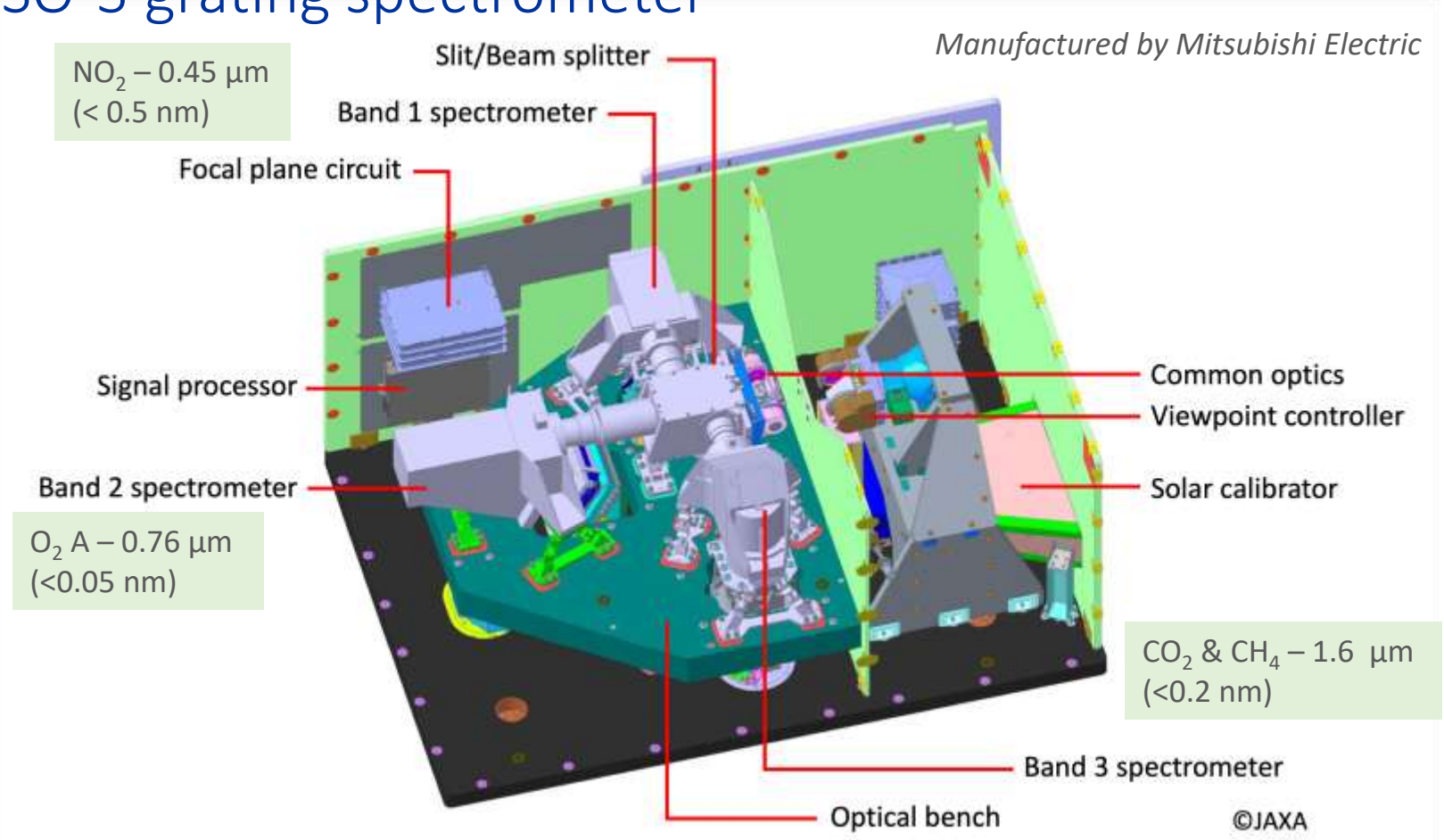
Wide mode



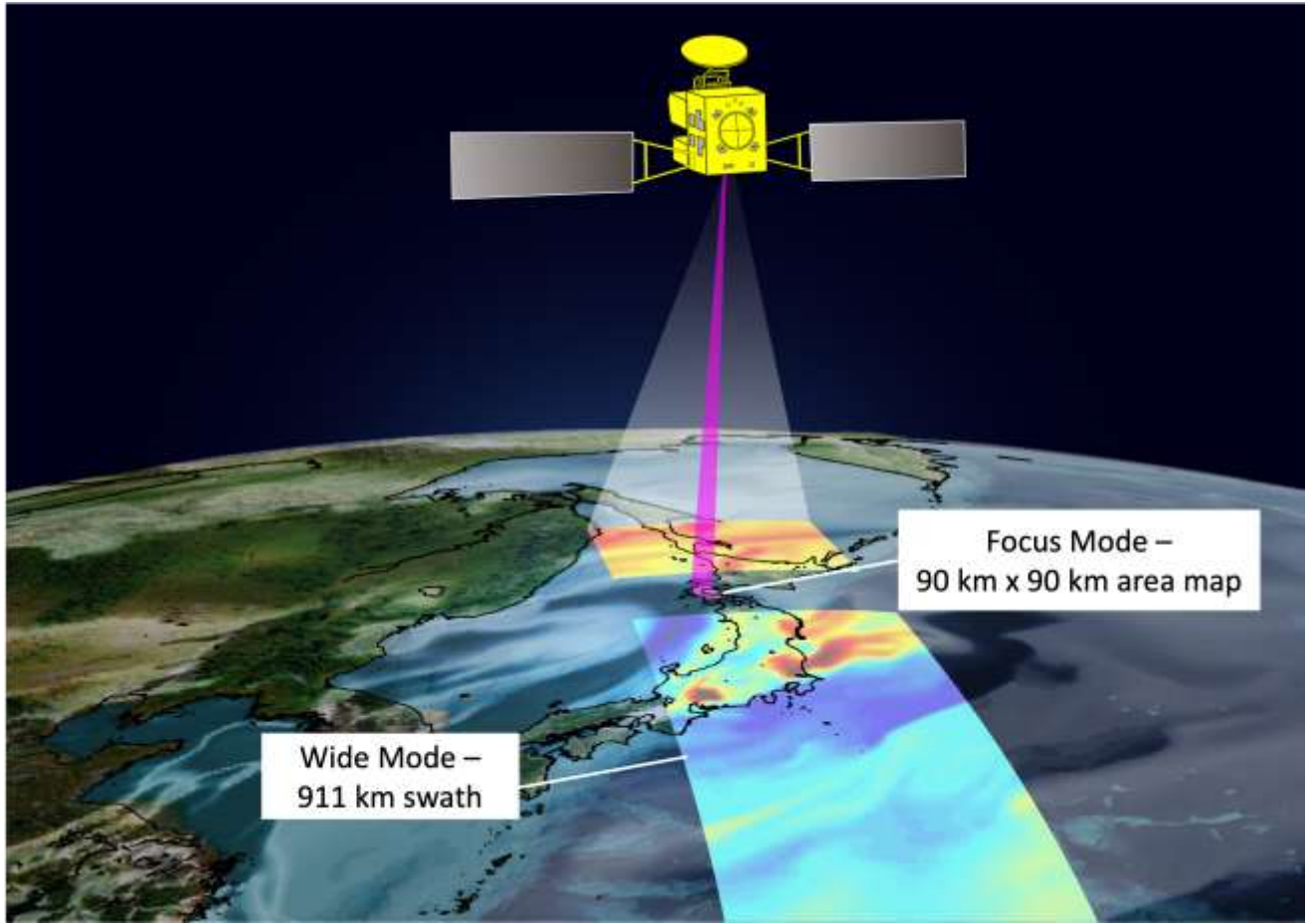
Focus mode

TANSO-3 grating spectrometer

Manufactured by Mitsubishi Electric



Focus mode makes high spatial resolution footprints



Focus Mode

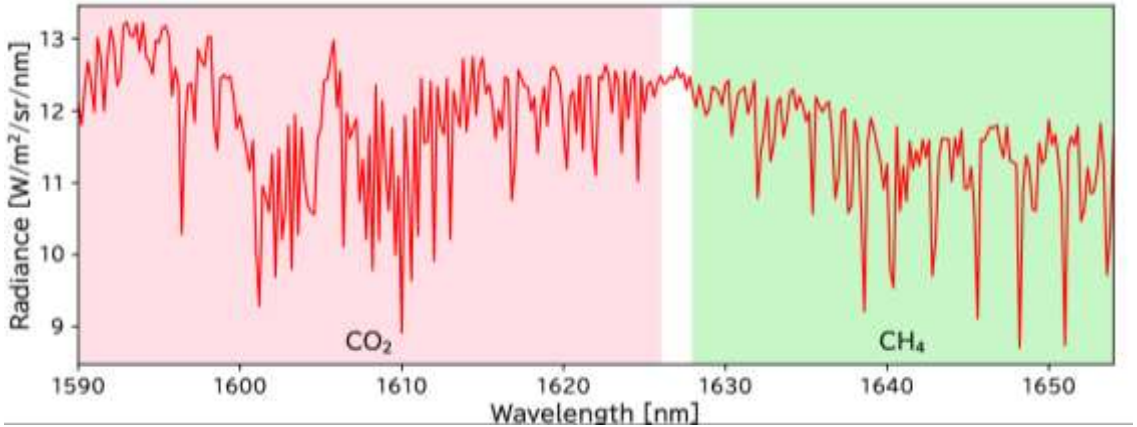
- Target area ≈ 90 km x 90 km
- Footprint ≈ 1 - 3 km
- Push-broom, AT/CT Pointing Func.
- Optional, upon request

Wide Mode

- Wide swath ≈ 911 km
- Footprint ≈ 10 km
- Push-broom, No AT/CT Pointing
- Standard operation

L2 product retrieval algorithm

Main targets	XCO_2, XCH_4	NO_2 (total + tropospheric column)
Other variables	XH_2O, SIF, AOT, ALH, albedo,…	Effective cloud fraction, Aerosol optical parameters
Retrieval technique	Full Physics (XCO_2, XCH_4, …) Proxy (XCH_4)	QDOAS (optical density fitting)
A priori	JRA-3Q (Japanese reanalysis) NICAM (for GHGs and aerosols)	JRA-3Q (Japanese reanalysis) CHASER V4.0 with bias correction (for gas species, such as NO_2, O_3, … and aerosol optical parameters)
Cloud screening	Reflectance test Surface pressure retrieval	Cloud fraction derived from O_2–O_2 absorption @ 477 nm

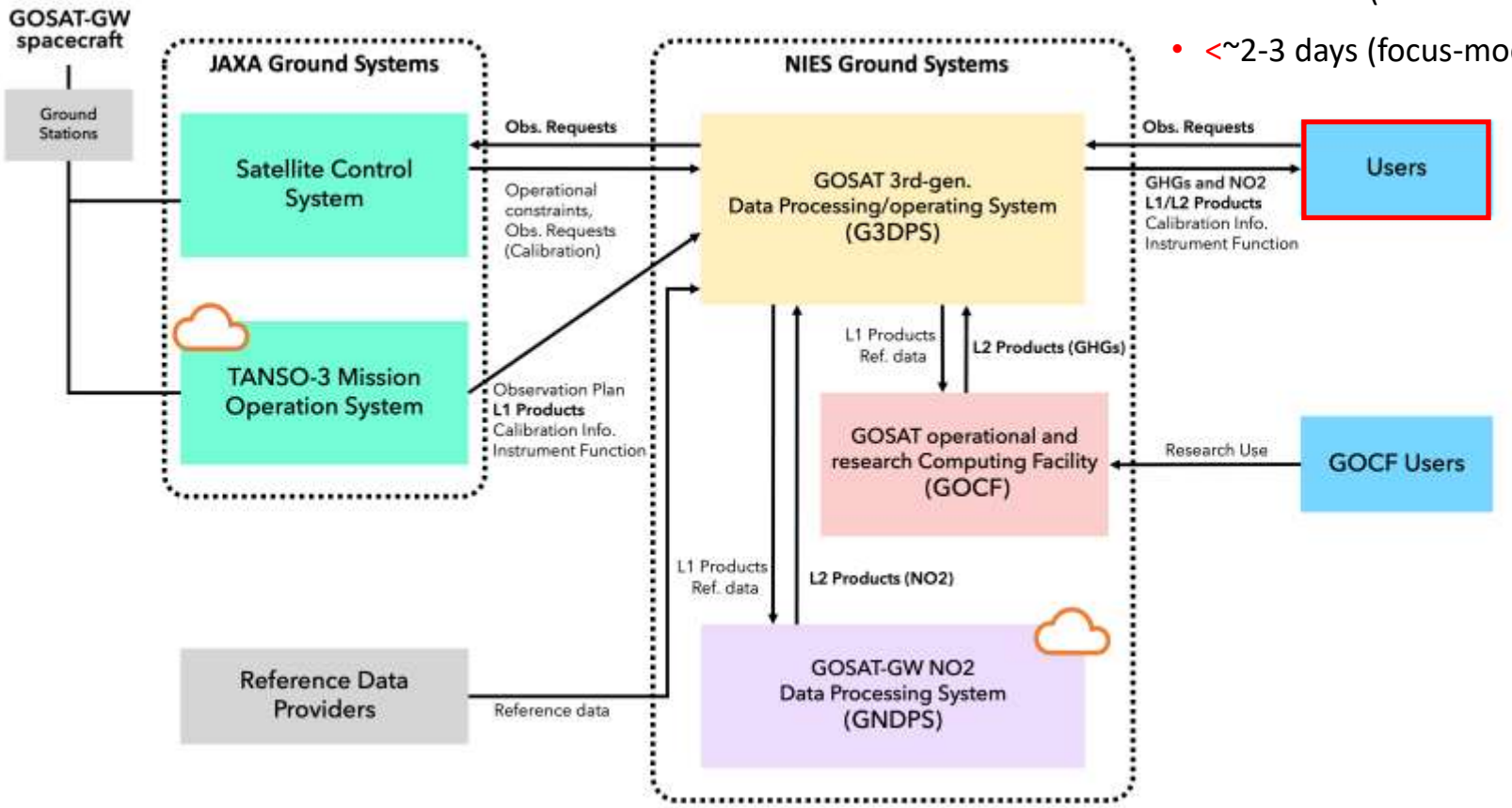


Yu Someya (GHG),
Tamaki Fujinawa, Hyunkwang Lim (NO2)

Ground data processing system

Latency - official products

- <~1 month (wide-swath mode L2)
- <~2-3 days (focus-mode L2)



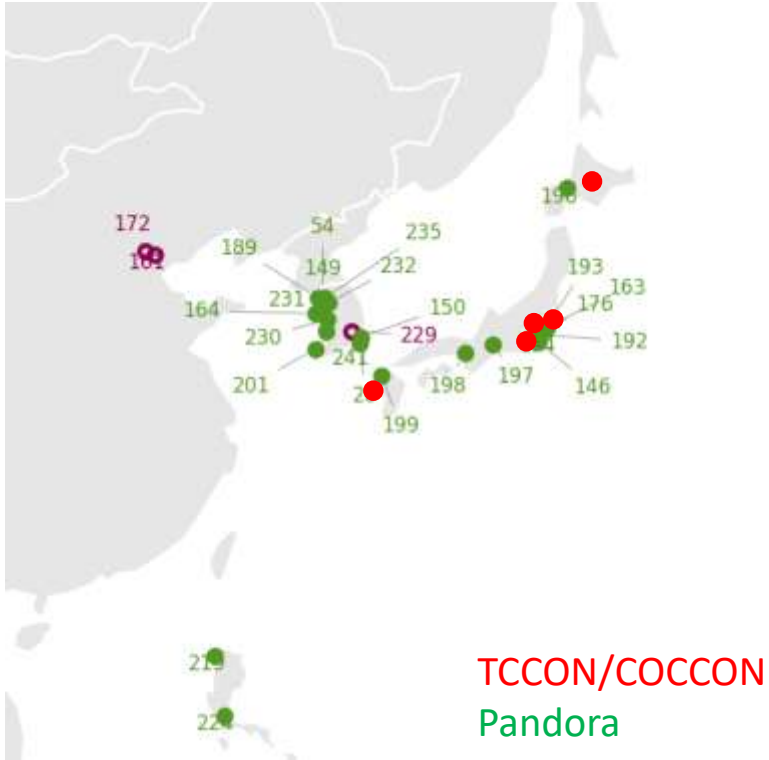
Hisashi Yashiro (GHG), Takafumi Sugita (NO2)

EM27/SUN and Pandora validation

EM27/SUN – CO_2, CH_4, CO

Pandora – NO_2, O_3, HCHO

	CO_2/CH_4		NO_2
	TCCON	EM27/SUN	Pandora
Hokkaido	ONGOING		ONGOING
Tsukuba	ONGOING	ONGOING	ONGOING
Central Tokyo		ONGOING	ONGOING
Suburban Tokyo			ONGOING
Yokosuka		ONGOING	ONGOING
Nagoya			ONGOING
Kobe			ONGOING
Kyushu	ONGOING		ONGOING

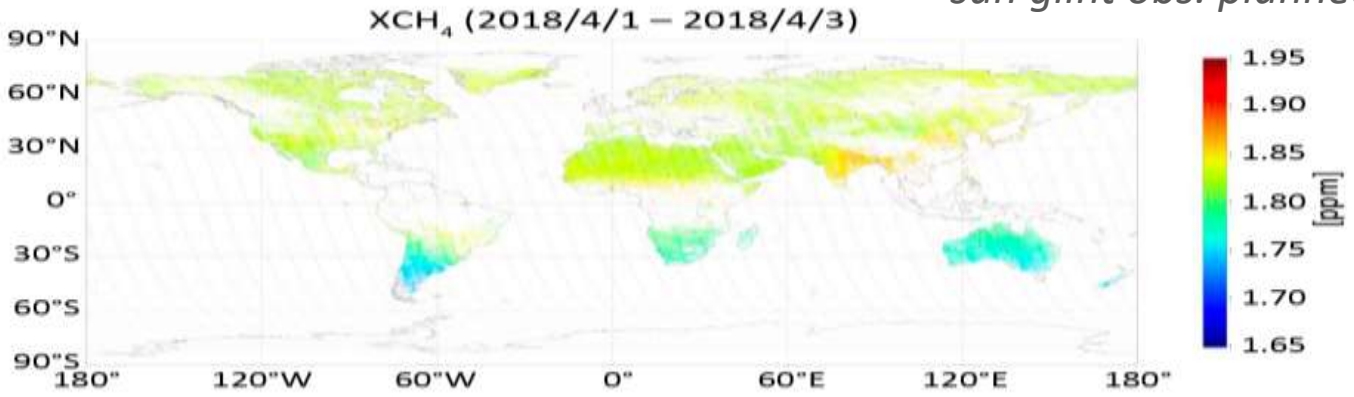


NIES (Morino, Ohyama, Müller, Inomata, Sugita, Fujinawa), JAMSTEC (Kanaya, Patra, Miyakawa)

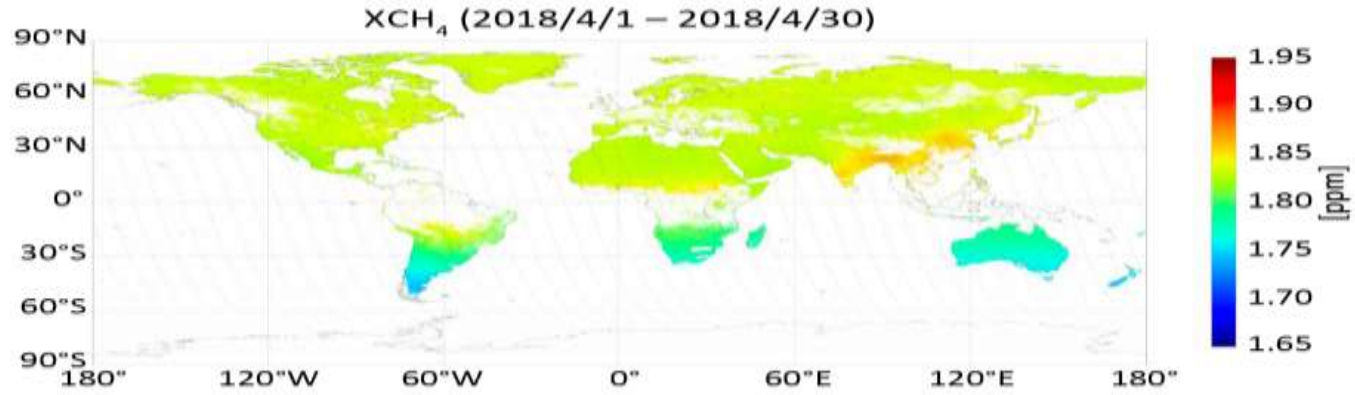
How does GOSAT-GW data look like?

sun glint obs. planned

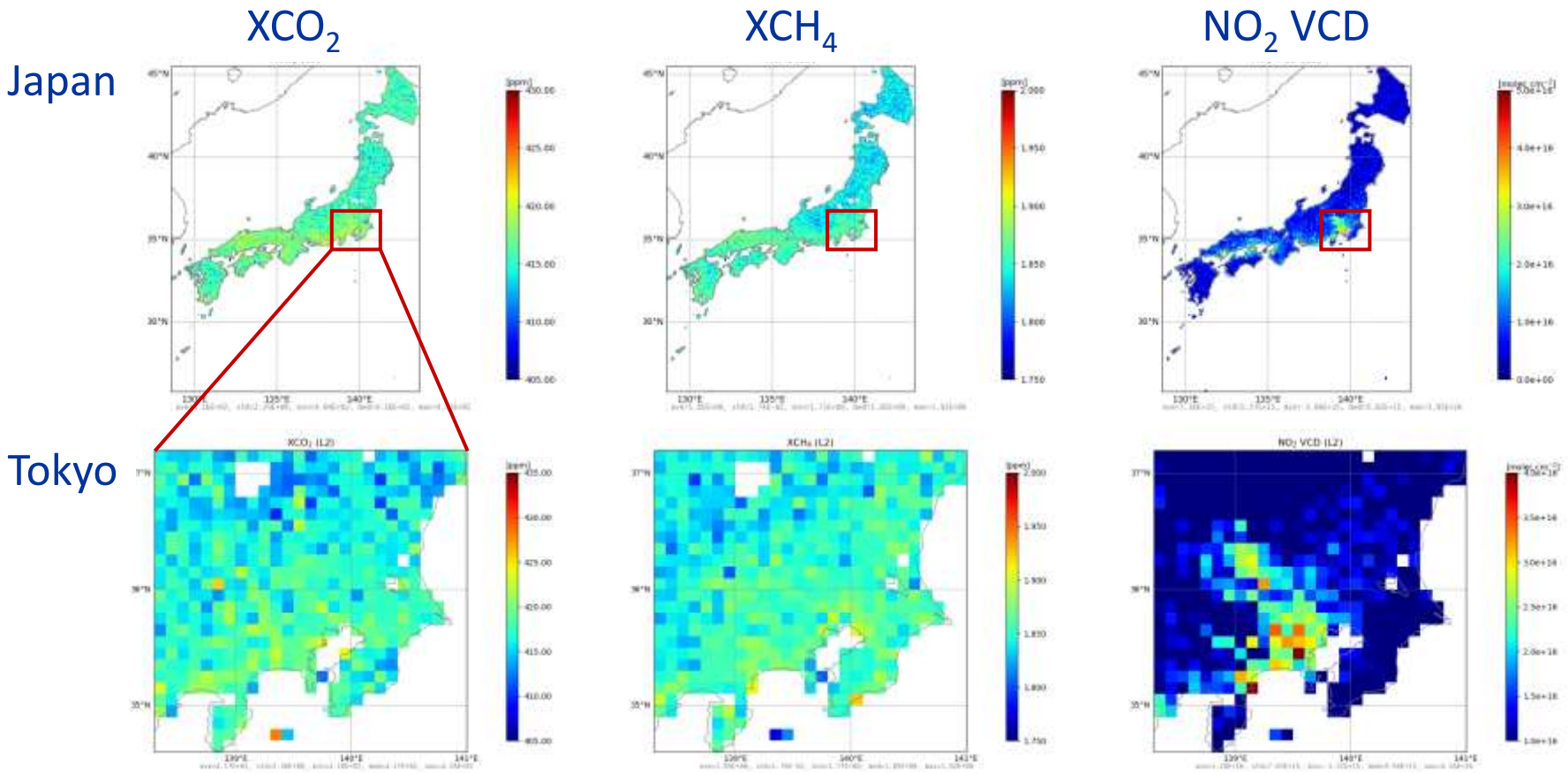
3 days



30 days

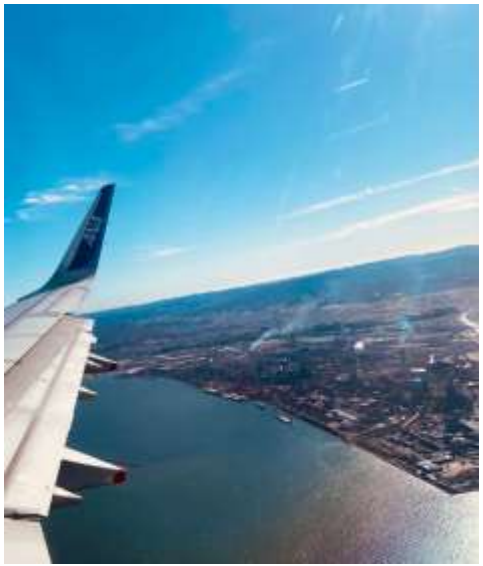


Simulated GOSAT-GW data – 10 km x 10 km



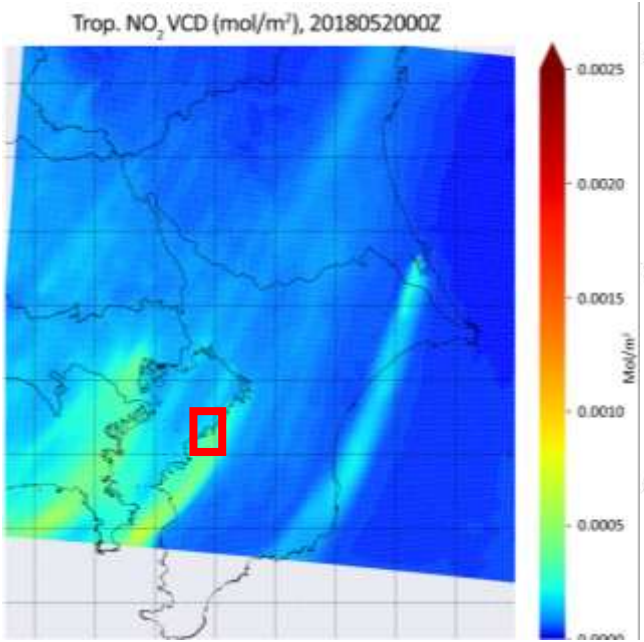
Detection of NOx Emissions from Power Plants

Sodegaura Power Plant

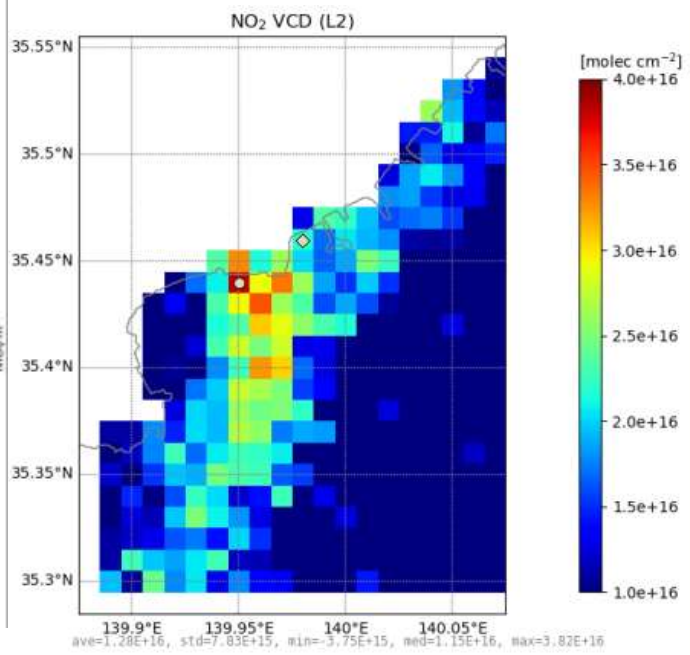


JERA, 3600 MW

1 km x 1 km WRF-Chem model

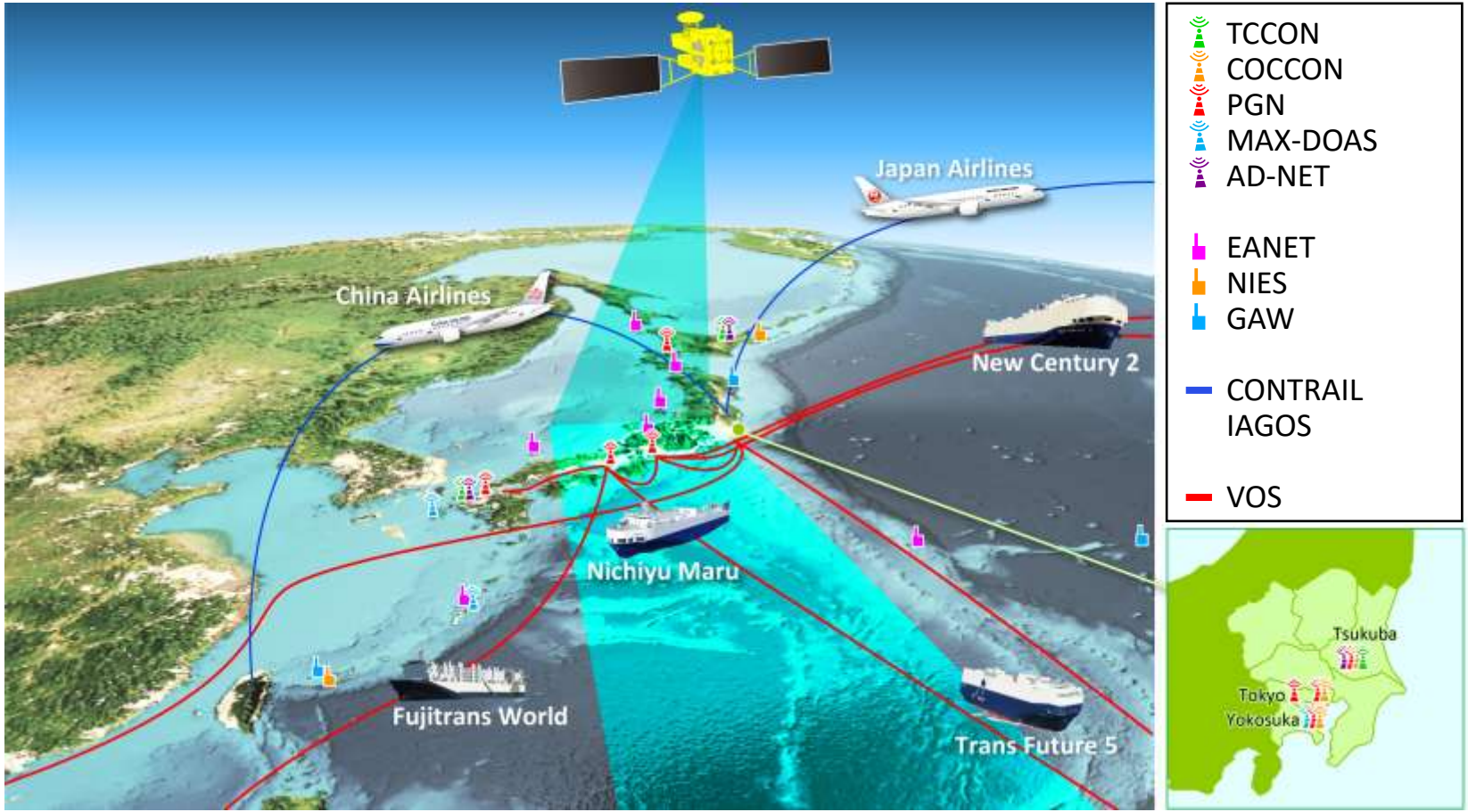


TANSO-3 simulator



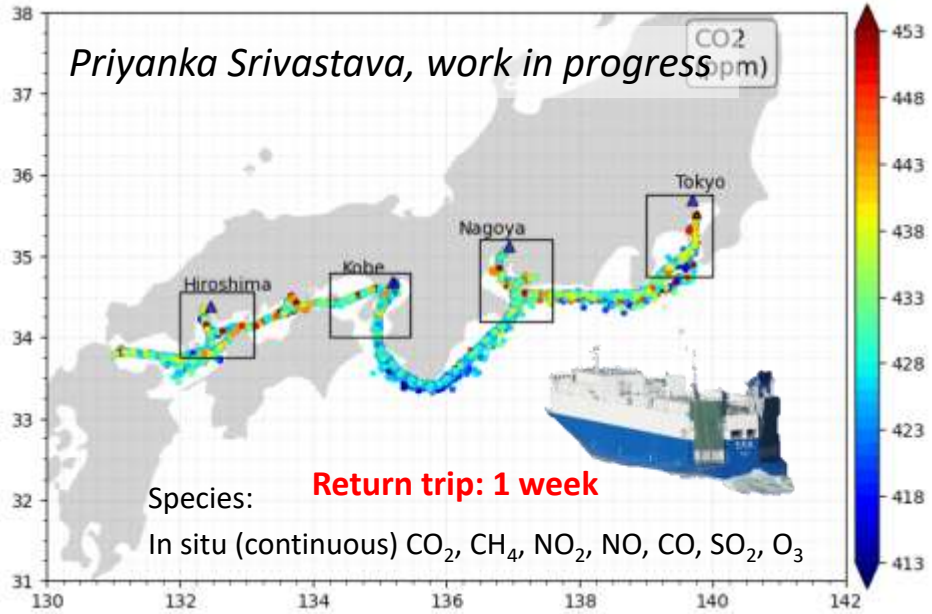
WRF model results:
Masahiro Yamaguchi, Masayuki Takigawa, Prabir Patra, Jagat Bisht, Yugo Kanaya

Extensive validation + supporting observations



Cargoship-based monitoring along Japan's east coast

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



Species:

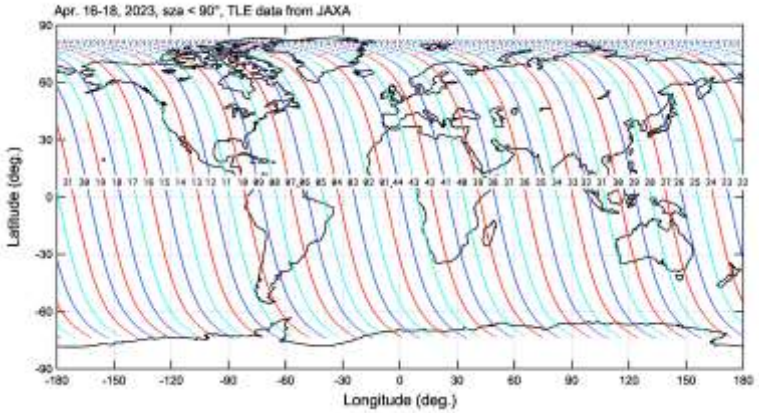
In situ (continuous) CO_2, CH_4, NO_2, NO, CO, SO_2, O_3

Return trip: 1 week

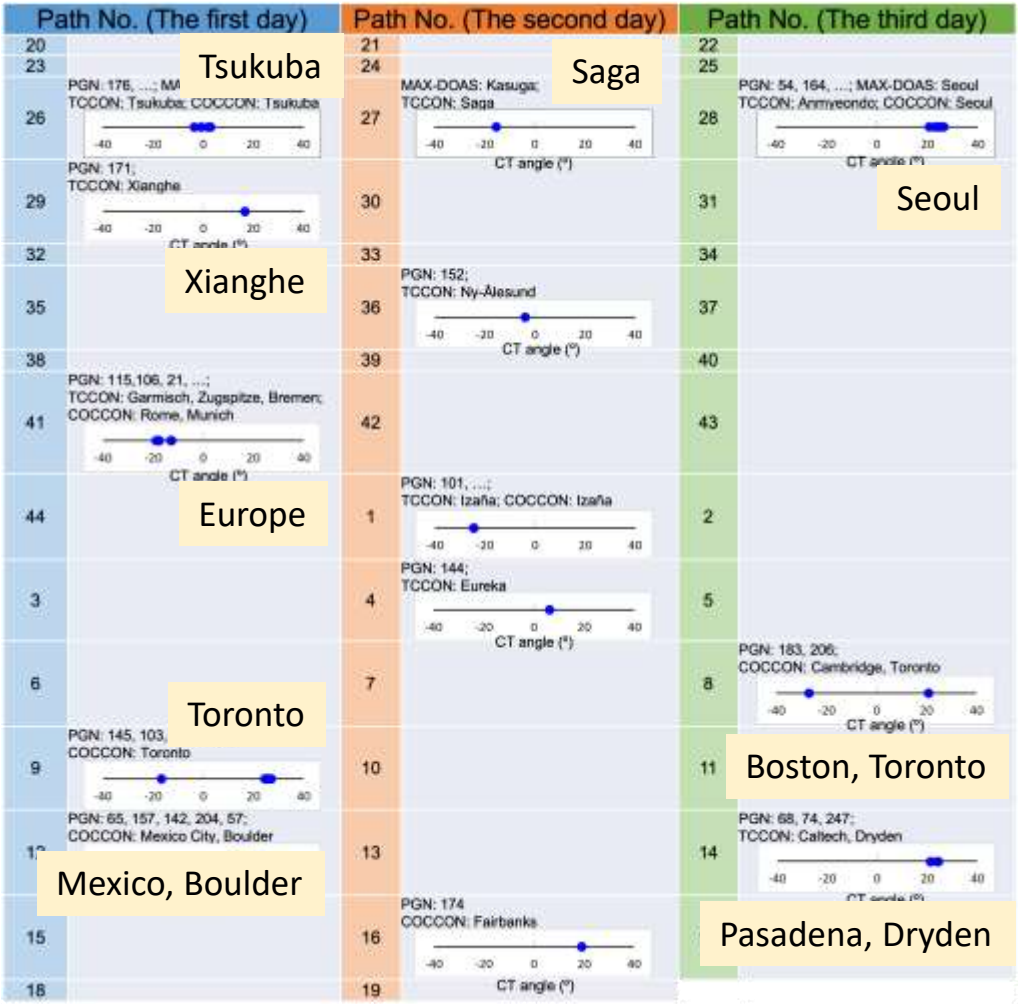
Satellite validation / Continuous emission monitoring / Plume transects from point sources

Collaboration: NIES, Japan (Astrid Müller, Matthias Max Frey, Hiroshi Tanimoto, Isamu Morino, Shin-Ichiro Nakaoka), Heidelberg University, Germany (Ralph Kleinschek, Ken von Buenau, Karolin Voss, Vincent Enders, André Butz)

Focus mode validation

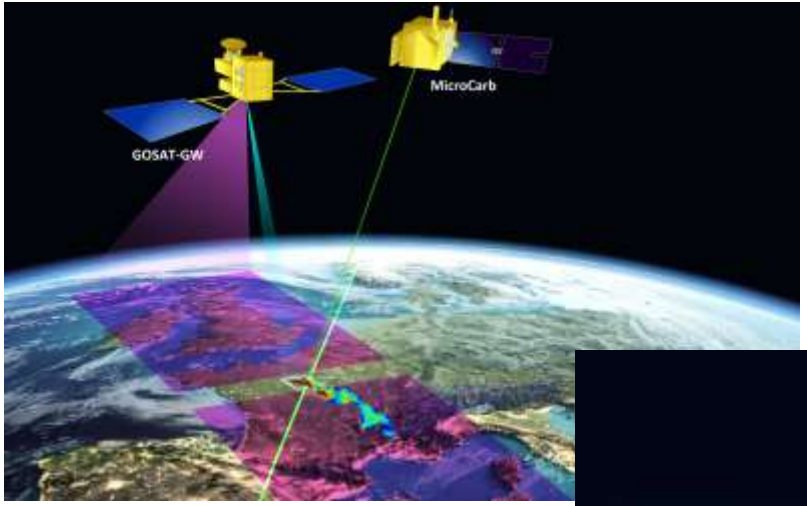


- 3-day global coverage
- <90 focus mode requests possible
- ~18 co-located sites for TCCON/COCCON and PGN (GHG&NO_2)

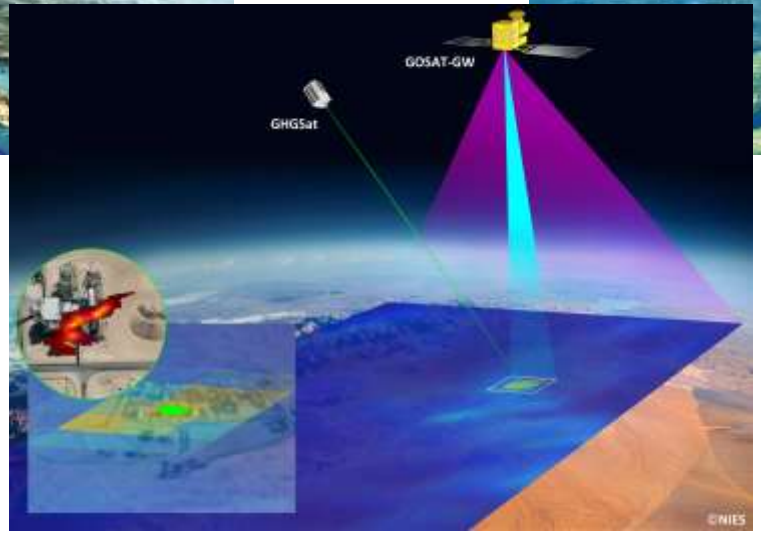


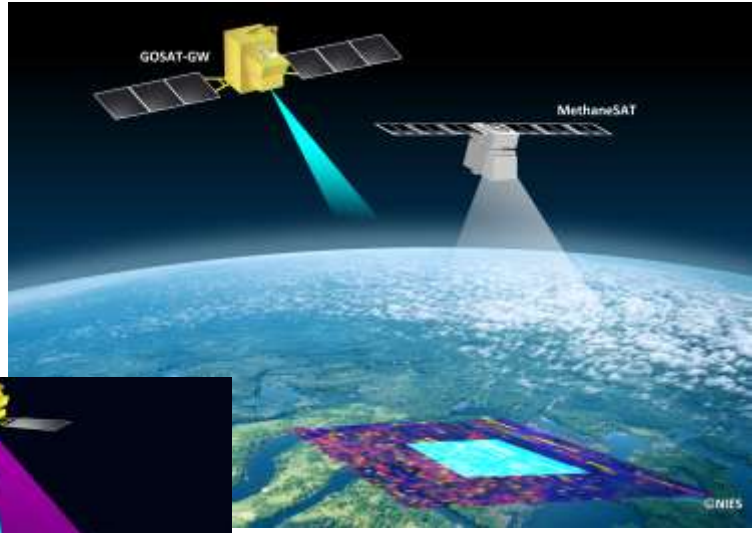
Hirofumi Ohyama, Satoshi Inomata

International collaborations to better identify/quantify CH_4 emissions



Japan – France:
GOSAT and MicroCarb
(to be launched in July 2025)

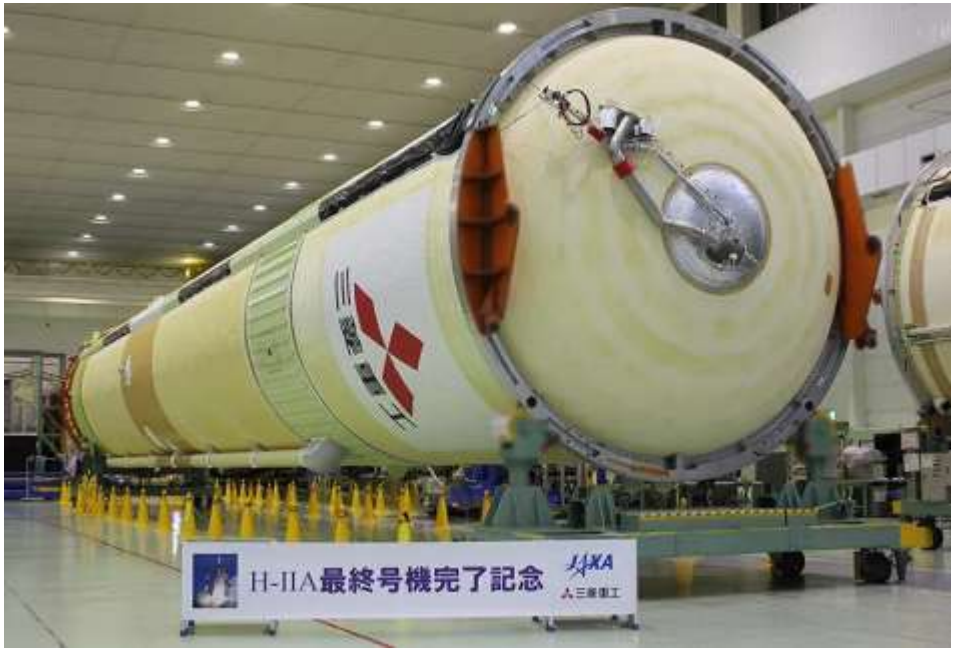


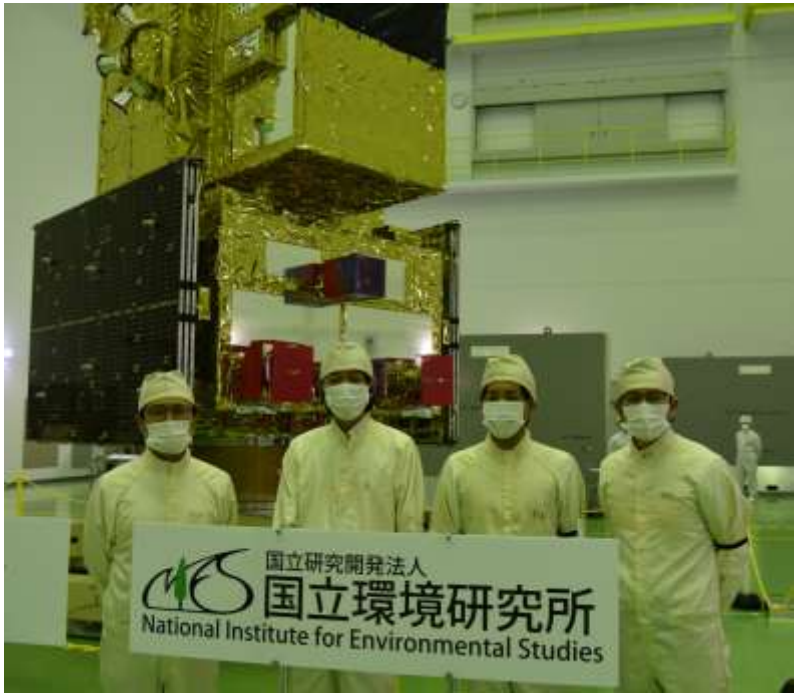


Global mappers – plume monitors:
GOSAT and GHGSat, MethaneSAT, …

The launch within 3 weeks!

H-IIA rocket No.50 (last!)





https://www.mhi.com/jp/news/24092502.html

- The GOSAT-GW satellite will be launched with the 50th H-IIA rocket, the last vehicle of the H-IIA series
- The launch is scheduled to be at 1:33:03 - 1:52:00 am Japan time on 24th June at Tanegashima Space Center

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