The GOSAT-GW greenhouse gases observing mission: Updates

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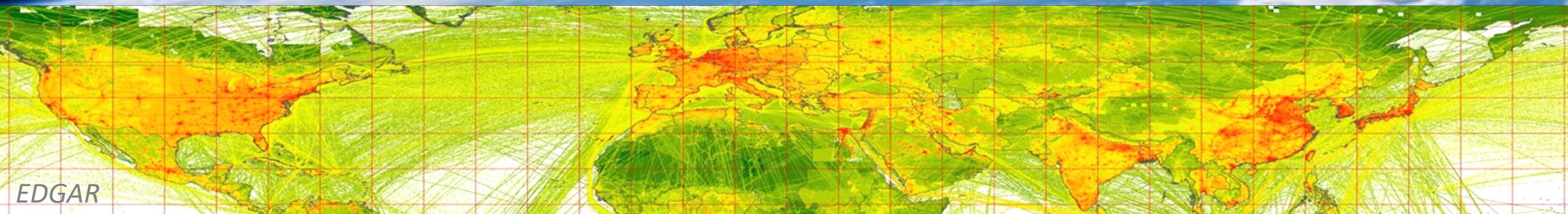
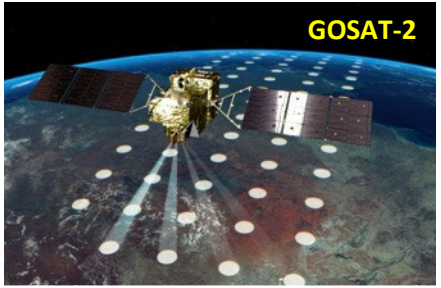
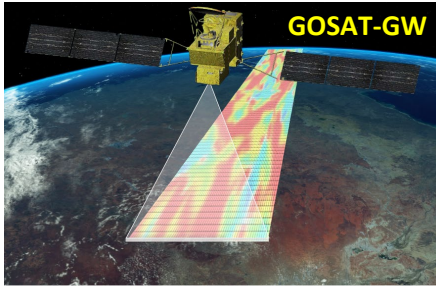
from
National Institute for Environmental Studies (NIES)
Japan Agency for Marine-Earth Science and Technology (JAMSTEC)
National Institute of Information and Communications Technology (NICT)



GOSAT, GOSAT-2, and …

Figures: Courtesy of JAXA

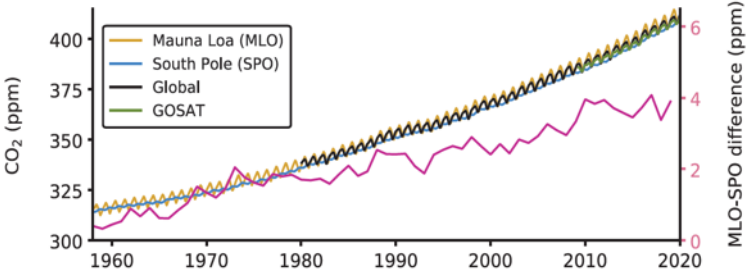




	GOSAT	GOSAT-2	GOSAT-GW
Launch / lifetime	2009 / 5 years	2018 / 5 years	FY2023 / 7 years
Satellite mass / power	1.75 t / 3770 W	1.8 t / 5000 W	2.9 t / 5200 W
Orbit	666 km, 3 days, 13:00, descending	613 km, 6 days, 13:00, descending	666 km, 3 days, 13:30, ascending
Spectrometer	FTS	FTS-2	TANSO-3 (Grating)
Major targets	CO_2, CH_4	CO_2, CH_4, CO	CO_2, CH_4, NO_2
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 (AT/CT)	±40 / ±35 deg (AT/CT)	± 40 / ± 34.4 deg (AT/CT) for Focus Mode
Other instruments	CAI (Cloud and Aerosol Imager)	CAI-2 (Cloud and Aerosol Imager 2)	AMSR3 (Advanced Microwave Scanning Radiometer 3)

GOSAT-GW Mission Requirements (by the Ministry of Environ.)

- 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), and permafrost



IPCC AR6, 2021

Maksyutov et al.

Ohyama et al., Remote Sens. Environ.
Fujinawa et al., Geophys. Res. Lett.

Global Stocktake = “Science” x “Paris Agreement”

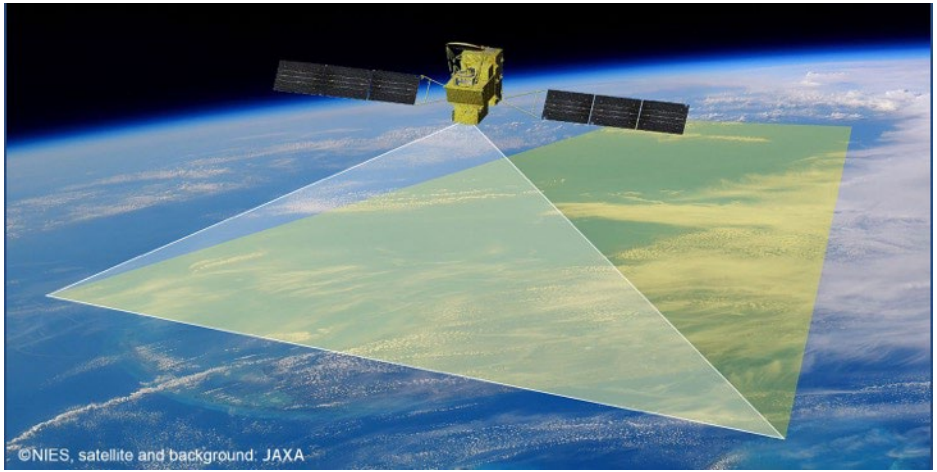
- Global Stocktake (GST) in 2023 and 2028 (and …)
  - New challenge for Earth Science/Environmental Science communities
  - R&D from multiple aspects are needed and can add value
- Visualization of Decarbonizing Process
- Answering to “Do we succeed in GHG emission reduction, and to what extent?”

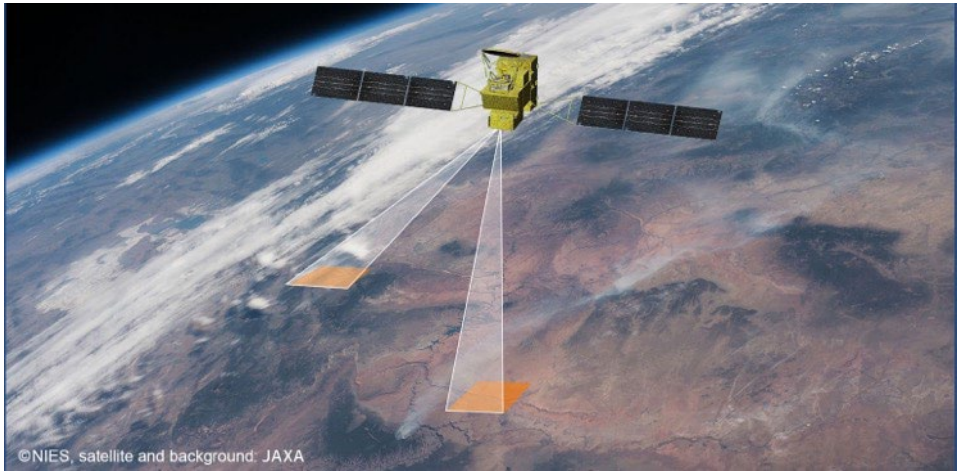
  => Contributing to enhanced reliability on NDCs, which are decided by policymakers
  - Trends and variability of emissions
  - Improving accuracy of bottom-up “national” emission estimates
  - Improving transparency by independent top-down estimates
- Country/State/City sectors: validation of current NDC, decision of next NDC
- Private sectors: incentive to reduce GHG emissions

C => A

- Advancing atmospheric chemistry approach to quantify emissions
- Better connecting inventories, observations, and modeling
- Synergetic use of GHGs and air pollutants
- Opportunities to engage society -- public & private sectors

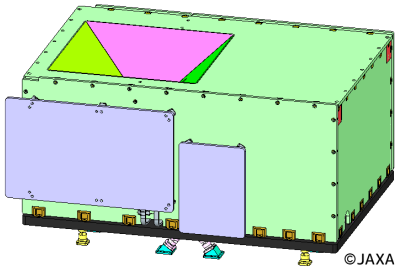
GOSAT-GW two observation modes





Wide Mode

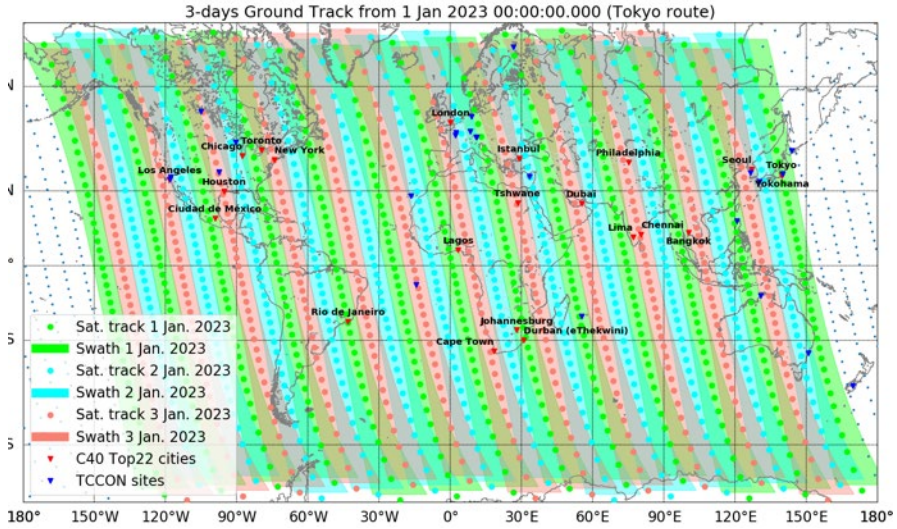
- Swath ≈ 900 km
- Footprint ≈ 10 km
- No AT/CT Pointing
- Default observation

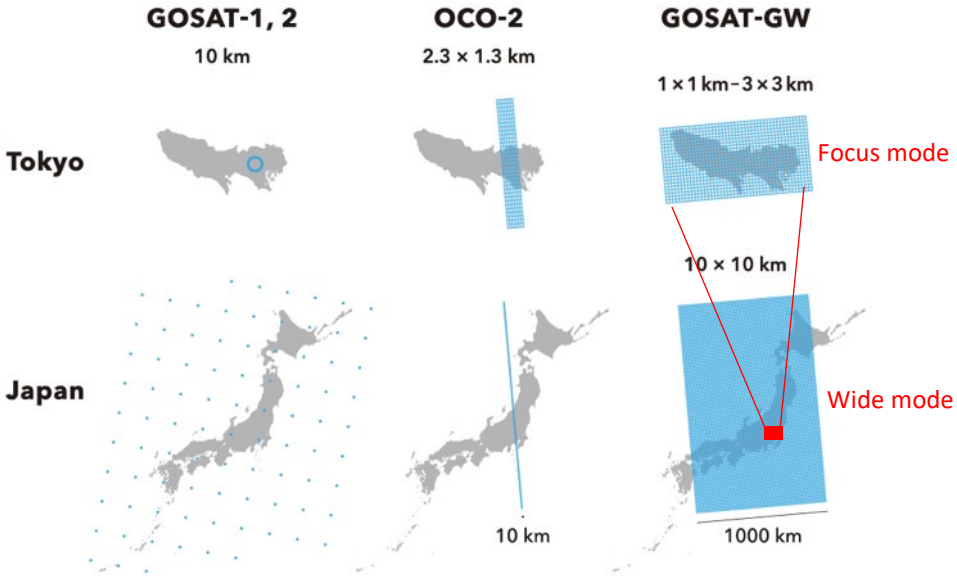


Focus Mode

- Swath ≈ 90 km
- Footprint ≈ 1 - 3 km
- AT/CT Pointing
- Upon requests

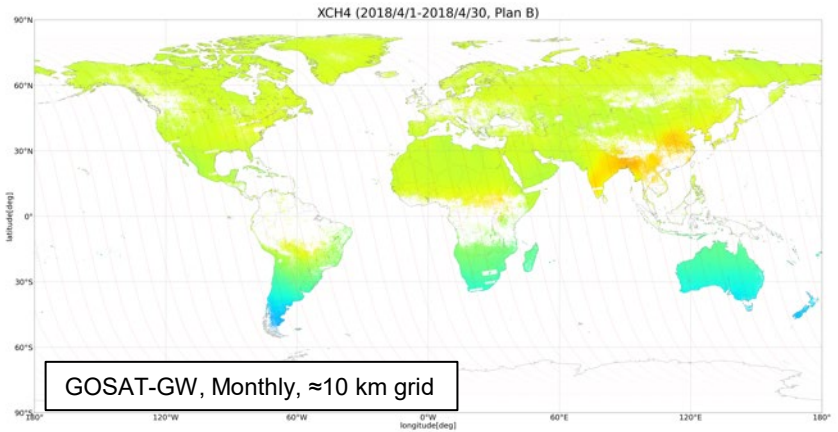
GOSAT-GW two observation modes

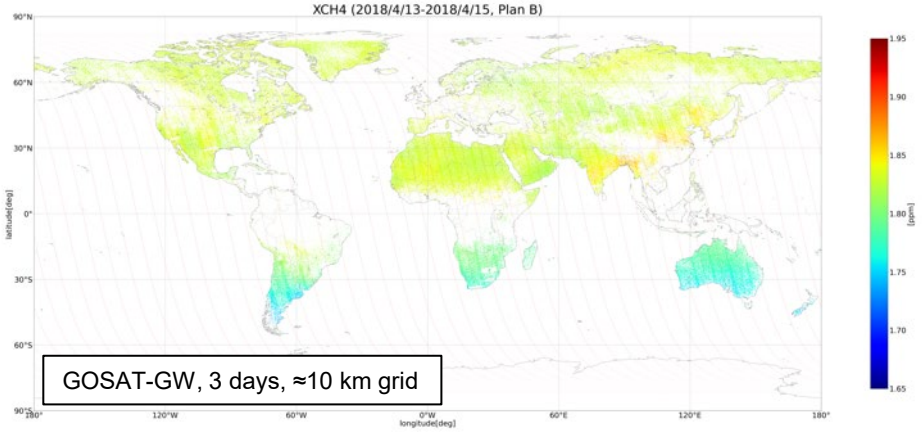




- 3-day global coverage (repeating)
- 911 km wide swath mode (10 km resolution)
- 90 km focus pointing mode (1-3 km resolution)
- CO_2 & CH_4 + NO_2

Simulated GOSAT-GW data in April 2018 (XCH_4)





But… real world is not that ideal nor smooth!!

Hence, we need science (and scientific community efforts) to play in!

- *retrieval algorithm*
- *ground data-processing system*
- *product validation*
- *model development*

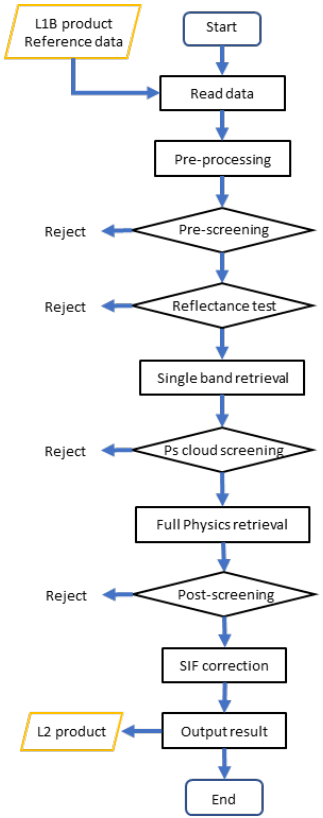
Retrieval algorithm and L2 product - GHGs

GOSAT Retrieval Algorithm (GORAL)

Main targets	XCO_2, XCH_4
Other variables	XH_2O, SIF, AOT, ALH, albedo,…
Retrieval technique	Full Physics (XCO_2, XCH_4, …) Proxy (XCH_4)
A priori	JRA-3Q (Japanese reanalysis) NICAM (for GHGs and aerosols)
Cloud screening	Reflectance test Surface pressure retrieval

TANSO-3 L2 GHG product

Stored items	All the retrieval results from GORAL and ancillary parameters
File format	HDF5
File unit	file/day (Wide mode) file/scene (Focus mode)



Flow of the GORAL processing

3-P15:
Yu Someya,
Design of the retrieval algorithm and level 2 product for greenhouse gases from GOSAT-GW

Team: Yu Someya, Yukio Yoshida, Hisashi Yashiro, Hirofumi Ohyama, Isamu Morino, Tazu Saeki

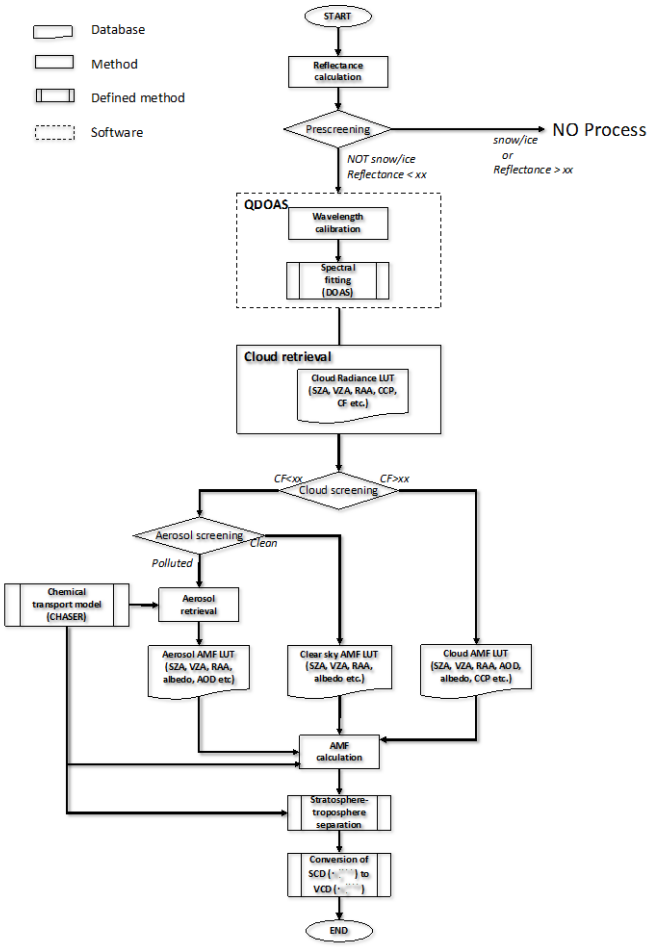
Retrieval algorithm and L2 product - NO_2

GOSAT-GW Retrieval Algorithm

Main targets	NO_2 (total + tropospheric column)
Other variables	Effective cloud fraction, Aerosol optical parameters
Retrieval technique	DOAS (optical density fitting)
A priori	JRA-3Q (Japanese reanalysis) CHASER with bias correction (for gas species, such as NO_2, O_3, … and aerosol optical parameters)
Cloud screening	Cloud fraction derived from O_2–O_2 absorption @ 477 nm

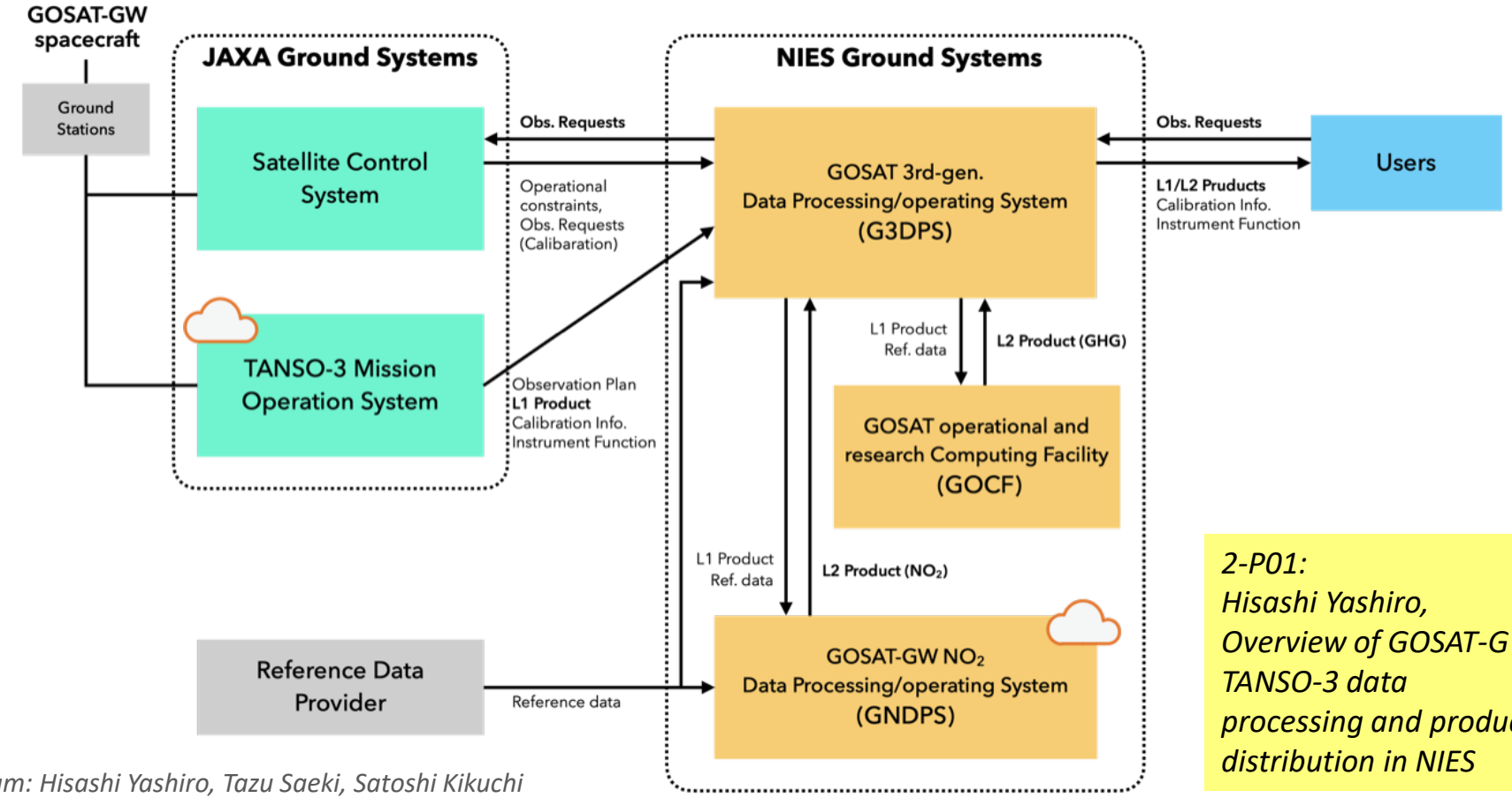
TANSO-3 L2 NO_2 product

Stored items	Total + tropospheric NO_2 vertical column densities [molecules cm^{-2}] and ancillary parameters
File format	HDF5
File unit	file/day (wide mode) file/scene (Focus mode)



Team: Tamaki Fujinawa, Yosuke Yamashita, Tomohiro Sato, Thi Ngoc Trieu Tran, Takashi Sekiya, Hyunkwang Lim, Takafumi Sugita

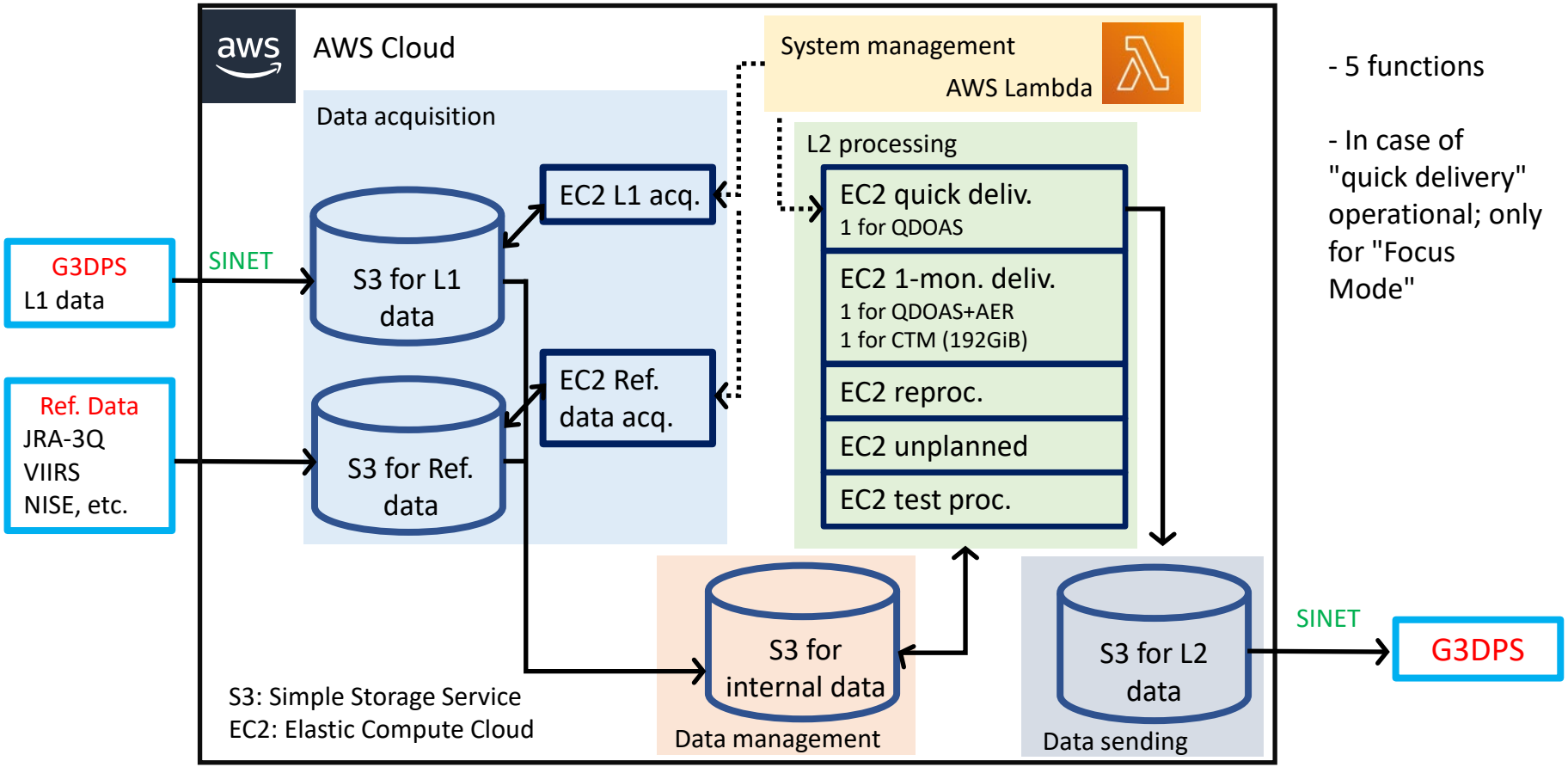
Ground data-processing system (G3DPS, incl. GHGs)



Team: Hisashi Yashiro, Tazu Saeki, Satoshi Kikuchi

2-P01:
Hisashi Yashiro, Overview of GOSAT-GW TANSO-3 data processing and product distribution in NIES

NO2 Data Processing System (GNDPS)



- 5 functions

- In case of "quick delivery" operational; only for "Focus Mode"

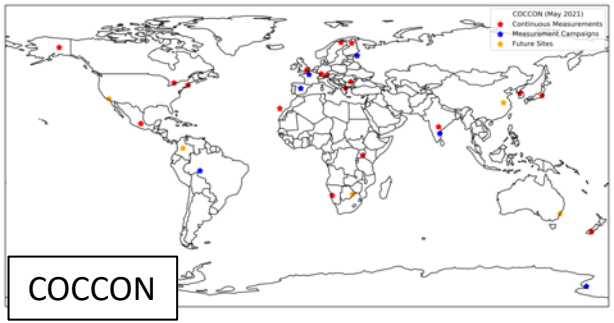
Team: Takafumi Sugita, Takashi Sekiya, Yousuke Yamashita, Tomohiro Sato, Yasko Kasai, Ayano Nakamura, Thi Ngoc Trieu Tran

Validation plan for GHGs and NO_2

- Primary approach is ground-based column obs., complemented by additional obs. (e.g., airplane, ship, satellite, etc.)
- Besides above, campaign-based measurements will be made as needed
- Separate validation exercises are now being planned for the wide- and focus-modes

Platform	CO_2/CH_4	NO_2
Ground-based	TCCON COCOON	Pandora MAX-DOAS
Airplane	CONTRAIL IAGOS-CORE	IAGOS
Satellite	GOSAT, GOSAT-2 OCO-2, OCO-3 TROPOMI	OMI TROPOMI GEMS

TCCON



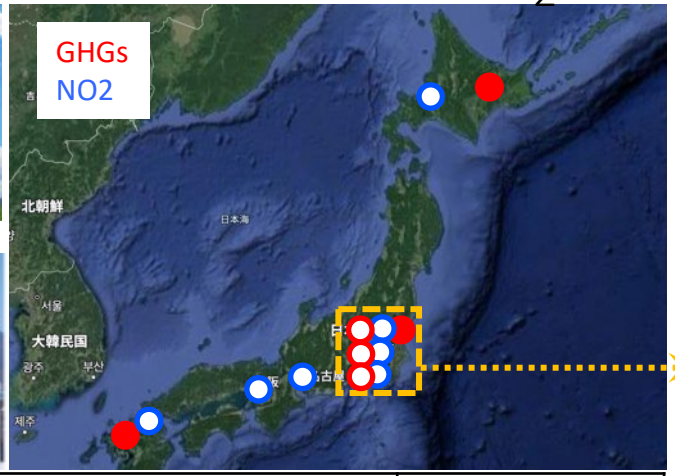
COCCON

PGN

Team: Hirofumi Ohyama, Satoshi Inomata, Isamu Morino, Matthias Frey, Astrid Müller, Hao Xu, Yugo Kanaya, Yongjoo Choi

Validation of GHGs and NO_2 in urban area

5-P03:
Matthias M. Frey,
Urban Greenhouse Gas Emission Monitoring in Seoul and Tokyo



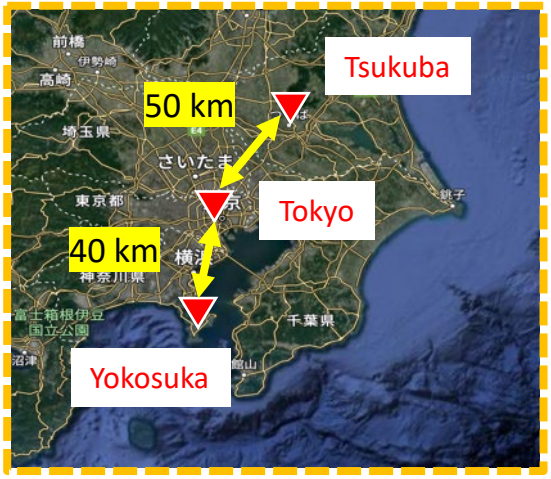
	CO_2/CH_4		NO_2
	TCCON	EM27/SUN	Pandora
Hokkaido	ONGOING		ONGOING
Tsukuba	ONGOING	ONGOING	ONGOING
Central Tokyo		IN PREP.	IN PREP.
Suburban Tokyo			ONGOING
Yokosuka		IN PREP.	ONGOING
Nagoya			ONGOING
Kobe			ONGOING
Kyushu	ONGOING		ONGOING

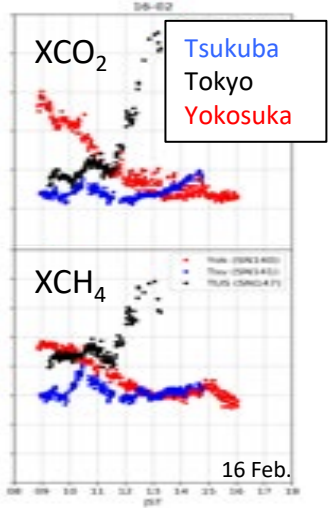
Campaign-based GHG measurements in urban area

Tokyo(-Seoul) campaign, 14-25 Feb 2022 (w/ Hayoung Park)

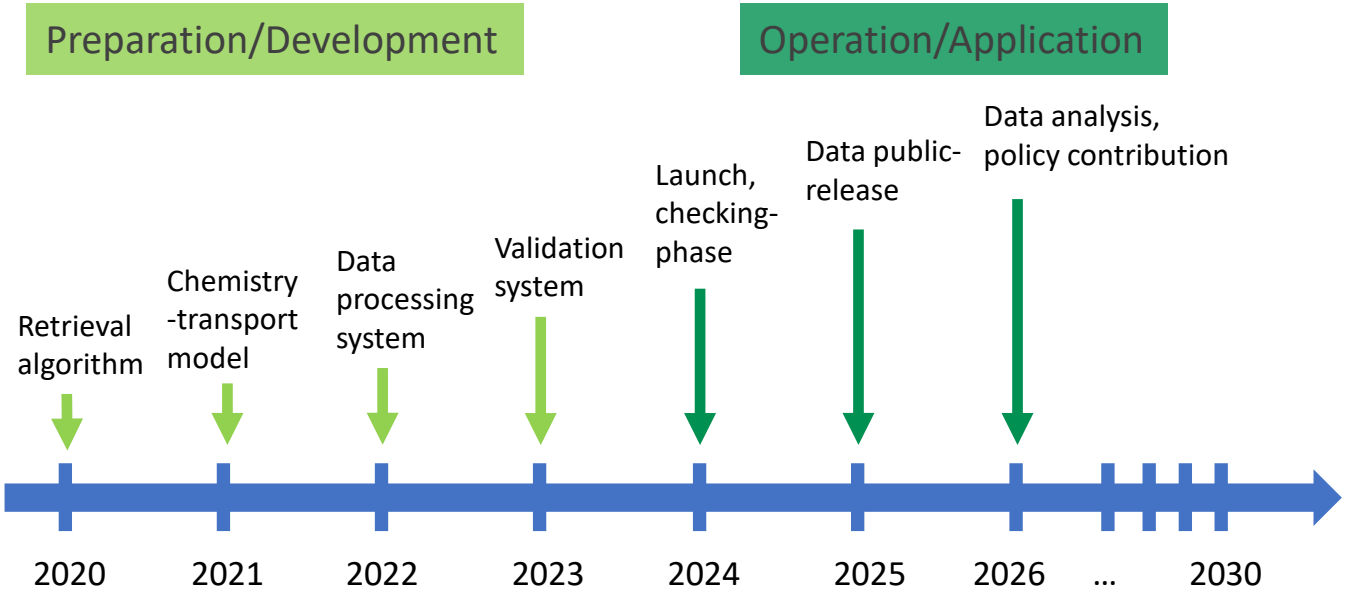
Objective: Monitoring changes of CO_2 and CH_4 in the urban atmosphere: now and in future;

Test for the long-term validation of GOSAT-GW (**especially focus-mode**) in central Tokyo.





Timeline of Development and Data Release



NIES ground-based, ship and aircraft GHG monitoring

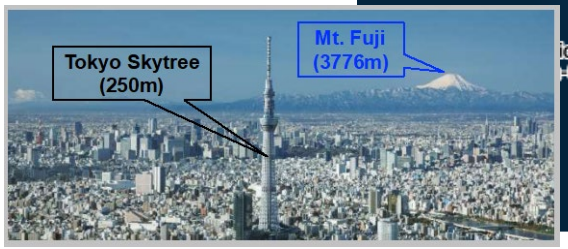
NIES Center for Global Environmental Research (CGER) monitoring platforms


Monitoring station, Cape Ochiishi


Monitoring station, Hateruma


Mt. Fuji automated weather station


Rikubetsu, TCCON site




Trans Future 5

4-1.
Astrid Müller, Commercial ship and aircraft-based evaluation of satellite derived XCO2 and XCH4 over oceans - updates and prospective

How can we best use these obs. capabilities for the GOSAT-GW validation?