

The GOSAT-GW greenhouse gas observing mission

Hiroshi Tanimoto, *Science and Application Lead*

Tsuneo Matsunaga, *Project Management Lead*

National Institute for Environmental Studies, Japan

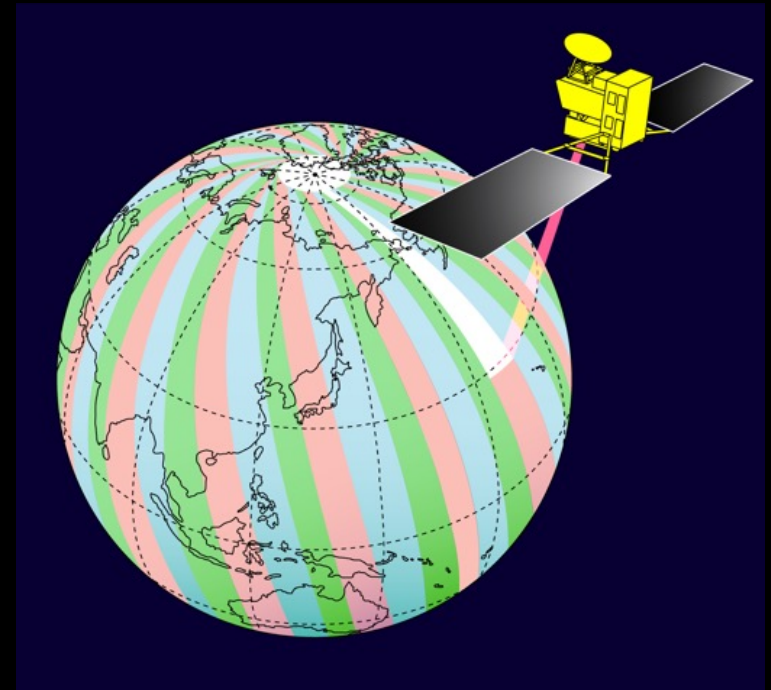
with

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, 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)



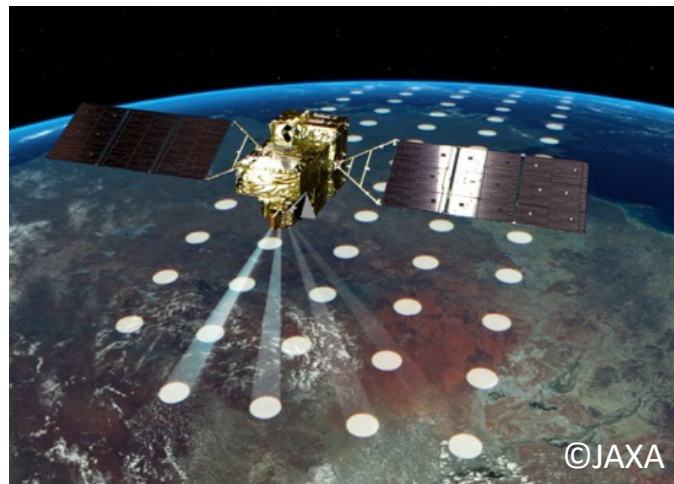
The greenhouse gas observation mission with Global Observing SATellite for Greenhouse gases and Water cycle (GOSAT-GW): Objectives, conceptual framework and scientific contributions, in review, Prog. Earth Planet. Sci., Preprint - doi:10.21203/rs.3.rs-4754270/v1

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

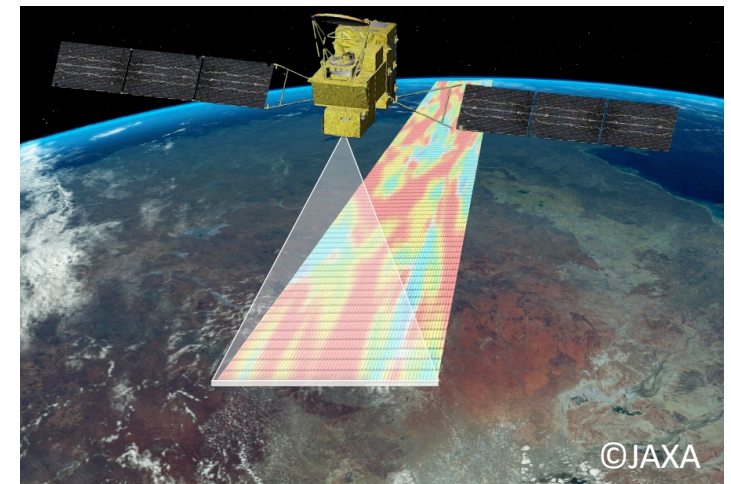
GOSAT 2009 --



GOSAT-2 2018 --



GOSAT-GW JP's FY 2024 --



- 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

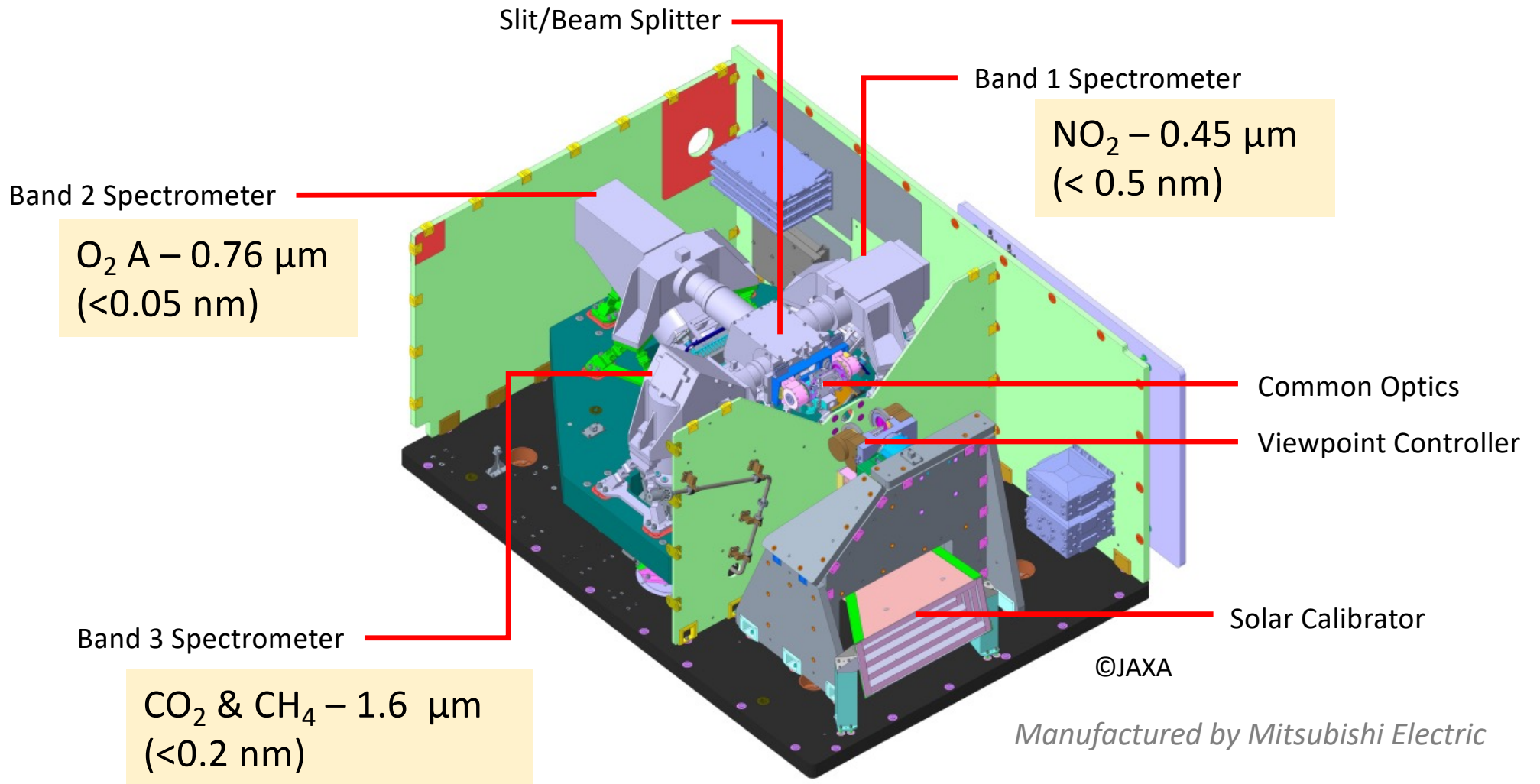


GOSAT-GW GHG obs. mission requirements (by the Ministry of Environ., Japan)

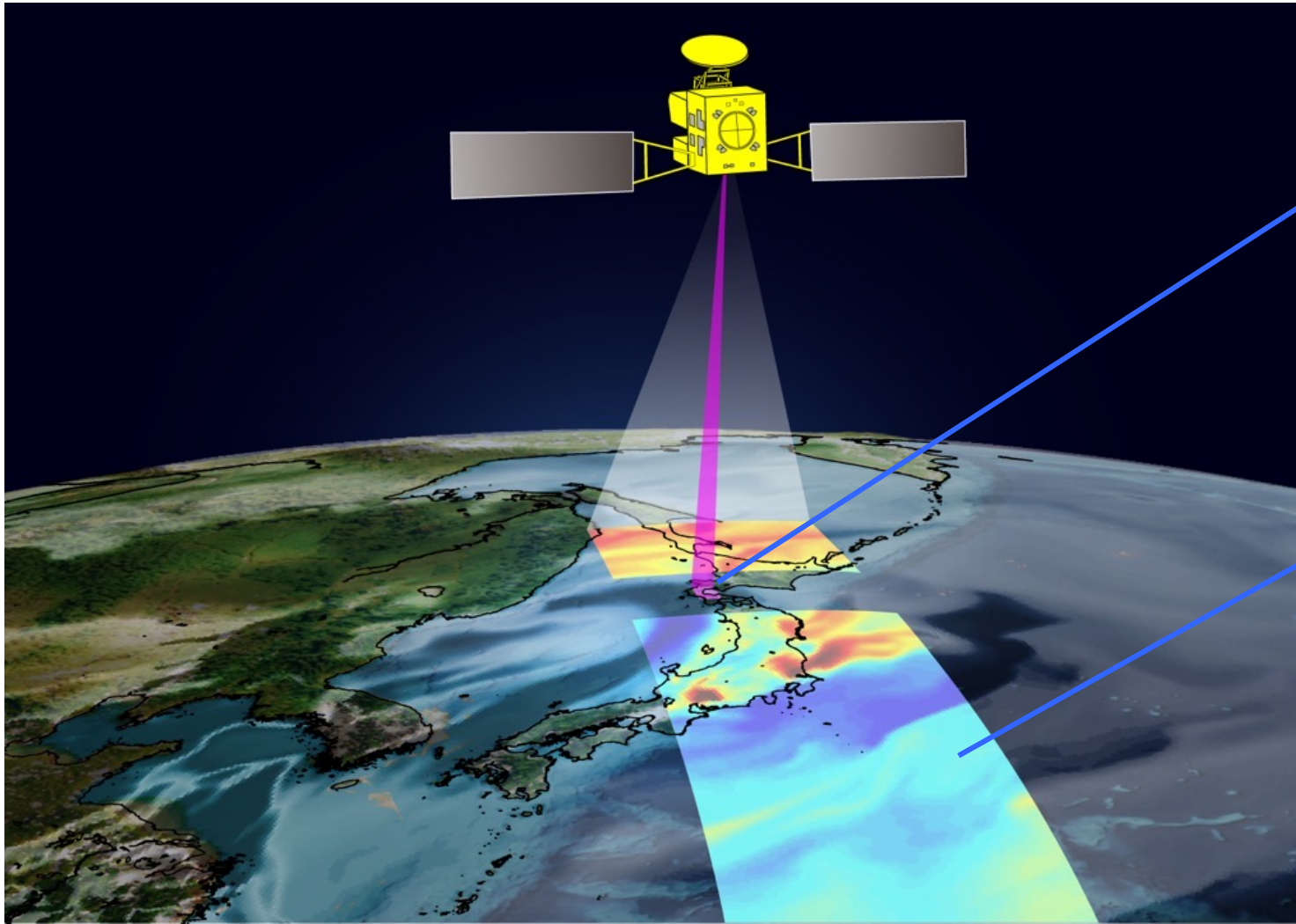
- Monitoring of whole atmosphere global-mean concentrations of GHGs
- Verification of national (or country-specific) anthropogenic emissions inventory of GHGs
- Detection of GHGs emissions from large emission sources, such as megacities, power plants (>6.5 Mt CO₂/yr), etc

	GOSAT-GW
Launch / lifetime	Japan's 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	CO₂ (FP), CH₄ (FP, Proxy), NO₂ (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

TANSO-3 grating spectrometer



Focus mode makes 1 x 1 km² spatial resolution footprints



Focus mode

- Swath ≈ 90 km x 90 km
- Footprint ≈ 1 km
- AT/CT Pointing
- Upon requests

Wide-Swath mode

- Swath ≈ 911 km
- Footprint ≈ 10 km
- No AT/CT Pointing
- Standard operation

EM27/SUN and Pandora validation

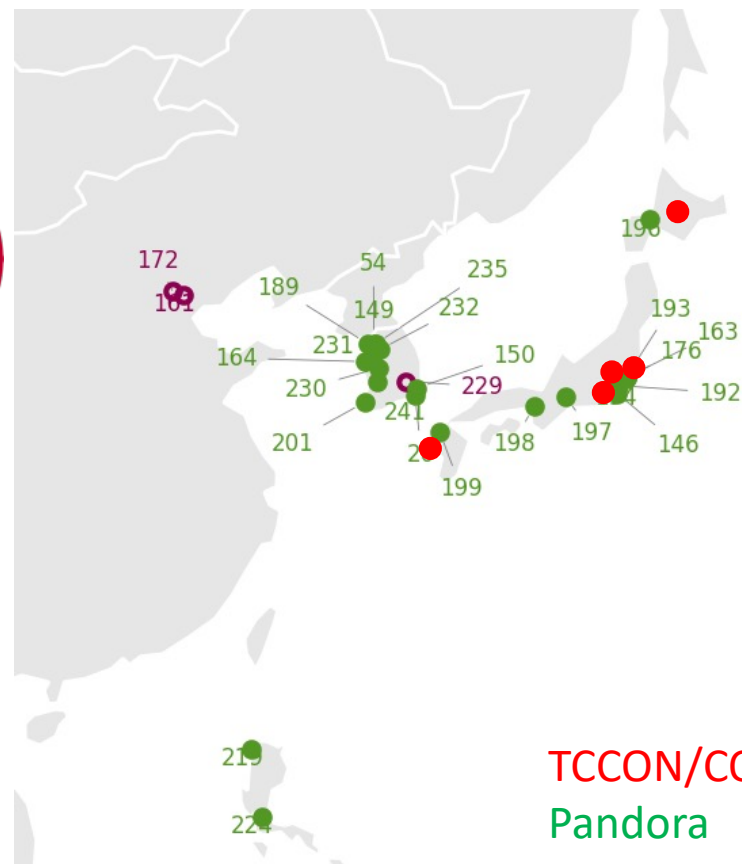
EM27/SUN – CO₂, CH₄, CO



Pandora – NO₂, O₃, HCHO



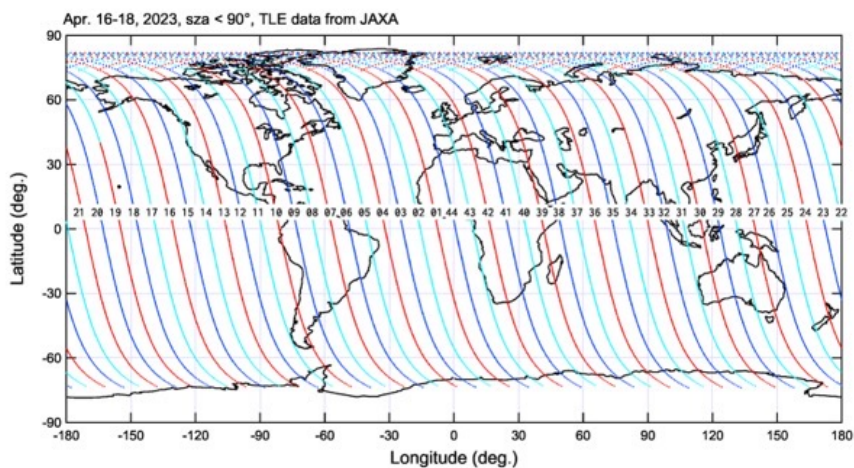
	CO ₂ /CH ₄		NO ₂
	TCCON	EM27/SUN	Pandora
Hokkaido	ONGOING		ONGOING
Tsukuba	ONGOING	ONGOING	ONGOING
Central Tokyo		ONGOING	ONGOING
Suburban Tokyo			ONGOING
Yokosuka		ONGOING	ONGOING
Nagoya			ONGOING
Kobe			ONGOING
Kyushu	ONGOING		ONGOING



TCCON/COCCON
Pandora

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

Focus mode validation

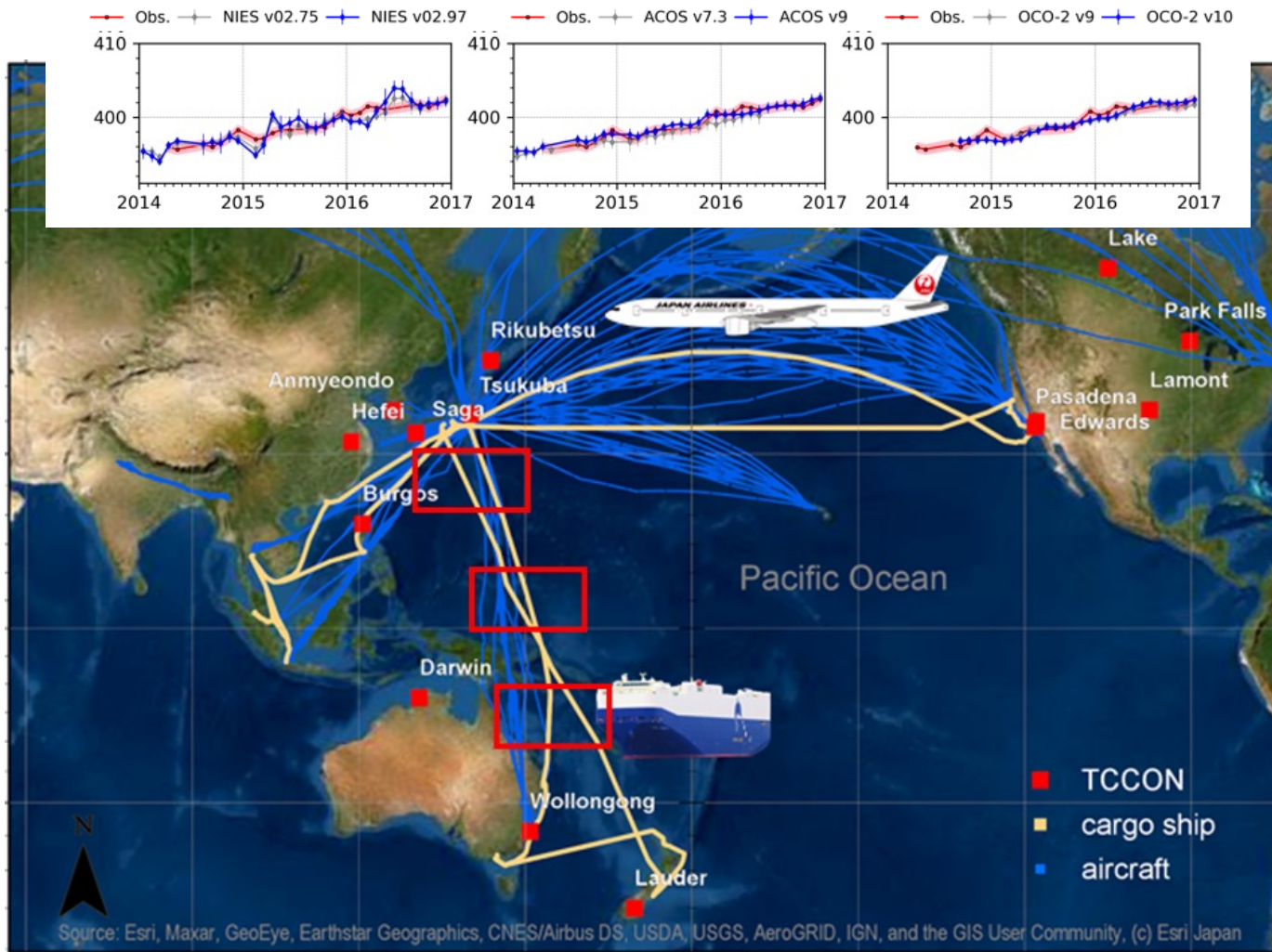


Path No. (The first day)	Path No. (The second day)	Path No. (The third day)
20	21	22
23	24	25
26 PGN: 176, ...; M/ TCCON: Tsukuba Tsukuba	27 MAX-DOAS: Kasuga; TCCON: Saga Saga	28 PGN: 54, 164, ...; MAX-DOAS: Seoul TCCON: Anmyeondo; COCCON: Seoul
29 PGN: 171; TCCON: Xianghe Xianghe	30	31 Seoul
32	33	34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

- 3-day global coverage
- <90 focus mode requests possible
- ~18 co-located sites for TCCON/COCCON and PGN (GHG&NO₂ supersites)

Hirofumi Ohyama et al.

Integrated ship-aircraft evaluation of XCO₂ over open oceans

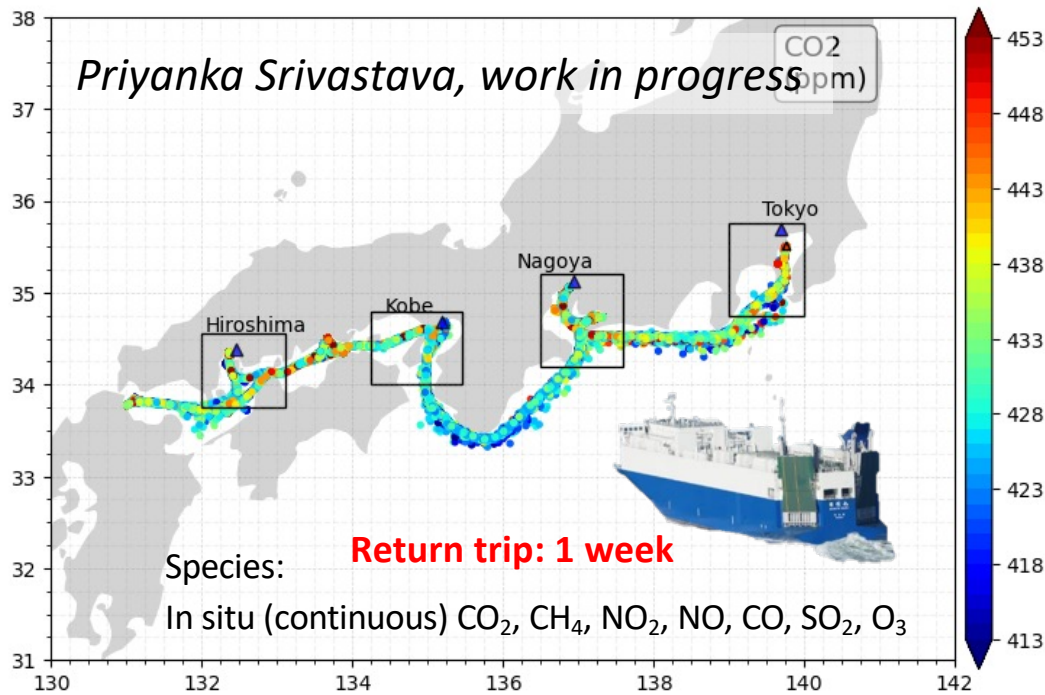


- Extension of the record in a **timely manner** and providing to the community as **operational products**
- Application to other Pan-Pacific areas – **North Pacific, Southeast Asia**
- Application to other species such as **CH₄ and CO**
- Application to other areas of open oceans such as the **Atlantic**,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

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

Cargoship-based monitoring along Japan's east coast

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



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

NIES, Japan (Müller, Frey, Morino, Nakaoka), Heidelberg University, Germany (Kleinschek, von Buenau, Voss, Butz)

TANSO-3 sensor in testing

H-IIA rocket No.50 (last!) completed



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

- Pre-flight model ground test was done
- TVAC test will be soon (or now?)

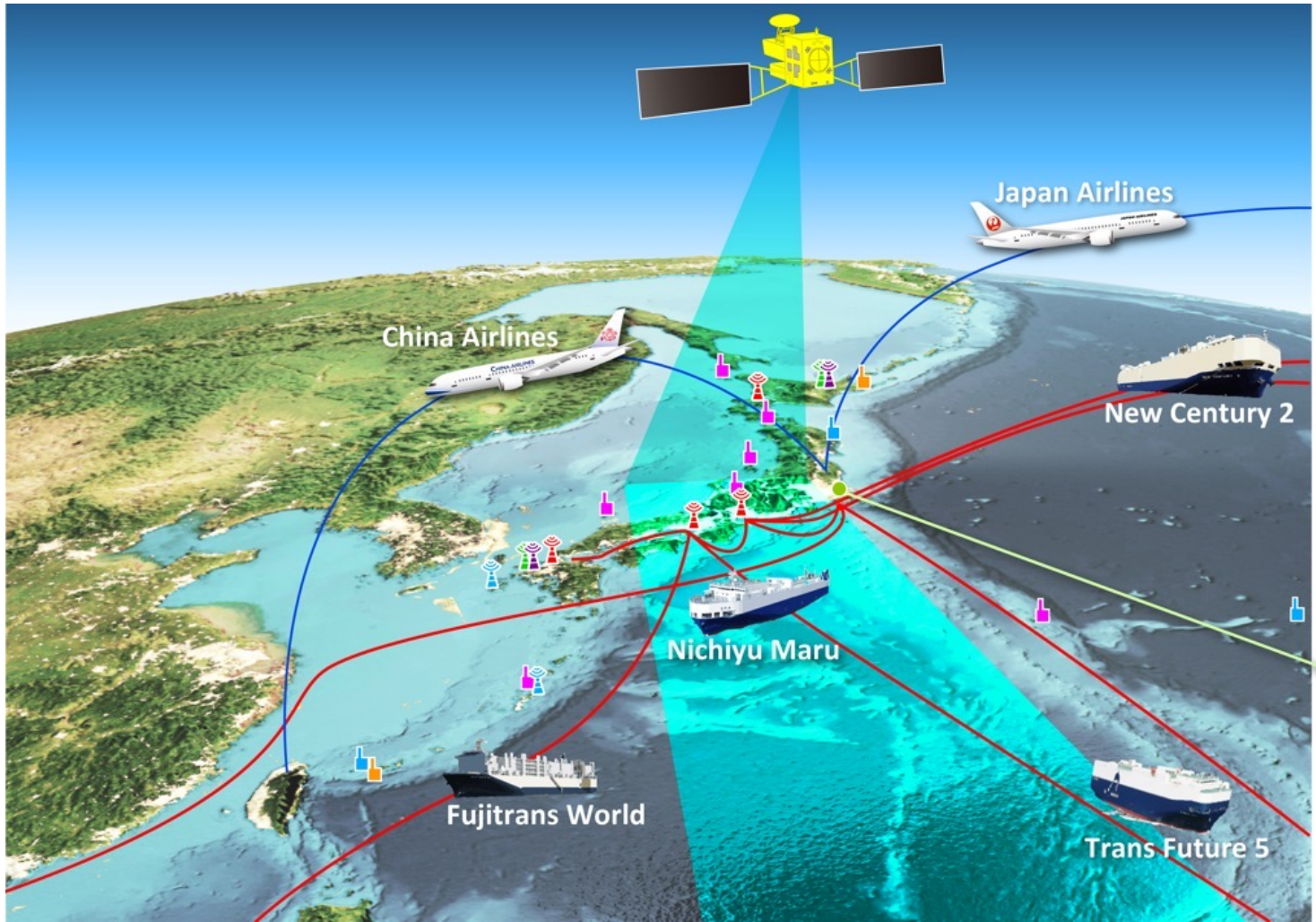
Summary

- **Validation or algorithm needs**

- “Systematic XCO₂ errors still limit both science and policy use of satellite data” (Chris O’Dell). Importance of iterating retrieval-validation efforts and resulting version updates, in particular, during the commissioning phase
- Will join the intercomparison activity of L2 retrieval of CO₂ and CH₄ (and NO₂)
- CO₂: NIES operational–ACOS, CH₄: NIES operational–Leicester–SRON?, NO₂: NIES–BIRA–KNMI/Copernicus?
- Aircraft validation campaigns in 2025-2026, with NASA, Korea NIMS/KMA+SNU? (Barry Lefer, Sang-Woo Kim)
- Intercomparison of BIRA’s oversampling TROPOMI and GOSAT-GW NO₂ L2 1 km x 1 km (BIRA Tijl Verhoelst)
- Africa target cities – Johannesburg, Lagos, Nairobi, Tshwane (NCAR Pietermel Levelt)
- Diurnal cycle info ?? – GOSAT-GW: 13:30, CO2M: 11:00, Microcarb: 10:30
- GOSAT-GW – TANGO collaboration (SRON Jochen Landgraf)
- AO for cal/val needs from the community??

- **Stakeholder requirements (science or decision making)**

- Global XCO₂ & XCH₄ trend + national E.I. verification + urban/facility-scale emission identification/quantification
- Global survey of possible CH₄ huge-leaks with wide-swath CH₄ L2 products delivery within 7 days to compare with TROPOMI and to help GHGSat, MethaneSat,... for IMEO MARS (SRON, Ilse Aben)
- India CO₂, CH₄, and NO_x emissions (NIES–ARIES Manish Naja, BIRA Mahesh Sha, NASA/LaRC Jim Crawford, etc)
- Data assimilation needs? (JPL Kazu Miyazaki, Kevin Bowman)



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