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NIES
GOSAT-2 Product File Format Descriptions
(Product edition)

Vol.5
GOSAT-2 TANSO-FTS-2 SWIR L2 Column-averaged Dry-air Mole
Fraction Product

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National Institute for Environmental Studies
GOSAT-2 Project

Revision History

Version	Revised on	Page	Description
00	Nov. 2019	-	-
01	Oct. 2020	p.1	Added product version
		p.5, p.9	Added a note of the following dataset - SceneAttribute/numSounding
02	Oct. 2021	p.1	Added product version

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1 Introduction

1.1 Purpose

The purpose of this document is to define the file format of the GOSAT-2 TANSO-FTS-2 SWIR L2 Column-averaged Dry-air Mole Fraction Product which is one of the Greenhouse gases Observing SATellite-2 (hereinafter referred to as “GOSAT-2”) products generated by the National Institute for Environmental Studies, Japan (hereinafter referred to as “NIES”).

1.2 Data product and version

The product and its version described in this document are listed below (Table 1-1).

Table 1-1 Product and version explained in the document

Product name	Product version
GOSAT-2 TANSO-FTS-2 SWIR L2	01.01
Column-averaged Dry-air Mole Fraction	01.04
Product	01.07

02

2 GOSAT-2 TANSO-FTS-2 SWIR L2 Column-averaged Dry-air Mole Fraction Product

(1) Description of GOSAT-2 TANSO-FTS-2 SWIR L2 Column-averaged Dry-air Mole Fraction Product

GOSAT-2 TANSO-FTS-2 SWIR L2 Column-averaged Dry-air Mole Fraction Product stores column-averaged dry-air mole fraction of atmospheric gases retrieved by a full-physics method based on MAP method* using Band 1-3 spectral radiance data in TANSO-FTS-2 L1B Product. TANSO-FTS-2 SWIR data acquired under the condition where cloud-free or only optically thin cirrus clouds are present within the TANSO-FTS-2 instantaneous field of view, are used to generate this product.

* MAP method: maximum a posteriori method

(2) Major dataset

XCO₂ (full-physics method), XCH₄ (full-physics method), XCO (full-physics method), XH₂O (full-physics method)

(3) Category

Standard

(4) Unit

Daily (00:00~23:59 (UTC))

(5) File format

HDF5

(6) File naming convention

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
G	O	S	A	T	2	T	F	T	S	2	Y	Y	Y	Y	M	M	D	D	_	0	2	S	W	F	P	V	M	M	N	N	R	R	o	o	o	o	.	h	5

GOSAT2: Satellite name (Fixed)

TFTS2: Sensor name (Fixed)

YYYYMMDD: Observation date (UTC)

02: Processing level (Fixed)

SWFP: Product code (Fixed)

V: Processing identifier (V: Steady, T: Test), added as necessary

MMNN: Product version (MM: Major version, NN: Minor version)

RR: Revision

oooo: Input data version

h5: Extension

(7) File size

Approx. 23MB

3 Product Format

3.1 Dataset structure

Table 3-1 shows the dataset structure of GOSAT-2 TANSO-FTS-2 SWIR L2 Column-averaged Dry-air Mole Fraction Product.

Table 3-1 Dataset structure of GOSAT-2 TANSO-FTS-2 SWIR L2 Column-averaged Dry-air Mole Fraction Product

No.	Group	Outline
1	Metadata	The following items are mainly included to describe overview of the product. <ul style="list-style-type: none"> - Processing date - Start/End date - Sensor name - Processing level - Algorithm researcher
2	SceneAttribute	The following items are mainly included to provide information related to the observation. <ul style="list-style-type: none"> - Number of retrievals - Number of bands - Number of retrieval layers - Number of albedo parameters
3	SoundingAttribute	The following items are mainly included to provide information related to the observation. <ul style="list-style-type: none"> - Sounding unique ID - Detailed operation mode - Observation time
4	SoundingGeometry	The following items are mainly included to provide information related to the observation. <ul style="list-style-type: none"> - Geodetic latitude/longitude - Mean of the DEM altitude within the FTS-2 IFOV - Sensor zenith/azimuth angle - Solar zenith/azimuth angle
5	L1QualityInfo	The following items are mainly included to provide information related to the observation. <ul style="list-style-type: none"> - Sounding quality flag transferred from L1 product - SNR for synthesized spectrum
6	CloudInformation	The following items are mainly included to provide information related to the observation. <ul style="list-style-type: none"> - Confidence level within the FTS-2 IFOV (GOSAT-2 TANSO-CAI-2 L2 Cloud Discrimination Product) - Coherent within the FTS-2 IFOV (GOSAT-2 TANSO-CAI-2 L1B Product) - Cloud flags based on the FTS-2 TIR measurement (GOSAT-2 TANSO-FTS-2 TIR L2 Cloud and Aerosol Property Product)
7	RetrievalResult	The following items are mainly included to provide information related to the observation. <ul style="list-style-type: none"> - XCO₂ - XCH₄ - XCO - XH₂O

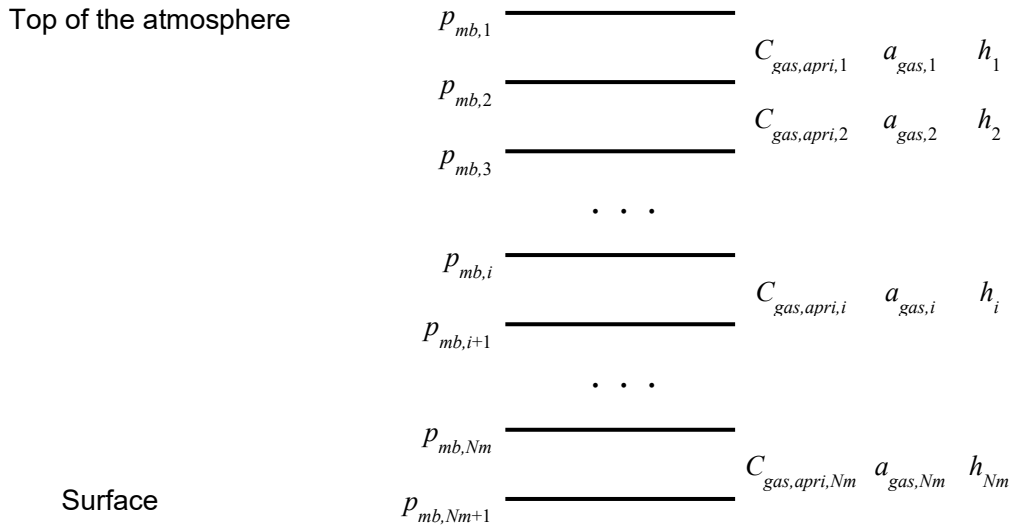
The special mention about “Group” above is shown below.

- RetrievalResult

xco2, xch4, xco and xh2o under RetrievalResult are retrieved column-averaged dry-air mole fraction. Since these datasets may contain low quality case data or invalid value, each quality flag (*_quality flag) should be referred together.

In SWIR L2 processing, not dry-air mole fraction at boundary layer, but partial column-averaged dry-air mole fraction for each layer is set as a state vector element, so following formulas are applied for calculating column-averaged dry-air mole fraction using vertical profiles of gas concentrations acquired by observation or model.

$$X_{gas,user} = \sum_{i=1}^{Nm} [C_{gas,apri,i} + (C_{gas,user,i} - C_{gas,apri,i}) \cdot a_{gas,i}] \cdot h_i$$



Symbol	Description	Group / Dataset of SWIR L2 product
Nm	Number of layer of main-layer	SceneAttribute/numLayer
$p_{mb,i}$	Pressure level at layer boundary	RetrievalResult/pressure_level
$C_{gas,apri,i}$	A priori value of partial column-averaged dry-air mole fraction of <i>gas</i> for each layer	RetrievalResult/ <i>gas</i> _profile_apriori
$a_{gas,i}$	Column averaging kernel of <i>gas</i>	RetrievalResult/x <i>gas</i> _column_averaging_kernel
h_i	Pressure weighting function	RetrievalResult/pressure_weighting_function

gas : CO₂, CH₄, H₂O, CO

3.2 File format details

Table 3-2 shows the file format details of the GOSAT-2 TANSO-FTS-2 SWIR L2 Column-averaged Dry-air Mole Fraction Product.

Table 3-2 GOSAT-2 TANSO-FTS-2 SWIR L2 Column-averaged Dry-air Mole Fraction Product Format (1/5)

Group	Group / Dataset	Dataspace		Datatype	Dataset name	attribute				
		Rank	Size			unit	validRange	invalidValue	description	
G	Metadata									
		fileID	1	1	H5T_STRING	File identifier	(none)	(none)	(none)	file identifier of the product
		processingDate	1	1	H5T_STRING	Processing date	UTC	(none)	(none)	date of product creation (UTC): Time format is "YYYY-MM-DDThh:mm:ss.ffffffZ"
		startDate	1	1	H5T_STRING	Start date	UTC	(none)	"_"	start date of file(UTC): Time format is "YYYY-MM-DDThh:mm:ss.ffffffZ"
		endDate	1	1	H5T_STRING	End date	UTC	(none)	"_"	end date of file(UTC): Time format is "YYYY-MM-DDThh:mm:ss.ffffffZ"
		geodeticDatum	1	1	H5T_STRING	Geodetic datum	(none)	(none)	(none)	reference ellipsoid model/frame of reference: "WGS84/WGS84"(Fixed)
		satelliteName	1	1	H5T_STRING	Satellite name	(none)	(none)	(none)	satellite name: "GOSAT-2" - Greenhouse gases Observing SATellite-2 (Fixed)
		sensorName	1	1	H5T_STRING	Sensor name	(none)	(none)	(none)	sensor name: "TANSO-FTS-2" - Fourier Transform Spectrometer-2 (Fixed)
		processingLevel	1	1	H5T_STRING	Processing level	(none)	(none)	(none)	processing level: "L2" - Level 2 (Fixed)
		algorithmName	1	1	H5T_STRING	Algorithm name	(none)	(none)	(none)	algorithm name: "TANSO-FTS-2_SWIR_L2"(Fixed)
		algorithmVersion	1	1	H5T_STRING	Algorithm version	(none)	(none)	(none)	algorithm version is stored
		productVersion	1	1	H5T_STRING	Product version	(none)	(none)	(none)	product version is stored
		inputDataVersion	1	1	H5T_STRING	Input data version	(none)	(none)	(none)	version of input data list is stored
		processingFacility	1	1	H5T_STRING	Processing facility	(none)	(none)	(none)	processing facility name: "G2DPS" - GOSAT-2 Data Processing System (Fixed)
		contact_01	1	1	H5T_STRING	Organization name 01	(none)	(none)	(none)	organization name: "Japan Aerospace Exploration Agency (JAXA)"(Fixed)
	contact_02	1	1	H5T_STRING	Organization name 02	(none)	(none)	(none)	organization name: "National Institute for Environmental Studies (NIES)"(Fixed)	
	contact_03	1	1	H5T_STRING	Algorithm researcher	(none)	(none)	(none)	researcher	
	e-mail	1	1	H5T_STRING	E-mail address	(none)	(none)	(none)	e-mail address	
G	SceneAttribute									
		numSounding	1	1	H5T_STD_I32LE	Number of retrievals *1	(none)	(none)	0	number of retrievals
		numBand	1	1	H5T_STD_I32LE	Number of bands	(none)	(none)	(none)	number of FTS-2 SWIR bands "6"(Fixed)
		numLayer	1	1	H5T_STD_I32LE	Number of layers	(none)	(none)	(none)	number of retrieval layers "15"(Fixed)
		numAlb_SB1	1	1	H5T_STD_I32LE	Number of albedo parameters *2	(none)	(none)	(none)	number of retrieved albedo parameters for SB1
		numAlb_SB2	1	1	H5T_STD_I32LE	Number of albedo parameters *2	(none)	(none)	(none)	number of retrieved albedo parameters for SB2
		numAlb_SB3	1	1	H5T_STD_I32LE	Number of albedo parameters *2	(none)	(none)	(none)	number of retrieved albedo parameters for SB3
		numAlb_SB4	1	1	H5T_STD_I32LE	Number of albedo parameters *2	(none)	(none)	(none)	number of retrieved albedo parameters for SB4
	numAlb_SB5	1	1	H5T_STD_I32LE	Number of albedo parameters *2	(none)	(none)	(none)	number of retrieved albedo parameters for SB5	
G	SoundingAttribute									
		soundingUniqueID	1	numSounding	H5T_STRING	Sounding unique ID	(none)	(none)	(none)	sounding unique ID is stored: Format is "YYYYMMDD_AAA_NNNN". "YYYYMMDD" - Observation date, "AAA" - Path No., "NNNN" - Sounding ID(0-1245)
		detailedOperationMode	1	numSounding	H5T_STRING	Detailed operation mode	(none)	(none)	(none)	detailed operation mode is stored: "OBD" - Observation Mode (day/All data are observed by decimated mode.), "OB2D" - Observation Mode except for full-observation (day/All data are observed by decimated mode. specific bands are not observed.), "SUNG" - Sunlight observation Mode, "SPPT" - Specific point observation Mode
		observationRequestID	1	numSounding	H5T_STRING	Observation request ID	(none)	(none)	(none)	observation request ID is stored: Format is "XKYYYYMMDDaaaaannnn_mmmmmmm". "X" - Request from (J:JAXA, N:NIES), "K" - Kind of request(F:routine, T:temporary, I:internal), "YYYYMMDD" - start date of observation of request, "aaaa" - observation code(e.g. "FT206"), "nnnn" - observation request Number (0000-9999), "mmmmmm" - branch Number (0000000-9999999)
		observationTime	1	numSounding	H5T_STRING	Observation time	UTC	(none)	"_"	observation time of each sounding is stored: Observation time is expressed as follows: ObservationTime =Launched time of sample window + 2.012 sec. Time format is "YYYY-MM-DDThh:mm:ss.ffffffZ"
		scanDirection	1	numSounding	H5T_STRING	Scan direction	(none)	(none)	"_"	scan direction of each sounding is stored: "FWD" - Forward, "BWD" - Backward
		sensorGain	2	numSounding, numBand	H5T_STD_I8LE	Sensor gain	(none)	0, 15	-128	gain for each bands are stored in order of 1P, 1S, 2P, 2S, 3P, 3S
		IP_Request	1	numSounding	H5T_STD_I8LE	IP request flag	(none)	0, 1	-128	IP request flag is stored: 0 - Intelligent pointing was disabled. (IP="No"), 1 - Intelligent pointing was enabled. (IP="Yes")
		yawSteeringFlag	1	numSounding	H5T_STD_I8LE	Yaw steering flag	(none)	0, 1	2	yaw steering flag indicates the operation of yaw steering: 0 - Not execute(OFF), 1 - Execute(ON)
	pointingAT	1	numSounding	H5T_IEEE_F64LE	The motor rotation angle about the AT axis	deg	-180.0, 180.0	-999.0	The motor rotation angle about the AT axis at observation time is stored.The range that the motor can be physically driven is as follows: -180.0 < pointingAT	

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Table 3-2 GOSAT-2 TANSO-FTS-2 SWIR L2 Column-averaged Dry-air Mole Fraction Product Format (2/5)

Group	Group / Dataset	Dataspace		Datatype	Dataset name	attribute				
		Rank	Size			unit	validRange	invalidValue	description	
G	pointingCT	1	numSounding	H5T_IEEE_F64LE	The motor rotation angle about the CT axis	deg	-180.0, 180.0	-999.0	The motor rotation angle about the CT axis at observation time is stored. The range that the motor can be physically driven is as follows: $-180.0 < \text{pointingCT}$	
	SoundingGeometry									
	latitude	1	numSounding	H5T_IEEE_F32LE	Geodetic latitude	deg	-90.0, 90.0	-999.0	geodetic latitude of observation point is stored	
	longitude	1	numSounding	H5T_IEEE_F32LE	Longitude	deg	-180.0, 180.0	-999.0	longitude of observation point is stored: $-180 < \text{longitude} \leq 180$	
	height	1	numSounding	H5T_IEEE_F32LE	Mean of the DEM altitude within the FTS-2 IFOV	m	-407.0, 8752.0	-999.0	mean of the DEM altitude within the FTS-2 IFOV	
	surfaceRoughness	1	numSounding	H5T_IEEE_F32LE	Standard deviation of the DEM altitude within the FTS-2 IFOV	m	(none)	-999.0	standard deviation of the DEM altitude within the FTS-2 IFOV	
	landFraction	1	numSounding	H5T_IEEE_F32LE	Percent of the land cover within the FTS-2 IFOV	%	0.0, 100.0	-999.0	percent of the land cover within the FTS-2 IFOV	
	viewZenith	1	numSounding	H5T_IEEE_F32LE	Sensor zenith angle	deg	0.0, 180.0	-999.0	sensor (satellite) zenith angle at observation point is stored: $0 \leq \text{viewZenith} \leq 180$	
	viewAzimuth	1	numSounding	H5T_IEEE_F32LE	Sensor azimuth angle	deg	0.0, 360.0	-999.0	sensor (satellite) azimuth angle at observation point is stored: $0 \leq \text{viewAzimuth} < 360$	
	solarZenith	1	numSounding	H5T_IEEE_F32LE	Solar zenith angle	deg	0.0, 180.0	-999.0	solar zenith angle at observation point is stored: $0 \leq \text{solarZenith} \leq 180$	
	solarAzimuth	1	numSounding	H5T_IEEE_F32LE	Solar azimuth angle	deg	0.0, 360.0	-999.0	solar azimuth angle at observation point is stored: $0 \leq \text{solarAzimuth} < 360$	
	sunlintFlag	1	numSounding	H5T_STD_I8LE	Sunlint flag	(none)	0, 1	-128	the flag indicates whether each exposure is sunglint observation or not is stored: This flag is valid for any landType. 0 - Not sunglint, 1 - Sunglint	
specular_viewVector_angle	1	numSounding	H5T_IEEE_F32LE	The angle between specular reflection vector and view vector	deg	0.0, 180.0	-999.0	the angle between specular reflection vector and view vector of observation time is stored: $0 \leq \text{specular_viewVector_angle} < 180$		
solarDistance	1	numSounding	H5T_IEEE_F64LE	Solar Distance	AU	(none)	-999.0	distance from sun to observation point is stored		
G	LIQualityInfo									
	soundingQualityFlag	1	numSounding	H5T_STRING	Sounding quality flag	(none)	(none)	"NG"	quality of each observation point on a four level scale as follows: "Good", "Fair", "Poor", "NG"	
	IMC_StabilityFlag	1	numSounding	H5T_STD_I8LE	IMC stability flag	(none)	0, 1	2	IMC stability flag is stored: 0 - Stable, 1 - Not	
	missingFlag	2	numSounding, numBand	H5T_STD_I8LE	Missing flag	(none)	(none)	1	missing data flag is stored in order of 1P, 1S, 2P, 2S, 3P, 3S: 0 - Normal (No loss), 1 - Full loss of interferogram, 9 - Normal without data (No interferogram for the sounding)	
	saturationFlag	2	numSounding, numBand	H5T_STD_I8LE	Saturation flag	(none)	0, 1	2	interferogram saturation flag is stored in order of 1P, 1S, 2P, 2S, 3P, 3S: 0 - DN saturation detection=Normal, 1 - DN saturation detection=Saturation	
	spikeFlag	2	numSounding, numBand	H5T_STD_I8LE	Spike flag	(none)	0, 1	2	spike flag is stored in order of 1P, 1S, 2P, 2S, 3P, 3S: If spike flag is "1", interferogram data are removed spikes. 0 - Normal (no spike), 1 - With spike	
	scanStabilityFlag	1	numSounding	H5T_STD_I8LE	Scan stability flag	(none)	0, 1	2	scan stability flag is stored: 0 - Stable, 1 - Not stable	
	interferogramQualityFlag	2	numSounding, numBand	H5T_STD_I8LE	Interferogram quality flag	(none)	0, 1	2	interferogram quality flag for each band is judged by saturation, scan stability, DC level flag is stored in order of 1P, 1S, 2P, 2S, 3P, 3S: 0 - Normal, 1 - Abnormal	
	spectrumQualityFlag	2	numSounding, numBand	H5T_STD_I8LE	Spectrum quality flag	(none)	0, 1	2	spectrum quality flag for each band spectrum is judged by out of spectral coverage data is stored in order of 1P, 1S, 2P, 2S, 3P, 3S: 0 - Normal, 1 - Abnormal	
	SNR	2	numSounding, numBand	H5T_IEEE_F64LE	SNR	(none)	(none)	-999.0	simplified calculated SNR is stored in order of 1P, 1S, 2P, 2S, 3P, 3S	
SNR_synthesized	2	numSounding, numBand/2	H5T_IEEE_F64LE	SNR for synthesized spectrum	(none)	(none)	-999.0	simplified calculated SNR for synthesized spectrum is stored		
G	CloudInformation									
	CAI-2_CLDD	3	numSounding, 2, 16	H5T_STD_I32LE	Confidence level within the FTS-2 IFOV (CAI-2 L2 Cloud Discrimination)	(none)	(none)	-999	frequency distribution of 16 levels of cloud discrimination for forward-/backward-viewing of CAI-2 within the FTS-2 IFOV are stored	
	CAI-2_Coherent	3	numSounding, 2, 5	H5T_IEEE_F32LE	Coherent within the FTS-2 IFOV (CAI-2 L1B)	W/m ² /str/micro m	(none)	-999.0	standard deviation of observed radiance of each CAI-2 band (5 bands for each forward-/backward-viewing) within the FTS-2 IFOV	
	FTS-2_2um	2	numSounding, 2	H5T_STD_I8LE	Scattering matter existence flags (2um)	(none)	0, 1	-1	higher-level scattering matter existence flags based on FTS-2 Band 3 P-/S-polarization measurement are stored: 0 - Not exist, 1 - Exist	
FTS-2_TIR	2	numSounding, 3	H5T_STD_I8LE	Cloud flags based on the FTS-2 TIR measurement (FTS-2 TIR L2 Cloud and Aerosol Property)	(none)	0, 2	-1	cloud flags based on the threshold method, split-window method, and slicing method based on the FTS-2 TIR measurement are stored: 0 - No cloud, 1 - With cloud, 2 - Unclassifiable		

Table 3-2 GOSAT-2 TANSO-FTS-2 SWIR L2 Column-averaged Dry-air Mole Fraction Product Format (3/5)

Group	Group / Dataset	Dataspace		Datatype	Dataset name	attribute			
		Rank	Size			unit	validRange	invalidValue	description
	surface_pressure_delta	1	numSounding	H5T_IEEE_F32LE	Difference of surface pressure	hPa	(none)	-999.0	difference of retrieved surface pressure (clear-sky retrieval) and its a priori value
	co2Ratio	1	numSounding	H5T_IEEE_F32LE	Ratio of XC02	(none)	(none)	-999.0	ratio of retrieved XC02 (clear-sky retrieval) in 1590 nm and 2060 nm CO2 band
	h2oRatio	1	numSounding	H5T_IEEE_F32LE	Ratio of XH20	(none)	(none)	-999.0	ratio of retrieved XH20 (clear-sky retrieval) in 1590 nm and 2060 nm H2O band
	ch4Ratio	1	numSounding	H5T_IEEE_F32LE	Ratio of XCH4	(none)	(none)	-999.0	ratio of retrieved XCH4 (clear-sky retrieval) in 1660 nm and 2350 nm CH4 band
G	RetrievalResult								
	xco2	1	numSounding	H5T_IEEE_F32LE	XC02	ppm	(none)	-999.0	retrieved XC02 (full-physics retrieval)
	xco2_apriori	1	numSounding	H5T_IEEE_F32LE	A priori value of XC02	ppm	(none)	-999.0	a priori value of XC02
	xco2_uncert	1	numSounding	H5T_IEEE_F32LE	Uncertainty of XC02	ppm	(none)	-999.0	uncertainty of XC02 (full-physics retrieval)
	xco2_column_averaging_kernel	2	numSounding, numLayer	H5T_IEEE_F32LE	Column averaging kernel for XC02	(none)	(none)	-999.0	column averaging kernel for XC02 (full-physics retrieval)
	xco2_dfs	1	numSounding	H5T_IEEE_F32LE	DFS for XC02	(none)	(none)	-999.0	degree of freedom for signal for XC02 (full-physics retrieval)
	xco2_quality_flag	1	numSounding	H5T_STD_I8LE	Quality flag for XC02	(none)	0, 3	-1	quality flag for XC02 (full-physics retrieval) 0 - Good, 1 - Fair, 2 - Poor, 3 - NG
	xch4	1	numSounding	H5T_IEEE_F32LE	XCH4	ppm	(none)	-999.0	retrieved XCH4 (full-physics retrieval)
	xch4_apriori	1	numSounding	H5T_IEEE_F32LE	A priori value of XCH4	ppm	(none)	-999.0	a priori value of XCH4
	xch4_uncert	1	numSounding	H5T_IEEE_F32LE	Uncertainty of XCH4	ppm	(none)	-999.0	uncertainty of XCH4 (full-physics retrieval)
	xch4_column_averaging_kernel	2	numSounding, numLayer	H5T_IEEE_F32LE	Column averaging kernel for XCH4	(none)	(none)	-999.0	column averaging kernel for XCH4 (full-physics retrieval)
	xch4_dfs	1	numSounding	H5T_IEEE_F32LE	DFS for XCH4	(none)	(none)	-999.0	degree of freedom for signal for XCH4 (full-physics retrieval)
	xch4_quality_flag	1	numSounding	H5T_STD_I8LE	Quality flag for XCH4	(none)	0, 3	-1	quality flag for XCH4 (full-physics retrieval) 0 - Good, 1 - Fair, 2 - Poor, 3 - NG
	xco	1	numSounding	H5T_IEEE_F32LE	XCO	ppm	(none)	-999.0	retrieved XCO (full-physics retrieval)
	xco_apriori	1	numSounding	H5T_IEEE_F32LE	A priori value of XCO	ppm	(none)	-999.0	a priori value of XCO
	xco_uncert	1	numSounding	H5T_IEEE_F32LE	Uncertainty of XCO	ppm	(none)	-999.0	uncertainty of XCO (full-physics retrieval)
	xco_column_averaging_kernel	2	numSounding, numLayer	H5T_IEEE_F32LE	Column averaging kernel for XCO	(none)	(none)	-999.0	column averaging kernel for XCO (full-physics retrieval)
	xco_dfs	1	numSounding	H5T_IEEE_F32LE	DFS for XCO	(none)	(none)	-999.0	degree of freedom for signal for XCO (full-physics retrieval)
	xco_quality_flag	1	numSounding	H5T_STD_I8LE	Quality flag for XCO	(none)	0, 3	-1	quality flag for XCO (full-physics retrieval) 0 - Good, 1 - Fair, 2 - Poor, 3 - NG
	xh2o	1	numSounding	H5T_IEEE_F32LE	XH20	ppm	(none)	-999.0	retrieved XH20 (full-physics retrieval)
	xh2o_apriori	1	numSounding	H5T_IEEE_F32LE	A priori value of XH20	ppm	(none)	-999.0	a priori value of XH20
	xh2o_uncert	1	numSounding	H5T_IEEE_F32LE	Uncertainty of XH20	ppm	(none)	-999.0	uncertainty of XH20 (full-physics retrieval)
	xh2o_column_averaging_kernel	2	numSounding, numLayer	H5T_IEEE_F32LE	Column averaging kernel for XH20	(none)	(none)	-999.0	column averaging kernel for XH20 (full-physics retrieval)
	xh2o_dfs	1	numSounding	H5T_IEEE_F32LE	DFS for XH20	(none)	(none)	-999.0	degree of freedom for signal for XH20 (full-physics retrieval)
	xh2o_quality_flag	1	numSounding	H5T_STD_I8LE	Quality flag for XH20	(none)	0, 3	-1	quality flag for XH20 (full-physics retrieval) 0 - Good, 1 - Fair, 2 - Poor, 3 - NG
	pressure_level	2	numSounding, numLayer+1	H5T_IEEE_F32LE	Pressure grid for retrieved state	hPa	(none)	-999.0	pressure grid for retrieved state
	pressure_weighting_function	2	numSounding, numLayer	H5T_IEEE_F32LE	Pressure weighting function	(none)	(none)	-999.0	pressure weighting function for retrieved state
	dry_air_column	1	numSounding	H5T_IEEE_F32LE	Vertical column of dry air	molecule/cm ²	(none)	-999.0	vertical column of dry air for retrieved state
	dry_air_column_apriori	1	numSounding	H5T_IEEE_F32LE	Vertical column of dry air for a priori state	molecule/cm ²	(none)	-999.0	vertical column of dry air for a priori state
	co2_profile	2	numSounding, numLayer	H5T_IEEE_F32LE	CO2 profile	ppm	(none)	-999.0	retrieved CO2 profile (full-physics retrieval)
	co2_profile_apriori	2	numSounding, numLayer	H5T_IEEE_F32LE	A priori profile of CO2	ppm	(none)	-999.0	a priori profile of CO2
	co2_profile_uncert	2	numSounding, numLayer	H5T_IEEE_F32LE	Uncertainty of CO2 profile	ppm	(none)	-999.0	uncertainty of CO2 profile (full-physics retrieval)
	ch4_profile	2	numSounding, numLayer	H5T_IEEE_F32LE	CH4 profile	ppm	(none)	-999.0	retrieved CH4 profile (full-physics retrieval)
	ch4_profile_apriori	2	numSounding, numLayer	H5T_IEEE_F32LE	A priori profile of CH4	ppm	(none)	-999.0	a priori profile of CH4
	ch4_profile_uncert	2	numSounding, numLayer	H5T_IEEE_F32LE	Uncertainty of CH4 profile	ppm	(none)	-999.0	uncertainty of CH4 profile (full-physics retrieval)
	co_profile	2	numSounding, numLayer	H5T_IEEE_F32LE	CO profile	ppm	(none)	-999.0	retrieved CO profile (full-physics retrieval)
	co_profile_apriori	2	numSounding, numLayer	H5T_IEEE_F32LE	A priori profile of CO	ppm	(none)	-999.0	a priori profile of CO
	co_profile_uncert	2	numSounding, numLayer	H5T_IEEE_F32LE	Uncertainty of CO profile	ppm	(none)	-999.0	uncertainty of CO profile (full-physics retrieval)

Table 3-2 GOSAT-2 TANSO-FTS-2 SWIR L2 Column-averaged Dry-air Mole Fraction Product Format (4/5)

Group	Group / Dataset	Dataspace		Datatype	Dataset name	attribute			
		Rank	Size			unit	validRange	invalidValue	description
	h2o_profile	2	numSounding, numLayer	H5T_IEEE_F32LE	H2O profile	ppm	(none)	-999.0	retrieved H2O profile (full-physics retrieval)
	h2o_profile_apriori	2	numSounding, numLayer	H5T_IEEE_F32LE	A priori profile of H2O	ppm	(none)	-999.0	a priori profile of H2O
	h2o_profile_uncert	2	numSounding, numLayer	H5T_IEEE_F32LE	Uncertainty of H2O profile	ppm	(none)	-999.0	uncertainty of H2O profile (full-physics retrieval)
	fluorescence_at_reference	1	numSounding	H5T_IEEE_F32LE	Chlorophyll fluorescence at reference wavelength	W/cm ² /str/cm ⁻¹	(none)	-999.0	retrieved chlorophyll fluorescence at reference wavelength (full-physics retrieval)
	fluorescence_at_reference_apriori	1	numSounding	H5T_IEEE_F32LE	A priori value of chlorophyll fluorescence at reference wavelength	W/cm ² /str/cm ⁻¹	(none)	-999.0	a priori value of chlorophyll fluorescence at reference wavelength
	fluorescence_at_reference_uncert	1	numSounding	H5T_IEEE_F32LE	Uncertainty of chlorophyll fluorescence at reference wavelength	W/cm ² /str/cm ⁻¹	(none)	-999.0	uncertainty of chlorophyll fluorescence at reference wavelength (full-physics retrieval)
	fluorescence_slope	1	numSounding	H5T_IEEE_F32LE	Fluorescence slope	(none)	(none)	-999.0	retrieved fluorescence slope (full-physics retrieval)
	fluorescence_slope_apriori	1	numSounding	H5T_IEEE_F32LE	A priori value of fluorescence slope	(none)	(none)	-999.0	a priori value of fluorescence slope
	fluorescence_slope_uncert	1	numSounding	H5T_IEEE_F32LE	Uncertainty of fluorescence slope	(none)	(none)	-999.0	uncertainty of fluorescence slope (full-physics retrieval)
	surface_pressure	1	numSounding	H5T_IEEE_F32LE	Surface pressure	hPa	(none)	-999.0	retrieved surface pressure (full-physics retrieval)
	surface_pressure_apriori	1	numSounding	H5T_IEEE_F32LE	A priori value of surface pressure	hPa	(none)	-999.0	a priori value of surface pressure
	surface_pressure_uncert	1	numSounding	H5T_IEEE_F32LE	Uncertainty of surface pressure	hPa	(none)	-999.0	uncertainty of surface pressure (full-physics retrieval)
	temperature_shift	1	numSounding	H5T_IEEE_F32LE	Offset of temperature profile	K	(none)	-999.0	retrieved offset of temperature profile
	temperature_shift_apriori	1	numSounding	H5T_IEEE_F32LE	A priori value of offset of temperature profile	K	(none)	-999.0	a priori value of offset of temperature profile
	temperature_shift_uncert	1	numSounding	H5T_IEEE_F32LE	Uncertainty of offset of temperature profile	K	(none)	-999.0	uncertainty of offset of temperature profile
	aerosol_profile_type1	2	numSounding, numLayer	H5T_IEEE_F32LE	Aerosol optical thickness profile (type 1)	(none)	(none)	-999.0	retrieved aerosol optical thickness profile (type 1)
	aerosol_profile_type1_apriori	2	numSounding, numLayer	H5T_IEEE_F32LE	A priori value of aerosol optical thickness profile (type 1)	(none)	(none)	-999.0	a priori value of aerosol optical thickness profile (type 1)
	aerosol_profile_type1_uncert	2	numSounding, numLayer	H5T_IEEE_F32LE	Uncertainty of aerosol optical thickness profile (type 1)	(none)	(none)	-999.0	uncertainty of aerosol optical thickness profile (type 1)
	aerosol_profile_type2	2	numSounding, numLayer	H5T_IEEE_F32LE	Aerosol optical thickness profile (type 2)	(none)	(none)	-999.0	retrieved aerosol optical thickness profile (type 2)
	aerosol_profile_type2_apriori	2	numSounding, numLayer	H5T_IEEE_F32LE	A priori value of aerosol optical thickness profile (type 2)	(none)	(none)	-999.0	a priori value of aerosol optical thickness profile (type 2)
	aerosol_profile_type2_uncert	2	numSounding, numLayer	H5T_IEEE_F32LE	Uncertainty of aerosol optical thickness profile (type 2)	(none)	(none)	-999.0	uncertainty of aerosol optical thickness profile (type 2)
	albedo_subband01	2	numSounding, numAlb_SB1	H5T_IEEE_F32LE	Surface albedo (sub-band 1)	(none)	(none)	-999.0	retrieved surface albedo at sub-band 1 (for land case)
	albedo_subband01_apriori	2	numSounding, numAlb_SB1	H5T_IEEE_F32LE	A priori value of surface albedo (sub-band 1)	(none)	(none)	-999.0	a priori value of surface albedo at sub-band 1 (for land case)
	albedo_subband01_uncert	2	numSounding, numAlb_SB1	H5T_IEEE_F32LE	Uncertainty of surface albedo (sub-band 1)	(none)	(none)	-999.0	uncertainty of surface albedo at sub-band 1 (for land case)
	albedo_subband02	2	numSounding, numAlb_SB2	H5T_IEEE_F32LE	Surface albedo (sub-band 2)	(none)	(none)	-999.0	retrieved surface albedo at sub-band 2 (for land case)
	albedo_subband02_apriori	2	numSounding, numAlb_SB2	H5T_IEEE_F32LE	A priori value of surface albedo (sub-band 2)	(none)	(none)	-999.0	a priori value of surface albedo at sub-band 2 (for land case)
	albedo_subband02_uncert	2	numSounding, numAlb_SB2	H5T_IEEE_F32LE	Uncertainty of surface albedo (sub-band 2)	(none)	(none)	-999.0	uncertainty of surface albedo at sub-band 2 (for land case)
	albedo_subband03	2	numSounding, numAlb_SB3	H5T_IEEE_F32LE	Surface albedo (sub-band 3)	(none)	(none)	-999.0	retrieved surface albedo at sub-band 3 (for land case)
	albedo_subband03_apriori	2	numSounding, numAlb_SB3	H5T_IEEE_F32LE	A priori value of surface albedo (sub-band 3)	(none)	(none)	-999.0	a priori value of surface albedo at sub-band 3 (for land case)
	albedo_subband03_uncert	2	numSounding, numAlb_SB3	H5T_IEEE_F32LE	Uncertainty of surface albedo (sub-band 3)	(none)	(none)	-999.0	uncertainty of surface albedo at sub-band 3 (for land case)
	albedo_subband04	2	numSounding, numAlb_SB4	H5T_IEEE_F32LE	Surface albedo (sub-band 4)	(none)	(none)	-999.0	retrieved surface albedo at sub-band 4 (for land case)
	albedo_subband04_apriori	2	numSounding, numAlb_SB4	H5T_IEEE_F32LE	A priori value of surface albedo (sub-band 4)	(none)	(none)	-999.0	a priori value of surface albedo at sub-band 4 (for land case)
	albedo_subband04_uncert	2	numSounding, numAlb_SB4	H5T_IEEE_F32LE	Uncertainty of surface albedo (sub-band 4)	(none)	(none)	-999.0	uncertainty of surface albedo at sub-band 4 (for land case)
	albedo_subband05	2	numSounding, numAlb_SB5	H5T_IEEE_F32LE	Surface albedo (sub-band 5)	(none)	(none)	-999.0	retrieved surface albedo at sub-band 5 (for land case)
	albedo_subband05_apriori	2	numSounding, numAlb_SB5	H5T_IEEE_F32LE	A priori value of surface albedo (sub-band 5)	(none)	(none)	-999.0	a priori value of surface albedo at sub-band 5 (for land case)

Table 3-2 GOSAT-2 TANSO-FTS-2 SWIR L2 Column-averaged Dry-air Mole Fraction Product Format (5/5)

Group	Group / Dataset	Dataspace		Datatype	Dataset name	attribute			
		Rank	Size			unit	validRange	invalidValue	description
	albedo_subband05_uncert	2	numSounding, numAlb_SB5	H5T_IEEE_F32LE	Uncertainty of surface albedo (sub-band 5)	(none)	(none)	-999.0	uncertainty of surface albedo at sub-band 5 (for land case)
	wind_speed	1	numSounding	H5T_IEEE_F32LE	Surface wind speed	m/s	(none)	-999.0	retrieved surface wind speed (for ocean case)
	wind_speed_apriori	1	numSounding	H5T_IEEE_F32LE	A priori value of surface wind speed	m/s	(none)	-999.0	a priori value of surface wind speed (for ocean case)
	wind_speed_uncert	1	numSounding	H5T_IEEE_F32LE	Uncertainty of surface wind speed	m/s	(none)	-999.0	uncertainty of surface wind speed (for ocean case)
	dispersion_adjustment_subband01	1	numSounding	H5T_IEEE_F32LE	Dispersion adjustment factor (sub-band 1)	(none)	(none)	-999.0	retrieved dispersion adjustment factor for sub-band 1
	dispersion_adjustment_subband01_apriori	1	numSounding	H5T_IEEE_F32LE	A priori value for dispersion adjustment factor (sub-band 1)	(none)	(none)	-999.0	a priori value for dispersion adjustment factor for sub-band 1
	dispersion_adjustment_subband01_uncert	1	numSounding	H5T_IEEE_F32LE	Uncertainty of dispersion adjustment factor (sub-band 1)	(none)	(none)	-999.0	uncertainty of dispersion adjustment factor for sub-band 1
	dispersion_adjustment_subband02	1	numSounding	H5T_IEEE_F32LE	Dispersion adjustment factor (sub-band 2)	(none)	(none)	-999.0	retrieved dispersion adjustment factor for sub-band 2
	dispersion_adjustment_subband02_apriori	1	numSounding	H5T_IEEE_F32LE	A priori value for dispersion adjustment factor (sub-band 2)	(none)	(none)	-999.0	a priori value for dispersion adjustment factor for sub-band 2
	dispersion_adjustment_subband02_uncert	1	numSounding	H5T_IEEE_F32LE	Uncertainty of dispersion adjustment factor (sub-band 2)	(none)	(none)	-999.0	uncertainty of dispersion adjustment factor for sub-band 2
	dispersion_adjustment_subband03	1	numSounding	H5T_IEEE_F32LE	Dispersion adjustment factor (sub-band 3)	(none)	(none)	-999.0	retrieved dispersion adjustment factor for sub-band 3
	dispersion_adjustment_subband03_apriori	1	numSounding	H5T_IEEE_F32LE	A priori value for dispersion adjustment factor (sub-band 3)	(none)	(none)	-999.0	a priori value for dispersion adjustment factor for sub-band 3
	dispersion_adjustment_subband03_uncert	1	numSounding	H5T_IEEE_F32LE	Uncertainty of dispersion adjustment factor (sub-band 3)	(none)	(none)	-999.0	uncertainty of dispersion adjustment factor for sub-band 3
	dispersion_adjustment_subband04	1	numSounding	H5T_IEEE_F32LE	Dispersion adjustment factor (sub-band 4)	(none)	(none)	-999.0	retrieved dispersion adjustment factor for sub-band 4
	dispersion_adjustment_subband04_apriori	1	numSounding	H5T_IEEE_F32LE	A priori value for dispersion adjustment factor (sub-band 4)	(none)	(none)	-999.0	a priori value for dispersion adjustment factor for sub-band 4
	dispersion_adjustment_subband04_uncert	1	numSounding	H5T_IEEE_F32LE	Uncertainty of dispersion adjustment factor (sub-band 4)	(none)	(none)	-999.0	uncertainty of dispersion adjustment factor for sub-band 4
	dispersion_adjustment_subband05	1	numSounding	H5T_IEEE_F32LE	Dispersion adjustment factor (sub-band 5)	(none)	(none)	-999.0	retrieved dispersion adjustment factor for sub-band 5
	dispersion_adjustment_subband05_apriori	1	numSounding	H5T_IEEE_F32LE	A priori value for dispersion adjustment factor (sub-band 5)	(none)	(none)	-999.0	a priori value for dispersion adjustment factor for sub-band 5
	dispersion_adjustment_subband05_uncert	1	numSounding	H5T_IEEE_F32LE	Uncertainty of dispersion adjustment factor (sub-band 5)	(none)	(none)	-999.0	uncertainty of dispersion adjustment factor for sub-band 5
	iteration	1	numSounding	H5T_STD_I32LE	Number of iterations	(none)	(none)	-999	number of iterations for full-physics retrieval
	residual_reduced_chi2_subband01	1	numSounding	H5T_IEEE_F32LE	Squares of normalized residuals (sub-band 1)	(none)	(none)	-999.0	squares of normalized residuals of sub-band 1 for full-physics retrieval
	residual_reduced_chi2_subband02	1	numSounding	H5T_IEEE_F32LE	Squares of normalized residuals (sub-band 2)	(none)	(none)	-999.0	squares of normalized residuals of sub-band 2 for full-physics retrieval
	residual_reduced_chi2_subband03	1	numSounding	H5T_IEEE_F32LE	Squares of normalized residuals (sub-band 3)	(none)	(none)	-999.0	squares of normalized residuals of sub-band 3 for full-physics retrieval
	residual_reduced_chi2_subband04	1	numSounding	H5T_IEEE_F32LE	Squares of normalized residuals (sub-band 4)	(none)	(none)	-999.0	squares of normalized residuals of sub-band 4 for full-physics retrieval
	residual_reduced_chi2_subband05	1	numSounding	H5T_IEEE_F32LE	Squares of normalized residuals (sub-band 5)	(none)	(none)	-999.0	squares of normalized residuals of sub-band 5 for full-physics retrieval

*1 If numSounding is 0, corresponding datasets under the following groups are not stored.
SoundingAttribute, SoundingGeometry, L1QualityInfo, CloudInformation, RetrievalResult

2 If numAlb_ is 0, corresponding datasets under the following group are not stored.
RetrievalResult

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