

# The GOSAT-GW greenhouse gas observing mission: Updates

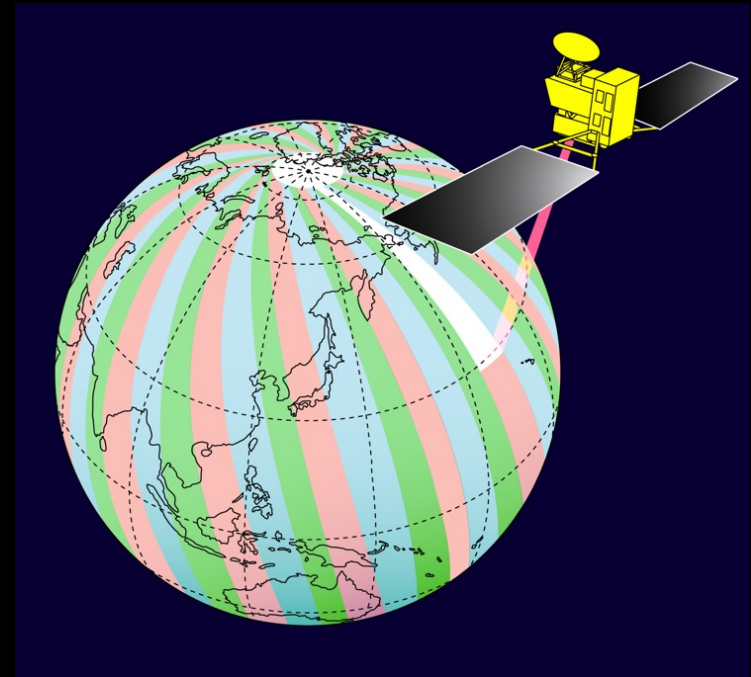
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Tsuneo Matsunaga, *Project Management Lead*

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, Ayano Nakamura

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

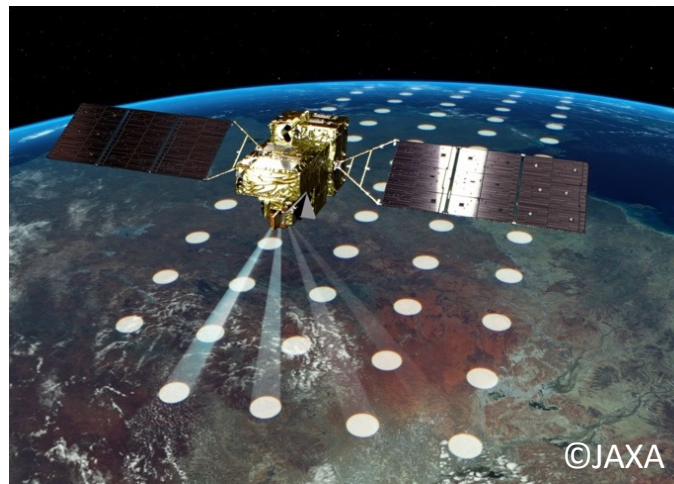


# GOSAT, GOSAT-2, and ... GOSAT-GW

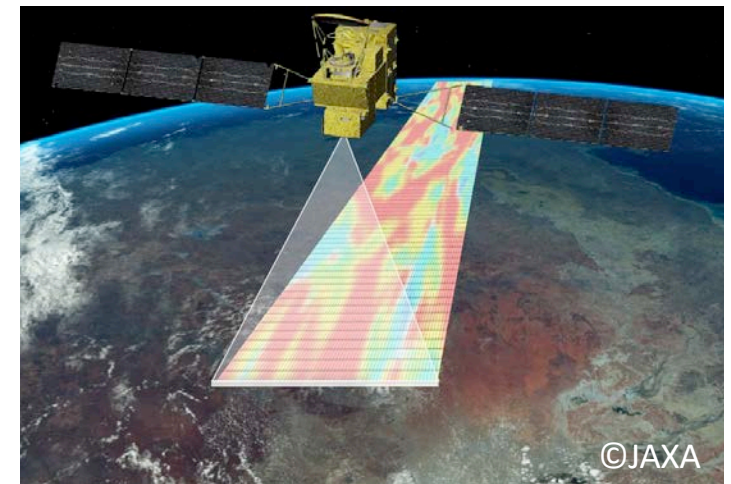
GOSAT 2009 --



GOSAT-2 2018 --



GOSAT-GW 2024/25 --



- 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

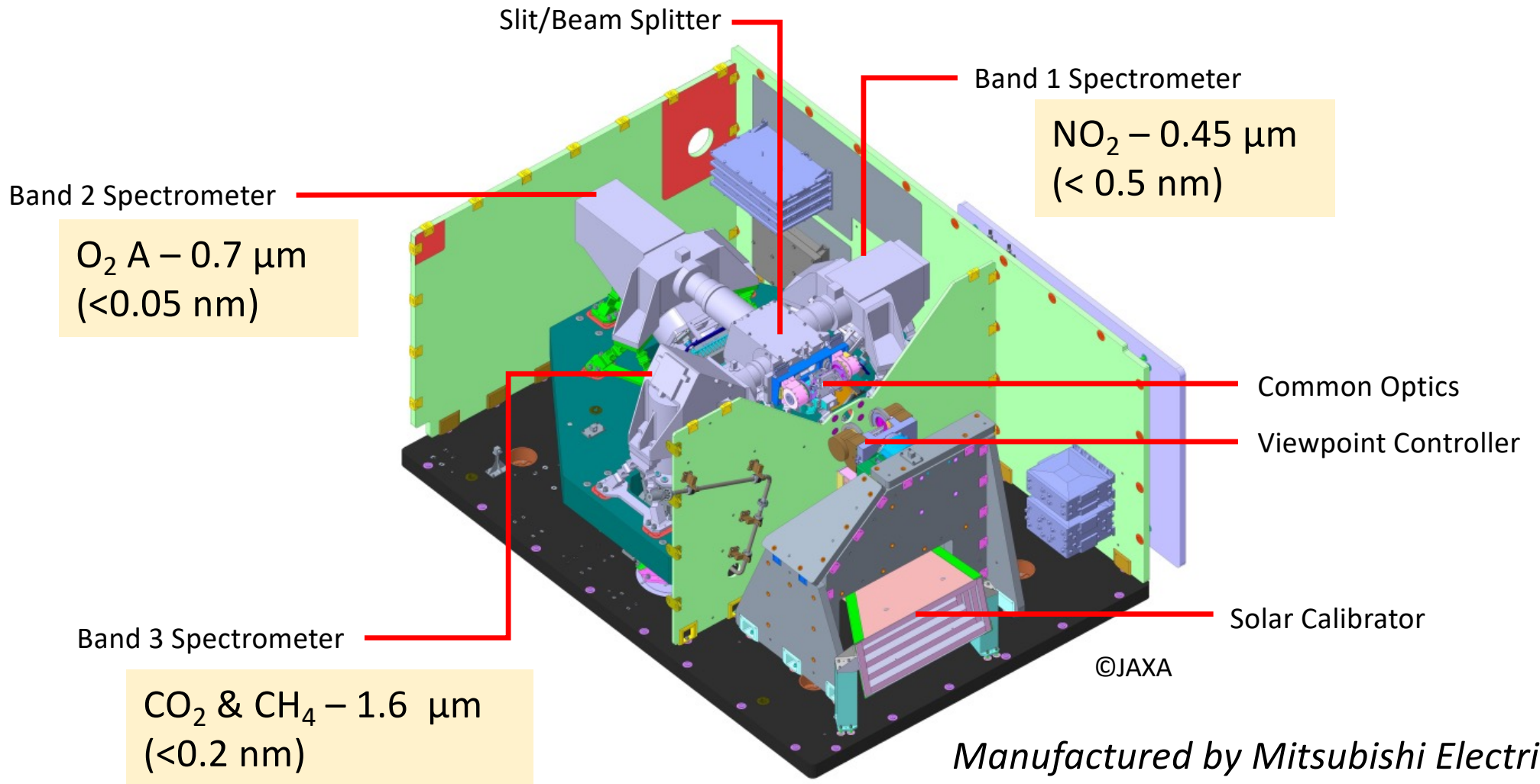


## GOSAT-GW GHG obs. mission requirements (by the Ministry of Environ., Japan)

- *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 CO<sub>2</sub>/yr), etc*

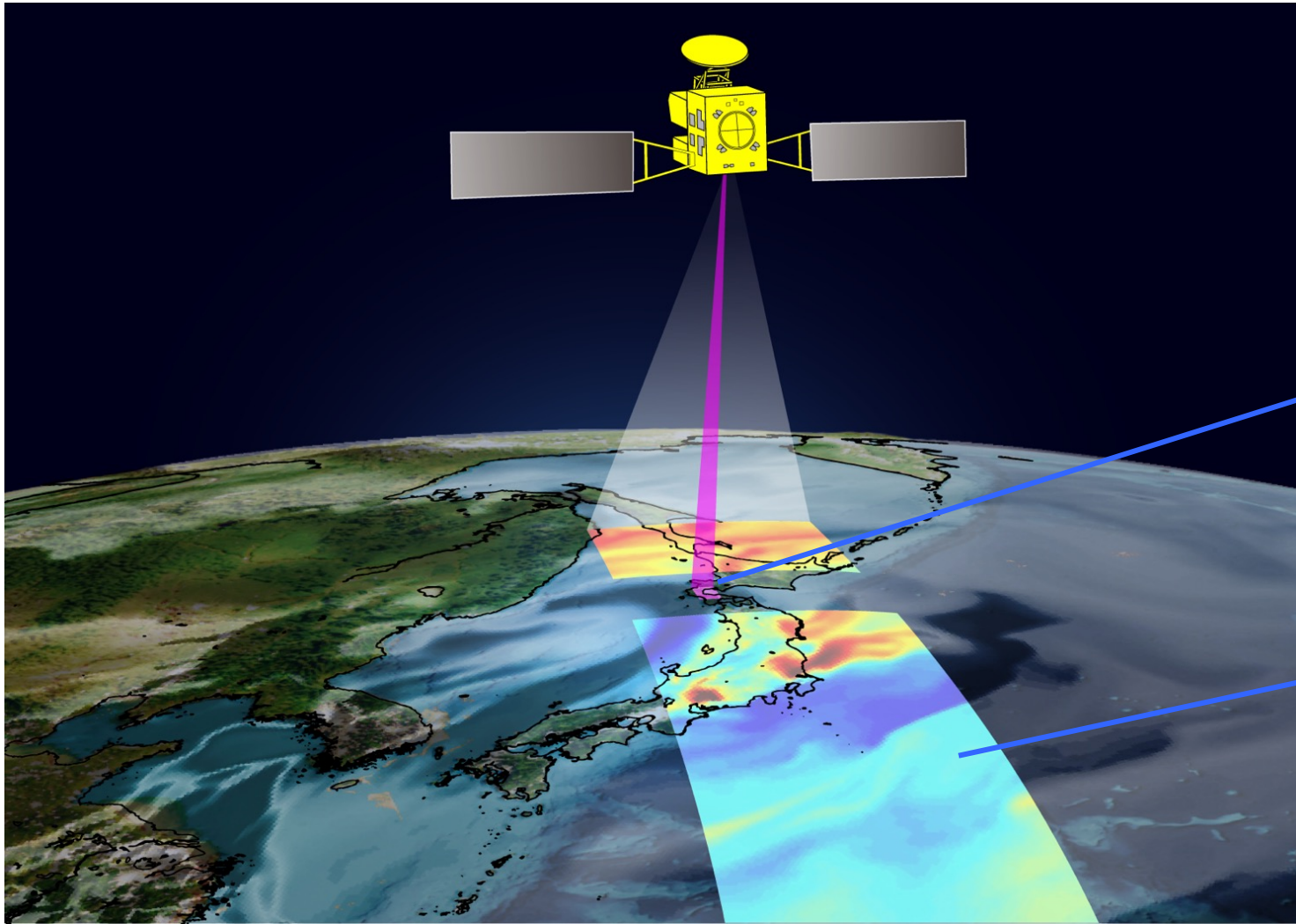
	GOSAT-GW
Launch / lifetime	FY2024 / 7 years
Satellite mass / power	2.9 t / 5200 W
Launcher	H-IIA rocket
Orbit	666 km, 13:30, ascending
Repeat cycle	3 days (44 cycles/3days)
Spectrometer	TANSO-3 (Grating) by Mitsubishi Electric
Major targets	CO <sub>2</sub> , CH <sub>4</sub> , NO <sub>2</sub>
Spectral 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

# TANSO-3 grating spectrometer





# Focus mode makes high spatial resolution footprints



## Focus mode

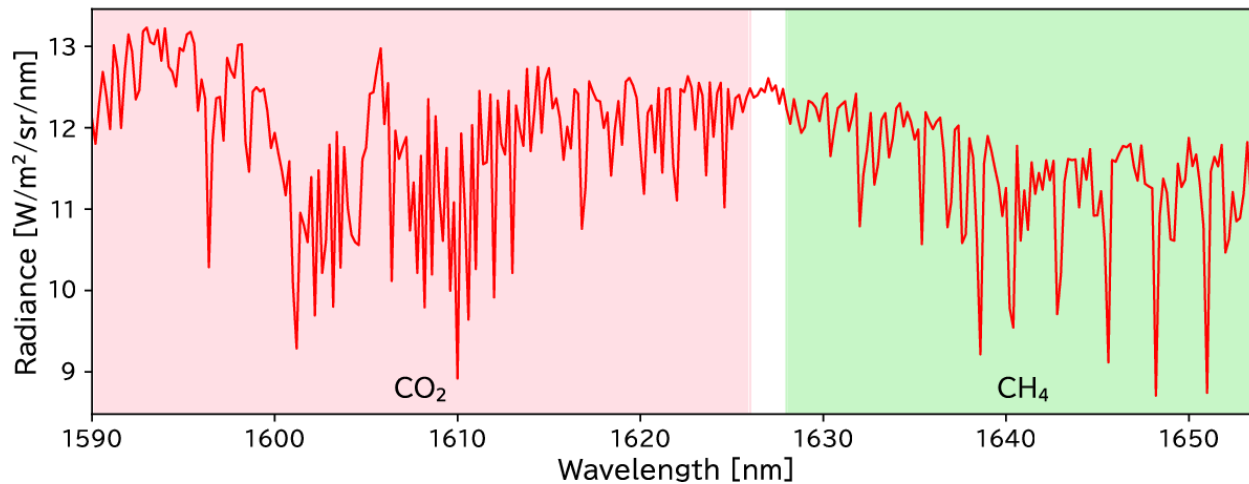
- Swath  $\approx 90 \text{ km} \times 90 \text{ km}$
- Footprint  $\approx 1 - 3 \text{ km}$
- AT/CT Pointing
- Upon requests

## Wide-Swath push-broom mode

- Swath  $\approx 911 \text{ km}$
- Footprint  $\approx 10 \text{ km}$
- No AT/CT Pointing
- Standard operation

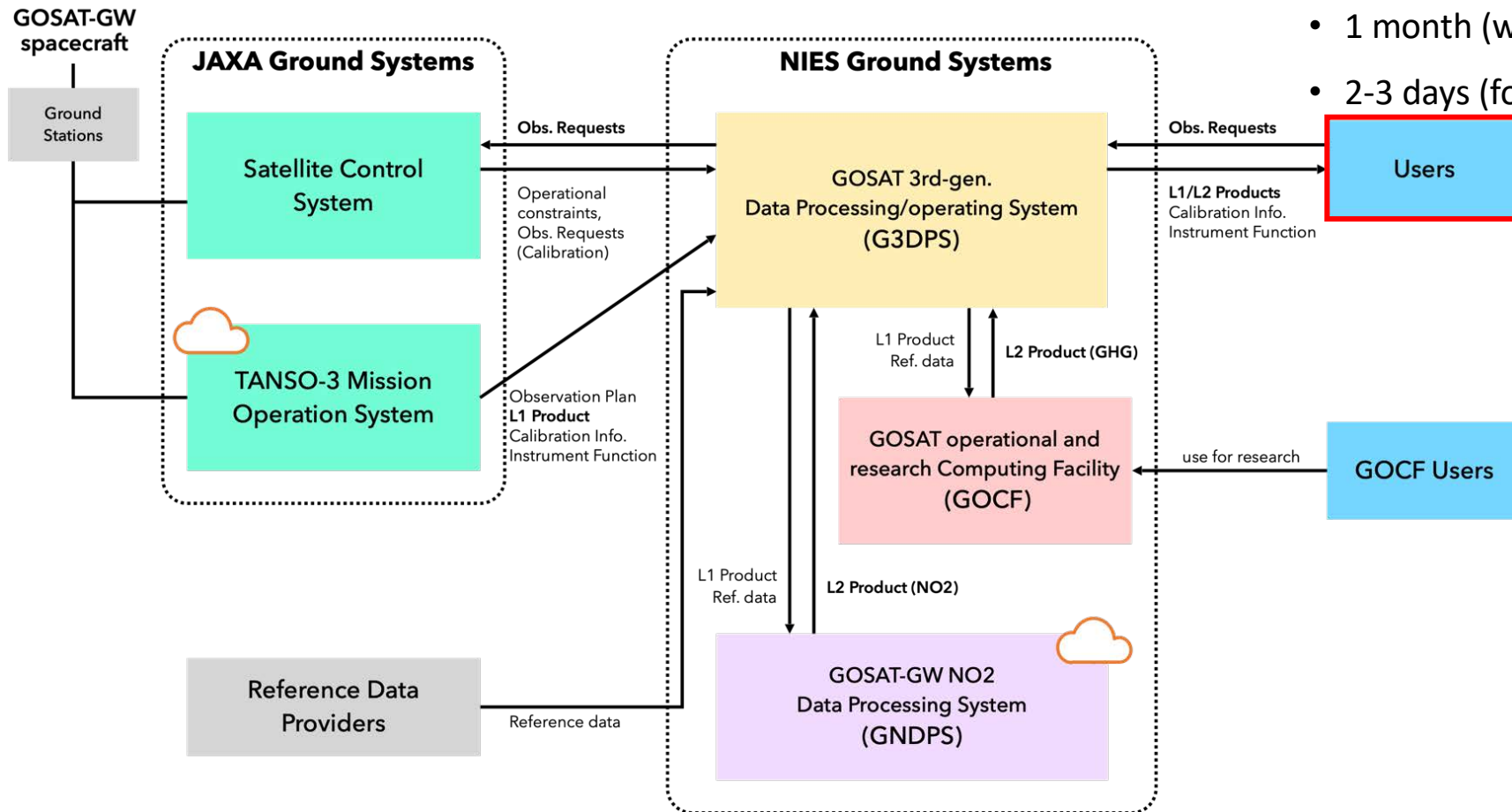
# L2 product retrieval algorithm

Main targets	XCO <sub>2</sub> , XCH <sub>4</sub>	NO <sub>2</sub> (total + tropospheric column)
Other variables	XH <sub>2</sub> O, SIF, AOT, ALH, albedo,...	Effective cloud fraction, Aerosol optical parameters
Retrieval technique	Full Physics (XCO <sub>2</sub> , XCH <sub>4</sub> , ...) Proxy (XCH <sub>4</sub> )	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 <sub>2</sub> , O <sub>3</sub> , ... and aerosol optical parameters)
Cloud screening	Reflectance test Surface pressure retrieval	Cloud fraction derived from O <sub>2</sub> -O <sub>2</sub> absorption @ 477 nm



*Yu Someya (GHG), Tamaki Fujinawa,  
Hyunkwang Lim (NO<sub>2</sub>)*

# Ground data processing system



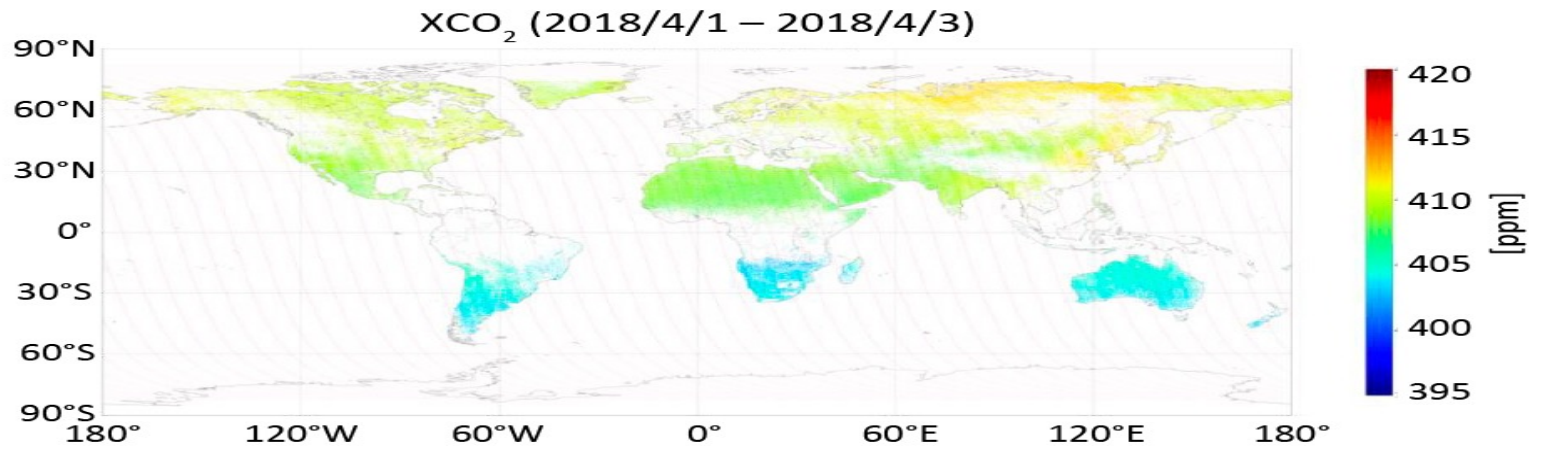
## Latency

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

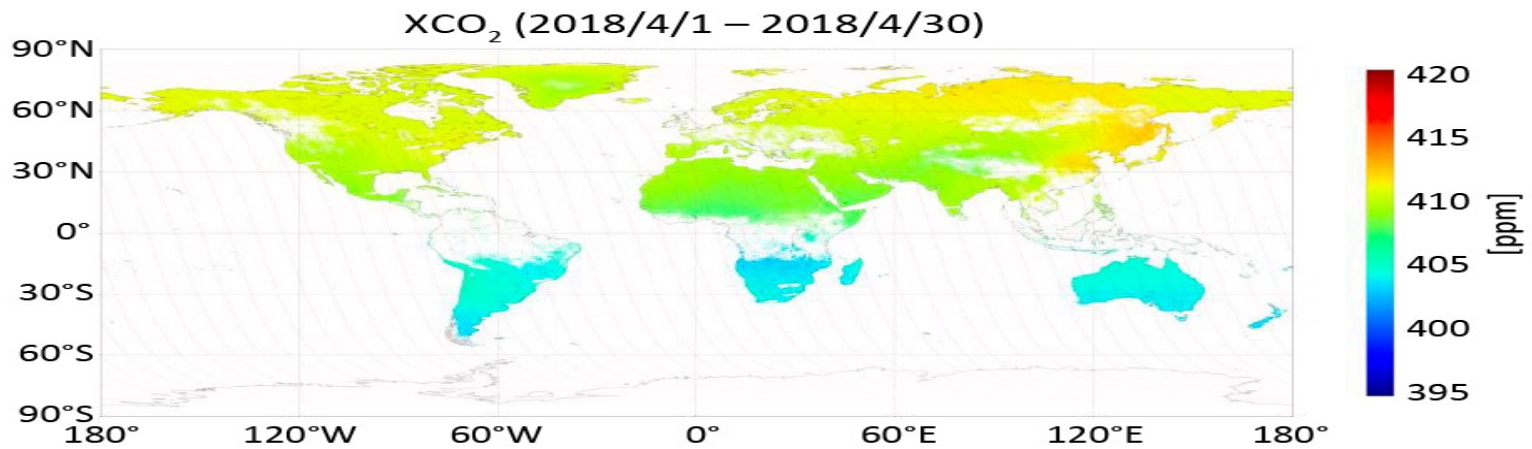
Hisashi Yashiro (GHG), Takafumi Sugita (NO2)

# Simulated GOSAT-GW XCO<sub>2</sub>

3 days



30 days

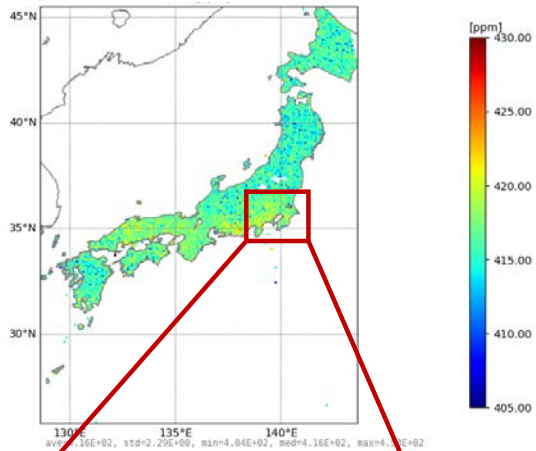




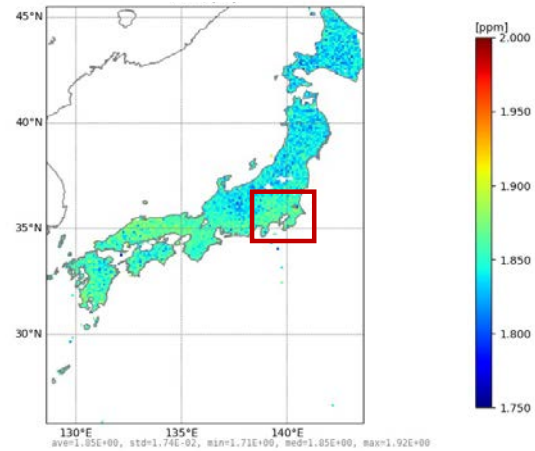
# Simulated GOSAT-GW data – 10 km x 10 km, monthly

Japan

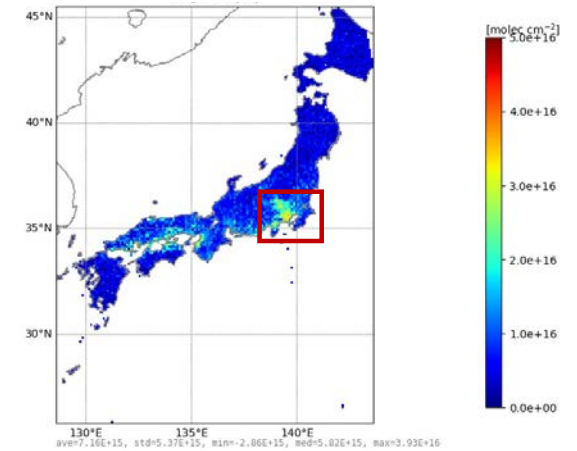
XCO<sub>2</sub>



XCH<sub>4</sub>

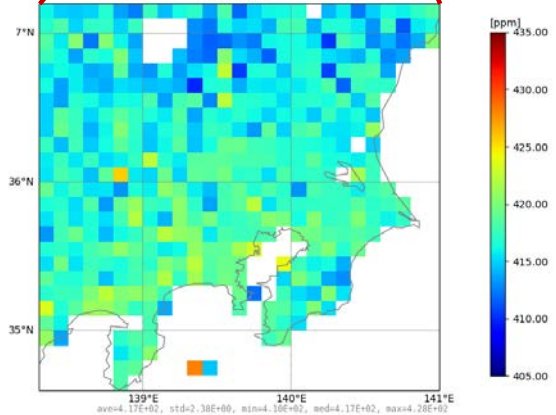


NO<sub>2</sub> VCD

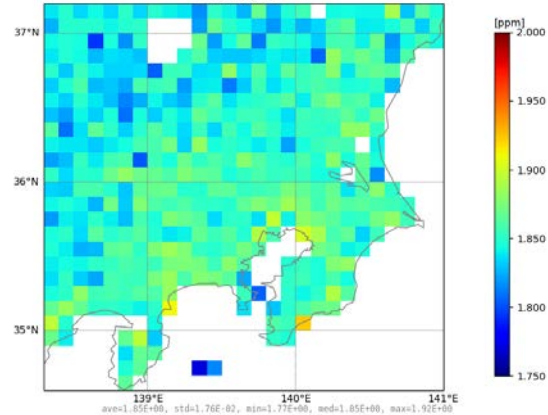


Tokyo

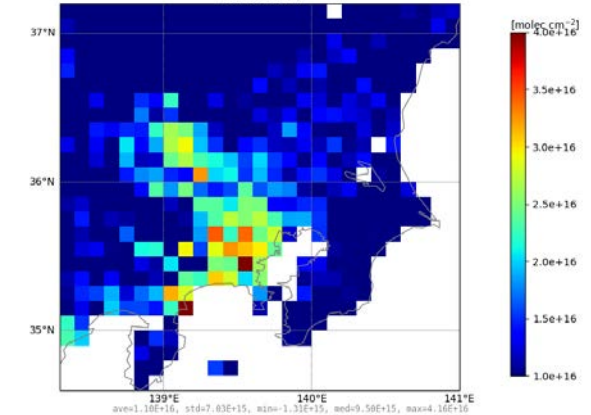
XCO<sub>2</sub> (L2)



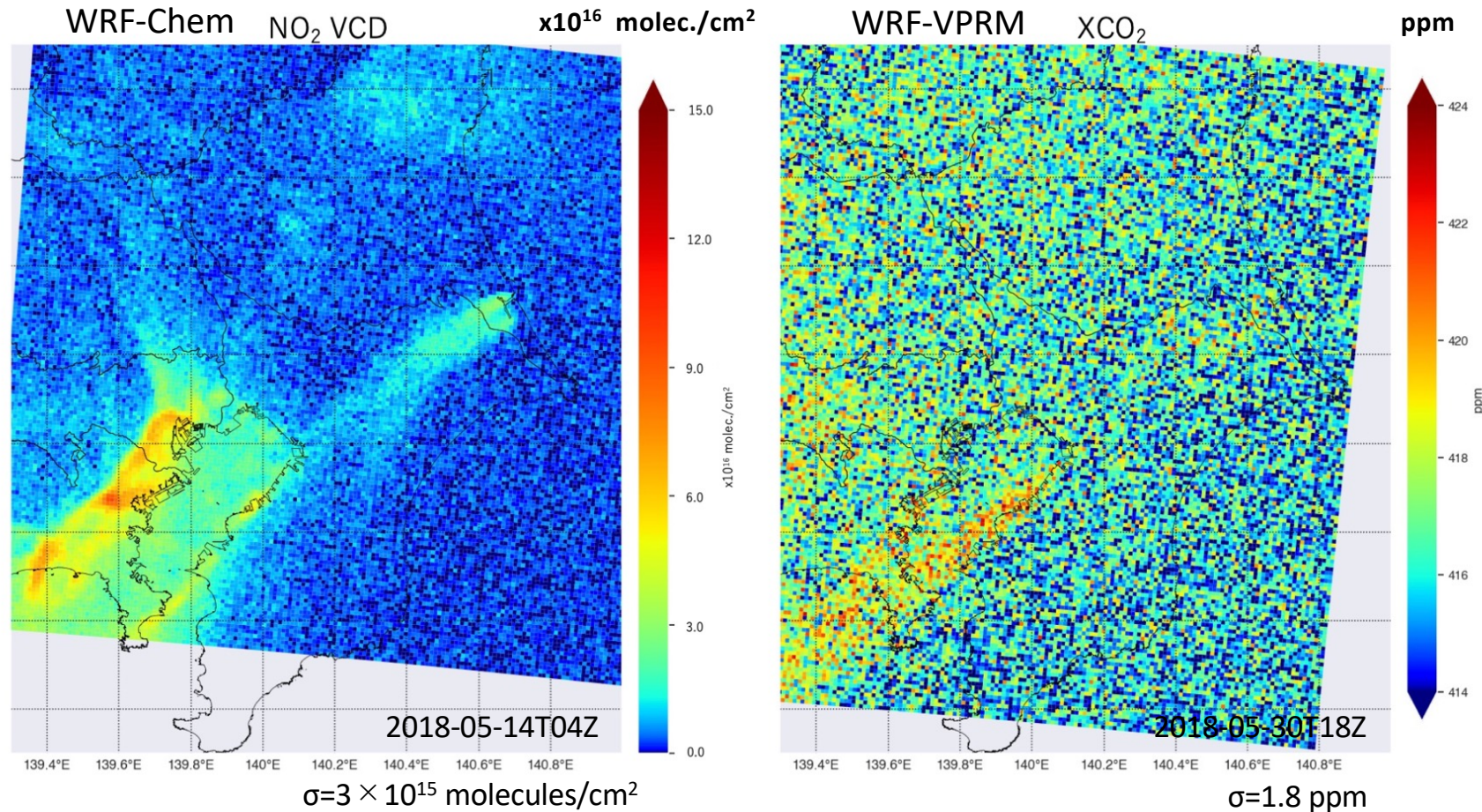
XCH<sub>4</sub> (L2)



NO<sub>2</sub> VCD (L2)



# Urban plumes seen at 1 km x 1 km satellite observations



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

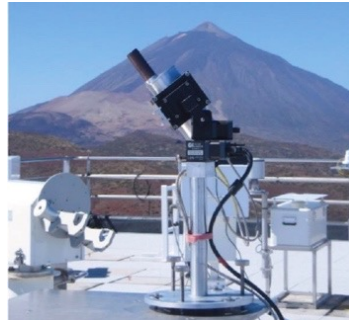


# EM27/SUN and Pandora validation

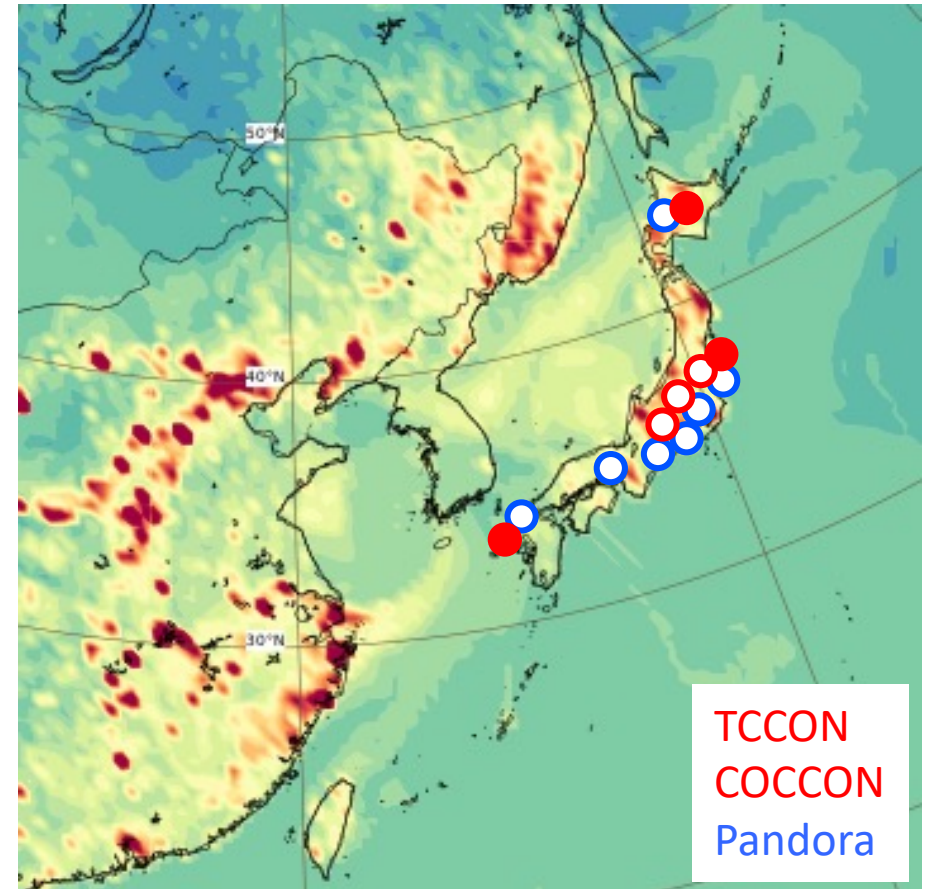
EM27/SUN – CO<sub>2</sub>, CH<sub>4</sub>, CO



Pandora – NO<sub>2</sub>, O<sub>3</sub>, HCHO



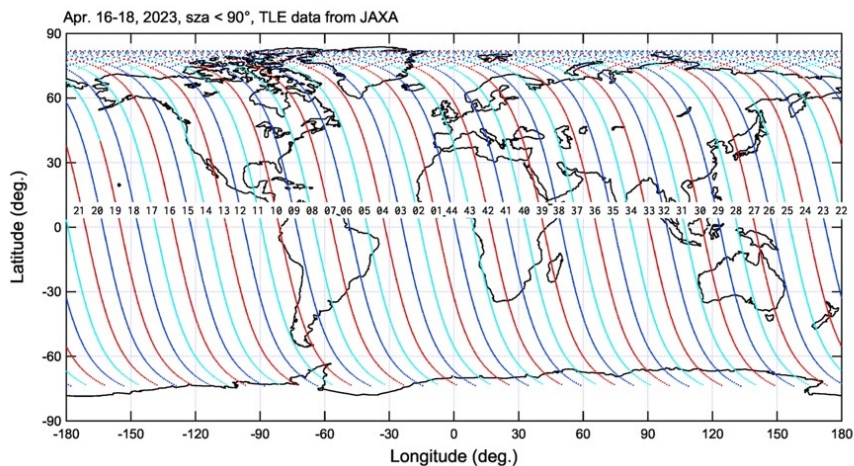
	CO <sub>2</sub> /CH <sub>4</sub>		NO <sub>2</sub>
	TCCON	EM27/SUN	Pandora
Hokkaido	ONGOING		ONGOING
Tsukuba	ONGOING	ONGOING	ONGOING
Central Tokyo		ONGOING	ONGOING
Suburban Tokyo			ONGOING
Yokosuka		ONGOING	ONGOING
Nagoya			ONGOING
Kobe			ONGOING
Kyushu	ONGOING		ONGOING



Hirofumi Ohyama (GHG), Satoshi Inomata (NO<sub>2</sub>)

Collaboration: NIES (Morino, Frey, Ohyama, Müller, Tanimoto, Inomata, Sugita, Fujinawa), JAMSTEC (Kanaya, Patra, Miyakawa)

# Focus mode validation



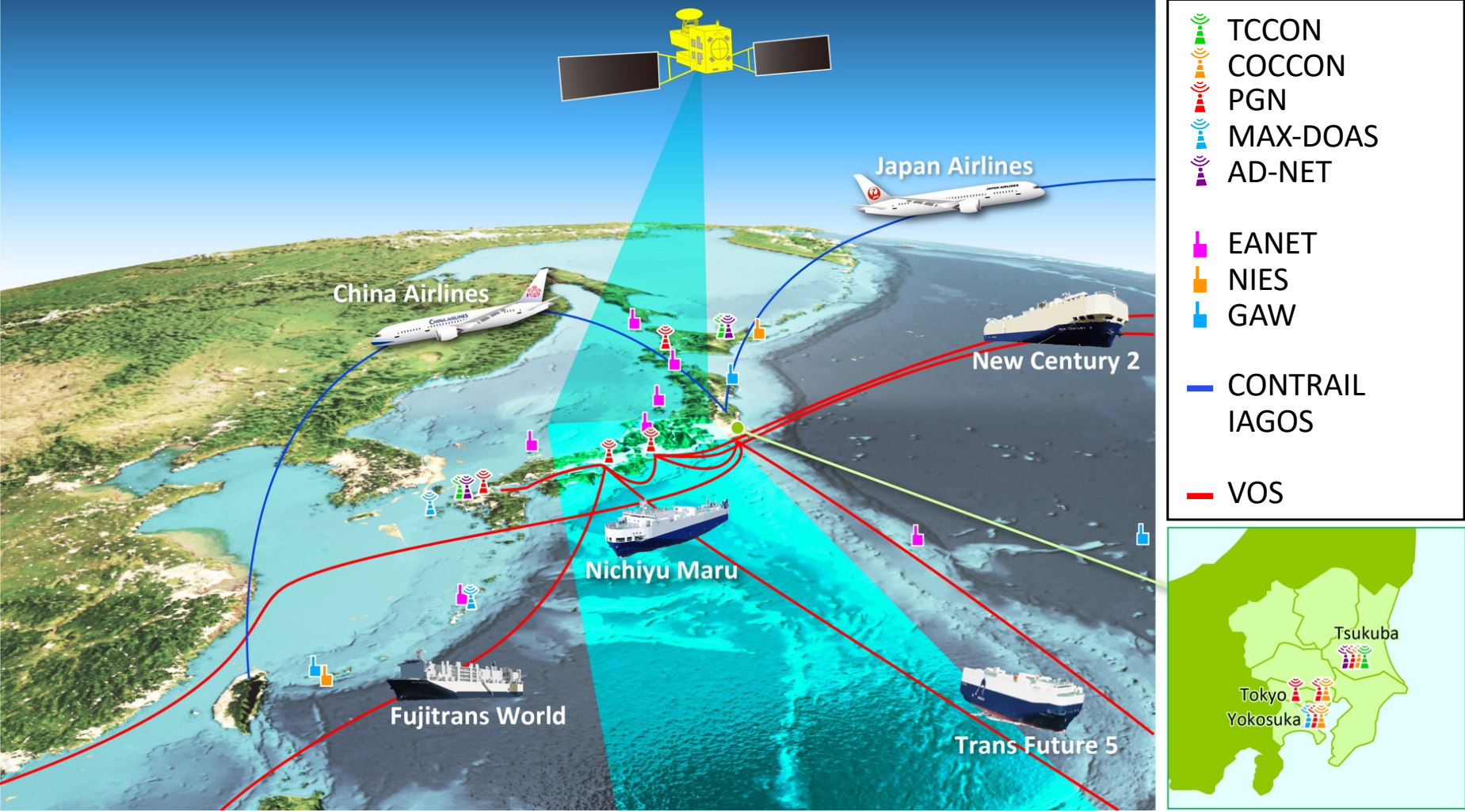
- 3-day global coverage
- <90 focus mode requests possible
- ~18 co-located sites for TCCON/COCCON and PGN (GHG&NO<sub>2</sub>)

*Hirofumi Ohyama et al.*

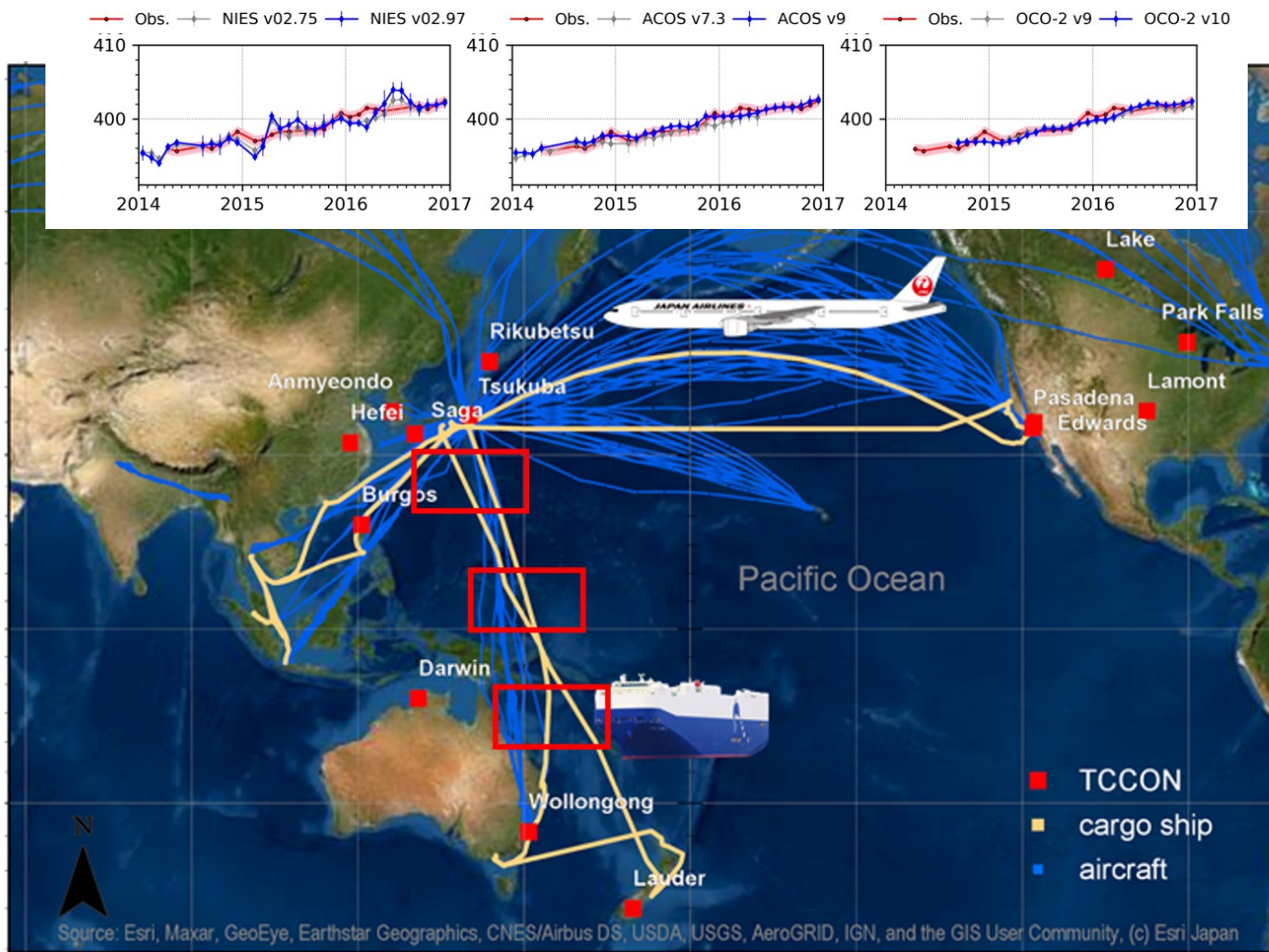
Path No. (The first day)		Path No. (The second day)		Path No. (The third day)	
20		21		22	
23		24		25	
26	PGN: 176, ...; MA TCCON: Tsukuba <b>Tsukuba</b>	27	MAX-DOAS: Kasuga; TCCON: Saga <b>Saga</b>	28	PGN: 54, 164, ...; MAX-DOAS: Seoul TCCON: Anmyeondo; COCCON: Seoul <b>Seoul</b>
29	PGN: 171; TCCON: Xianghe <b>Xianghe</b>	30		31	
32		33		34	
35		36	PGN: 152; TCCON: Ny-Ålesund <b>Europe</b>	37	
38		39		40	
41	PGN: 115, 106, 21, ...; TCCON: Garmisch, Zugspitze, Bremen; COCCON: Rome, Munich <b>Europe</b>	42		43	
44		1	PGN: 101, ...; TCCON: Izaña; COCCON: Izaña <b>Toronto</b>	2	
3		4	PGN: 144; TCCON: Eureka <b>Toronto</b>	5	
6		7		8	PGN: 183, 206; COCCON: Cambridge, Toronto <b>Boston, Toronto</b>
9	PGN: 145, 103, COCCON: Torc <b>Toronto</b>	10		11	
1	PGN: 65, 157, 142, 204, 57; COCCON: Mexico City, Boulder <b>Mexico, Boulder</b>	13		14	PGN: 68, 74, 247; TCCON: Caltech, Dryden <b>Pasadena, Dryden</b>
15		16	PGN: 174 COCCON: Fairbanks <b>Pasadena, Dryden</b>	17	
18		19			



# Extensive validation + supporting observations



# Integrated ship-aircraft evaluation of XCO<sub>2</sub> over open oceans



- Application to other Pan-Pacific areas – North Pacific, Southeast Asia
- Application to other species such as CH<sub>4</sub> 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

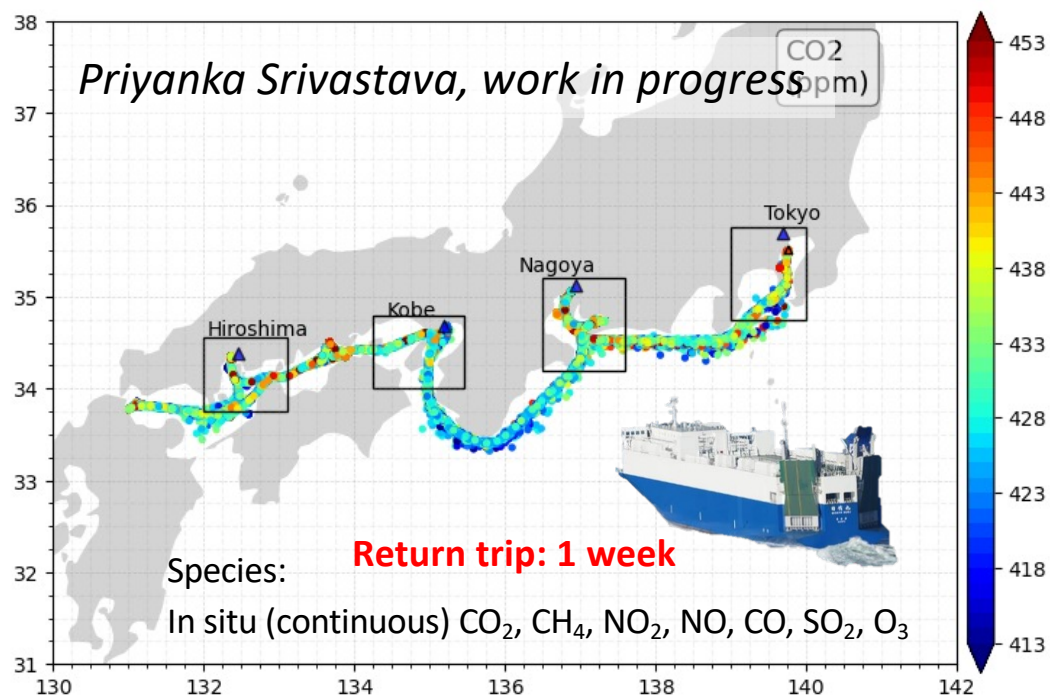
*Mueller et al.,  
ACP 2021, AMT 2023*

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



# Cargoship-based monitoring along Japan's east coast

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

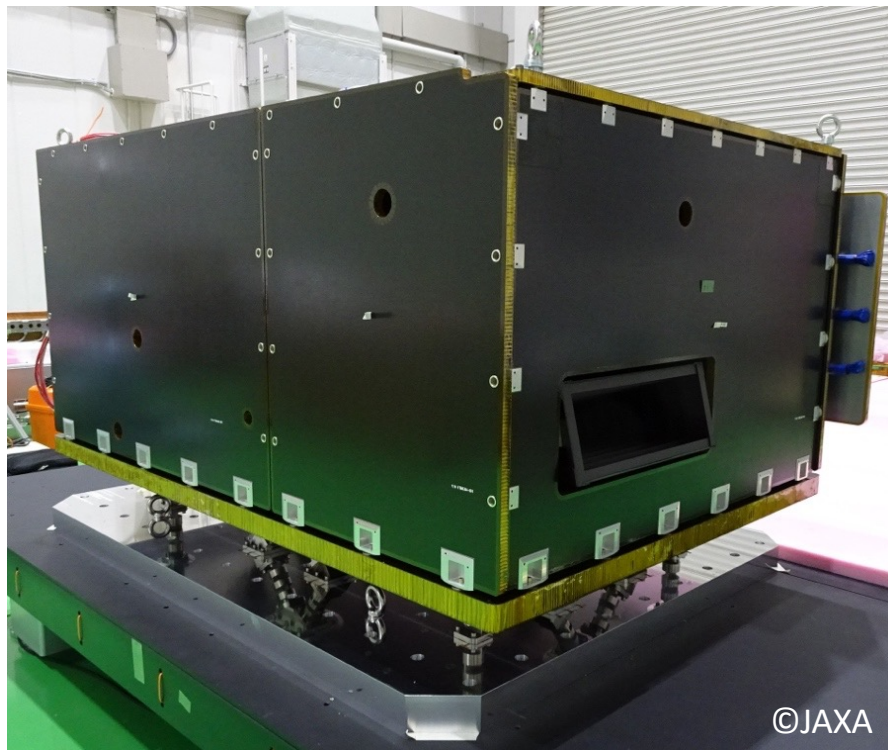


Satellite validation / Continuous emission monitoring / Plume transects from point sources

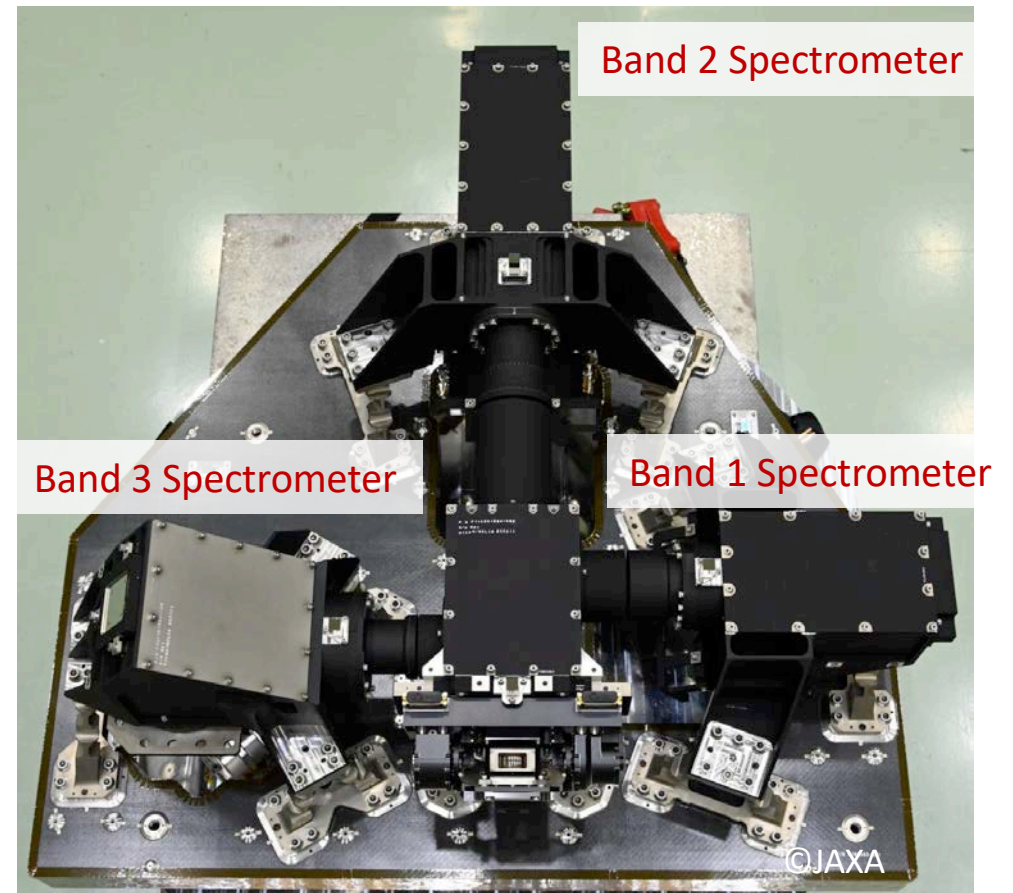
Collaboration: NIES, Japan (Astrid Müller, Matthias Max Frey, Hiroshi Tanimoto, Isamu Morino, Shin-Ichiro Nakaoka), Heidelberg University, Germany (Ralph Kleinschek, Ken von Buenau, Karolin Voss, Vincent Enders, André Butz)

# TANSO-3 sensor in testing

Sensor Box (PFM)



Optics (PFM)





# Summary

- To be launched in FY2024 (April 2024 - [March 2025](#))
- What [new/additional opportunities](#) can GOSAT-GW offer to the community?
  - Emission estimates at sub-annual scales (seasonal, monthly, ...)
  - High spatial resolution data for hot spot detection/emission quantification
- We continue to be [open for international collaborations](#) on retrieval, validation, flux estimates, and more!
- [Airborne CO<sub>2</sub>/CH<sub>4</sub>/NO<sub>x</sub> campaign](#) planned for validation/retrieval improvement
- [Japan GHG Center](#) discussion started with the MOEJ funding and NIES as a lead institute

***H. Tanimoto + 31 co-authors, The GOSAT-GW greenhouse gases observing mission: Concept and science, ready for submission***



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