

NIES GOSAT-GW  
Greenhouse Gas Observation Mission Project  
Level 2 (NO<sub>2</sub>) Product Format Descriptions

Version C June 2025

Version B March 2024

Version A February 2022

National Institute for Environmental Studies  
Satellite Observation Center  
GOSAT-GW Project

(Blank)

## Revision History

| Version   | Date of Creation | Revised Section                        | Description of Revision, Reason                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-----------|------------------|----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Version A | February 2022    | –                                      | –                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Version B | March 2024       | 2.1.1. TANSO-3 L2 (NO2) Product        | Revised the file naming convention for the L2 (NO2) Product to align with the format of the L2 (GHG) Product.<br>Deleted time information from the file naming convention.<br>Revised the item convention due to the deletion of time information.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|           |                  | 2.1.2. Level 2 Processing Result (NO2) | Revised the file naming convention for the L2 (NO2) Product to align with the format of the L2 (GHG) Product.<br>Deleted time information from the file naming convention.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|           |                  | 2.1.3. Level 2 Plot Image (NO2)        | Revised the file naming convention for the L2 (NO2) Product to align with the format of the L2 (GHG) Product.<br>Revised from "Quick-look Image" to "Plot Image".<br>Deleted time information from the file naming convention.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|           |                  | 2.2.3. Version definition              | Revised the format to align with the L2 (GHG) Product.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|           |                  | 2.2.4.1 Product data group. Structure  | Addition of SoundingGeometry field. Updated the data to be stored.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|           |                  | 2.2.4.2. Dimension scale               | Added heading.<br>Added Table 2-3 Dimension Scale Details.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|           |                  | 2.2.4.3. Data type definition          | Added heading.<br>Added Table 2-4 Definition of Stored Data Types.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|           |                  | 2.2.4.4. File format details           | The following updates were made to the format of the L2 (NO2) Product. <ul style="list-style-type: none"> <li>• Metadata <ul style="list-style-type: none"> <li>- Deleted "productQualityFlag".</li> <li>- Added to the description of "processResult".</li> </ul> </li> <li>• SceneInfo <ul style="list-style-type: none"> <li>- Deleted the following.<br/>"planStartDateTime"<br/>"planEndDateTime", "obsQualityFlag"</li> </ul> </li> <li>• FrameInfo <ul style="list-style-type: none"> <li>- Deleted "temperature".</li> <li>- Added "pixID".</li> </ul> </li> <li>• SoundingGeometry <ul style="list-style-type: none"> <li>- Addition of field.</li> </ul> </li> <li>• T3L2NO2CalculatedData (Quick-delivery version) <ul style="list-style-type: none"> <li>- Deleted "amf", "no2Vcd".</li> <li>- Added the following.<br/>"geomAmf", "geomNo2Vcd", "No2Scd"<br/>"rootMeanSquareError", "qualityFlag"<br/>"stripeAmplitude"</li> </ul> </li> <li>• T3L2NO2CalculatedData <ul style="list-style-type: none"> <li>- Revised according to the latest study status.<br/>(Description omitted due to numerous updates)</li> </ul> </li> </ul> |

| Version   | Date of Creation | Revised Section                 | Description of Revision, Reason                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-----------|------------------|---------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|           |                  |                                 | Corrected the correspondence between tag names and definitions for "algorithmVersion" and "parameterVersion", as they were reversed.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|           |                  | 2.3.4. File format details      | <p>The following updates were made to the format of the Level 2 Processing result (NO2).</p> <ul style="list-style-type: none"> <li>• Metadata <ul style="list-style-type: none"> <li>- Deleted the following.<br/>"observationRequestID", "pathNo"</li> <li>- Added "productType".</li> <li>- Added to the description of "processResult".</li> </ul> </li> <li>• Observation <ul style="list-style-type: none"> <li>- Changed the following names.<br/>"inputGranuleID" to "L1granuleID"</li> <li>- Deleted the following.<br/>"obsQualityFlag", "observationID "</li> <li>- Added the following.<br/>"observationRequestID ", "pathNo"</li> </ul> </li> </ul> <p>Corrected the correspondence between tag names and definitions for "algorithmVersion" and "parameterVersion", as they were reversed.</p> |
| Version C | June 2025        | Front cover                     | Added a cover page for the NIES created document.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|           |                  | Entire document                 | Revised the header.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|           |                  | 1. Introduction                 | <ul style="list-style-type: none"> <li>• Revised the heading. ("1. General Provisions" to "1. Introduction")</li> <li>• Revised the heading. ("1.1 Purpose" to "1.1 Purpose of this document")</li> <li>• Deleted the heading (1.2 Applicable/Reference Documents).</li> <li>• Added the following headings. <ul style="list-style-type: none"> <li>- 1.2 Product and version</li> <li>- 1.3 Correspondence between L1 and L2 products (NO2)</li> </ul> </li> </ul>                                                                                                                                                                                                                                                                                                                                          |
|           |                  | 2.1. File name list             | Revised the definition of operation mode.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|           |                  | 2.1.1. TANSO-3 L2 (NO2) Product | <ul style="list-style-type: none"> <li>• Revised the file naming convention (X: Observation request source) to align with the L1 product specification revision.</li> <li>• Added a note for creating the Wide Mode Quick-delivery version.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|           |                  | 2.1.3. Level 2 Plot Image (NO2) | Added the percentage of pixels with "Good" retrieval results to the file naming convention.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|           |                  | 2.2.2. File provision unit      | Table 2-1 L2 (NO2) Product File Provision Unit: Updated file size.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|           |                  | 2.2.4. File format details      | <ul style="list-style-type: none"> <li>• Updated the following tables in accordance with the revision of the source documents. Also, corrected the version number of the source documents. <ul style="list-style-type: none"> <li>- Table 2-3 Dimension Scale Details</li> <li>- Table 2-4 Definition of Stored Data Types</li> </ul> </li> <li>• Added and updated the following tables due to format review. <ul style="list-style-type: none"> <li>- Table 2-2 TANSO-3 L2 (NO2) Product Data Group Structure</li> </ul> </li> </ul>                                                                                                                                                                                                                                                                       |

| Version | Date of Creation | Revised Section                        | Description of Revision, Reason                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|---------|------------------|----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|         |                  |                                        | <ul style="list-style-type: none"> <li>- Table 2-5 L2 (NO2) Product Format Details (GlobalAttribute)</li> <li>- Table 2-6 L2 (NO2) Product Format Details (Metadata)</li> <li>- Table 2-7 L2 (NO2) Product Format Details (L1bproductfileInfo)</li> <li>- Table 2-8 L2 (NO2) Product Format Details (SoundingInfo)</li> <li>- Table 2-9 L2 (NO2) Product Format Details (FrameInfo)</li> <li>- Table 2-10 L2 (NO2) Product Format Details (PixelInfo)</li> <li>- Table 2-11 L2 (NO2) Product Format Details (RetrievalResult_NO2 (Quick-delivery version))</li> <li>- Table 2-12 L2 (NO2) Product Format Details (RetrievalResult_NO2 (Standard version))</li> <li>- Table 2-13 L2 (NO2) Product Format Details (Dimension)</li> </ul> |
|         |                  | 2.2.4.1. Product data group. Structure | Table 2-2 TANSO-3 L2 (NO2) Product Data Group Structure: Updated format.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|         |                  | 2.3.2. File provision unit             | Table 2-14 L2 Processing Result (NO2) File Provision Unit: Updated file size.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|         |                  | 2.3.4. File format details             | Table 2-12 Level 2 Processing Result (NO2) File Format Details: Added a note that the namespace is not specified. Updated parameter names and descriptions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|         |                  | 2.4.2. File provision unit             | Table 2-16 Level 2 Plot Image (NO2) File Provision Unit: Updated file size.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|         |                  | 2.4.4. File format details             | Added information about the plot image file format.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

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## 1. Introduction

### 1.1. Purpose of this document

This document defines the format of the GOSAT-GW TANSO-3 Level 2 (NO<sub>2</sub>) product ("L2 (NO<sub>2</sub>) Product"), which is a product of the Greenhouse gases and Water cycle Observation SATellite ("GOSAT-GW") created by the National Institute for Environmental Studies ("NIES").

### 1.2 Product and version

The product and its product versions described in this document are shown in Table 1-1.

Table 1-1 Managed Products

| Product                                                               | Product Version |
|-----------------------------------------------------------------------|-----------------|
| GOSAT-GW TANSO-3 Wide Mode L2 NO <sub>2</sub> Product                 | (TBD)           |
| GOSAT-GW TANSO-3 Focus Mode L2 NO <sub>2</sub> Product                | (TBD)           |
| GOSAT-GW TANSO-3 Focus Mode L2 NO <sub>2</sub> Product Quick Delivery | (TBD)           |

### 1.3. Correspondence between L1 and L2 (NO<sub>2</sub>) Products

The correspondence of creation units between L1 and L2 (NO<sub>2</sub>) Products is shown in Table 1-2.

Table 1-2 Correspondence of Creation Units between L1 and L2 (NO<sub>2</sub>) Products

| Observation mode           | L1 Product | L2 (NO <sub>2</sub> ) Product |
|----------------------------|------------|-------------------------------|
| Wide Mode                  | Path unit  | Daily (UTC)                   |
| Focus Mode (1km, 2km, 3km) | Scene unit | Scene unit                    |

\* Scene: Observation identified by observation request ID

\* Path: Observation from one ascending node to the next

## 2. Product format

### 2.1. File name list

#### 2.1.1. TANSO-3 L2 (NO2) Product

- File naming convention:

TANSO3\_YYYYMMDD\_Xxyyznnnn\_02NO2P\_VMMNNRRmooo.h5

The convention for each item is described below.

- TANSO3: Sensor name (Fixed)
- YYYYMMDD: Observation date (Year, Month, Day) (UTC)
- X: Observation request source
  - J: JAXA
  - N: NIES
  - I: Satellite control system (Wide Mode observation)
  - M: TANSO-3 mission operation system (Unplanned)
- xxyz: Operation mode
  - xx: Observation/Calibration mode type
    - O1: Normal observation (Output bands: Band1, Band 2, Band 3)
    - O3: Normal observation (Output band: Band1)
    - O6: Normal observation (Output bands: Band1, Band 2)
    - O7: Normal observation (Output bands: Band1, Band3)
  - yy: Imaging mode/Resolution
    - WD: Wide Mode
    - F1: Focus Mode 1km
    - F2: Focus Mode 2km
    - F3: Focus Mode 3km
  - z: Wavelength binning state (1 to c)
- nnnn: Observation request number (0001 to 9999).
  - A serial number starting from 000 within observations with the same observation date, request source, and operation mode.
  - For observation request sources J and N, it increments for each observation ID.
  - For request source s (wide-area observation), it increments for each orbit.
- 02NO2: Processing level (02) + Product identifier (NO2)
- P: Product type
  - Q: Quick-delivery version                      \* Indicates Quick-delivery version.
  - M: Standard (Monthly) version                \* Indicates Standard version.
- V: Processing identifier



- V: Standard processing
- R: Reprocessing \* Indicates Reprocessing.
- U: Unplanned processing \* Indicates Unplanned.
- T: Test processing \* Indicates Test.
- MMNRR: Product version (Major, Minor, Revision)
- mooo: Input dataset version (Imaging mode + Product type, Version)
  - M: The following number representing the combination of imaging mode type and product type is entered.
    - 0-1: Wide Mode Standard version
    - 2-3: Unassigned
      - \* Unassigned to align the format with the L2 (GHG) Product.
      - Also, this value is used when creating an "Wide Mode Quick-delivery version" as an internal product.
    - 4-6: Focus Mode Standard version
    - 7-9: Focus Mode Quick-delivery version
  - ooo: Version number
- Extension: h5 (Fixed)

### **2.1.2. Level 2 Processing Result (NO2)**

- File naming convention:

TANSO3\_YYYYMMDD\_Xxyyznnnn\_02NO2P\_VMMNNRRmooo.xml

The convention for each item is the same as in '2.1.1 TANSO-3 L2 (NO2) Product'. However, the following are different.

- Extension: xml (Fixed)

### **2.1.3. Level 2 Plot Image (NO2)**

- File naming convention:

TANSO3\_YYYYMMDD\_Xxyyznnnn\_02NO2P\_VMMNNRRmooo\_AA.A.png

The convention for each item is the same as in '2.1.1 TANSO-3 L2 (NO2) Product'. However, the following are different.

- AA.A: The percentage of pixels with a "Good" retrieval result, rounded down to one decimal place. The criteria for a "Good" retrieval result is TBD (expected to be decided around the start of operations), but screening is planned to be performed using L2 Product 'RetrievalResults\_NO2/pixelQualityValue'.
- Extension: png (Fixed)

## **2.2. TANSO-3 L2 (NO<sub>2</sub>) Product**

### **2.2.1. Outline**

This data includes the total NO<sub>2</sub> slant column, total NO<sub>2</sub> vertical column, etc., calculated by the higher-level processing software (L2, NO<sub>2</sub>). The product is created for each of the five processes (standard processing (Quick-delivery version), standard processing (Standard version), reprocessing, test processing, and unplanned processing). For details on the data included in the L2 (NO<sub>2</sub>) Product, see Section 2.2.4.

### 2.2.2. File provision unit

The TANSO-3 L2 (NO2) Product is a standard product. Products that meet the conditions specified by the user (observation period, observation range, etc.) are provided via G3DPS in HDF5 format (.h5) files.

The following file provision units are used for each mode of the Standard and Quick-delivery versions.

Table 2-1 L2 (NO2) Product File Provision Unit

| Type                                     | Provision unit | Data size (MB/File) | Storage unit                                                                                                                                                                                                                                                                                                                                           |
|------------------------------------------|----------------|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Standard Wide Mode                       | One day        | 1500                | The L2 (NO2) Product is created for one day of data where the observation end time falls between UT 00:00:00 and 23:59:59 (fractional seconds truncated). The number of files corresponds to the number of days in that month.<br>* Immediately after the start of operations, the number of files will be the number of days of standard observation. |
| Standard Focus Mode (1km /2km/3km)       | Scene          | 10 / 5 / 3          | One L2 (NO2) Product is created for each L1 product provided in scene units. The number of files corresponds to the number of scenes observed (Focus Mode) in that month.                                                                                                                                                                              |
| Quick-delivery Focus Mode (1km /2km/3km) | Scene          | 10 / 5 / 3          | One L2 (NO2) Product is created for each L1 product provided in scene units. The number of files corresponds to the number of scenes in the Focus Mode for that observation.                                                                                                                                                                           |

\* Data size is the maximum value without file splitting or compression.

\* The file provision unit for reprocessing is the same as for the Standard version.

\* Files for test processing and unplanned processing are omitted as they are not subject to provision.

### 2.2.3. Version definition

The version definition for the TANSO-3 L2 (NO<sub>2</sub>) Product is stored in the file name for both the product version and the input dataset version. It is also stored within the L2 (NO<sub>2</sub>) Product and Level 2 Processing Result (NO<sub>2</sub>) files as part of the metadata.

- MMNNRR: Product version (Major, Minor, Revision)
- mooo: Input dataset version (Imaging mode + Product type, Version)
  - m: The following number representing the combination of imaging mode type and product type is entered.
    - 0-1: Wide Mode Standard version
    - 2-3: Unassigned X Unassigned to align the format with the L2 (GHG) Product.
    - 4-6: Focus Mode Standard version
    - 7-9: Focus Mode Quick-delivery version
  - 000: Version number

#### 2.2.4. File format details

The details of the file format will be determined after the detailed design phase.

##### 2.2.4.1. Product data group structure

The data group structure of the product is shown in Table 2-2.

Also, the L2 (NO2) Product created in standard processing (Standard version, Wide Mode) receives multiple L1 products as input and contains information such as multiple observation request IDs. The data group containing data such as the observation request ID of the L2 Product has a data structure that is multiplexed by (observation request ID) X (number of path numbers) of the input L1 product.

Table 2-2 TANSO-3 L2 (NO2) Product Data Group Structure

| No. | Group              | Outline                                                                                                                                                                                                                                                                                                                                                                             |
|-----|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | GlobalAttribute    | Metadata based on the Climate and Forecast Convention (CF Convention) 1.7 and ADD (Attribute Conventions for Data Discovery) 1.3 is set as a global attribute. The following data is stored. <ul style="list-style-type: none"><li>· Product name</li><li>· Organization name/Project name/Contact email</li><li>· Product ID</li><li>· Observation range</li></ul>                 |
| 2   | Metadata           | Stores a description of the product type, contents, etc. The following data is stored. <ul style="list-style-type: none"><li>· Granule ID</li><li>· Satellite name/Sensor name</li><li>· Processing level</li><li>· Gas type</li><li>· Operation mode</li><li>· Processing algorithm version</li><li>· Product Version</li><li>· Number of bands</li><li>· Geodetic datum</li></ul> |
| 3   | L1bproductfileInfo | Stores mainly the following as information related to the observation. <ul style="list-style-type: none"><li>· Number of files for TANSO-3 L1B product</li><li>· Observation start/end date/time of TANSO-3 L1B product</li></ul>                                                                                                                                                   |

|   |                         |                                                                                                                                                                                                                                                                                                                                                  |
|---|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|   |                         | <ul style="list-style-type: none"> <li>· Observation request ID corresponding to TANSO-3 L1B product</li> <li>· Granule ID of TANSO-3 L1B product</li> </ul>                                                                                                                                                                                     |
| 4 | SoundingInfo            | Stores mainly the following as information related to the observation. <ul style="list-style-type: none"> <li>· Number of observation IDs</li> <li>· Observation ID</li> <li>· Observation start/end time of the observation ID in the observation plan</li> <li>· Number of frames for each observation ID</li> </ul>                           |
| 5 | FrameInfo               | Stores mainly the following as information related to the observation. <ul style="list-style-type: none"> <li>· Number of frames</li> <li>· Frame ID</li> <li>· Field-of-view direction AT/CT angle</li> <li>· Observation ID for each frame</li> <li>· Observation time for each frame</li> </ul>                                               |
| 6 | PixelInfo               | Stores mainly the following as information related to the observation. <ul style="list-style-type: none"> <li>· Number of spatial divisions</li> <li>· Spatial division ID</li> <li>· Latitude/Longitude/Altitude of division center</li> <li>· Land/Water flag</li> <li>· Solar zenith/azimuth angle, satellite zenith/azimuth angle</li> </ul> |
| 7 | RetrievalResult_NO<br>2 | Stores the following mainly as information related to retrieval results. <p>Derived value of NO2 column amount (total, tropospheric)</p> <p>Derived value of AMF</p> <p>Aerosol/cloud optical thickness and altitude, aerosol type</p>                                                                                                           |
| 8 | Dimension               | Stores a one-dimensional array dataset of the same size as each dimension of each dataset and also stores a scalar value of the number of array elements. The dataset is stored directly under the root group.                                                                                                                                   |

#### 2.2.4.2. Dimension scale

The details of the dimension scale in the product format are shown in Table 2-3.

Table 2-3 Dimension Scale Details

| No. | Dimension Name      | Name                                          | Number of arrays                             | Description                                                                                                            |
|-----|---------------------|-----------------------------------------------|----------------------------------------------|------------------------------------------------------------------------------------------------------------------------|
| 1   | AOCEStatus          | AOCE status                                   | Number of stored AOCE status data            | Stored in chronological order.                                                                                         |
| 2   | AttitudeData        | Attitude data                                 | Number of stored onboard attitude value data | Stored in chronological order.                                                                                         |
| 3   | AttitudeRPY         | Roll, Pitch, Yaw                              | 3 (Fixed)                                    | Attitude angles are stored in the order of roll (X-axis rotation), pitch (Y-axis rotation), and yaw (Z-axis rotation). |
| 4   | Band                | Number of bands                               | 3 (Fixed)                                    | Band1, Band2, Band3 are stored in order.                                                                               |
| 5   | CoordinatesXYZ      | XYZ vector                                    | 3 (Fixed)                                    | A vector in a Cartesian coordinate system is stored in the order of (X,Y,Z) components.                                |
| 6   | Dark1PixelB1        | Band1 spatial direction sample count (dark1)  | Band1 spatial direction sample count         | Stored in order of spatial direction division index.                                                                   |
| 7   | Dark1PixelB2        | Band2 spatial direction sample count (dark1)  | Band2 spatial direction sample count         | Stored in order of spatial direction division index.                                                                   |
| 8   | Dark1PixelB3        | Band3 spatial direction sample count (dark1)  | Band3 spatial direction sample count         | Stored in order of spatial direction division index.                                                                   |
| 9   | Dark2PixelB1        | Band1 spatial direction sample count (dark2)  | Band1 spatial direction sample count         | Stored in order of spatial direction division index.                                                                   |
| 10  | Dark2PixelB2        | Band2 spatial direction sample count (dark2)  | Band2 spatial direction sample count         | Stored in order of spatial direction division index.                                                                   |
| 11  | Dark2PixelB3        | Band 3 spatial direction sample count (dark2) | Band 3 spatial direction sample count        | Stored in order of spatial direction division index.                                                                   |
| 12  | DeterminedOrbitData | Number of definitive orbit data               | Number of stored definitive orbit data       | Stored in order of spatial direction division index.                                                                   |
| 13  | Frame               | Number of frames                              | Number of frames                             | Stored in chronological order.                                                                                         |



|    |                         |                                              |                                                       |                                                                                   |
|----|-------------------------|----------------------------------------------|-------------------------------------------------------|-----------------------------------------------------------------------------------|
| 14 | LunarOrbitData          | Number of ephemeris (moon) data              | Number of stored ephemeris (moon) data                | Stored in chronological order.                                                    |
| 15 | OnboardOrbitData        | Onboard orbit data                           | Number of stored onboard orbit value data             | Stored in chronological order.                                                    |
| 16 | PointingData            | Pointing data                                | Number of stored pointing information data            | Stored in chronological order.                                                    |
| 17 | PredictedOrbitData      | Number of predicted orbit data               | Number of stored predicted orbit data                 | Stored in chronological order.                                                    |
| 18 | Quaternion              | 4 (Fixed)                                    | Quaternions are stored in the order of (q0,q1,q2,q3). | q0 is the scalar component, q1, q2, and q3 are i, j, and k respectively.          |
| 19 | SiderealTimeDataInfo    | Number of sidereal time data                 | Number of stored Greenwich sidereal time data         | Stored in chronological order.                                                    |
| 20 | SolarOrbitData          | Number of ephemeris (sun) data               | Number of stored ephemeris (sun) data                 | Stored in chronological order.                                                    |
| 21 | Sounding                | Number of observations                       | Number of observation IDs                             | Stored in chronological order.                                                    |
| 22 | SpacecraftTimeErrorInfo | Time error data                              | Stored time error                                     | Stored in chronological order.                                                    |
| 23 | SpatialPixel            | Band common spatial direction sample count   | Band common spatial direction sample count            | Stored in order of spatial direction division index.                              |
| 24 | SpatialPixelB1          | Band1 spatial direction sample count         | Band1 spatial direction sample count                  | Stored in order of spatial direction division index.                              |
| 25 | SpatialPixelB2          | Band2 spatial direction sample count         | Band2 spatial direction sample count                  | Stored in order of spatial direction division index.                              |
| 26 | SpatialPixelB3          | Band 3 spatial direction sample count        | Band 3 spatial direction sample count                 | Stored in order of spatial direction division index.                              |
| 27 | TransCoordMatrix        | Coordinate transformation matrix             | 9 (Fixed)                                             | 3x3 matrix is stored in the following order.<br>(0,1,2)<br>(3, 4, 5)<br>(6, 7, 8) |
| 28 | TransCoordMatrixInfo    | Number of coordinate transformation matrices | Number of stored coordinate transformation matrices   | Stored in chronological order.                                                    |
| 29 | WavelengthPixelB1       | Band1 wavelength direction sample count      | Band1 wavelength direction sample count               | Stored in order of wavelength direction division index.                           |

|    |                                                            |                                                                        |                                                |                                                                                                                                      |
|----|------------------------------------------------------------|------------------------------------------------------------------------|------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| 30 | WavelengthPixelB2                                          | Band2 wavelength direction sample count                                | Band2 wavelength direction sample count        | Stored in order of wavelength direction division index.                                                                              |
| 31 | WavelengthPixelB3                                          | Band3 wavelength direction sample count                                | Band3 wavelength direction sample count        | Stored in order of wavelength direction division index.                                                                              |
| 32 | MinMax                                                     | Minimum/maximum value                                                  | 2 (Fixed)                                      | Stored in the order of min,max.                                                                                                      |
| 33 | WavelengthTemperatureCorrection<br>TemperatureNum          | Number of temperatures used for wavelength temperature correction      | 10 (Fixed)                                     | The following temperatures are stored in order.<br>0: TBD 5: TBD<br>1: TBD 6: TBD<br>2: TBD 7: TBD<br>3: TBD 8: TBD<br>4: TBD 9: TBD |
| 34 | WavelengthTemperatureCorrection<br>PolynomialFunctionOrder | Polynomial degree of temperature for wavelength temperature correction | 4 (Fixed)                                      | Coefficients from 0th to 3rd order are stored in order.                                                                              |
| 35 | NCorner                                                    | Four corners of the division                                           | 4 (Fixed)                                      | Stored in clockwise order.                                                                                                           |
| 36 | AD3_IP_TEMP                                                | Number of AD3_IP_TEMP data                                             | Number of AD3_IP_TEMP data                     | Stored in chronological order.                                                                                                       |
| 37 | AD3_AMP_TEMP                                               | Number of AD3_AMP_TEMP data                                            | Number of AD3_AMP_TEMP data                    | Stored in chronological order.                                                                                                       |
| 38 | B1_DET_TEMP_A                                              | B1_DET_TEMP_A data No.                                                 | Number of B1_DET_TEMP_A data                   | Stored in chronological order.                                                                                                       |
| 39 | PCA_DET1_TEMP_B                                            | Number of PCA_DET1_TEMP_B data                                         | Number of PCA_DET1_TEMP_B data                 | Stored in chronological order.                                                                                                       |
| 40 | B2_DET_TEMP_A                                              | B2_DET_TEMP_A data No.                                                 | Number of B2_DET_TEMP_A data                   | Stored in chronological order.                                                                                                       |
| 41 | B2_DET_TEMP_B                                              | B2_DET_TEMP_B data No.                                                 | Number of B2_DET_TEMP_B data                   | Stored in chronological order.                                                                                                       |
| 42 | B3_DET_TEMP_A                                              | B3_DET_TEMP_A data No.                                                 | Number of B3_DET_TEMP_A data                   | Stored in chronological order.                                                                                                       |
| 43 | B3_DET_TEMP_B                                              | B3_DET_TEMP_B data No.                                                 | Number of B3_DET_TEMP_B data                   | Stored in chronological order.                                                                                                       |
| 44 | OC_IF                                                      | Number of A system/B system judgment flag data                         | Number of A system/B system judgment flag data | Stored in chronological order.                                                                                                       |

\* Quoted from 'GOSAT-GW/TANSO-3 Level 1 Product Format Descriptions (Draft 9), 4. Format Details, Table 4-25 Level 1 Product Dimension Details'.

### 2.2.4.3. Data type definition

The definitions of the stored data types in the product format are shown in Table 2-4.

Table 2-4 Definition of Stored Data Types

| HDF5 type      | Definition                                                                                                                                                           |
|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| H5T_STRING     | String with a length of 1 byte or more                                                                                                                               |
| H5T_STD_I8LE   | Signed 1-byte integer<br>(-128 to 127)                                                                                                                               |
| H5T_STD_U8LE   | Unsigned 1-byte integer<br>(0 to 255)                                                                                                                                |
| H5T_STD_I16LE  | Signed 2-byte integer<br>(-32768 to 32767)                                                                                                                           |
| H5T_STD_U16LE  | Unsigned 2-byte integer<br>(0 to 65535)                                                                                                                              |
| H5T_STD_I32LE  | Signed 4-byte integer<br>(-2147483648 to 2147483647)                                                                                                                 |
| H5T_STD_U32LE  | Unsigned 4-byte integer<br>(0 to 4294967295)                                                                                                                         |
| H5T_IEEE_F32LE | 4-byte floating-point number<br>(Significant digits: 7 decimal digits. Maximum absolute value: 3.402823e+38, minimum absolute value greater than 0: 1.175494e-38)    |
| H5T_IEEE_F64LE | 8-byte floating-point number<br>(Significant digits: 15 decimal digits. Maximum absolute value: 1.797693e+308, minimum absolute value greater than 0: 2.225074e-308) |

\* Quoted from 'GOSAT-GW/TANSO-3 Level 1 Product Format Descriptions (Draft 9), 2.5.5.1. Definition of Stored Data Types'.

#### 2.2.4.4. Product format details

The file format details for each data group of the L2 (NO2) Product are shown in Tables 2-5 to 2-13. The Data Type in the tables is defined the same as for the L1 product. (For Data Type, see '2.2.4.3 Data type definition'.)

##### (1) GlobalAttribute

Table 2-5 L2 (NO2) Product Format Details (GlobalAttribute)

| No. | Attribute Name            | Data Type  | Name                                | Explanation                                                                                                                  |
|-----|---------------------------|------------|-------------------------------------|------------------------------------------------------------------------------------------------------------------------------|
| 1   | Conventions               | H5T_STRING | Convention                          | CF Convention, ACDD version "CF-1.7, ACDD-1.3" (Fixed)                                                                       |
| 2   | title                     | H5T_STRING | Product name                        | Stores the product name with the following value. "GOSAT-GW/TANSO-3 L2(NO2)" (Fixed)                                         |
| 3   | institution               | H5T_STRING | Organization name                   | Sets the name of the organization that created the product. "National Institute for Environmental Studies (NIES)" (Fixed)    |
| 4   | project                   | H5T_STRING | Project name                        | Describes the name of the project that created the product. "NIES GOSAT-GW Project" (Fixed)                                  |
| 5   | summary                   | H5T_STRING | Summary                             | Describes the summary of the file.                                                                                           |
| 6   | license                   | H5T_STRING | Data rights                         | Stores the data rights, terms of use, or the URL of the Website where they are posted.                                       |
| 7   | creator_name              | H5T_STRING | Product creation organization       | Describes the name of the entity that created the product. "National Institute for Environmental Studies (NIES)" (Fixed)     |
| 8   | creator_type              | H5T_STRING | Organization type                   | Stores the type of the entity that created the product. "institution" (Fixed)                                                |
| 9   | creator_email             | H5T_STRING | Creation organization contact email | Stores the contact email of the entity that created the product.                                                             |
| 10  | creator_url               | H5T_STRING | Creation organization Website       | Stores the URL of the Website where information about the entity that created the product can be accessed.                   |
| 11  | keywords                  | H5T_STRING | Keywords                            | Stores keywords representing the file content, separated by commas.                                                          |
| 12  | standard_names_vocabulary | H5T_STRING | vocabulary citing standard_name     | Stores the name and version of the vocabulary citing standard_name. "CF Standard Name Table (v49, 12 February 2018)" (Fixed) |
| 13  | id                        | H5T_STRING | Product id                          | Stores the granule ID                                                                                                        |

|    |                     |            |                             |                                                                                                                                                                                                                                                                                                                   |
|----|---------------------|------------|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 14 | naming_authority    | H5T_STRING | Organization name           | Stores the name of the organization providing the product in a format with the DNS name reversed.                                                                                                                                                                                                                 |
| 15 | source              | H5T_STRING | Data generation method      | Stores the version of the algorithm theoretical basis document as the method used to generate the data.                                                                                                                                                                                                           |
| 16 | processing_level    | H5T_STRING | Processing level            | Stores the processing level in the following format.<br>"Level2" (Fixed)                                                                                                                                                                                                                                          |
| 17 | comment             | H5T_STRING | Comment                     | Stores comments not included in other attributes.                                                                                                                                                                                                                                                                 |
| 18 | date_created        | H5T_STRING | Creation date/time          | Stores the file creation date/time (UTC) in the format "YYYY-MM-DDT hh:mm:ssZ".<br>YYYY: Year<br>MM: 01 to 12 (Month)<br>DD: 01 to 31 (Day)<br>T: "T" (Fixed)<br>hh: 00 to 23 (Hour)<br>mm: 00 to 59 (Minute)<br>ss: 00 to 60 (Second)<br>Z: "Z" (Fixed)                                                          |
| 19 | time_coverage_start | H5T_STRING | Observation start date/time | Stores the observation date and time of the start of the data in the format "YYYY-MM-DDThh:mm:ss.uuuZ".<br>YYYY: Year<br>MM: 01 to 12 (Month)<br>DD: 01 to 31 (Day)<br>T: "T" (Fixed)<br>hh: 00 to 23 (Hour)<br>mm: 00 to 59 (Minute)<br>ss: 00 to 60 (Second)<br>uuu: 000 to 999 (millisecond)<br>Z: "Z" (Fixed) |
| 20 | time_coverage_end   | H5T_STRING | Observation end date/time   | Stores the observation date and time of the end of the data in the format "YYYY-MM-DDThh:mm:ss.uuuZ".<br>YYYY: Year<br>MM: 01 to 12 (Month)                                                                                                                                                                       |

|    |                              |                    |                                                                              |                                                                                                                                                                   |
|----|------------------------------|--------------------|------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    |                              |                    |                                                                              | DD: 01 to 31 (Day)<br>T: "T" (Fixed)<br>hh: 00 to 23 (Hour)<br>mm: 00 to 59 (Minute)<br>ss: 00 to 60 (Second)<br>uuu: 000 to 999 (millisecond)<br>Z: "Z" (Fixed)  |
| 21 | geospatial_lat_min           | H5T_IEEE_F3<br>2LE | Northernmost latitude of observation<br>range                                | Stores the latitude of the northernmost pixel center in the range of -90.0 to 90.0.                                                                               |
| 22 | geospatial_lat_max           | H5T_IEEE_F3<br>2LE | Southernmost latitude of observation<br>range                                | Stores the latitude of the southernmost pixel center in the range of -90.0 to 90.0.                                                                               |
| 23 | geospatial_lon_min           | H5T_IEEE_F3<br>2LE | Westernmost longitude of<br>observation range                                | Stores the longitude of the westernmost pixel center in the range of -180.0 to 180.0.                                                                             |
| 24 | geospatial_lon_max           | H5T_IEEE_F3<br>2LE | Easternmost longitude of<br>observation range                                | Stores the longitude of the easternmost pixel center in the range of -180.0 to 180.0.                                                                             |
| 25 | geospatial_vertical_min      | H5T_IEEE_F3<br>2LE | Minimum altitude of observation<br>range                                     | Stores the minimum altitude of the data in the range of 0 to 6000.                                                                                                |
| 26 | geospatial_vertical_max      | H5T_IEEE_F3<br>2LE | Maximum altitude of observation<br>range                                     | Stores the maximum altitude of the data in the range of 0 to 6000.                                                                                                |
| 27 | geospatial_vertical_positive | H5T_STRING         | Vertical direction value<br>interpretation, Altitude/Depth<br>identification | Stores the identification for altitude/depth.<br>"up" (Fixed)                                                                                                     |
| 28 | language                     | H5T_STRING         | Language                                                                     | Stores the language used.<br>"en" (Fixed)                                                                                                                         |
| 29 | topicCategory                | H5T_STRING         | Category code                                                                | Stores the optimal discipline code from the ISO 19115 topic category code table (see Section 8.8), separated by commas.<br>"004,007" (Climatology, Oceans: Fixed) |
| 30 | role                         | H5T_STRING         | Role code                                                                    | Stores the ISO 19115 role code.<br>"003" (Owner of information: Fixed)                                                                                            |
| 31 | history                      | H5T_STRING         | File revision history                                                        | Stores the file revision history with one record per line for each modification.                                                                                  |

|    |                 |            |                                   |                                                                                                |
|----|-----------------|------------|-----------------------------------|------------------------------------------------------------------------------------------------|
| 32 | characterSet    | H5T_STRING | Character code                    | Stores the corresponding code from the ISO-19115 character code table.<br>"004" (UTF-8: Fixed) |
| 33 | acknowledgement | H5T_STRING | Project supplementary information | Stores supplementary information about the project.                                            |
| 34 | publisher_name  | H5T_STRING | Name of responsible person        | Stores the name of the person responsible for data publication.                                |
| 35 | publisher_email | H5T_STRING | Responsible person email address  | Stores the contact email address of the person responsible for data publication.               |
| 36 | publisher_url   | H5T_STRING | Responsible person Website URL    | Stores the URL of the Website of the person responsible for data publication.                  |

(2) Metadata

Table 2-6 L2 (NO2) Product Format Details (Metadata)

| No. | Group Path/Dataset Name  | Data Type  | Dimension |       | Name                | Explanation                                                                                                                                                   | Attribute                                             |
|-----|--------------------------|------------|-----------|-------|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|
|     |                          |            | Rank      | Shape |                     |                                                                                                                                                               | description                                           |
| 0   | /Metadata                | -          | -         | -     |                     |                                                                                                                                                               | -                                                     |
| 1   | granuleID                | H5T_STRING | 1         | (1,)  | Granule ID          | Stores the ID that uniquely identifies the observation                                                                                                        | long_name:File identifier of the product (granule ID) |
| 2   | satelliteName            | H5T_STRING | 1         | (1,)  | Satellite name      | Stores the satellite name.<br>"GOSAT-GW" (Fixed)                                                                                                              | long_name:Satellite name                              |
| 3   | sensorName               | H5T_STRING | 1         | (1,)  | Sensor name         | Stores the sensor name.<br>"TANSO-3" (Fixed)                                                                                                                  | long_name:Sensor name                                 |
| 4   | processingLevel          | H5T_STRING | 1         | (1,)  | Processing level    | Processing level<br>"Level2" (Fixed)                                                                                                                          | long_name: Processing level                           |
| 5   | gasType                  | H5T_STRING | 1         | (1,)  | Gas type            | Gas type<br>"NO2" (Fixed)                                                                                                                                     | ong_name: Retrieved gas                               |
| 6   | operationMode            | H5T_STRING | 1         | (1,)  | Operation mode      | Stores the operation mode in the following format<br>"xxyz"<br>xx: Observation/Calibration mode<br>yy: Imaging mode/Resolution<br>Z: WAVELENGTH BINNING STATE | long_name: Operation mode of TANSO-3                  |
| 7   | processingClassification | H5T_STRING | 1         | (1,)  | Processing category | Stores the processing category with the following value.<br>V: Standard processing, Reprocessing<br>T: Test processing                                        | long_name: Processing classification                  |



|    |                    |            |   |      |                                  |                                                                                                                                                                                                                                                                               |                                          |
|----|--------------------|------------|---|------|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|
| 8  | productionDateTime | H5T_STRING | 1 | (1,) | Product creation date/time (UTC) | Stores the product creation date/time (UTC) in the following format.<br><br>"YYYY-MM-DD T hh:mm:ssZ"<br>YYYY: Year<br>MM: 01 to 12 (Month)<br>DD: 01 to 31 (Day)<br>T: "T" (Fixed)<br>hh: 00 to 23 (Hour)<br>mm: 00 to 59 (Minute)<br>ss: 00 to 60 (Second)<br>Z: "Z" (Fixed) | long_name: Date and time product created |
| 9  | algorithmVersion   | H5T_STRING | 1 | (1,) | Processing algorithm version     | Stores the algorithm development version.                                                                                                                                                                                                                                     | long_name:Algorithm version              |
| 10 | productVersion     | H5T_STRING | 1 | (1,) | Product Version                  | Stores the product version (characters 40-45 of the file name).                                                                                                                                                                                                               | long_name:Product version                |
| 11 | inputDataVersion   | H5T_STRING | 1 | (1,) | Input dataset version            | Stores the input dataset version. (characters 46-49 of the file name)                                                                                                                                                                                                         | long_name: Input data version            |
| 12 | band               | H5T_STRING | 1 | (1,) | Number of bands                  | Number of bands<br>"3" (Fixed)                                                                                                                                                                                                                                                | long_name: The number of TANSO-3 bands   |
| 13 | geodeticDatum      | H5T_STRING | 1 | (1,) | Geodetic datum                   | Ellipsoid model/reference coordinate system<br>"WGS84/WGS84" (Fixed)                                                                                                                                                                                                          | long_name: Geodetic datum                |

(3) L1bproductfileInfo

Table 2-7 L2 (NO2) Product Format Details (L1bproductfileInfo)

| No. | Group Path/Dataset Name  | Data Type  | Dimension |                 | Name                                                    | Explanation                                                                                                                                                                                                                                                                                                                                       | Attribute                                                |       |
|-----|--------------------------|------------|-----------|-----------------|---------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|-------|
|     |                          |            | Rank      | Shape           |                                                         |                                                                                                                                                                                                                                                                                                                                                   | description                                              | Units |
| 0   | /L1bproductfileInfo      | -          | -         | -               |                                                         |                                                                                                                                                                                                                                                                                                                                                   | -                                                        |       |
| 1   | pathNo                   | H5T_STRING | 2         | (1, numL1bfile) | Path number of the first frame included in the L1B file | Path number (0 to 44)                                                                                                                                                                                                                                                                                                                             | long_name: Path number included in L2 product            |       |
| 2   | observationStartDateTime | H5T_STRING | 2         | (1, numL1bfile) | Observation start time                                  | Stores the observation date and time of the start frame of the L1B product used for creation in the format "YYYY-MM-DD Thh:mm:ss.uuuZ".<br>YYYY: Year<br>MM: 01 to 12 (Month)<br>DD: 01 to 31 (Day)<br>T: "T" (Fixed)<br>hh: 00 to 23 (Hour)<br>mm: 00 to 59 (Minute)<br>ss: 00 to 60 (Second)<br>uuu: 000 to 999 (millisecond)<br>Z: "Z" (Fixed) | long_name: Observation start date and time for each path |       |

|   |                        |            |   |                 |                             |                                                                                                                                                                                                                                                                                                                                       |                                                        |     |
|---|------------------------|------------|---|-----------------|-----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|-----|
| 3 | observationEndDateTime | H5T_STRING | 2 | (1, numL1bfile) | Observation end time        | Stores the observation date and time of the end frame of the L1B product used for creation in the format "YYYY-MM-DD Thh:mm:ss.uuuZ".<br>YYYY: Year<br>MM: 01 to 12 (Month)<br>MM: 01 to 31 (Day) T: "T" (Fixed) hh: 00 to 23 (Hour)<br>mm: 00 to 59 (Minute)<br>ss: 00 to 60 (Second)<br>uuu: 000 to 999 (millisecond)Z: "Z" (Fixed) | long_name: Observation end date and time for each path | UTC |
| 4 | observationRequestID   | H5T_STRING | 2 | (1, numL1bfile) | Observation request ID      | Observation request ID                                                                                                                                                                                                                                                                                                                | long_name: Observation request ID                      | -   |
| 5 | level1bGranuleID       | H5T_STRING | 2 | (1, numL1bfile) | L1B product file granule ID | Granule ID of the L1B product used for creation.                                                                                                                                                                                                                                                                                      | long_name: Granule ID of L1B product                   | -   |

(4) Soundinginfo

Table 2-8 L2 (NO2) Product Format Details (Soundinginfo)

| No. | Group Path/Dataset Name | Data Type     | Dimension |                  | Name                                           | Explanation                                                                                                                                                                                                                                                                                                                                        | Attribute                                         |       |     |       |         |
|-----|-------------------------|---------------|-----------|------------------|------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|-------|-----|-------|---------|
|     |                         |               | Rank      | Shape            |                                                |                                                                                                                                                                                                                                                                                                                                                    | description                                       | Units | Min | Max   | Invalid |
| 0   | /SoundingInfo           | -             |           | -                | Scene information                              | Stores information for each observation ID.                                                                                                                                                                                                                                                                                                        | -                                                 |       |     |       |         |
| 1   | obsID                   | H5T_STD_I32LE | 2         | (1, numSounding) | Observation ID                                 | Stores the observation ID.                                                                                                                                                                                                                                                                                                                         | long_name: Observation ID                         | -     | 0   | 65535 | 99999   |
| 2   | planStartDateTime       | H5T_STRING    | 2         | (1, numSounding) | Observation start time in the observation plan | Stores the observation start time (UTC) of each observation ID in the observation plan in the following format.<br>"YYYY-MM-DDT hh:mm:ss.ffffffZ"<br>YYYY: Year<br>MM: 01 to 12 (Month)<br>DD: 01 to 31 (Day)<br>T: "T" (Fixed)<br>hh: 00 to 23 (Hour)<br>mm: 00 to 59 (Minute)<br>ss: 00 to 60 (Second)<br>ffffff: 000000 to 999999 (Microsecond) | long_name: Planed observation start date and time | UTC   | -   | -     | -       |

|   |                  |            |   |                  |                                              |                                                                                                                                                                                                                                                                                                                                                                          |                                                      |     |   |   |   |
|---|------------------|------------|---|------------------|----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|-----|---|---|---|
| 3 | planEndDateTime  | H5T_STRING | 2 | (1, numSounding) | Observation end time in the observation plan | Stores the observation end time (UTC) of each observation ID in the observation plan in the following format. "YYYY-MM-DDT hh:mm:ss.ffffffZ"<br>YYYY: Year<br>MM: 01 to 12 (Month)<br>DD: 01 to 31 (Day)<br>T: "T" (Fixed)<br>hh: 00 to 23 (Hour)<br>mm: 00 to 59 (Minute)<br>ss: 00 to 60 (Second)<br>ffffff: 000000 to 999999 (Microsecond)                            | long_name: Planed observation end date and time      | UTC | - | - | - |
| 4 | obsStartDateTime | H5T_STRING | 2 | (1, numSounding) | Actual observation start time                | Stores the observation start time (UTC) of each observation ID, considering delay time and integration time, in the following format.<br>"YYYY-MM-DDT hh:mm:ss.ffffffZ"<br>YYYY: Year<br>MM: 01 to 12 (Month)<br>DD: 01 to 31 (Day)<br>T: "T" (Fixed)<br>hh: 00 to 23 (Hour)<br>mm: 00 to 59 (Minute)<br>ss: 00 to 60 (Second)<br>ffffff: 000000 to 999999 (Microsecond) | long_name: Corrected observation start date and time | UTC | - | - | - |

|   |                |               |   |                  |                                          |                                                                                                                                                                                                                                                                                                                                                                           |                                                     |     |   |      |      |
|---|----------------|---------------|---|------------------|------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|-----|---|------|------|
| 5 | obsEndDateTime | H5T_STRING    | 2 | (1, numSounding) | Actual observation end time              | Stores the observation end time (UTC) of each observation ID, considering delay time and integration time, in the following format.<br>"YYYY-MM-DDT<br>hh:mm:ss.ffffffZ"<br>YYYY: Year<br>MM: 01 to 12 (Month)<br>DD: 01 to 31 (Day)<br>T: "T" (Fixed)<br>hh: 00 to 23 (Hour)<br>mm: 00 to 59 (Minute)<br>ss: 00 to 60 (Second)<br>ffffff: 000000 to 999999 (Microsecond) | long_name: Corrected observation end date and time  | UTC | - | -    | -    |
| 6 | numObsFrame    | H5T_STD_I16LE | 2 | (1, numSounding) | Number of frames for each observation ID | Stores the number of frames for each observation ID.                                                                                                                                                                                                                                                                                                                      | long_name: Number of frames for each observation ID | -   | 0 | 9999 | -999 |

## (5) FrameInfo

Table 2-9 L2 (NO2) Product Format Details (Frameinfo)

| No. | Group Path/Dataset Name | Data Type       | Dimension |               | Name                             | Explanation                                                                                                                                                      | Attribute                                                                                                  |        |      |     |         |
|-----|-------------------------|-----------------|-----------|---------------|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|--------|------|-----|---------|
|     |                         |                 | Rank      | Shape         |                                  |                                                                                                                                                                  | description                                                                                                | Units  | Min  | Max | Invalid |
| 0   | FrameInfo               | -               |           | -             |                                  | -                                                                                                                                                                | -                                                                                                          |        |      |     |         |
| 1   | frameID                 | H5T_ST RING     | 2         | (1, numFrame) | Frame ID                         | Stores the frame ID. Numbered starting from 1 in chronological order of observation.                                                                             | long_name: Frame ID                                                                                        | -      | -    | -   | -       |
| 2   | angleAT                 | H5T_IEE E_F32LE | 2         | (1, numFrame) | Field-of-view direction AT angle | Field-of-view direction AT angle                                                                                                                                 | long_name: along-track angle                                                                               | degree | -180 | 180 | -999    |
| 3   | angleCT                 | H5T_IEE E_F32LE | 2         | (1, numFrame) | Field-of-view direction CT angle | Field-of-view direction CT angle                                                                                                                                 | long_name: cross-track angle                                                                               | degree | -180 | 180 | -999    |
| 4   | yawSteeringFlag         | H5T_ST D_I8LE   | 2         | (1, numFrame) | Yaw steering flag for each frame | Stores the yaw steering state for each frame with the following value.<br>0: OFF<br>1: ON<br>Other than above NA (when undeterminable due to missing data, etc.) | long_name: Yaw-steering flag in frame<br>flag_values: [0,1]<br>flag_meanings: "OFF ON"<br>_FillValue: -128 | -      | 0    | 1   | -128    |
| 5   | obsID                   | H5T_ST RING     | 2         | (1, numFrame) | Observation ID for each frame    | Stores the observation ID for each frame.                                                                                                                        | long_name: observation ID for each frame                                                                   | -      | -    | -   | -       |

|   |                    |                |   |               |                                                               |                                                                                                                                                                                                                                                                                                                                                           |                                        |                                    |   |   |   |
|---|--------------------|----------------|---|---------------|---------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|------------------------------------|---|---|---|
| 6 | frameTimeUTC       | H5T_STRING     | 2 | (1, numFrame) | Observation time for each frame (uncorrected) (UTC)           | Stores the common frame observation time (UTC), not considering delay time and integration time, in the following format.<br>"YYYY-MM-DDT hh:mm:ss.ffffffZ"<br>YYYY: Year<br>MM: 01 to 12 (Month)<br>DD: 01 to 31 (Day) T: "T"<br>(Fixed) hh: 00 to 23 (Hour)<br>mm: 00 to 59 (Minute)<br>ss: 00 to 60 (Second)<br>ffffff: 000000 to 999999 (Microsecond) | long_name:Frame common time (UTC)      | UTC                                | - | - | - |
| 7 | frameTime          | H5T_IEEE_F64LE | 2 | (1, numFrame) | Observation time for each frame (uncorrected) (total seconds) | Stores the common frame time (total seconds), not considering delay time and integration time, as total seconds with December 31, 2012 23:59:59 as 0 (sec).                                                                                                                                                                                               | long_name:Frame common time (seconds)  | Seconds since 2012-12-31T23:59:59Z | - | - | - |
| 8 | observationTimeUTC | H5T_STRING     | 2 | (1, numFrame) | Observation time for each frame (UTC)                         | Stores the common frame observation time (UTC), considering delay time and integration time, in the following format.<br>"YYYY-MM-DDT hh:mm:ss.ffffffZ"<br>YYYY: Year<br>MM: 01 to 12 (Month)<br>DD: 01 to 31 (Day)                                                                                                                                       | long_name:Frame observation time (UTC) | UTC                                | - | - | - |



|   |  |                 |                    |   |                  |                                                                                                                                      |                                                                                                                                                                        |                                                   |                                                      |   |   |   |
|---|--|-----------------|--------------------|---|------------------|--------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|------------------------------------------------------|---|---|---|
|   |  |                 |                    |   |                  | T: "T" (Fixed)<br>hh: 00 to 23 (Hour)<br>mm: 00 to 59 (Minute)<br>ss: 00 to 60 (Second)<br>ffffff: 000000 to 999999<br>(Microsecond) |                                                                                                                                                                        |                                                   |                                                      |   |   |   |
| 9 |  | observationTime | H5T_IEE<br>E_F64LE | 2 | (1,<br>numFrame) | (Observation<br>time for each<br>frame (total<br>seconds)                                                                            | Stores the common frame<br>time (total seconds),<br>considering delay time and<br>integration time, as total<br>seconds with December 31,<br>2012 23:59:59 as 0 (sec). | long_name:Fram<br>e observation<br>time (seconds) | Seconds<br>since<br>2012-<br>12-<br>31T23:5<br>9:59Z | - | - | - |

## (6) Pixelinfo

Table 2-10 L2 (NO2) Product Format Details (Pixelinfo)

| No. | Group Name | Path/Dataset | Data Type       | Dimension |               | Name                | Explanation                                                                                                                                                                                                                                                                                                  | Attribute                                                                                                                                    |        |     |     |         |
|-----|------------|--------------|-----------------|-----------|---------------|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|--------|-----|-----|---------|
|     |            |              |                 | Rank      | Shape         |                     |                                                                                                                                                                                                                                                                                                              | description                                                                                                                                  | Units  | Min | Max | Invalid |
| 0   | PixelInfo  |              | -               |           | -             |                     | -                                                                                                                                                                                                                                                                                                            | -                                                                                                                                            |        |     |     |         |
| 1   | pixelID    |              | H5T_STRING      | 2         | (1, numPixel) | Spatial division ID | Stores the spatial division ID.                                                                                                                                                                                                                                                                              | long_name: Pixel ID<br>pixel ID (1:28) = Observation request ID (1:18) + Division number (19:20) + Frame index (21:25) + Pixel index (26:28) | -      | -   | -   | -       |
| 2   | obsTime    |              | H5T_STRING      | 2         | (1, numPixel) | Observation time    | Stores the observation time of each spatial division in the format "YYYY-MM-DDT hh:mm:ss.ffffffZ".<br>YYYY: Year<br>MM : 01 to 12 (Month)<br>DD : 01 to 31 (Day)<br>T: Fixed<br>hh: 00 to 23 (Hour)<br>mm : 00 to 59 (Minute)<br>ss: 00 to 60 (Second)<br>ffffff: 000000 to 999999 (Microsecond)<br>Z: Fixed | long_name: Observation time for each pixel                                                                                                   | UTC    | -   | -   | -       |
| 3   | latitude   |              | H5T_IEE_E_F32LE | 2         | (1, numPixel) | Latitude            | Stores the center latitude of the spatial division.                                                                                                                                                                                                                                                          | long_name: Geodetic latitude of observation point                                                                                            | degree | -90 | 90  | -999    |

|    |                         |                    |   |               |                                |                                                                                                 |                                                             |        |      |      |      |
|----|-------------------------|--------------------|---|---------------|--------------------------------|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------|--------|------|------|------|
| 4  | longitude               | H5T_IEE<br>E_F32LE | 2 | (1, numPixel) | Longitude                      | Stores the center longitude of the spatial division.                                            | long_name: Geodetic longitude of observation point          | degree | -180 | 180  | -999 |
| 5  | latitudePixelBounds     | H5T_IEE<br>E_F32LE | 2 | (1, numPixel) | Latitude of four corners       | Stores the latitude of the four corners of the spatial division.                                | long_name: Geodetic latitude of observation bounds          | degree | -90  | 90   | -999 |
| 6  | longitudePixelBounds    | H5T_IEE<br>E_F32LE | 2 | (1, numPixel) | Longitude of four corners      | Stores the longitude of the four corners of the spatial division.                               | long_name: Geodetic longitude of observation bounds         | degree | -180 | 180  | -999 |
| 7  | height                  | H5T_IEE<br>E_F32LE | 2 | (1, numPixel) | Altitude                       | Stores the average altitude within the spatial division.                                        | long_name: Mean altitude within each pixel                  | m      | -500 | 9999 | -999 |
| 8  | heightStandardDeviation | H5T_IEE<br>E_F32LE | 2 | (1, numPixel) | Standard deviation of altitude | Stores the standard deviation of altitude within the spatial division.                          | long_name: Standard deviation of altitude within each pixel | M      | 0    | 9999 | -999 |
| 9  | landwaterFlag           | H5T_ST<br>D_I8LE   | 2 | (1, numPixel) | Land/Water flag                | Stores the land/water flag.<br>1: Land<br>0: Water                                              | long_name: Land/water flag                                  | -      | 0    | 1    | -128 |
| 10 | landFraction            | H5T_IEE<br>E_F32LE | 2 | (1, numPixel) | Land fraction                  | Stores the percentage of land area within the spatial division.                                 | long_name: Land coverage within each pixel                  | %      | 0    | 100  | -999 |
| 11 | solarZenith             | H5T_IEE<br>E_F32LE | 2 | (1, numPixel) | Solar zenith angle             | Stores the solar zenith angle at the observation point.<br>$0 \leq \text{solarZenith} \leq 180$ | long_name: Solar zenith angle at observation point          | degree | 0    | 180  | -999 |
| 12 | solarAzimuth            | H5T_IEE<br>E_F32LE | 2 | (1, numPixel) | Solar azimuth angle            | Stores the solar azimuth angle at the observation point.<br>$0 \leq \text{solarAzimuth} < 360$  | long_name: Solar azimuth angle at observation point         | degree | 0    | 360  | -999 |

|    |               |                    |   |               |                         |                                                                                                    |                                                         |        |   |     |      |
|----|---------------|--------------------|---|---------------|-------------------------|----------------------------------------------------------------------------------------------------|---------------------------------------------------------|--------|---|-----|------|
| 13 | viewZenith    | H5T_IEE<br>E_F32LE | 2 | (1, numPixel) | Satellite zenith angle  | Stores the satellite zenith angle at the observation point.<br>$0 \leq \text{viewZenith} \leq 180$ | long_name: Satellite zenith angle at observation point  | degree | 0 | 180 | -999 |
| 14 | viewAzimuth   | H5T_IEE<br>E_F32LE | 2 | (1, numPixel) | Satellite azimuth angle | Stores the satellite azimuth angle at the observation point.<br>$0 \leq \text{viewAzimuth} < 360$  | long_name: Satellite azimuth angle at observation point | degree | 0 | 360 | -999 |
| 17 | solarDistance | H5T_IEE<br>E_F32LE | 2 | (1, numPixel) | Solar distance          | Stores the distance between the sun and the observation point at the time of observation.          | long_name: Distance from sun to observation point       | AU     | - | -   | -999 |

## (7) RetrievalResult\_NO2 (Quick-delivery version)

Table 2-11 L2 (NO2) Product Format Details (RetrievalResult\_NO2 (Quick-delivery version))

| No. | Group Path/Dataset Name | Data Type          | Dimension |                  | Name                                                           | Explanation                                                                                                                                                           | Attribute                                       |                |     |     |         |
|-----|-------------------------|--------------------|-----------|------------------|----------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|----------------|-----|-----|---------|
|     |                         |                    | Rank      | Shape            |                                                                |                                                                                                                                                                       | description                                     | Units          | Min | Max | Invalid |
| 0   | /RetrievalResult_NO2    | -                  |           | -                | T3L2NO2 calculation result data                                | -                                                                                                                                                                     | -                                               |                |     |     |         |
| 1   | no2ScdTotal             | H5T_IEE<br>E_F32LE | 2         | (1,<br>numPixel) | NO2 slant column density                                       | Stores the NO2 slant column density. In case of missing data, saturated pixels, or defective pixels, a special value is stored.                                       | long_name:<br>NO2 SCD data                      | molec.<br>/cm2 | -   | -   | -999    |
| 2   | rootMeanSquared Error   | H5T_IEE<br>E_F32LE | 2         | (1,<br>numPixel) | RMSE data                                                      | Stores the RMSE data. In case of missing data, saturated pixels, or defective pixels, a special value is stored.                                                      | long_name:<br>root mean square error data       | molec.<br>/cm2 | -   | -   | -999    |
| 3   | stripeAmplitude         | H5T_IEE<br>E_F32LE | 2         | (1,<br>numPixel) | De-stripe correction                                           | Stores the de-stripe correction. In case of missing data, saturated pixels, or defective pixels, a special value is stored.                                           | long_name:<br>stripe correction term            | molec.<br>/cm2 | -   | -   | -999    |
| 4   | climAmfTotal            | H5T_IEE<br>E_F32LE | 2         | (1,<br>numPixel) | Total AMF calculated using climatology                         | Stores the total AMF calculated using climatology. In case of missing data, saturated pixels, or defective pixels, a special value is stored.                         | long_name:<br>Climatological total amf          | -              | -   | -   | -999    |
| 5   | climAmfTroposphere      | H5T_IEE<br>E_F32LE | 2         | (1,<br>numPixel) | Tropospheric AMF calculated using climatology                  | Stores the tropospheric AMF calculated using climatology. In case of missing data, saturated pixels, or defective pixels, a special value is stored.                  | long_name:<br>Climatological tropospheric amf   | -              | -   | -   | -999    |
| 6   | climNo2VcdTotal         | H5T_IEE<br>E_F32LE | 2         | (1,<br>numPixel) | Total NO2 vertical column density calculated using climatology | Stores the total NO2 vertical column density calculated using climatology. In case of missing data, saturated pixels, or defective pixels, a special value is stored. | long_name:<br>Climatological total NO2 VCD data | molec.<br>/cm2 | -   | -   | -999    |

|    |                             |                    |   |                               |                                                                       |                                                                                                                                                                              |                                                                             |            |   |   |      |
|----|-----------------------------|--------------------|---|-------------------------------|-----------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|------------|---|---|------|
| 7  | climNo2VcdTroposphere       | H5T_IEE<br>E_F32LE | 2 | (1,<br>numPixel)              | Tropospheric NO2 vertical column density calculated using climatology | Stores the tropospheric NO2 vertical column density calculated using climatology. In case of missing data, saturated pixels, or defective pixels, a special value is stored. | long_name: Climatological tropospheric NO2 vcd data                         | molec./cm2 | - | - | -999 |
| 8  | climNo2ScdStratosphereCTM   | H5T_IEE<br>E_F32LE | 2 | (1,<br>numPixel)              | NO2 slant column (stratospheric) data by climatology                  | Stores the NO2 slant column (stratospheric) data by climatology. In case of missing data, saturated pixels, or defective pixels, a special value is stored.                  | long_name: "Climatological stratospheric NO2 slant column density from CTM" | molec./cm2 | - | - | -999 |
| 9  | climAerosolOpticalThickness | H5T_IEE<br>E_F32LE | 2 | (1,<br>numPixel)              | AOD calculated using climatology                                      | Stores the aerosol optical thickness calculated using climatology. In case of missing data, saturated pixels, or defective pixels, a special value is stored.                | long_name: Climatological aerosol optical thickness                         | -          | - | - | -999 |
| 10 | climAerosolType             | H5T_IEE<br>E_F32LE | 2 | (1,<br>numPixel)              | Aerosol type derived using climatology                                | Stores the aerosol type derived using climatology. In case of missing data, saturated pixels, or defective pixels, a special value is stored.                                | long_name: Climatological aerosol type                                      | -          | - | - | -999 |
| 11 | climNo2Profile              | H5T_IEE<br>E_F32LE | 3 | (1,<br>numPixel,<br>numLayer) | NO2 profile by climatology                                            | Stores the NO2 profile by climatology. In case of missing data, saturated pixels, or In case of defective pixels, a special value is stored.                                 | long_name: NO2 profile from climatology                                     | ppb        | - | - | -999 |
| 12 | climTropopauseFlag          | H5T_ST<br>D_I8LE   | 3 | (1,<br>numPixel,<br>numLayer) | Tropopause flag by climatology                                        | Stores the tropopause flag by climatology. In case of missing data, saturated pixels, or defective pixels, a special value is stored.                                        | long_name: tropopause flag from climatology                                 | -          | 0 | 1 | -128 |
| 13 | climAveragingKernel         | H5T_IEE<br>E_F32LE | 3 | (1,<br>numPixel,<br>numLayer) | Averaging kernel by climatology                                       | Stores the averaging kernel by climatology. In case of missing data, saturated pixels, or defective pixels, a special value is stored.                                       | long_name: averaging kernel from climatology                                | -          | - | - | -999 |

|    |                        |                    |   |                         |                                                      |                                                                                                                                                             |                                                                   |            |   |     |      |
|----|------------------------|--------------------|---|-------------------------|------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|------------|---|-----|------|
| 14 | climTemperatureProfile | H5T_IEE<br>E_F32LE | 3 | (1, numPixel, numLayer) | Temperature by climatology                           | Stores the temperature by climatology. In case of missing data, saturated pixels, or defective pixels, a special value is stored.                           | long_name: temperature profile from climatology                   | K          | - | -   | -999 |
| 15 | climPressureProfile    | H5T_IEE<br>E_F32LE | 3 | (1, numPixel, numLayer) | Pressure by climatology                              | Stores the pressure by climatology. In case of missing data, saturated pixels, or defective pixels, a special value is stored.                              | long_name: pressure profile from climatology                      | hPa        | - | -   | -999 |
| 16 | climAmfStratosphere    | H5T_IEE<br>E_F32LE | 2 | (1, numPixel)           | Stratospheric AMF by climatology                     | Stores the stratospheric AMF by climatology. In case of missing data, saturated pixels, or defective pixels, a special value is stored.                     | long_name: "Climatological stratospheric air mass factor"         | -          | - | -   | -999 |
| 17 | climNo2ScdTroposphere  | H5T_IEE<br>E_F32LE | 2 | (1, numPixel)           | Tropospheric NO2 slant column density by climatology | Stores the tropospheric NO2 slant column density by climatology. In case of missing data, saturated pixels, or defective pixels, a special value is stored. | long_name: "Climatological tropospheric NO2 slant column density" | molec./cm2 | - | -   | -999 |
| 18 | preScrIdx              | H5T_STD_I8LE       | 2 | (1, numPixel)           | prescreening result                                  | Stores the prescreening result. In case of missing data, saturated pixels, or defective pixels, a special value is stored.                                  | long_name: Pre-screening index                                    | -          | 0 | 5   | -128 |
| 19 | snowIceFlag            | H5T_STD_I16LE      | 2 | (1, numPixel)           | Snow/ice flag                                        | Stores the snow/ice flag. In case of missing data, saturated pixels, or defective pixels, a special value is stored.                                        | long_name: Snow/ice flag                                          | -          | 0 | 256 | -999 |
| 20 | climSurfaceAlbedo      | H5T_IEE<br>E_F32LE | 2 | (1, numPixel)           | Surface albedo by climatology                        | Stores the surface albedo by climatology. In case of missing data, saturated pixels, or defective pixels, a special value is stored.                        | long_name: Surface albedo from climatology                        | -          | + | -   | -999 |

|    |                   |                    |   |                      |                              |                                                                                                                                           |                                                 |   |   |     |      |
|----|-------------------|--------------------|---|----------------------|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|---|---|-----|------|
| 21 | climWindSpeed     | H5T_IEE<br>E_F32LE | 2 | (1,<br>numPi<br>xel) | Wind speed by<br>climatology | Stores the wind speed by climatology.<br>In case of missing data, saturated<br>pixels, or defective pixels, a special<br>value is stored. | long_name:<br>Wind speed<br>from<br>climatology | - | 0 | 256 | -999 |
| 22 | pixelQualityValue | H5T_IEE<br>E_F32LE | 2 | (1,<br>numPi<br>xel) | Pixel data<br>quality data   | Stores the pixel data quality data.<br>In case of missing data, saturated<br>pixels, or defective pixels, a special<br>value is stored.   | long_name:<br>pixel data<br>quality value       | - | 0 | 1   | -999 |



(8) RetrievalResult=NO2 (Standard version)

Table 2-12 L2 (NO2) Product Format Details (RetrievalResult\_NO2 (Standard version))

| No. | Group Name | Path/Dataset           | Data Type      | Dimension |               | Name                                         | Explanation                                                                                                                         | Attribute                                                  |            |     |     |         |
|-----|------------|------------------------|----------------|-----------|---------------|----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|------------|-----|-----|---------|
|     |            |                        |                | Rank      | Shape         |                                              |                                                                                                                                     | description                                                | Units      | Min | Max | Invalid |
| 0   |            | /RetrievalResult_NO2   | -              |           | -             | T3L2NO2 calculation result data              | -                                                                                                                                   | -                                                          |            |     |     |         |
| 1   |            | no2VcdTroposphere      | H5T_IEEE_F32LE | 2         | (1, numPixel) | NO2 vertical column (tropospheric) data      | Tropospheric NO2 vertical column density In case of missing data, saturated pixels, or defective pixels, a special value is stored. | long_name: tropospheric NO2 vertical column density        | molec./cm2 | -   | -   | -999    |
| 2   |            | amfTroposphere         | H5T_IEEE_F32LE | 2         | (1, numPixel) | AMF data (tropospheric)                      | Tropospheric AMF data In case of missing data, saturated pixels, or defective pixels, a special value is stored.                    | long_name: tropospheric air mass factor                    | -          | -   | -   | -999    |
| 3   |            | no2ScdStratosphere CTM | H5T_IEEE_F32LE | 2         | (1, numPixel) | NO2 slant column (stratospheric) data by CTM | Stratospheric NO2 slant column density In case of missing data, saturated pixels, or defective pixels, a special value is stored.   | long_name: stratospheric NO2 slant column density from CTM | molec./cm2 | -   | -   | -999    |
| 4   |            | amfStratosphere        | H5T_IEEE_F32LE | 2         | (1, numPixel) | AMF data (stratospheric)                     | Stratospheric AMF data In case of missing data, saturated pixels, or defective pixels, a special value is stored.                   | long_name: stratospheric air mass factor                   | -          | -   | -   | -999    |

|    |                          |                |   |               |                                                   |                                                                                                                                                                                                                               |                                                              |            |   |   |      |
|----|--------------------------|----------------|---|---------------|---------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|------------|---|---|------|
| 5  | no2VcdTotal              | H5T_IEEE_F32LE | 2 | (1, numPixel) | Total NO2 vertical column density data            | Total NO2 vertical column density data (= Tropospheric NO2 vertical column density + Stratospheric NO2 vertical column density)<br>In case of missing data, saturated pixels, or defective pixels, a special value is stored. | long_name: tropospheric NO2 vertical column density from CTM | molec./cm2 | - | - | -999 |
| 6  | amfTotal                 | H5T_IEEE_F32LE | 2 | (1, numPixel) | Total AMF data                                    | total AMF data<br>In case of missing data, saturated pixels, or defective pixels, a special value is stored.                                                                                                                  | long_name: total air mass factor data                        | -          | - | - | -999 |
| 7  | no2ScdTotal              | H5T_IEEE_F32LE | 2 | (1, numPixel) | Total NO2 slant column density data               | Total NO2 slant column density data<br>In case of missing data, saturated pixels, or defective pixels, a special value is stored.                                                                                             | long_name: total NO2 slant column density                    | molec./cm2 | - | - | -999 |
| 8  | no2ScdTroposphere        | H5T_IEEE_F32LE | 2 | (1, numPixel) | Tropospheric NO2 slant column density data        | Tropospheric NO2 slant column density data<br>In case of missing data, saturated pixels, or defective pixels, a special value is stored.                                                                                      | long_name: tropospheric NO2 slant column density             | molec./cm2 | - | - | -999 |
| 9  | pixelQualityValue        | H5T_IEEE_F32LE | 2 | (1, numPixel) | Pixel data quality data                           | Pixel data quality data<br>In case of missing data, saturated pixels, or defective pixels, a special value is stored.                                                                                                         | long_name: pixel data quality value                          | -          | 0 | 1 | -999 |
| 10 | rootMeanSquaredError     | H5T_IEEE_F32LE | 2 | (1, numPixel) | RMSE data                                         | RMSE data<br>In case of missing data, saturated pixels, or defective pixels, a special value is stored.                                                                                                                       | long_name: root mean square error data                       | -          | - | - | -999 |
| 11 | no2VcdStratosphere Error | H5T_IEEE_F32LE | 2 | (1, numPixel) | Stratospheric NO2 slant column density error data | Stratospheric NO2 slant column density error data<br>In case of missing data, saturated pixels, or defective pixels, a special value is stored.                                                                               | long_name: stratospheric NO2 slant column density error      | molec./cm2 | - | - | -999 |

|    |                         |                |   |               |                                                     |                                                                                                                                                   |                                      |            |   |     |      |
|----|-------------------------|----------------|---|---------------|-----------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|------------|---|-----|------|
| 12 | airMassFactorError      | H5T_IEEE_F32LE | 2 | (1, numPixel) | AMF error data                                      | AMF error data<br>In case of missing data, saturated pixels, or defective pixels, a special value is stored.                                      | long_name: air mass factor error     | -          | - | -   | -999 |
| 13 | no2VcdTroposphereError  | H5T_IEEE_F32LE | 2 | (1, numPixel) | Tropospheric NO2 vertical column density error data | Tropospheric NO2 vertical column density error data<br>In case of missing data, saturated pixels, or defective pixels, a special value is stored. | long_name: data quality flag         | molec./cm2 | - | -   | -999 |
| 14 | snowIceFlag             | H5T_IEEE_F32LE | 2 | (1, numPixel) | snow/ice flag data                                  | snow/ice flag data<br>In case of missing data, saturated pixels, or defective pixels, a special value is stored.                                  | long_name: snow/ice flag             | -          | 0 | 256 | -999 |
| 15 | aerosolOpticalThickness | H5T_IEEE_F32LE | 2 | (1, numPixel) | Aerosol optical thickness                           | Aerosol optical thickness<br>In case of missing data, saturated pixels, or defective pixels, a special value is stored.                           | long_name: aerosol optical thickness | -          | - | -   | -999 |
| 16 | aerosolLayerHeight      | H5T_IEEE_F32LE | 2 | (1, numPixel) | Aerosol layer altitude                              | Aerosol layer altitude<br>In case of missing data, saturated pixels, or defective pixels, a special value is stored.                              | long_name: aerosol layer height      | hPa        | - | -   | -999 |
| 17 | stripeAmplitude         | H5T_IEEE_F32LE | 2 | (1, numPixel) | De-stripe correction                                | De-stripe correction<br>In case of missing data, saturated pixels, or defective pixels, a special value is stored.                                | long_name: stripe correction term    | molec./cm2 | - | -   | -999 |
| 18 | surfaceAlbedo           | H5T_IEEE_F32LE | 2 | (1, numPixel) | Surface albedo                                      | Surface albedo<br>In case of missing data, saturated pixels, or defective pixels, a special value is stored.                                      | long_name: surface albedo            | -          | 0 | 1   | -999 |
| 19 | preScrIdx               | H5T_STD_I8LE   | 2 | (1, numPixel) | prescreening result                                 | Prescreening result<br>In case of missing data, saturated pixels, or defective pixels, a special value is stored.                                 | long_name: pre-screening index       | -          | 0 | 5   | -128 |

|    |                       |                |   |                         |                             |                                                                                                                           |                                            |            |   |   |      |
|----|-----------------------|----------------|---|-------------------------|-----------------------------|---------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|------------|---|---|------|
| 20 | no2ProfileCTM         | H5T_IEEE_F32LE | 2 | (1, numPixel, numLayer) | NO2 profile by CTM          | NO2 profile by CTM<br>In case of missing data, saturated pixels, or defective pixels, a special value is stored.          | long_name: NO2 profile from CTM            | ppb        | - | - | -999 |
| 21 | tropopauseFlagCTM     | H5T_STD_I8LE   | 2 | (1, numPixel, numLayer) | Tropopause flag by CTM      | Tropopause flag by CTM<br>In case of missing data, saturated pixels, or defective pixels, a special value is stored.      | long_name: tropopause flag from CTM        | -          | 0 | 1 | -128 |
| 22 | averagingKernel       | H5T_IEEE_F32LE | 2 | (1, numPixel, numLayer) | Averaging kernel            | Averaging kernel<br>In case of missing data, saturated pixels, or defective pixels, a special value is stored.            | long_name: averaging kernel                | -          | - | - | -999 |
| 23 | biasCorrectionFactor  | H5T_IEEE_F32LE | 2 | (1, numPixel)           | Bias correction term by CTM | Bias correction term by CTM<br>In case of missing data, saturated pixels, or defective pixels, a special value is stored. | long_name: bias correction factor from CTM | molec./cm2 | - | - | -999 |
| 24 | temperatureProfileCTM | H5T_IEEE_F32LE | 2 | (1, numPixel, numLayer) | Temperature by CTM          | Temperature by CTM<br>In case of missing data, saturated pixels, or defective pixels, a special value is stored.          | long_name: temperature profile from CTM    | K          | - | - | -999 |
| 25 | pressureProfileCTM    | H5T_IEEE_F32LE | 2 | (1, numPixel, numLayer) | Pressure by CTM             | Pressure by CTM<br>In case of missing data, saturated pixels, or defective pixels, a special value is stored.             | long_name: pressure profile from CTM       | hPa        | - | - | -999 |
| 26 | cloudLayerHeight      | H5T_IEEE_F32LE | 2 | (1, numPixel)           | Cloud altitude data         | Cloud altitude data<br>In case of missing data, saturated pixels, or defective pixels, a special value is stored.         | long_name: Cloud layer height              | hPa        | - | - | -999 |

|    |                           |                    |   |                      |                            |                                                                                                                                                                                                                                                                                   |                                             |     |   |    |      |
|----|---------------------------|--------------------|---|----------------------|----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|-----|---|----|------|
| 27 | cloudOpticalThickn<br>ess | H5T_IEEE<br>_F32LE | 2 | (1,<br>numPi<br>xel) | Cloud optical<br>thickness | Cloud optical thickness<br>In case of missing data, saturated<br>pixels, or defective pixels, a special<br>value is stored.                                                                                                                                                       | long_name;<br>Cloud<br>optical<br>thickness | -   | 0 | 99 | -999 |
| 28 | aerosolType               | H5T_STD<br>_I8LE   | 2 | (1,<br>numPi<br>xel) | Aerosol type               | Aerosol type<br>6: (MA, MX)<br>7: (MA, DU)<br>8: (MA, NA)<br>9: (MA, NC)<br>15: (MX, DU)<br>16: (MX, NA)<br>17: (MX, NC)<br>18: (DU, NA)<br>19: (DU, NC)<br>20: (NA, NC)<br>MA: Moderately-absorbing,<br>MX: Mixture, DU: Dust,<br>NA: Non-absorbing, NC: Non-<br>absorbing-coast | long_name;<br>Aerosol type                  | -   | 0 | 99 | -128 |
| 29 | windSpeed                 | H5T_IEEE<br>_F32LE | 2 | (1,<br>numPi<br>xel) | Wind speed                 | Wind speed                                                                                                                                                                                                                                                                        | long_name;<br>Wind speed                    | w/s | 0 | 99 | -999 |

(9) Dimension

Table 2-13 L2 (NO2) Product Format Details (Dimension)

| No. | Group Path/Dataset Name | Dimension |             | Data Type      | Name                        | Explanation                                                     | Attribute                                    |       |     |           |         |
|-----|-------------------------|-----------|-------------|----------------|-----------------------------|-----------------------------------------------------------------|----------------------------------------------|-------|-----|-----------|---------|
|     |                         | Rank      | Shape       |                |                             |                                                                 | description                                  | Units | Min | Max       | Invalid |
| 1   | Band                    | 1         | numBand     | H5T_IEEE_F32LE | Band                        | Number of bands =3 (Fixed)                                      | TANSO-3 bands                                | N/A   | 0   | 0         | N/A     |
| 2   | numBand                 | 0         | scalar      | H5T_STD_I8LE   | Number of bands             | Stores the number of bands.                                     | Number of TANSO-3 bands                      |       | 3   | 3         | N/A     |
| 3   | Frame                   | 1         | numFrame    | H5T_IEEE_F32LE | Frame                       | Number of frames.                                               | Frames in the product file                   | N/A   | 0   | 0         | N/A     |
| 4   | numFrame                | 0         | scalar      | H5T_STD_I32LE  | Number of frames            | Stores the number of frames included in the product file.       | Number of frames in the product file         | N/A   | 0   | 99,999    | -999    |
| 5   | Layer                   | 1         | numLayer    | H5T_IEEE_F32LE | Retrieval layer             | Number of vertical layers                                       | Vertical layers                              | N/A   | 0   | 0         | N/A     |
| 6   | numLayer                | 0         | scalar      | H5T_STD_I8LE   | Number of retrieval layers  | Stores the number of vertical layers.                           | Number of vertical layers                    | N/A   | 15  | 15        | -128    |
| 7   | L1bfile                 | 1         | l1bfileNum  | H5T_IEEE_F32LE | L1B product file            | Number of L1B product files                                     | L1B product file                             | N/A   | 0   | 0         | N/A     |
| 8   | numL1bfile              | 0         | scalar      | H5T_STD_I8LE   | Number of L1B product files | Stores the number of L1B product files used for creation.       | Number of L1B product file                   | N/A   | 0   | 99        | -128    |
| 9   | Pixel                   | 1         | numPixel    | H5T_IEEE_F32LE | Spatial division            | Number of spatial divisions                                     | Spatial pixels in the product file           | N/A   | 0   | 0         | N/A     |
| 10  | numPixel                | 0         | scalar      | H5T_STD_I32LE  | Number of spatial divisions | Stores the number of spatial divisions included in the product. | Number of spatial pixels in the product file | N/A   | 0   | 9,999,999 | -999    |
| 11  | Sounding                | 1         | numSounding | H5T_IEEE_F32LE | Observation ID              | Number of observation IDs                                       | Number of observation Id in the product file | N/A   | 0   | 0         | N/A     |
| 12  | numSounding             | 0         | scalar      | H5T_STD_I32LE  | Number of observation IDs   | Stores the number of observation IDs contained in the product.  | Number of observation Id in the product file | N/A   | 0   | 9,999     | -999    |

|    |           |   |           |                |                                  |                                              |                                       |     |   |    |      |
|----|-----------|---|-----------|----------------|----------------------------------|----------------------------------------------|---------------------------------------|-----|---|----|------|
| 13 | Column    | 1 | numColumn | H5T_IEEE_F32LE | Across-track divisions           | Number of across-track divisions             | Number of across-track spatital pixel | N/A | 0 | 0  | N/A  |
| 14 | numColumn | 0 | scalar    | H5T_STD_I8LE   | Number of across-track divisions | Stores the number of across-track divisions. | Number of across-track spatital pixel | N/A | 0 | 96 | -128 |
| 15 | Time      | 1 | numTime   | H5T_IEEE_F32LE | Time direction                   | Dummy axis for data shaping                  |                                       | N/A | 0 | 0  | N/A  |
| 16 | numTime   | 0 | scalar    | H5T_STD_I8LE   | Number of time directions        | Dummy axis for data shaping.                 |                                       | N/A | 0 | 96 | -128 |

## 2.3. Level 2 Processing Result (NO2)

### 2.3.1. Outline

The Level 2 Processing Result (NO2) is an XML format (.xml) file that stores the processing results (product information) from the creation of the TANSO-3 L2 (NO2) Product.

### 2.3.2. File provision unit

The Level 2 Processing Result (NO2) is a standard product. When providing an L2 (NO2) Product that meets the conditions specified by the user (observation period, observation range, etc.) via G3DPS, this file is also provided. It is stored in an XML format (.xml) file.

The following file provision units are used for each mode of the Standard and Quick-delivery versions.

Table 2-14 L2 Processing Result (NO2) File Provision Unit

| Type                                      | Provision unit | Data size (KB/file) |
|-------------------------------------------|----------------|---------------------|
| Standard Wide Mode                        | One day        | 10                  |
| Standard Focus Mode (1km /2km/3km)        | Scene          | 7 / 7 / 6           |
| Quick-delilvery Focus Mode (1km /2km/3km) | Scene          | 7 / 7 / 6           |

\* Data size is the maximum value without file splitting or compression.

\* The file provision unit for reprocessing is the same as for the Standard version.

\* Files for test processing and unplanned processing are omitted as they are not subject to provision.

\* The file storage unit is the same as for the TANSO-3 L2 Product.<sup>1</sup>

### 2.3.3. Version definition

The version of the Level 2 Processing Result (NO2) file itself is not defined.

The version information of the L2 (NO2) Product that stores the processing results is stored in the file name for both the product version and the input dataset version.

- MMNNRR: Product version (Major, Minor, Revision)
- 0000: Input dataset version

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<sup>1</sup> For the file storage unit of the TANSO-3 L2 Product, see Section 2.2.2.



#### **2.3.4. File format details**

The file format of the Level 2 Processing Result (NO<sub>2</sub>) is shown in Table 2-15.

Table 2-15 Level 2 Processing Result (NO2) File Format Details

| Level 2 Processing Result (NO2) File (XML) Format Details (Draft) |                    |                                 |                                                                                                                                                                                                                                                                                                                                             | Remarks                                                       |
|-------------------------------------------------------------------|--------------------|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------|
| Tag name                                                          | Number of elements | Name                            | Explanation                                                                                                                                                                                                                                                                                                                                 |                                                               |
| L2Result_NO2                                                      | 1                  | Level 2 Processing Result (NO2) |                                                                                                                                                                                                                                                                                                                                             | The namespace is not specified in the processing result file. |
| MetaData                                                          | 1                  | Metadata                        |                                                                                                                                                                                                                                                                                                                                             | The L2 (NO2) Product also includes the same information.      |
| processResult                                                     | 1                  | Processing Result               | Stores the result of the Level 2 Processing (NO2) with the following values. An abnormal end is recorded only when processing fails for all input data.<br>"OK": Normal end<br>"NG": Abnormal end                                                                                                                                           |                                                               |
| granuleID                                                         | 1                  | Granule ID                      | Stores the granule ID.                                                                                                                                                                                                                                                                                                                      | Granule ID of the L2 (NO2) Product.                           |
| satelliteName                                                     | 1                  | Satellite name                  | Stores the satellite name.<br>"GOSAT-GW" Fixed                                                                                                                                                                                                                                                                                              |                                                               |
| sensorName                                                        | 1                  | Sensor name                     | Stores the sensor name. "TANSO-3" Fixed                                                                                                                                                                                                                                                                                                     |                                                               |
| observationStartDateTime                                          | 1                  | Observation start time          | Stores the observation time of the first frame (UT) in the format "YYYY-MM-DDThh:mm:ss.ffffffZ". Stores the earliest time from the observation start times for each L1B product, obsStartDateTime, described later.<br>If the product creation fails and the observation start date and time cannot be obtained, an empty string is stored. |                                                               |
| observationEndDateTime                                            | 1                  | Observation end time            | Stores the observation time of the last frame (UT) in the format "YYYY-MM-DDThh:mm:ss.ffffffZ". Stores the latest time from the observation end times obsEndDateTime for each L1B product, described later.<br>If the product creation fails and the observation end date and time cannot be obtained, an empty string is stored.           |                                                               |
| productionDateTime                                                | 1                  | Processing date/time            | Stores the processing date/time (UT) in the format "YYYY-MM-DDThh:mm:ss.ffffffZ".<br>If the product creation fails and the processing date and time                                                                                                                                                                                         |                                                               |

|                      |   |                          |                                                                                                                                                                                                                                                            |                                                                                 |
|----------------------|---|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|
|                      |   |                          | cannot be obtained, an empty string is stored.                                                                                                                                                                                                             |                                                                                 |
| processingLevel      | 1 | Processing level         | Stores the processing level.<br>"Level2" Fixed                                                                                                                                                                                                             |                                                                                 |
| productType          | 1 | Product type             | Stores the product type as either "Monthly" or "Quick-Delivery".                                                                                                                                                                                           |                                                                                 |
| parameterVersion     | 1 | Input dataset version    | Stores the input dataset version ('mo00' in the file name).                                                                                                                                                                                                |                                                                                 |
| algorithmVersion     | 1 | Product version          | Stores the processor version managed by a separately defined ATBD, etc.                                                                                                                                                                                    |                                                                                 |
| Observation          | N |                          | Stores the processing result for each L1B product, with the same number of entries as the number of L1B products specified in the L2 processing plan.                                                                                                      |                                                                                 |
| L1 granuleID         | 1 | L1 product granule ID    | Stores the granule ID of the input L1 product.                                                                                                                                                                                                             | For information on each observation ID, refer to the L1 processing result file. |
| observationRequestID | 1 | Observation request ID   | Stores the observation request ID.                                                                                                                                                                                                                         |                                                                                 |
| pathNo               | 1 | Path number              | Stores the path number (1 to 44) without 0 padding.                                                                                                                                                                                                        |                                                                                 |
| obsStartDateTime     | 1 | Observation start time   | Stores the observation time of the first frame (UT) in the format "YYYY-MM-DDThh:mm:ss.ffffffZ".                                                                                                                                                           |                                                                                 |
| obsEndDateTime       | 1 | Observation end time     | Stores the observation time of the last frame (UT) in the format "YYYY-MM-DDThh:mm:ss.ffffffZ".                                                                                                                                                            |                                                                                 |
| geospatial_bounds    | 1 | Observation range on map | Stores the latitude/longitude range in the OGC Well-Known Text (WKT) Geometry format.<br>Latitude and longitude values are stored with 2 decimal places, without 0 padding. Stored only for fine products.<br>An empty value is stored for other products. |                                                                                 |

## 2.4. Level 2 Plot Image (NO2)

### 2.4.1. Outline

The Level 2 Plot Image (NO2) is an image generated based on the TANSO-3 L2 (NO2) Product, displaying the total NO2 slant column density.

### 2.4.2. File provision unit

The Level 2 Plot Image (NO2) is a standard product. Products that meet the conditions specified by the user (observation period, observation range, etc.) are provided via G3DPS in PNG format (.png) files.

The following file provision units are used for each mode of the Standard and Quick-delivery versions.

Table 2-16 Level 2 Plot Image (NO2) File Provision Unit

| Type                      | Provision unit | Data size (MB/file) |
|---------------------------|----------------|---------------------|
| Standard Wide Mode        | One day        | -                   |
| Standard Focus Mode       | Scene          | -                   |
| Quick-delivery Focus Mode | Scene          | 1                   |

\* Data size is the maximum value without file splitting or compression.

\* Files for reprocessing, test processing, and unplanned processing are omitted as they are not subject to provision.

\* The file storage unit is the same as for the TANSO-3 L2 Product<sup>2</sup>.

### 2.4.3. Version information

The version of the Level 2 Plot Image (NO2) file itself is not defined. The version information of the L2 (NO2) Product that is the basis for the image is stored in the file name for both the product version and the input dataset version.

- MMNNRR: Product version (Major, Minor, Revision)
- mooo: Input dataset version

### 2.4.4. File format details

The Level 2 Plot Image (NO2) illustrates the total NO2 slant column density for the Quick-delivery version, and the tropospheric NO2 vertical column density for the Standard version (units are molec. cm<sup>-2</sup> for each), respectively.

The drawing range and file format are summarized below.

- Drawing range: Longitude -180 to 180 degrees, Latitude -90 to 90 degrees
- File format: PNG (.png)
- Resolution: 200 (dpi)
- File size: Approx. 400 kB

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<sup>2</sup> For the file storage unit of the TANSO-3 L2 Product, see Section 2.2.2.