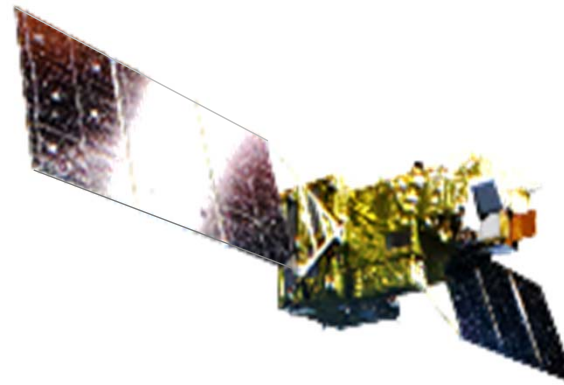# More than a decade of GOSAT and GOSAT-2 operations and data products using their unique capabilities of FTS multiplex advantage and target observations
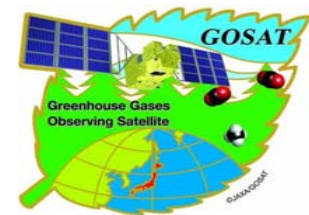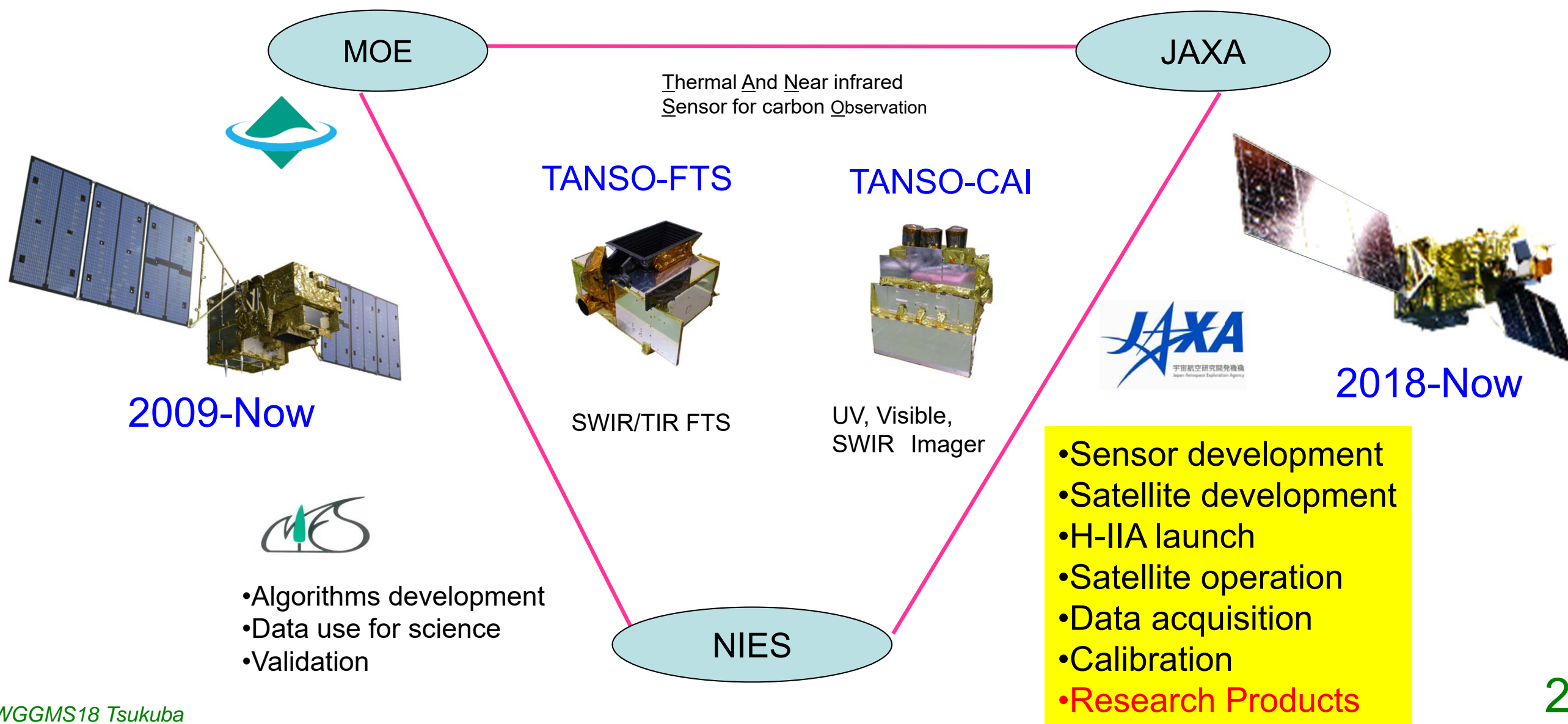
2009-Now

2018-Now

July 12, 2022,16:00-

Akihiko Kuze, Hiroshi Suto, Kei Shiomi, JAXA GOSAT and GOSAT-2 team,
CEOS WGCV, EO-Dashboard team

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

TANSO-FTS

TANSO-CAI

2018-Now

2009-Now

SWIR/TIR FTS

UV, Visible,
SWIR Imager

- Algorithms development
- Data use for science
- Validation

NIES

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

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
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
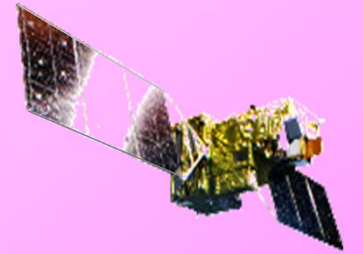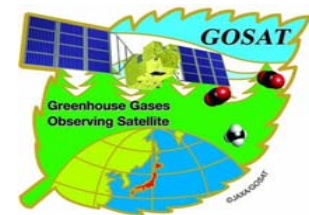
Calibration

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
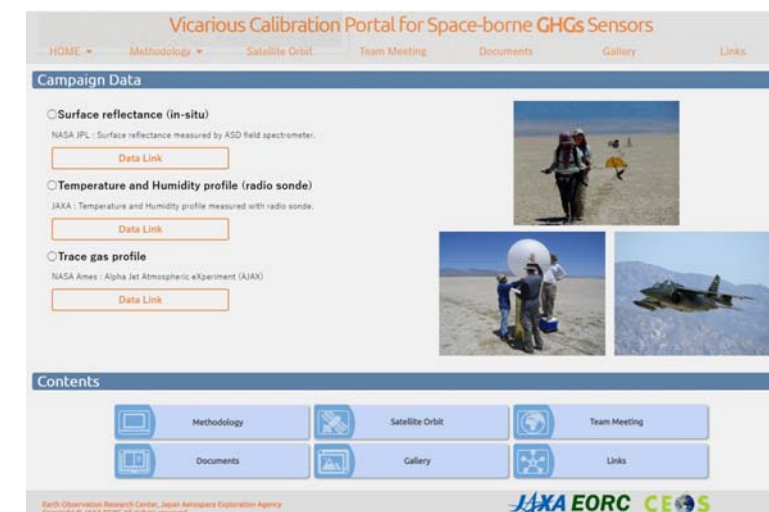Minor: TIR calibration updated in large-AT angles (backward viewing)

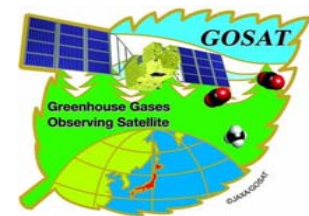# Joint RRV 2022 campaign and VCAL portal for GHG sensors

- 14th annual vicarious calibration campaign was successfully completed in June 2020, Railroad valley Nevada.
- Coincident measurements of GOSAT, GOSAT-2, OCO-2 (partially cloud), OCO-3, TROPOMI (everyday).
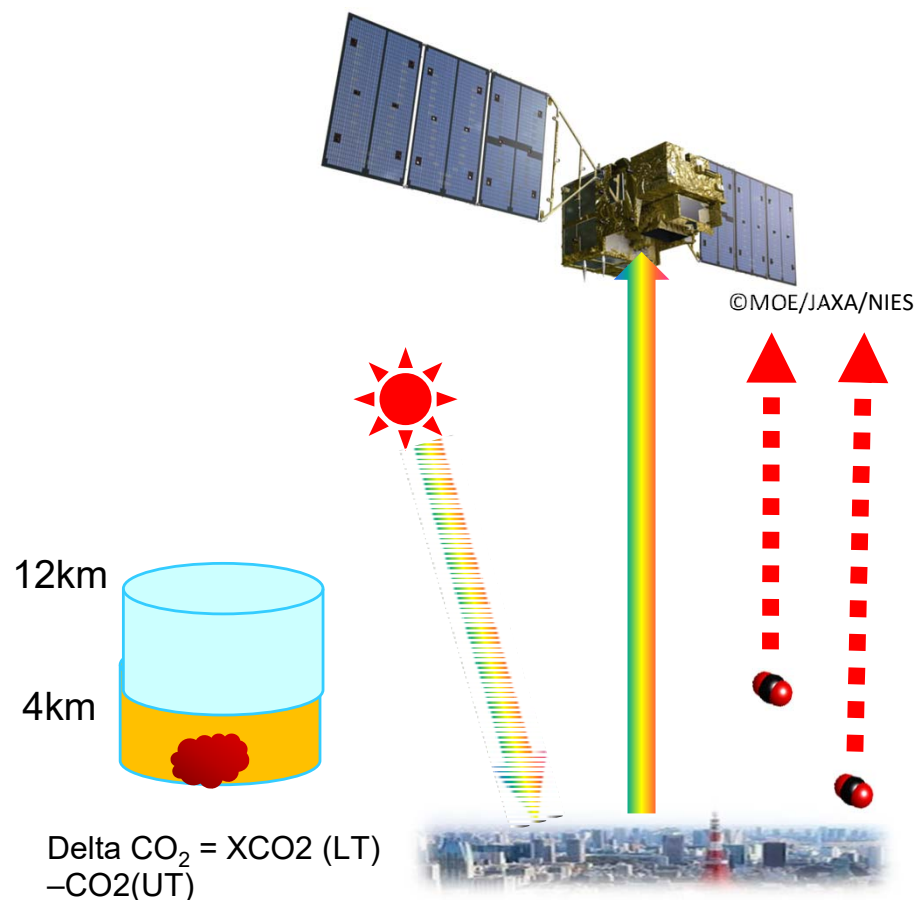

❖ https://www.eorc.jaxa.jp/GOSAT/GHGs_Vical/index.html

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

4

(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.

©MOE/JAXA/NIES

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)

12km

4km

Delta CO_2 = XCO2 (LT) –CO2(UT)
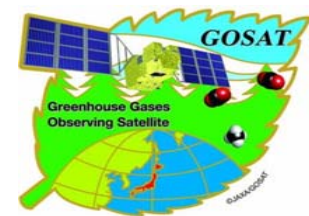
JAXA EORC Partial Column Products

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)
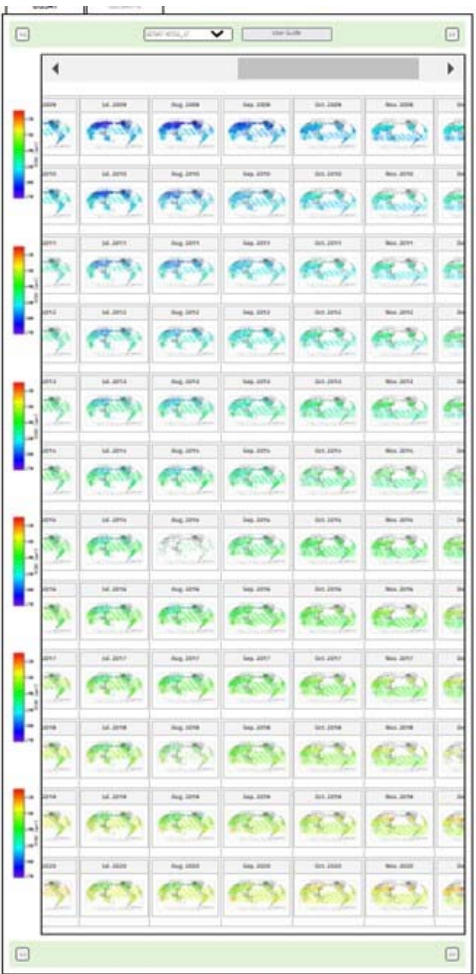
time, geometry

(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

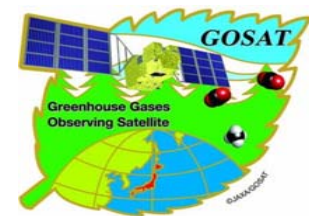CO2 from GOSAT target　observations over global megacities, Remote Sensing
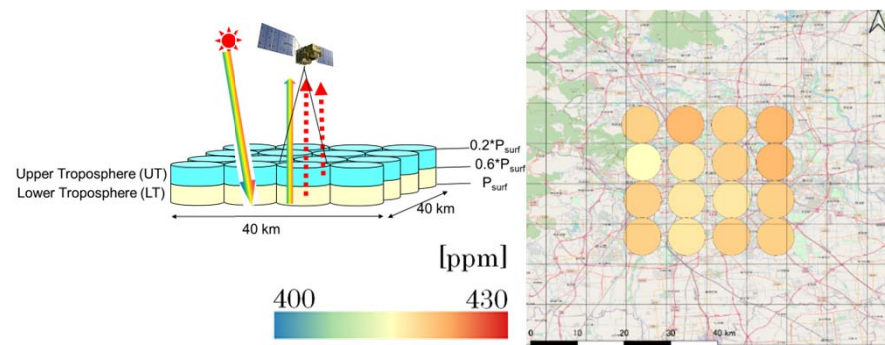
XCO_2^{LT}
(1-0.6 P_{surf})

GOSAT-1 Version 1

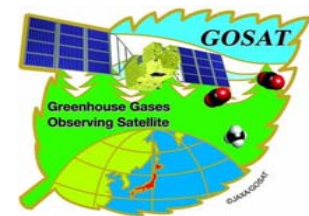| yyyy/mm/dd	hh:mm:ss	Latitude	Longitude	LSFLG	XCO2_apr	XCO2_tot	XCO2_low	XCO2_upp	XCH4_apr	XCH4_tot	XCH4_low	XCH4_upp	XCO_apr	XCO_tot	Psrf_apr	Psrf_ret	AOT_076	AOT_160	AOT_206	SIF	Cloud scanID
2019/01/01	01:13:04	-41.3061	173.4926	0	406.5682	397.9352	395.1537	399.3747	1.7439	1.7464	1.8315	1.7634	0.00000	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

XCO_2^{LT} (circles) in March 2019

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

Estimation from GOSAT vs. CO_2 inventory
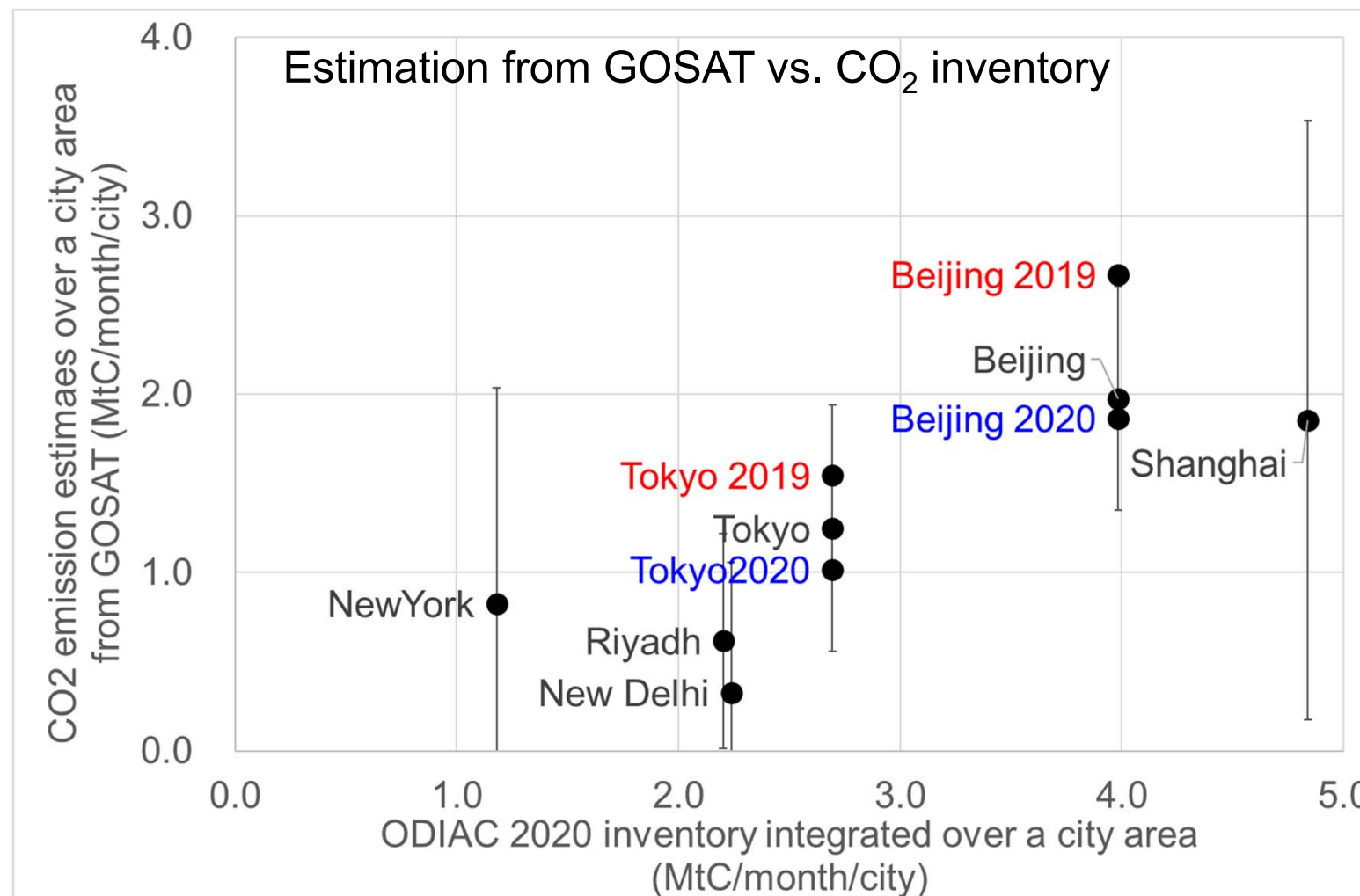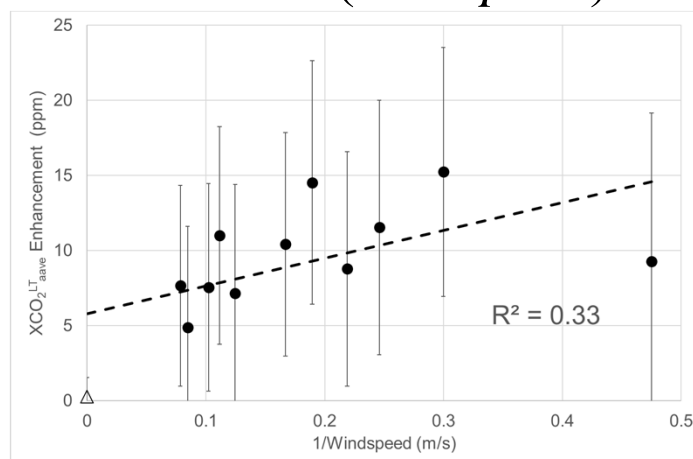
Recent publication. Kuze et al., Examining partial-column density retrieval of lower-tropospheric CO2 from GOSAT target observations over global megacities, Remote Sensing of Environment 2022
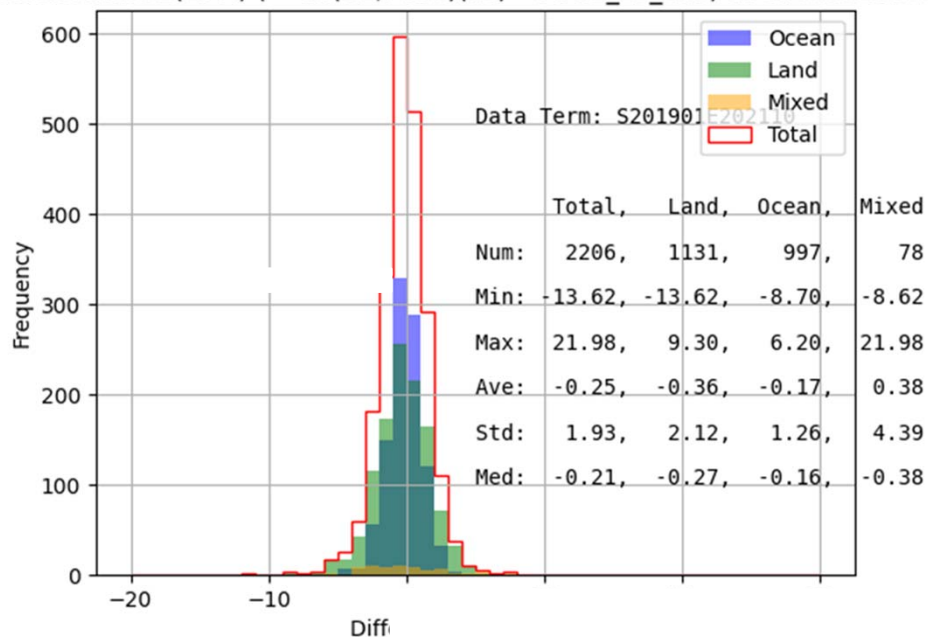
IWGGMS18 Tsukuba

7

XCO$_2$: OCO-2 L2 vs. GOSAT EORC Research L2 Match up (2019/01 ~ 2021/10)
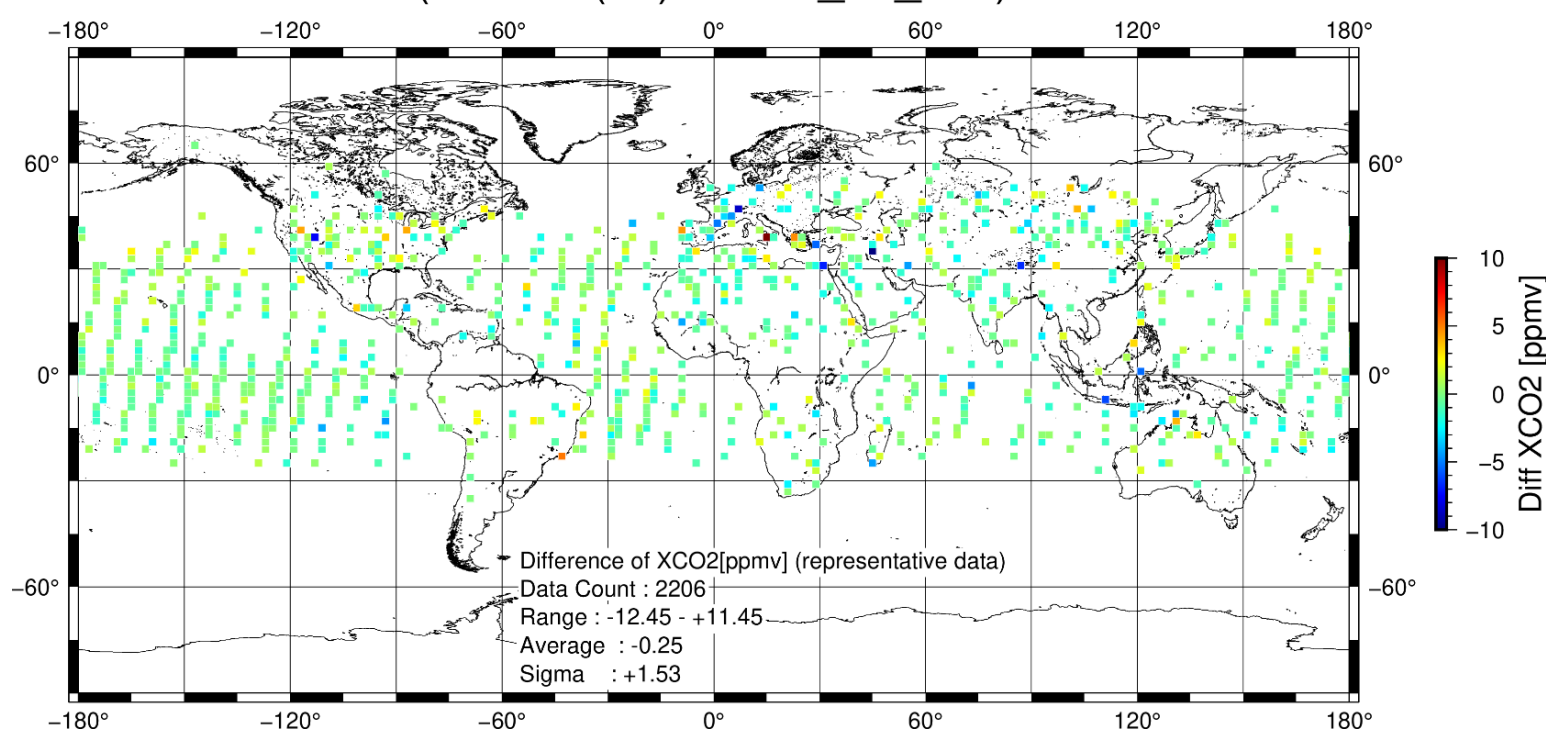
- Almost no bias for both Ocean and Land
- Topography dependent bias (Kataoka et al., 2017) over central Asia has been removed.
- Multiple sensor data set for model comparisons

Difference of XCO2(G1/FTS(2L)-OCO2_L2_Lite) for 201901-202110

GOSAT EORC L2 ver.2 (XCO$_2$) vs OCO-2 XCO$_2$: L2_Lite_FP.10r (land/ocean)
Match up +/1 hour, more than 5 OCO-2 data within a single GOSAT footprint
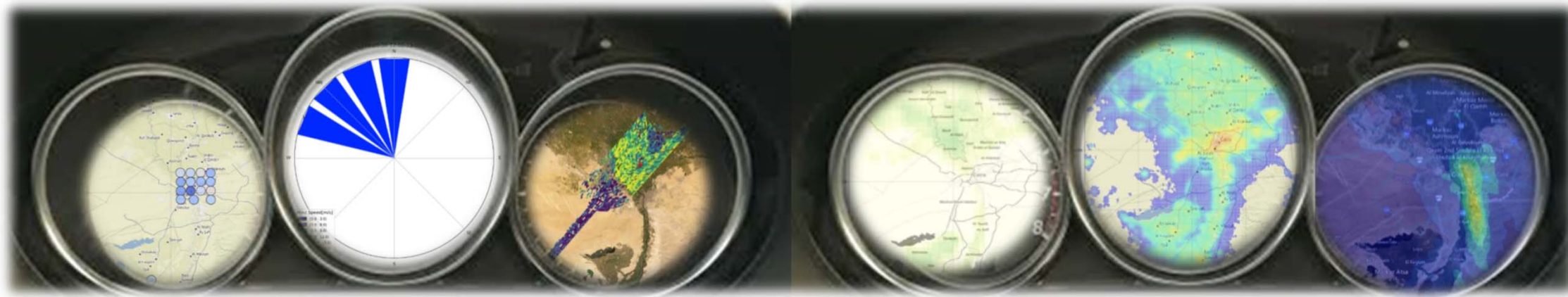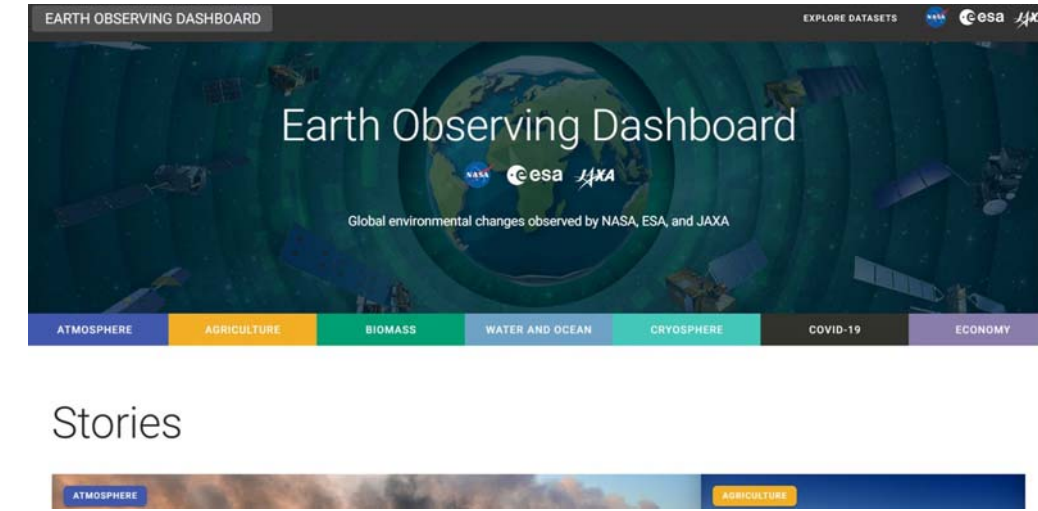
Earth Observation Dashboard - Local Urban Story
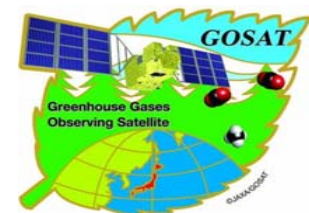## ESA-NASA-JAXA collaboration

- 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
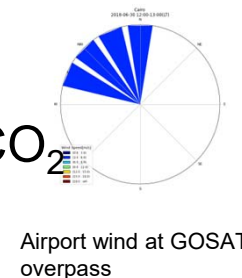
# Earth Observation Dashboard - Local Urban Story Cairo

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
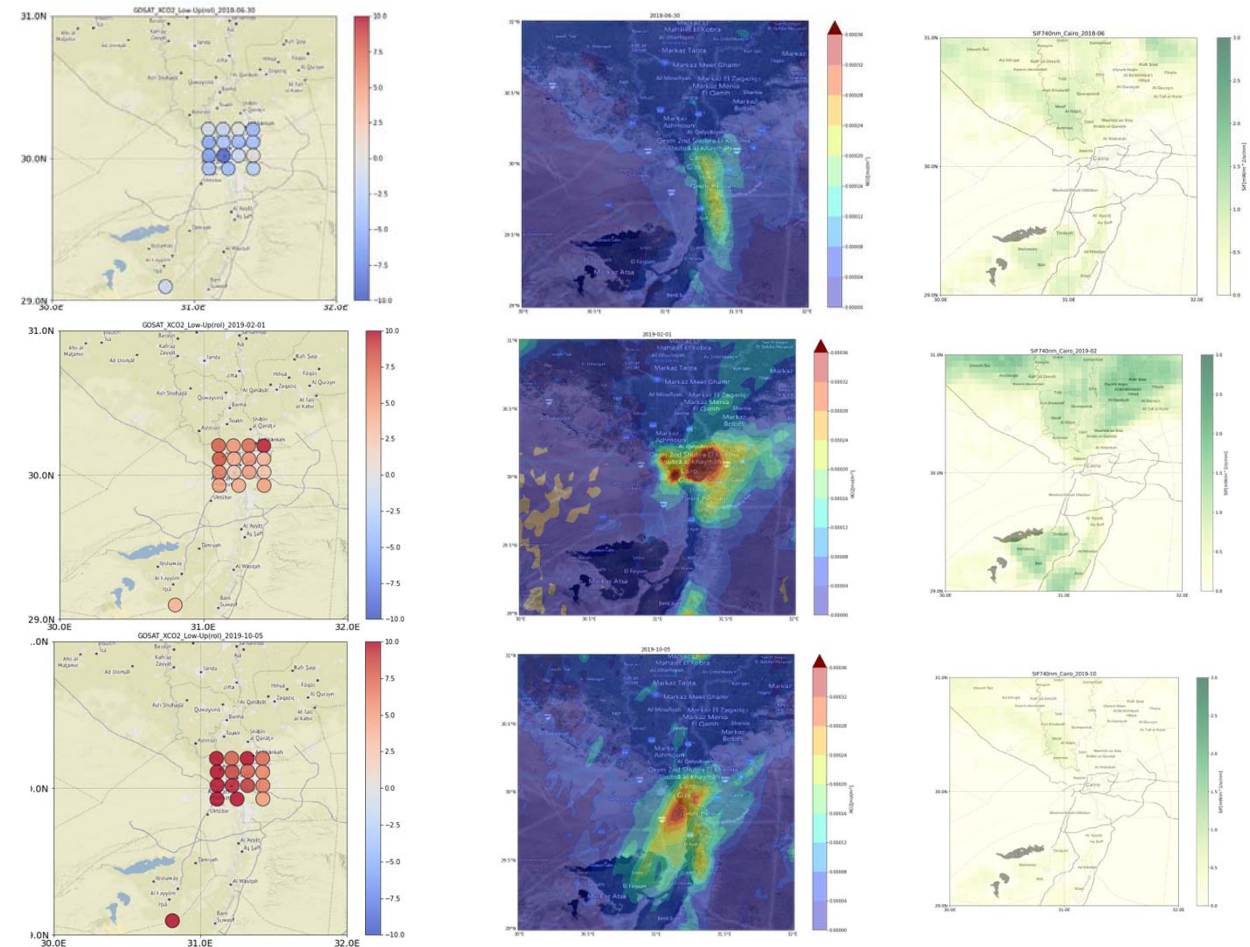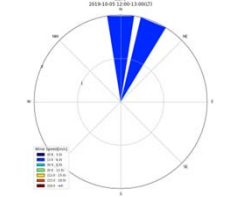

2018-06-30
Negative enhacementCO_2
Wind from North
Nile delta Farmland

Airport wind at GOSAT overpass

2019-02-01
CO_2 Enhancement
Wind from East
Nile delta Strong SIF
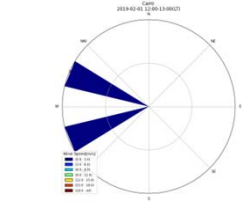
2019-10-05
CO_2 Enhancement
Wind Weak SIF

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