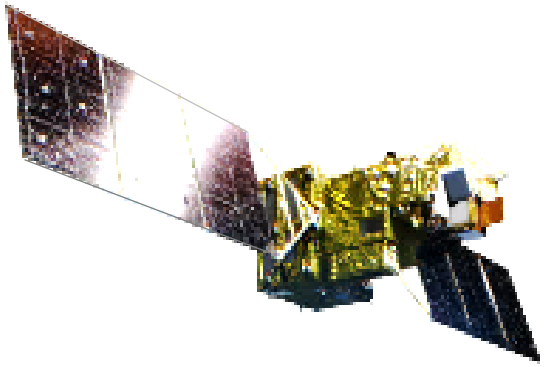
Greenhouse gases observation from space by GOSAT series satellites since 2009

2009-Now



2018-Now

Akihiko KUZE, Kei SHIOMI, Hiroshi SUTO (JAXA)

Nov. 15, 2022

GOSAT & GOSAT-2 Organization

GOSAT and GOSAT-2 are the joint projects of JAXA, MOE (Ministry of the Environment) and NIES (National Institute for Environmental Studies)

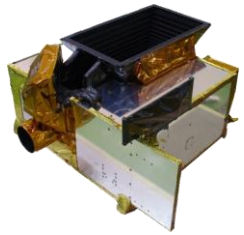
MOE

JAXA

Thermal And Near infrared Sensor for carbon Observation

2009-Now

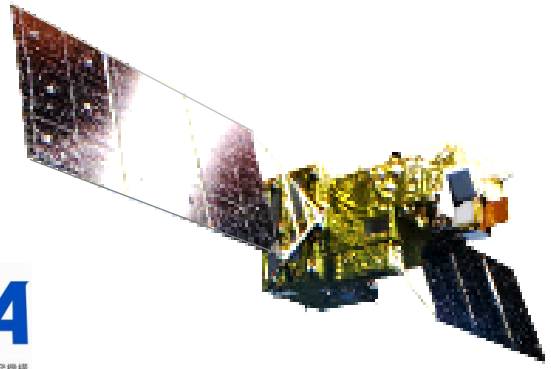
TANSO-FTS



SWIR/TIR FTS

TANSO-CAI

UV, Visible, SWIR Imager



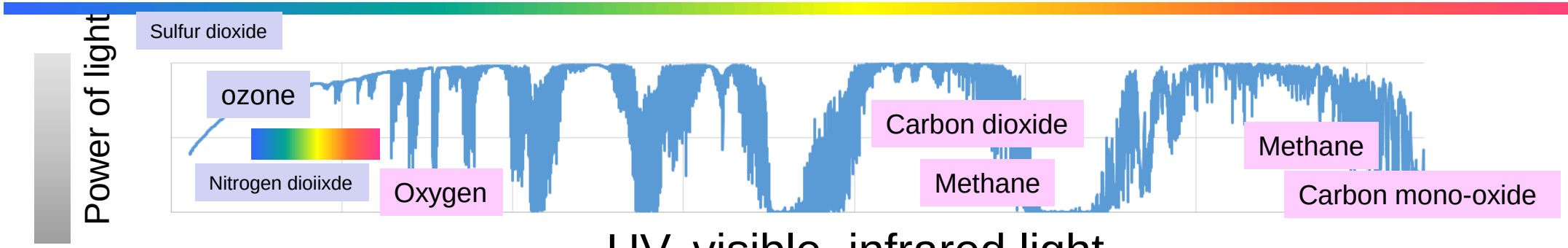
2018-Now

- Algorithms development
- Data use for science
- Validation

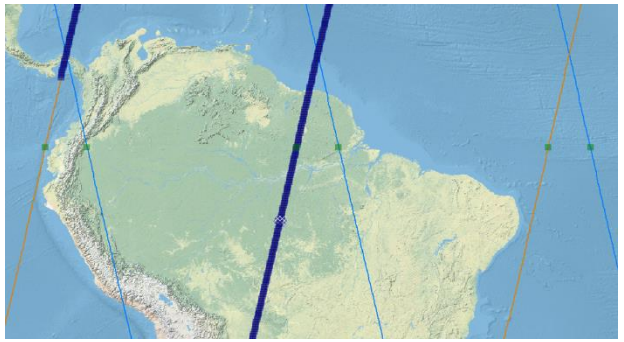
NIES

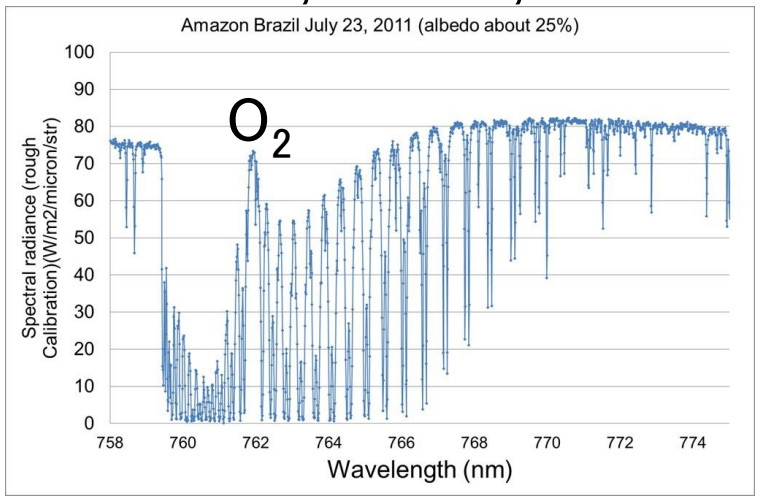
- Sensor development
- Satellite development
- H-IIA launch
- Satellite operation
- Data acquisition
- Calibration
- Research Products

10,000 color channel data from space

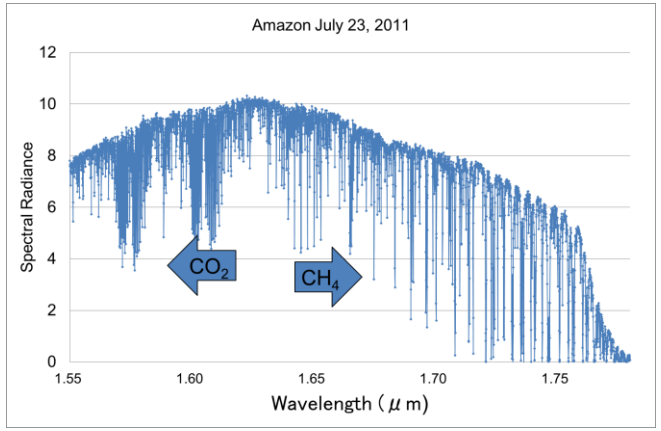


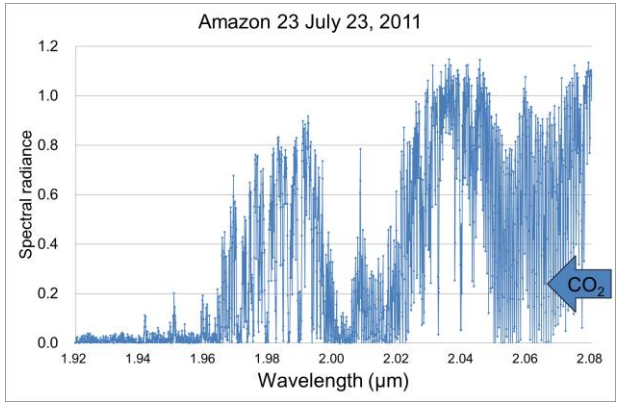
UV, visible, infrared light





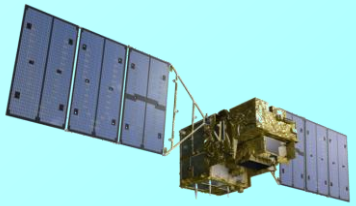
Retrieving carbon dioxide (CO_2) and methane (CH_4) by comparing more abundant oxygen (O_2)(spectral interval of 0.012nm)





On orbit Status and Level 1 products

Long term (14-year) calibrated validated dataset



Satellite Condition

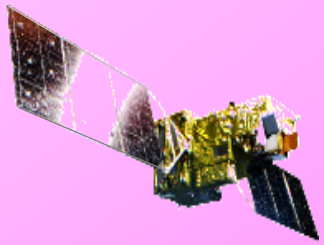
Enough fuel to operate for at least another 10-year
All four batteries are healthy

13-year data set of JAXA EORC research product (partial column density)(version 3 in process).

Fine temperature control for the FTS mechanism has been performed since 2020 to operate under lower metrology laser detection level.

Next L1 release V300.300, Major (Nov. 1 review completed)
Best-estimate radiance spectra using TSIS-HSRS and 14-year vicarious calibration results
14-year solar irradiance data for solar physics community

Intense target observations using flexible and wide angle pointing



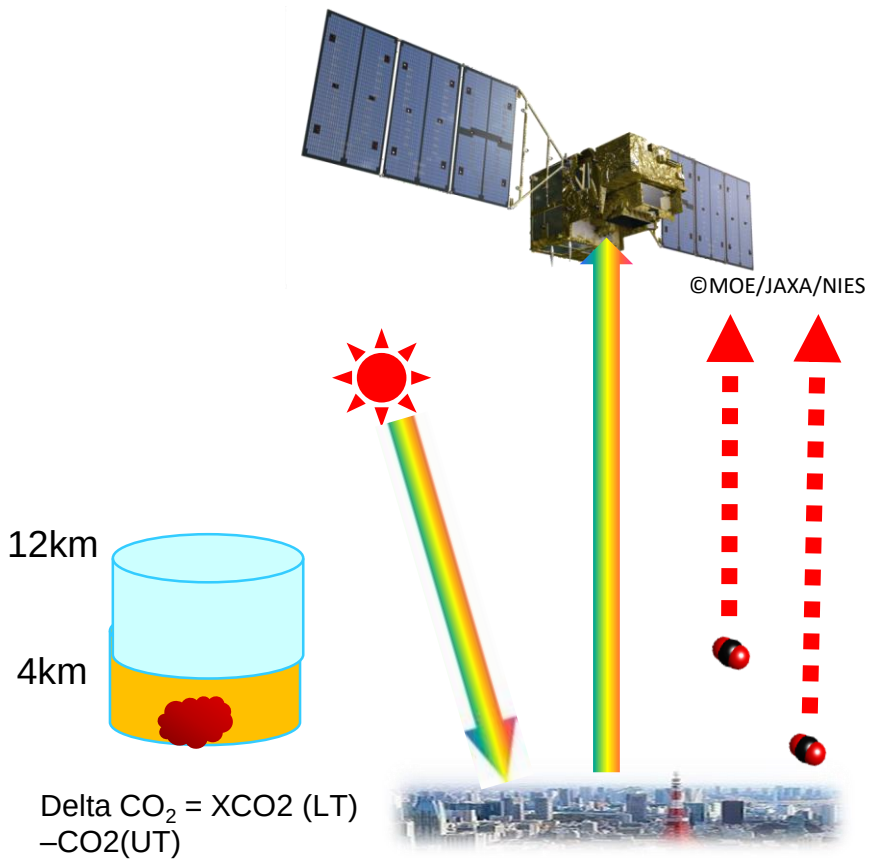
Calibration

February 2021, Anomaly occurred in the solar diffuser panel mechanism. The solar irradiance calibration has been suspended since then,

Lunar and ILS laser calibrations are normal.

Next L1 release: V220 (Nov. 1 review completed)
Minor: TIR calibration updated in large-AT angles (backward viewing)

JAXA EORC Research Product
Retrieving Partial Column Density of UT and LT



(1) SWIR constrains column density

(2) Two orthogonal linear polarization data remove aerosol contamination.

(3) TIR provides difference in partial column density between lower and upper troposphere.

Cloud screening using onboard camera

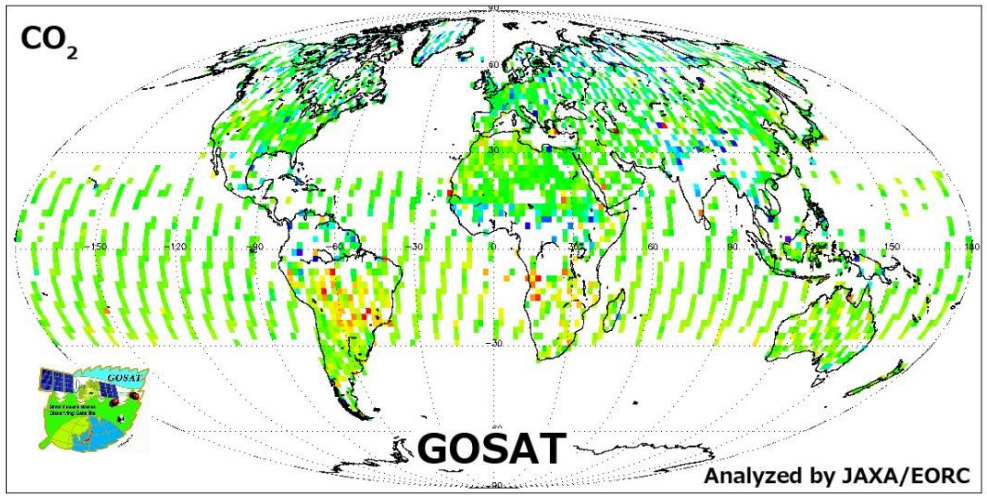
Parameters to be retrieved

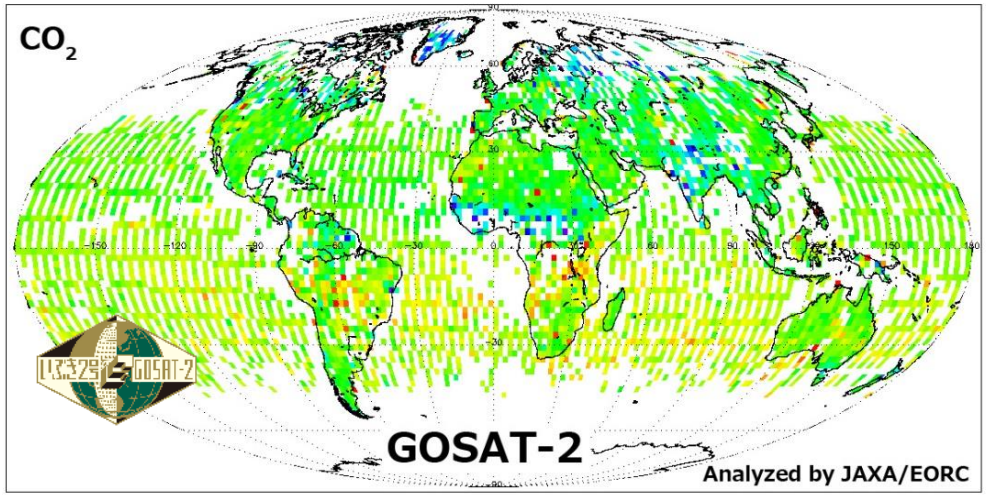
(1) CO_2 CH_4 (5 layers: 2 for troposphere and 3 for stratosphere)

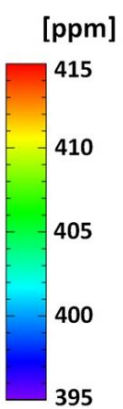
H_2O (11 layers)

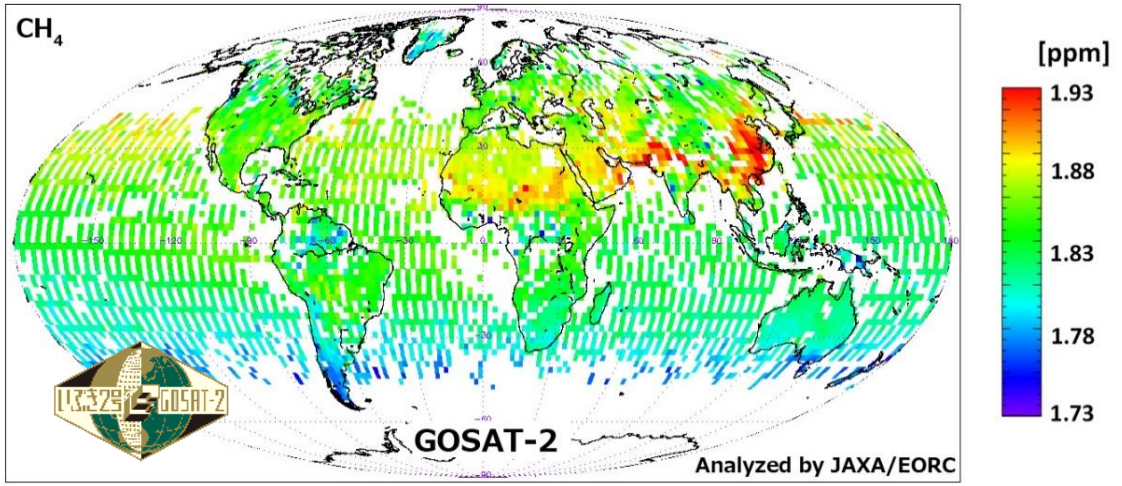
(2) Surface albedo (polynomial)

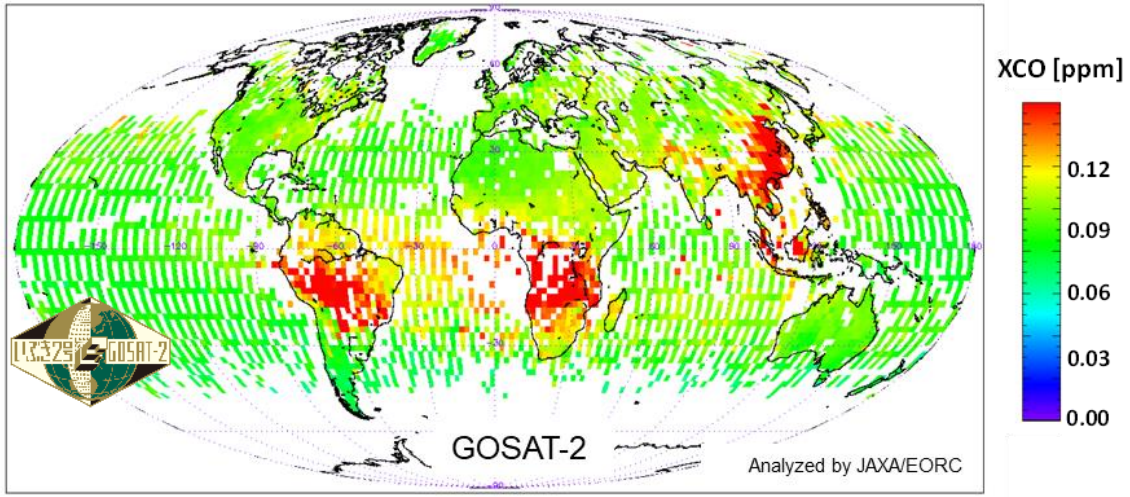
Sep 2019 GOSAT,GOSAT-2 CO_2 CH_4 CO











JAXA EORC Partial Column Products

https://www.eorc.jaxa.jp/GOSAT/Global_GHGs_Map/index.html

(1) 13-year GOSAT and 2-year GOSAT-2 products

One file per month with clear sky data, CSV format

(2) Contents

XCO_2, XCH_4, XCO_2 (LT, UT), XCH_4 (LT, UT), XCO (GOSAT-2 only),

H_2O (11 layers) aerosol optical thickness (AOT),

Retrieved surface pressure (P), solar-induced chlorophyll fluorescence (SIF)

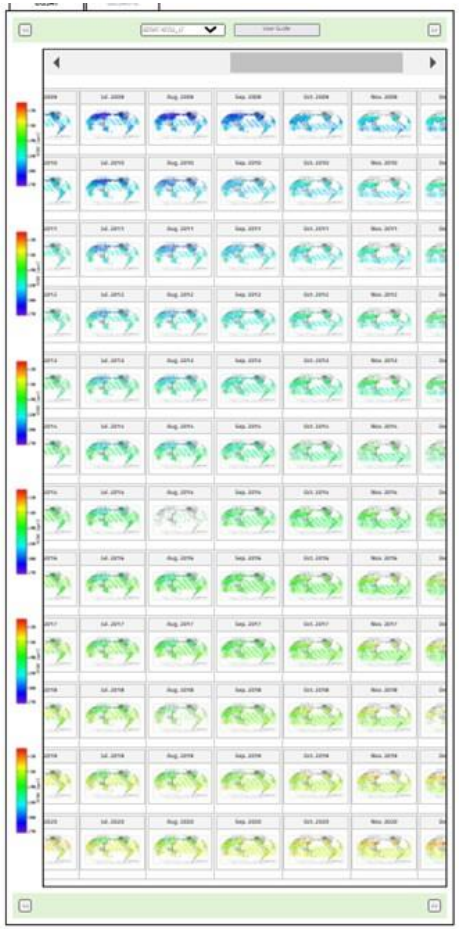
time, geometry

(3) https://www.eorc.jaxa.jp/GOSAT/GPCG/download_v2/

ID：gosat、PW：***** (please contact us)

(4) Kuze et al., Examining partial-column density retrieval of lower-tropospheric CO2 from GOSAT target observations over global megacities, Remote Sensing

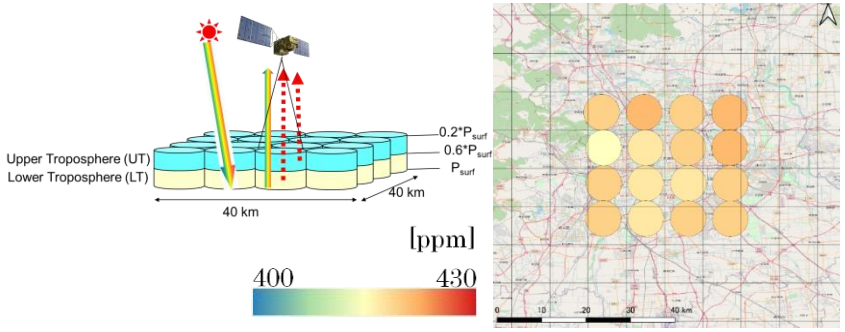
XCO_2^{LT} ($1\text{-}0.6\ P_{surf}$)



GOSAT-1 Version 1

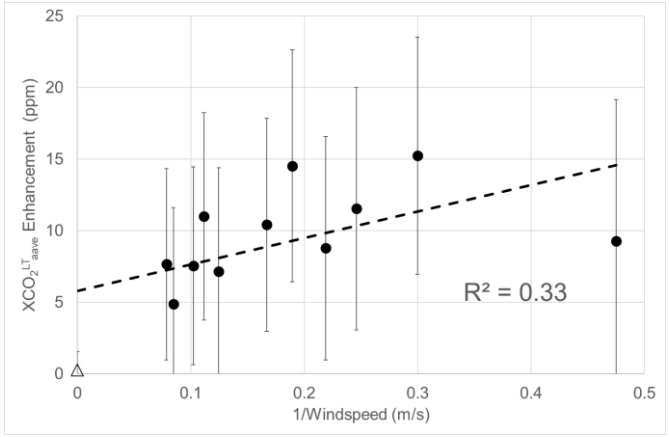
yyyy/mm/dd	hh:mm:ss	Latitude	Longitude	LSFLG	XCO2_apr	XCO2_tot	XCO2_low	XCO2_upp	XCH4_apr	XCH4_tot	XCH4_low	XCH4_upp	XCO_apr	XCO_tot	Psrf_apr	Psrf_ret	AOT_076	AOT_160	AOT_206	SIF	Cloud	scanID
2019/01/01	01:13:04	-41.3061	173.4926	0	406.5682	397.9352	395.1537	399.3747	1.7439	1.7464	1.8315	1.7634	0.00000	0.00000	967.86	977.05	0.0963	0.0886	0.0820	10.4642	-1.000000	F190101011304
2019/01/01	02:46:15	-23.9153	151.2222	0	407.7506	402.3643	402.1988	403.2452	1.7683	1.8030	1.7950	1.8469	0.00000	0.00000	1007.32	1001.42	0.3487	0.3636	0.3583	1.2205	-1.000000	F190101024615
2019/01/01	02:47:06	-23.9548	148.3777	0	407.6141	404.1903	401.7923	406.6639	1.7696	1.8011	1.8437	1.8281	0.00000	0.00000	990.35	989.26	0.0255	0.0134	0.0110	-0.1822	-1.000000	F190101024706

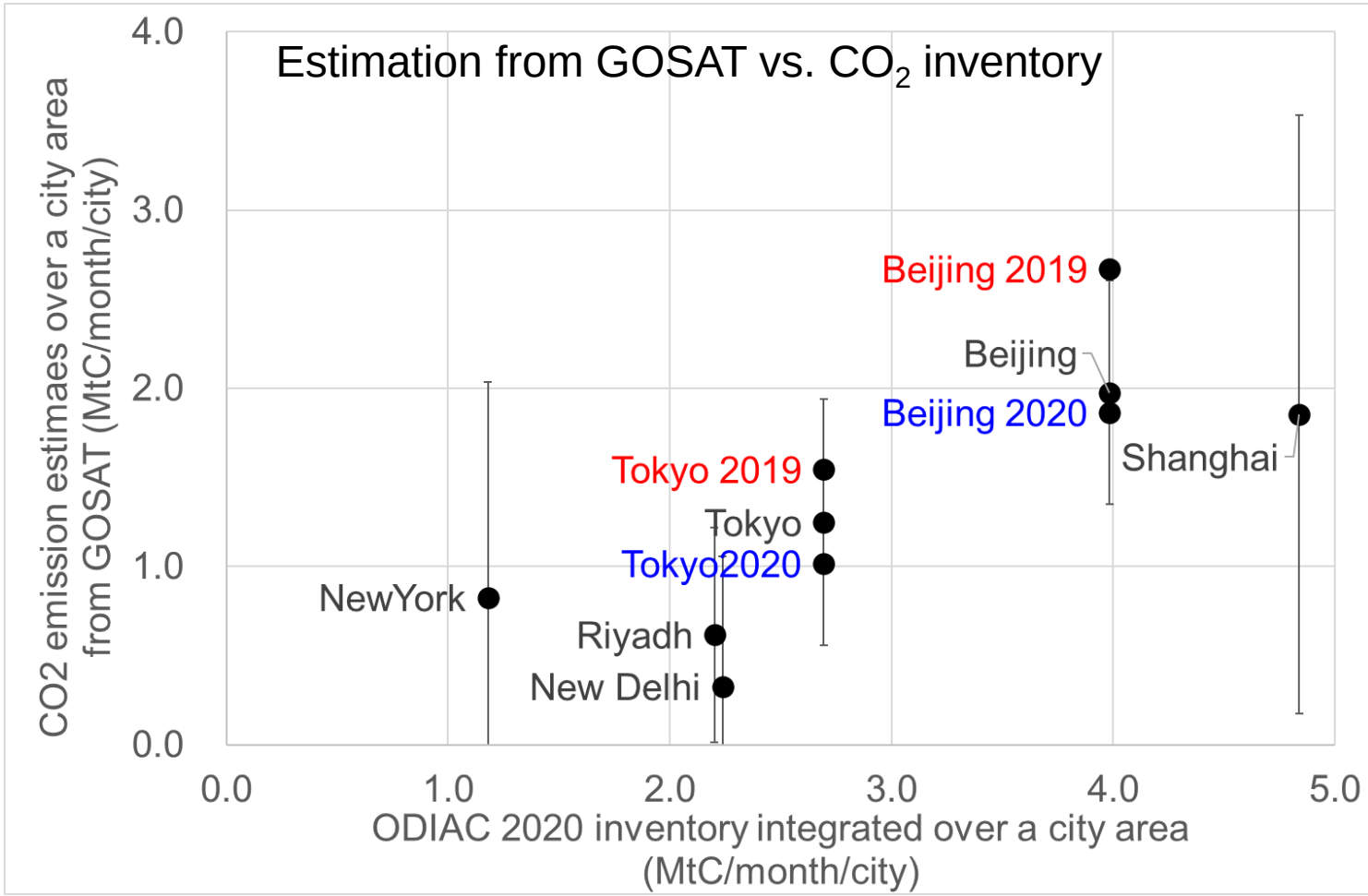
JAXA EORC Research Product
Application



XCO_2^{LT} (circles) in March 2019

$$\Delta XCO_2^{LT} \propto \frac{F_{CO_2}(Emission)}{V(windspeed)}$$

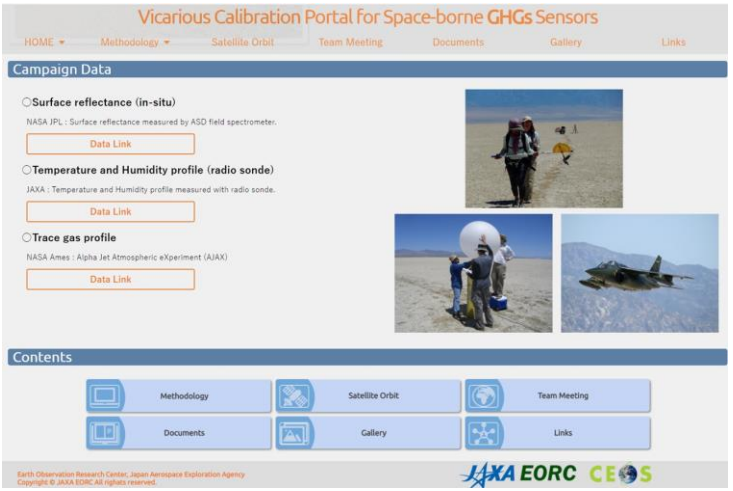




Recent publication. Kuze et al., Examining partial-column density retrieval of lower-tropospheric CO2 from GOSAT target observations over global megacities, Remote Sensing of Environment 2022

Joint RRV 2022 campaign and VCAL portal for GHG sensors

- 14th annual vicarious calibration campaign was successfully completed in June 2022, Railroad valley Nevada.
- Coincident measurements of GOSAT, GOSAT-2, OCO-2 (partially cloud), OCO-3, TROPOMI (everyday).



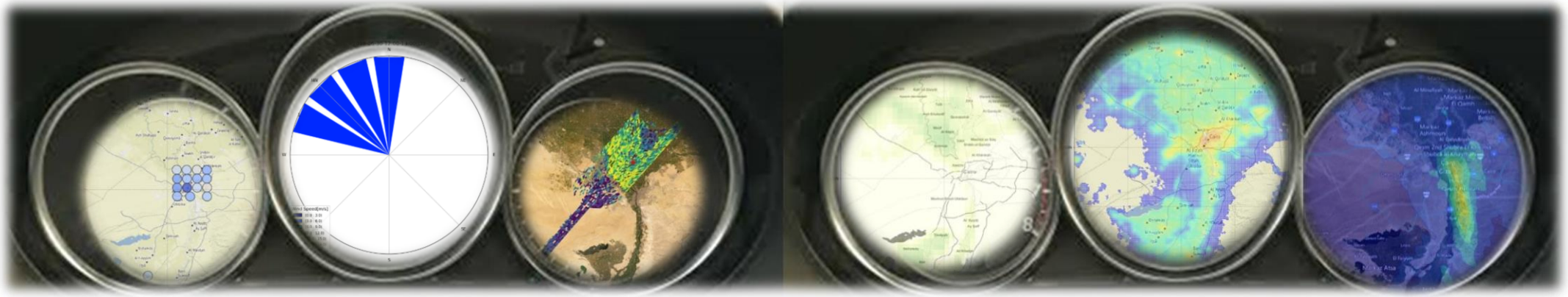
❖ https://www.eorc.jaxa.jp/GOSAT/GHGs_Vical/index.html

The VCAL Portal site provides

(1) Methodology of vicarious calibration for various size footprint and off-nadir data.
(2) 14-year annual joint campaign data for CAL-VAL
(3) Dataset for analysis
(4) Analytical results from various type of spectrometers: GOSAT FTS, OCO, S5P TROPOMI

Earth Observation Dashboard - Local Urban Story
ESA-NASA-JAXA collaboration

- The first release on May 20, 2022
- Provide measured values from multiple instruments
- Tell stories to the public
- Collaboration between ESA-NASA-JAXA



GOSAT XCO_2^{LT}-XCO_2^{UT} (partial Column) Met (Wind speed & direction), OCO-3 XCO_2

TROPOMI SIF (Solar-Induced chlorophyll fluorescence), ODIAC CO_2 inventory, TROPOM NO_2 CH_4

Earth Observation Dashboard - Local Urban Story
Cairo (COP27 host country)

Cairo Story (1) COP27 host country (2) Downtown in South (3) Nile delta in North
(4) Double peak SIF (summer and December) (solar-induced chlorophyll fluorescence) Multiple Cropping

2018-06-30

Negative enhacementCO_2

Wind from North

Nile delta Farmland

2019-02-01

CO_2 Enhancement

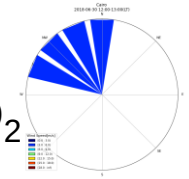
Wind from East

Nile delta Strong SIF

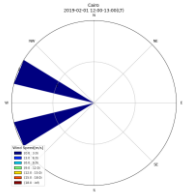
2019-10-05

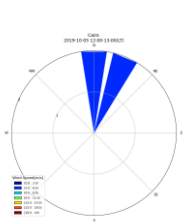
CO_2 Enhancement

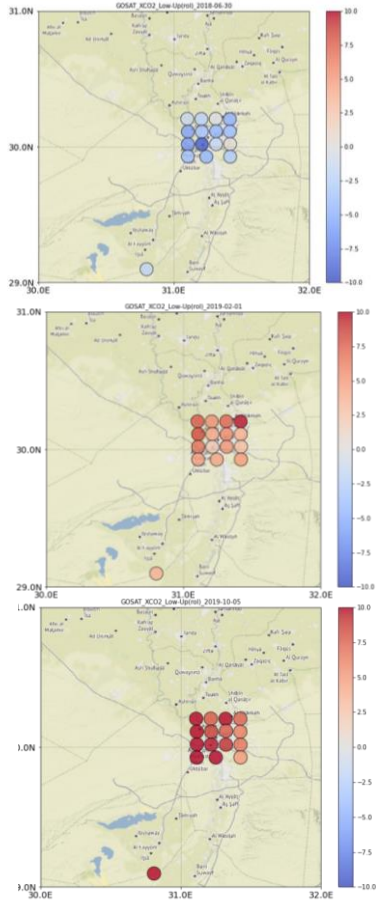
Wind Weak SIF

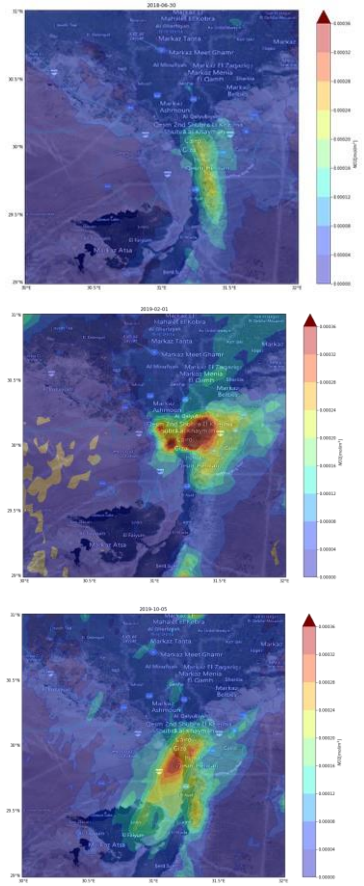


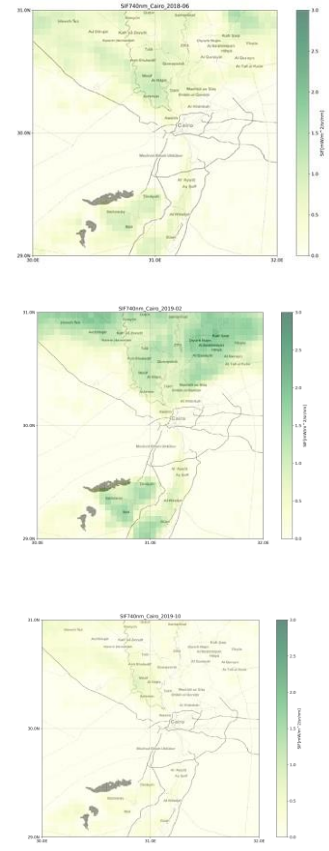
Airport wind at GOSAT overpass











GOSAT partial column from SWIR and TIR XCO_2^{LT}-XCO_2^{UT} average Daily TROPOMI NO_2 Monthly TROPOMI SIF