NIES-GOSAT2-SYS-20240201-015-00

Release Note

GOSAT-2 L4A Global CO_2 Flux Product

Product version 01.02

March 2024

National Institute for Environmental Studies
GOSAT-2 Project

Revision History

Version	Revised	Page	Description
00	Mar. 2024	-	-

1 Introduction

The purpose of this document is to provide considerations for the Greenhouse gases Observing SATellite-2 (hereinafter referred to as “GOSAT-2”) products generated by the National Institute for Environmental Studies, Japan.
The product and its version described in this document are listed in Table 1-1.

Table 1-1 Product and version

Product name	Product version
GOSAT-2 L4A Global CO_2 Flux Product	01.02

2 Difference from previous version

The difference between the previous version (01.01) and this version (01.02) is shown as follows:

2.1 Change of processing algorithm

The change in the processing algorithm for generating this product is shown as follows:

(1) The model-observation misfits of atmospheric concentrations in the model were specified for individual measurements in the previous version, but in this version, a uniform value (R = 4 ppm) was adopted for whole measurements over the globe to represent the misfits.
(2) No uncertainty was given for *a priori* anthropogenic fossil fuel emissions.

2.2 Change of input data

The change in the input data is shown as follows:

(1) Prior error given for *a priori* flux estimates on source and sink strengths was modified from that in the previous version.
(2) The L2 product after bias correction and outlier removal was used for the atmospheric inversion.

2.3 Change of file format

The change in the file format of the product is shown as follows:

(1) Removed the following variables.
- *A posteriori* gross primary productivity flux (flux_apos_gpp)
- *A posteriori* ecosystem respiration flux (flux_apos_re)
- *A posteriori* land use change and disturbance CO_2 flux (flux_apos_luc)

(2) Newly added the following variable.
- *A posteriori* terrestrial biosphere CO_2 flux (flux_apos_teb)

Note: *A posteriori* fluxes for gross primary productivity, ecosystem respiration, and land use change and disturbance were integrated to *a posteriori* terrestrial biosphere flux.

3 Important information

The important information for this version is shown as follows:

(1) The L2 product version and period corresponding to this version is shown below.
- GOSAT-2 TANSO-FTS-2 SWIR L2 Column-averaged Dry-air Mole Fraction Product: 02.00
- Period: August 2019 to December 2020

Note: Biases being inherent in the L2 product were corrected using the methodology proposed by Yoshida et al. (2023). Then, the data more than 1.5 times interquartile range

above the third quartile or below the first quartile were removed as outliers every 30-degree latitudinal band and every month for respective land and ocean.

(2) The atmospheric tracer transport model and inverse analysis system used in this version is shown below.
- NISMON-CO_2 (Non-hydrostatic Icosahedral Atmospheric Model (NICAM)-based Inverse Simulation for Monitoring CO_2)

(3) *A priori* fluxes information used in this version is shown below.
- *A priori* fossil fuel (FOS) CO_2 emissions (flux_apri_fos; monthly): ODIAC* (Open-Data Inventory for Anthropogenic Carbon dioxide; ver. ODIAC2020)
- *A priori* gross primary productivity (GPP) flux (flux_apri_gpp; hourly), *a priori* ecosystem respiration (RE) flux (flux_apri_re; hourly), *a priori* land use change and disturbance (LUC) CO_2 flux (flux_apri_luc; monthly): VISIT (Vegetation Integrative SImulator for Trace gases)
- *A priori* biomass burning (BMB) CO_2 flux (flux_apri_bmb; monthly): GBEI (Global Biomass Burning Emissions Inventory; ver. 2022a)
- *A priori* Ocean (OCN) CO_2 flux (flux_apri_ocn; monthly): JMA (Japan Meteorological Agency) Ocean CO_2 Map

* As ODIAC data cover by 2019, the data in 2020 were approximated by multiplying ODIAC data in 2019 by 0.94. The value of 0.94 was obtained from “energy over total world” in 2019 and 2020 that was reported in “bp Statistical Review of World Energy.”

(4) *A posteriori* fluxes information used in this version is shown below.
- No uncertainty was given to *a priori* FOS emissions (flux_apri_fos) for deducing global surface CO_2 flux, and thereby identical values are provided for both *a priori* and *a posteriori* FOS emissions (flux_apos_fos).
- Integrated values of *a posteriori* fluxes for GPP, RE, and LUC are provided as *a posteriori* terrestrial biosphere flux (flux_apos_teb = flux_apos_re + flux_apos_luc - flux_apos_gpp) instead providing individual *a posteriori* fluxes.
- *A posteriori* total surface CO_2 flux (flux_apos_tot) being stored was calculated as flux_apos_tot = flux_apos_fos + flux_apos_teb + flux_apos_bmb + flux_apos_ocn, where flux_apos_bmb and flux_apos_ocn are *a posteriori* BMB and OCN, respectively.
- *A posteriori* BMB flux (flux_apos_bmb) potentially include values being smaller than 0. As such negative values are artifacts introduced as a result of the model processing, those values must be filtered and be replaced with 0.
- Global monthly surface total CO_2 flux confirmed that the seasonal variability of GOSAT-2 L4A product is closer to that of GOSAT L4A product (Figure 3-1; RMSE = 0.31). The difference of integrated values for 13 months (Oct. 2019 – Oct. 2020) was 0.26 Pg C between GOSAT and GOSAT-2 L4A products (6.73 and 6.47 Pg C, respectively).
- The differences of *a posteriori* surface total CO_2 flux between GOSAT and GOSAT-2 L4A products are larger in East and South Asia, southern Sahara, and eastern South America (Figure 3-2). **Even after applying the bias correction and outlier removal for the L2 product, the observational errors still remain, leading to obvious differences in spatial distribution and the values for *a posteriori* surface total CO_2 flux between GOSAT and GOSAT-2 L4A products. We have been working on solving the problem, but this matter is still pending. Note that the GOSAT-2 L4A product in this version has even more errors than the GOSAT L4A product.**

(5) The period covered in this version is shown below.
- 13 months from October 2019 to October 2020

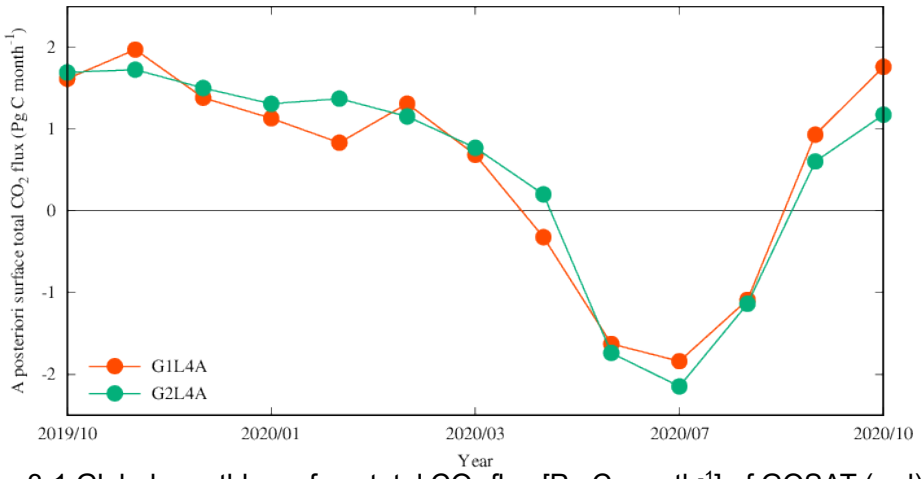

Figure 3-1 Global monthly surface total CO_2 flux [Pg C month^{-1}] of GOSAT (red) and GOSAT-2 L4A (green) products

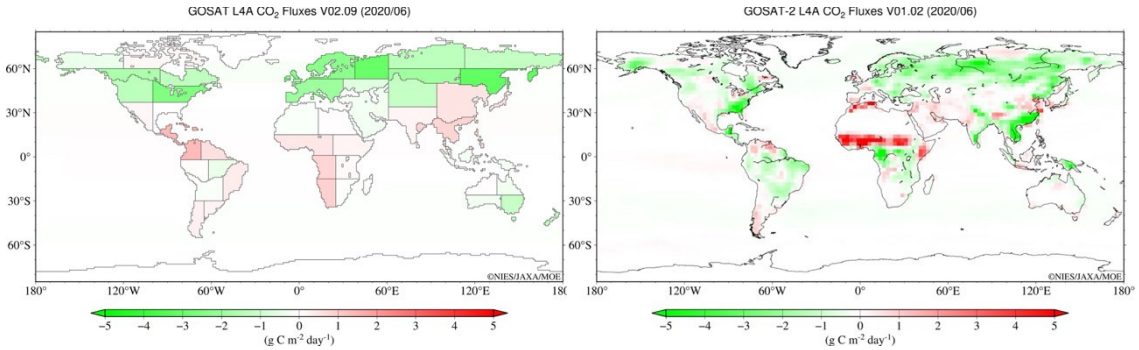

Figure 3-2 *A posteriori* surface total CO_2 flux [g C m^{-2}] of GOSAT (left) and GOSAT-2 (right) L4A products in June 2020 (Red colors indicate net CO_2 sources and green ones indicate net CO_2 sinks)

4 Version upgrade history

The version upgrade history of the product described in this document is shown in Table 4-1.

Table 4-1 Version upgrade history

Product version	Date	Remarks
01.01	Oct. 2022	Released to RA users
01.02	Mar. 2024	Changed processing algorithm Changed input data Changed file format Changed important information Release to General users

References

Yoshida Y., Y. Someya, H. Ohyama, I. Morino, T. Matsunaga, N. M. Deutscher, D. W. T. Griffith, F. Hase, L. T. Iraci, R. Kivi, J. Notholt, D. F. Pollard, Y. Té, V. A. Velazco, and D. Wunch (2023). Quality Evaluation of the Column-Averaged Dry Air Mole Fractions of Carbon Dioxide and Methane Observed by GOSAT and GOSAT-2, SOLA, 19, 173-184, doi:10.2151/sola.2023-023.