Greenhouse gases observation from space by GOSAT series satellites since 2009

2009-Now

2018-Now

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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)

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

2009-Now

• Algorithms development
• Data use for science
• Validation

NIES

2018-Now

• Sensor development
• Satellite development
• H-IIA launch
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MOE

JAXA

Thermal And Near infrared Sensor for carbon Observation

TANSO-FTS

TANSO-CAI

UV, Visible, SWIR Imager

SWIR/TIR FTS
10,000 color channel data from space

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.

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)

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
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$_2$O (11 layers)

(2) Surface albedo (polynomial)
Sep 2019  GOSAT,GOSAT-2 CO\(_2\) CH\(_4\) CO
(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$_2$O (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
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

\[ \Delta X_{CO_2}^{LT} \propto \frac{F_{CO_2}(\text{Emission})}{V(\text{windspeed})} \]

\[ X_{CO_2}^{LT} \text{ (circles) in March 2019} \]
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).

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

https://www.eorc.jaxa.jp/GOSAT/GHGs_Vical/index.html
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 enhancement CO₂  
Wind from North  
Nile delta Farmland

2019-02-01  
CO₂ Enhancement  
Wind from East  
Nile delta Strong SIF

2019-10-05  
CO₂ Enhancement  
Wind Weak SIF

GOSAT partial column from SWIR and TIR XCO₂ LT-XCO₂ UT average  
Daily TROPOMI NO₂ Monthly TROPOMI SIF