Sentinel-5 precursor/TROPOMI
Level 2 Product User Manual
Cloud Properties
## Document approval record

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1 Introduction

1.1 Identification

This document, identified as S5P-L2-DLR-PUM-400I, describes the technical characteristics of the S5p/TROPOMI Level 2 products that are needed for efficient and correct use of the data contained. This product user manual is specific for Cloud.

1.2 Purpose and objective

The Sentinel-5 Precursor (S5p) mission is a low Earth orbit polar satellite system to provide information and services on air quality, climate and the ozone layer. The S5p mission is part of the Global Monitoring of the Environment and Security (GMES/COPERNICUS) space component programme. The S5p mission consists of a satellite bus, the payload consisting of the TROPOspheric Monitoring Instrument (TROPOMI), and a ground system. A journal paper describing the mission and its objectives can be found in [RD1], while a comprehensive description of the mission can be found in [RD2]. Furthermore, various websites are maintained with S5p/TROPOMI information, e.g. [ER1, ER2].

From the data collected by the TROPOMI instrument, a number of geophysical (L2) products are derived. The algorithms for the raw data treatment (L0 – L1b) and the actual L2 data processing are each described in an algorithm theoretical basis document (ATBD). This Product User Manual (PUM) describes the technical characteristics of the S5p/TROPOMI Level 2 geophysical data products that are needed for efficient and correct use of the data contained.

In the PUM, the common structure of the datafiles and metadata used in all the delivered L2 products as well as a specific section related to the Cloud product are described.

1.3 Document overview

We start with a summary of the S5p L2 products and information needed to obtain and inspect data, as well as how to obtain product support. The Cloud data product is described next, with examples, and information about the use of the data. Format, L2 structure and metadata are addressed in the next chapter, followed by the detailed description of the Cloud data. We then continue with a discussion of units and quality assurance parameters. The final chapter contains information about generic metadata and the Appendix lists measurement flags, processing quality flags, and surface classifications.
2 Applicable and reference documents

2.1 Applicable documents

source: ESA/ESTEC; ref: S5P-TN-ESA-GS-106; issue: 2.2; date: 2015-02-20.

2.2 Standard documents

There are no standard documents

2.3 Reference documents


[RD2] Input/output data specification for the TROPOMI L01b data processor.  
source: KNMI; ref: S5P-KNMI-L01B-0012-SD; issue: 5.0.0; date: 2015-09-22.

source: DLR; ref: S5P-DLR-L2-ATBD-400I; issue: 2.1.0; date: 2020-02-28.

[RD4] SSP-NPP Cloud Processor ATBD.  
source: RAL Space; ref: S5P-NPPC-RAL-ATBD-0001; issue: 0.11.0; date: 2014-05-15.

[RD5] SSP/TROPOMI HCHO ATBD.  
source: BIRA; ref: S5P-BIRA-L2-400F-ATBD; issue: 2.1.0; date: 2020-02-28.

source: DLR; ref: S5P-L2-DLR-PUM-400F; issue: 2.1.0; date: 2020-02-28.

[RD7] SSP/TROPOMI SO₂ ATBD.  
source: BIRA; ref: S5P-BIRA-L2-400E-ATBD; issue: 2.1.0; date: 2020-02-28.

source: DLR; ref: S5P-L2-DLR-PUM-400E; issue: 2.1.0; date: 2020-02-28.

[RD9] SSP/TROPOMI Total ozone ATBD.  
source: DLR/BIRA; ref: S5P-L2-DLR-ATBD-400A; issue: 2.1.0; date: 2020-02-28.

source: DLR; ref: S5P-L2-DLR-PUM-400A; issue: 2.1.0; date: 2020-02-28.

source: DLR/IUP; ref: S5P-DLR-IUP-L2-400C; issue: 2.1.0; date: 2020-02-28.

source: DLR; ref: S5P-L2-DLR-PUM-400C; issue: 2.1.0; date: 2020-02-28.

[RD13] TROPOMI ATBD of the Aerosol Layer Height product.  
source: KNMI; ref: S5P-KNMI-L2-0006-RP; issue: 1.0.1; date: 2019-06-24.

source: KNMI; ref: S5P-KNMI-L2-0022-MA; issue: 0.0.2dr; date: 2014-10-16.

[RD15] TROPOMI ATBD of the UV aerosol index.  
source: KNMI; ref: S5P-KNMI-L2-0008-RP; issue: 1.0.0; date: 2016-02-03.

source: KNMI; ref: S5P-KNMI-L2-0026-MA; issue: 0.0.2dr; date: 2014-10-16.
[RD17] TROPOMI ATBD Ozone profile and tropospheric profile.

**source:** KNMI; **ref:** S5P-KNMI-L2-0004-RP; **issue:** 0.13.0; **date:** 2015-09-15.


**source:** KNMI; **ref:** S5P-KNMI-L2-0020-MA; **issue:** 0.0.2dr; **date:** 2014-10-16.

[RD19] TROPOMI ATBD of the total and tropospheric NO\textsubscript{2} data products.

**source:** KNMI; **ref:** S5P-KNMI-L2-0005-RP; **issue:** 1.0.0; **date:** 2016-02-05.


**source:** KNMI; **ref:** S5P-KNMI-L2-0021-MA; **issue:** 0.0.2dr; **date:** 2014-10-16.


**source:** SRON; **ref:** SRON-S5P-LEV2-RP-002; **issue:** 1.0.0; **date:** 2016-02-05.


**source:** SRON/KNMI; **ref:** SRON-S5P-LEV2-MA-002; **issue:** 0.0.2dr; **date:** 2014-10-16.


**source:** SRON; **ref:** SRON-S5P-LEV2-RP-001; **issue:** 1.0.0; **date:** 2016-02-05.


**source:** SRON/KNMI; **ref:** SRON-S5P-LEV2-MA-001; **issue:** 0.0.2dr; **date:** 2014-10-16.


**source:** ESA/ESTEC; **ref:** S5P-TN-ESA-GS-106; **issue:** 2.2; **date:** 2015-02-20.


**source:** ESA/ESTEC; **ref:** PE-TN-ESA-GS-0001; **issue:** 2.0; **date:** 2012-05-03.


**source:** ISO; **ref:** ISO 19115:2003(E); **issue:** 1; **date:** 2003-05-01.


**source:** ISO; **ref:** ISO 19115-2:2009(E); **issue:** 1; **date:** 2009-02-12.


**source:** ISO; **ref:** ISO 19157; **issue:** 1; **date:** 2013-10-10.


**source:** Open Geospatial Consortium; **ref:** OGC 10-157r3; **issue:** 1.0; **date:** 2012-06-12.

[RD31] Data Standards Requirements for CCI Data Producers.

**source:** ESA; **ref:** CCI-PRGM-EOPS-TN-13-0009; **issue:** 1.1; **date:** 2013-05-24.


**source:** KNMI; **ref:** S5P-KNMI-L01B-0014-SD; **issue:** 2.0.0; **date:** 2014-12-09.

[RD33] Sentinel-4 UVN Phase B2, C/D and support to phase E1 – Level 0 to Level 1b data processing software Input/Output Data Specification (IODS): Level 1b output products and metadata contents and format.

**source:** ESA/ESTEC; **ref:** S4.ESA.UVN.TN.1206; **issue:** 1.0; **date:** 2011-06-23.

[RD34] Algorithm theoretical basis document for the TROPOMI L01b data processor.

**source:** KNMI; **ref:** S5P-KNMI-L01B-0009-SD; **issue:** 6.0.0; **date:** 2015-09-22.


**source:** ISO; **ref:** ISO 8601:2004(E); **issue:** 3; **date:** 2004-12-01.

\textbf{source:} EC; \textbf{ref:} Commission Regulation (EC) No 1205/2008; \textbf{date:} 2008-12-03.

\textbf{source:} EC JRC; \textbf{ref:} MD_IR_and_ISO_v1_2_20100616; \textbf{issue:} 1.2; \textbf{date:} 2010-06-16.

\textbf{source:} ISO; \textbf{ref:} ISO 19156:2011(E); \textbf{date:} 2011-12-20.

\textbf{source:} ISO; \textbf{ref:} ISO 19139:2007(E); \textbf{issue:} 1; \textbf{date:} 2010-12-13.

\textbf{source:} OGC; \textbf{ref:} OGC 10-025r1; \textbf{issue:} 2.0; \textbf{date:} 2011-03-22.

\textbf{source:} Open Geospatial Consortium; \textbf{ref:} OGC 10-025r1; \textbf{issue:} 2.0; \textbf{date:} 2011-03-22.

\textbf{source:} DLR-IMF; \textbf{ref:} S5P-L2-DR-LIODD-3002; \textbf{issue:} 3.6.0; \textbf{date:} 2020-02-28.

[RD44] SSP-NPP Cloud Processor IODD.  
\textbf{source:} RAL; \textbf{ref:} SSP-NPPC-RAL-IODD-0001; \textbf{issue:} 0.10.0; \textbf{date:} 2014-05-28.


2.4 Electronic references


3 Terms, definitions and abbreviated terms

Terms, definitions, and abbreviated terms that are specific for this document can be found below.

3.1 Terms and definitions

- ATBD: Algorithm Theoretical Basis Document
- TBA: To be Added
- TBC: To be Confirmed
- TBD: To be Defined

3.2 Acronyms and Abbreviations

- ATBD: Algorithm Theoretical Basis Document
- DLR: Deutsches Zentrum für Luft- und Raumfahrt
- ESA: European Space Agency
- KNMI: Koninklijk Nederlands Meteorologisch Instituut
- IODD: Input Output Data Definition
- OCRA: Optical Cloud Recognition Algorithm
- ROCINN: Retrieval of Cloud Information using Neural Networks
- QA: Quality Assurance
- UPAS: Universal Processor for UV/VIS Atmospheric Spectrometers

4 Overview of the Sentinel 5 precursor/TROPOMI Level 2 Products

The Sentinel 5 Precursor mission aims at providing information and services on air quality and climate in the timeframe 2017–2023. The S5p mission is part of the Global Monitoring of the European Programme for the establishment of a European capacity for Earth Observation (COPERNICUS). TROPOMI will make daily global observations of key atmospheric constituents, including ozone, nitrogen dioxide, sulfur dioxide, carbon monoxide, methane, formaldehyde as well as cloud and aerosol properties. The list of standard S5p/TROPOMI L2 products is given in Table 1. Other products, such as UV index, are under development and will be made available at a later date.

Table 1: Standard S5P L2 products with name, identifier, and responsible institutes.

<table>
<thead>
<tr>
<th>Product</th>
<th>ATBD</th>
<th>PUM</th>
<th>Identifier</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cloud</td>
<td>[RD3]</td>
<td>This document</td>
<td>L2__CLOUD_</td>
<td>DLR</td>
</tr>
<tr>
<td>NPP-VIIRS Clouds</td>
<td>[RD4]</td>
<td>[RD4]</td>
<td>L2__NP_BDx</td>
<td>RAL</td>
</tr>
<tr>
<td>HCHO</td>
<td>[RD5]</td>
<td>[RD6]</td>
<td>L2__HCHO_</td>
<td>BIRA/DR</td>
</tr>
<tr>
<td>SO₂</td>
<td>[RD7]</td>
<td>[RD8]</td>
<td>L2__SO2_</td>
<td>BIRA/DR</td>
</tr>
<tr>
<td>O₃ Total Column</td>
<td>[RD9]</td>
<td>[RD10]</td>
<td>L2__O3_</td>
<td>BIRA/DR</td>
</tr>
<tr>
<td>O₃ Tropospheric Column</td>
<td>[RD11]</td>
<td>[RD12]</td>
<td>L2__O3_TCL</td>
<td>IUP/DR</td>
</tr>
<tr>
<td>Aerosol layer height</td>
<td>[RD13]</td>
<td>[RD14]</td>
<td>L2__AER_LH</td>
<td>KNMI</td>
</tr>
<tr>
<td>Ultra violet aerosol index</td>
<td>[RD15]</td>
<td>[RD16]</td>
<td>L2__AER_AI</td>
<td>KNMI</td>
</tr>
<tr>
<td>O₃ Full Profile</td>
<td>[RD17]</td>
<td>[RD18]</td>
<td>L2__O3_PR</td>
<td>KNMI</td>
</tr>
<tr>
<td>O₃ Tropospheric Profile</td>
<td>[RD17]</td>
<td>[RD18]</td>
<td>L2__O3_TPR</td>
<td>KNMI</td>
</tr>
<tr>
<td>NO₂</td>
<td>[RD19]</td>
<td>[RD20]</td>
<td>L2__NO2_</td>
<td>KNMI</td>
</tr>
<tr>
<td>CO</td>
<td>[RD21]</td>
<td>[RD22]</td>
<td>L2__CO_</td>
<td>SRON/KNMI</td>
</tr>
<tr>
<td>CH₄</td>
<td>[RD23]</td>
<td>[RD24]</td>
<td>L2__CH4_</td>
<td>SRON/KNMI</td>
</tr>
</tbody>
</table>
4.1 File name convention

The table specifies an identifier that is a substring of real name. The complete filename conventions for all the S5p products can be found in [RD25, chapter 4]. Note that intermediate L2 products beside those listed in table 1 may exist within the PDGS framework. For each of the products listed in the table, a PUM is available. Note that product documentation, e.g. ATBDs and PUMs, will be updated with new releases of processors. User documentation is distributed through the tropomi website [ER1]. Information about S5p mission can be found at the official ESA website for the Sentinel 5 precursor mission [ER2].

In the current PUM the Cloud product is described and an example of the full real name is as following: S5P\_NRTI\_L2\_CLOUD\__20140101T000000_20140102T000000_00099_01_000200_20141010T173511.nc

The components of this file name are given in table 2

Table 2: Components of an S5p product file name. Components are separated by underscores, except for the file extension at the end, which is separated by a period. Character indices start counting at 0, the end-index is a Python style index, it lists the first character not in the block.

<table>
<thead>
<tr>
<th>Start</th>
<th>End</th>
<th>Length</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>3</td>
<td>3</td>
<td>Mission name, always “S5P”</td>
</tr>
<tr>
<td>4</td>
<td>8</td>
<td>4</td>
<td>Processing stream, one of “NRTI” (near real-time), “OFFL” (offline) or “RPRO” (reprocessing)</td>
</tr>
<tr>
<td>9</td>
<td>19</td>
<td>10</td>
<td>Product identifier, as listed in table 1</td>
</tr>
<tr>
<td>20</td>
<td>35</td>
<td>15</td>
<td>Start of granule in UTC as “YYYYMMDDTHHmmss”. The “T” is a fixed character.</td>
</tr>
<tr>
<td>36</td>
<td>51</td>
<td>15</td>
<td>End of the granule in UTC as “YYYYMMDDTHHmmss”. The “T” is a fixed character.</td>
</tr>
<tr>
<td>52</td>
<td>57</td>
<td>5</td>
<td>Orbit number</td>
</tr>
<tr>
<td>58</td>
<td>60</td>
<td>2</td>
<td>Collection number</td>
</tr>
<tr>
<td>61</td>
<td>67</td>
<td>6</td>
<td>Processor version number as “MMmmpp”, with “MM” the major version number, “mm” the minor version number, and ”pp” the patch level.</td>
</tr>
<tr>
<td>68</td>
<td>83</td>
<td>15</td>
<td>The time of processing for this granule in UTC as “YYYYMMDDTHHmmss”. The “T” is a fixed character.</td>
</tr>
<tr>
<td>84</td>
<td>86</td>
<td>2</td>
<td>The file name extension. All Sentinel 5 precursor files are netCDF-4 files and use the extension “.nc”</td>
</tr>
</tbody>
</table>

5 Data Distribution and Product Support

The S5P/TROPOMI data is available via the ESA Copernicus Open Access Hub (https://scihub.copernicus.eu/) in the ‘Sentinel-5P Pre-Operations Hub’ (https://s5phub.copernicus.eu/dhus/home)

6 General Reader and Visualisation Tools

For reading and visualising you may find Panoply [ER3] a useful tool. Panoply is a cross-platform application that plots geo-gridded and other arrays from netCDF, HDF, GRIB, and other datasets, including the Sentinel 5 precursor Level 2 datafiles. With Panoply 4 you can:

- Slice and plot geo-gridded latitude-longitude, latitude-vertical, longitude-vertical, or time-latitude arrays from larger multidimensional variables.
- Slice and plot “generic” 2D arrays from larger multidimensional variables.
- Slice 1D arrays from larger multidimensional variables and create line plots.
- Combine two geo-gridded arrays in one plot by differencing, summing or averaging.
- Plot lon-lat data on a global or regional map using any of over 100 map projections or make a zonal average line plot.
- Overlay continent outlines or masks on lon-lat map plots.
- Use any of numerous color tables for the scale colorbar, or apply your own custom ACT, CPT, or RGB color table.
- Save plots to disk GIF, JPEG, PNG or TIFF bitmap images or as PDF or PostScript graphics files.
Figure 1: Panoply

- Export lon-lat map plots in KMZ format.
- Export animations as AVI or MOV video or as a collection of invididual frame images.
7 S5p/TROPOMI L2 Cloud Product Description

ROCINN algorithms have been employed as cloud retrieval algorithms based on measurements in and around the O\textsubscript{2} A-band at 760 nm for the GOME-family of sensors. These are all based on the Independent Pixel Approximation (IPA), which is the assumption that the “radiative properties of a single satellite “Pixel” are considered in isolation from neighbouring pixels” (definition of the American Meteorological Society). The IPA allows for the application of pseudo-spherical radiative transfer (RT) model in the forward simulation of cloud-contaminated atmospheric scenarios. The ROCINN algorithm is also based on O\textsubscript{2} A-band measurements, and is currently being used in the operational GOME and GOME-2 products. ROCINN 2.0 retrieves as primary quantities the cloud height and cloud albedo. The broad-band polarization measurements from GOME, SCIAMACHY and GOME-2 are used for computing cloud fraction, see for example OCRA which is also based on the IPA. In OCRA, optical sensor measurements are divided into two components: a cloud-free background and a contribution attributed to clouds. OCRA was first developed for GOME in the late 1990s, when enough data from the three sub-pixel broad-band PMDs (Polarization Measurement Devices) had accumulated to allow for the construction of the global cloud-free composite which is the key element in the algorithm. Over the course of the 16-year GOME record, the algorithm was refined and the cloud-free composite adjusted as more data became available. OCRA has also been applied to SCIAMACHY and GOME-2. Initial cloud-free composites for these sensors were based on GOME data before dedicated measurements became available from SCIAMACHY and GOME-2. For S5p, the initial cloud-free composite is based on GOME-2 and OMI (see [RD3], chapter 5.2).

ROCINN is based on the comparison of measured and simulated satellite sun-normalized radiances in and near the O\textsubscript{2} A-band, and it uses a neural network algorithm to retrieve cloud height and cloud albedo. ROCINN accepts the cloud fraction from OCRA as an input and retrieves the rest of the cloud parameters. Early versions of ROCINN used a transmittance model to compute simulated radiances, but the latest versions are based on the use of the VLIDORT radiative transfer scattering model. For GOME and GOME-2, ROCINN Version 2.0 is the current operational algorithm in the GDP [GOME Data Processor]. This version is based on the assumption that clouds are simple Lambertian reflecting surfaces, so that the two main retrieval products are the cloud height and the cloud albedo. This is the “Clouds-as-Reflecting-Boundaries” (CRB) model. Later, ROCINN has been updated to Version 3.0, in which the Tikhonov regularization technique was introduced for the solution of the inverse RT equation. For TROPOMI/S5p, we use ROCINN Version 4.0, which is based on a more realistic treatment of clouds as optically uniform layers of light-scattering particles (water droplets). This is the “Clouds-As-Layers” (CAL) model – here, the two main retrieval products are the cloud-top height and the cloud optical thickness. Although the CAL model will be the default for S5p, it has been requested that the CRB method should also be retained as an option. CAL is the preferred method for the relatively small TROPOMI/S5p ground pixels (7.0 x 3.5 km\textsuperscript{2}, respectively 5.5 x 3.5 km\textsuperscript{2} since 6th of August 2019). On the contrary, the CRB model might be considered more accurate for sensors with coarse spatial resolution footprints such as those from GOME (footprint size 320 x 40 km\textsuperscript{2}). Studies have shown that for the smaller GOME-2 pixels, CAL retrieval produces more reliable cloud information than CRB, not only with regard to the accuracy of the cloud parameters themselves, but also with regard to the effect of cloud parameter uncertainties on total O\textsubscript{3} accuracy [RD3]. In the current S5p/TROPOMI L2 Cloud both CAL and CRB models are included.

The latest OCRA 3.1 / ROCINN 4.1 includes changes in OCRA by the replacement of the OMI-based scan angle dependency correction and clear-sky reflectance composite maps with the TROPOMI data themselves (April 2018 - March 2019) and changes in ROCINN with an effective scene retrieval mode. This allows the replacement of a static surface albedo climatology with an dynamic on-line surface albedo retrieval. In addition, a more accurate treatment of the co-registration issue between bands 3/4 (UVVIS) and band 6 (NIR) has been implemented. Refer to the specific ATBD [RD3] documentation for further information about the L2 Cloud.

7.1 Data Product Examples

Quicklooks are reported in this section as data product examples of the Cloud. Cloud fraction, cloud pressure and cloud optical thickness parameters are reported in Figures 2, 3 and 4, respectively. Further quicklooks may be found here: https://atmos.eoc.dlr.de/tropomi

7.2 Product Geophysical Validation

For a detailed description of early validation results, please refer to section 3.2 of the S5P MPC Product Readme Cloud v2.0.0 (S5P-MPC-DLR-PRF-CLOUD).
Figure 2: A full day plot of the cloud fraction parameter acquired on 29th March 2018. Further quicklooks may be found here: https://atmos.eoc.dlr.de/tropomi

Figure 3: A full day plot of the cloud pressure parameter acquired on 29th March 2018. Further quicklooks may be found here: https://atmos.eoc.dlr.de/tropomi
7.3 History of product changes

This manual describes the current version of the L2 Cloud product. A brief description of data product changes is given here. Detailed description of the changes can be found in appropriate versions of the ATBD.

Table 3: History of product changes of Cloud

<table>
<thead>
<tr>
<th>Version</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Mainly changes to the background correction product (e.g. added qa-value, geolocations)</td>
</tr>
<tr>
<td>2.0</td>
<td>Added near infrared (nir) geolocations</td>
</tr>
<tr>
<td>2.0</td>
<td>Added effective scene variables</td>
</tr>
<tr>
<td>2.0</td>
<td>Retrieval parameters are now provided for nir geolocations as well as for the uvis geolocations (where they are coregistered)</td>
</tr>
<tr>
<td>2.0</td>
<td>Added diagnostic variables for the coregistration between uvis and nir</td>
</tr>
<tr>
<td>2.0</td>
<td>Added new ECMWF variables (wind-speed, snow-ice variables)</td>
</tr>
<tr>
<td>2.0</td>
<td>Added cloud-temperature and cloud-phase variables</td>
</tr>
<tr>
<td>1.1</td>
<td>Minor changes in long name attributes</td>
</tr>
<tr>
<td>0.12</td>
<td>Official version for E2 delivery</td>
</tr>
</tbody>
</table>

7.4 Using the S5p/TROPOMI L2 Cloud

For a detailed description of known data quality issues and suggestions on the usage of the data (e.g. incorporating the qa_value), please refer to section 4 of the S5P MPC Product Readme Cloud v2.0.0 (S5P-MPC-DLR-PRF-CLOUD).
8  General structure of S5P/TROPOMI Level 2 files

This section gives an overview of the basic structure of all Sentinel 5 precursor level 2 files. In subsections 8.2 – 8.3 and sections 9 – 11 some details are provided on the background of the structure of the level 2 files of Sentinel 5 precursor. A complete description of the variables in the Cloud files is given in section 13. Figure 5 gives a graphical representation of the generic structure of a TROPOMI Level 2 file. The outermost layer is the file itself. Within the file different groups are used to organise the data and make it easier to find what you are looking for. Within the file there are two groups: “PRODUCT” and “METADATA”. Both of these groups contain sub-groups. The purpose of each group is discussed below.

PRODUCT  The variables in this group will answer the questions what, when, where and how well. This group stores the main data fields of the product, including the precision of the main parameters, latitude, longitude and variable to determine the observation time and the dimensions needed for the data (a time reference dimension (time), the number of measurements in the granule (scanline), the number of spectra in a measurement (ground_pixel) and depending on the product also a pressure-level dimension, or state-vector dimensions). The “qa_value” parameter summarizes the processing flags into a continuous value, giving a quality percentage: 100 % is the most optimal value, 0 % is a processing failure, in between lies a continuum of values.

In the ‘PRODUCT’ group a sub-group ‘SUPPORT_DATA’ can be found:

SUPPORT_DATA  Additional data that is not directly needed for using and understanding the main data product is stored in sub-groups of this group.

The data in this group is further split up into the following sub groups:

GEOLOCATIONS  Additional geolocation and geometry related fields, including the pixel boundaries (pixel corners), viewing- and solar zenith angles, azimuth angles, and spacecraft location.

DETAILED_RESULTS  Additional output, including state-vector elements that are not the main parameter(s), output describing the quality of the retrieval result, such as a $\chi^2$ value, and detailed processing flags.

INPUT_DATA  Additional input data, such as meteorological input data, surface albedo values, surface altitude and other data that was used to derive the output. Note that input profile information is not stored here, but is available for download from elsewhere.

METADATA  This is a group to collect metadata items, such as the items that appear in the header file [RD26, section 7] and items required by INSPIRE [ER4], ISO 19115 [RD27], ISO 19115-2 [RD28], ISO 19157 [RD29] and OGC 10-157r3 [RD30]. These metadata standards are all meant to facilitate dataset discovery.

The metadata will be stored as attributes, while grouping attributes that belong to a specific standard will be done by using sub-groups in the Metadata group. Some attributes are required to be attached to the global level by convention, such as the CF metadata conventions [ER5], the Attribute Convention for Dataset Discovery [ER6], the NetCDF-4 user guide [ER7] and the ESA CCI project [RD31]. For interoperability reasons the conventions are followed, and the specified global attributes are added to the output files at the root-level.

ALGORITHM_SETTINGS  An attribute is added to this group for each key in the configuration file. The exact contents differ for each processor.

GRANULE_DESCRIPTION  Parameters describing the granule, such as an outline of the geolocations covered in the granule, the time coverage, and processing facility.

QA_STATISTICS  Quality assurance statistics. This group contains two types of data:

1. The total number of pixel matching a certain criterion: number of input pixels, number of pixels successfully processed and the number of pixels that failed for specific reasons. Also part of the pixel counting are the number of warnings that were raised, including those for the south Atlantic anomaly, sun glint and solar eclipse. This is collectively known as ‘event counting’.

2. Histogram(s) of the main parameter(s) in the file. Histograms are additive and allow for easy monitoring of changes over time. This can be a valuable addition for quality monitoring of the science data.

ESA_METADATA  The metadata items that are required in the ESA header.

ISO_METADATA  The ISO metadata items, organized in subgroups.

---

1 More detailed processing flags indicating precisely why the 100 % value isn’t reached, are available elsewhere in the product.
Figure 5: Graphical description of the generic structure of a Level 2 file. The elements labelled as a dimension are coordinate variables. See section 8 for a full description.
**EOP_METADATA** The EOP metadata items, organized in subgroups.

The work of Level 1B on metadata as described in the metadata specification for TROPOMI L01b data processor [RD32] is used as the basis for the level 2 metadata, in particular for the items in the ‘ISO_METADATA’ and ‘EOP_METADATA’ subgroups. The listed metadata standards give a data model and an implementation guideline for producing an XML file with the metadata -- as a side-file to the data-file itself. The Level 1B IODS [RD2] describes a method to store the metadata in the NetCDF-4 file, and produce XML side-files as needed. A detailed discussion on metadata as it applies to Level 2 can be found in section 11.

Details of the specific format of the level 2 product file for the Cloud product is given in section 13. Here all variables are described in detail. A dump output of the final structure proposed in Figure 5 shall have a hierarchy as follows:

```
/root/PRODUCT
/root/PRODUCT/SUPPORT_DATA
/root/PRODUCT/SUPPORT_DATA/DETAILED_RESULTS
/root/PRODUCT/SUPPORT_DATA/GEOLOCATION
/root/PRODUCT/SUPPORT_DATA/INPUT_DATA
/root/METADATA
/root/METADATA/ALGORITHM_SETTINGS
/root/METADATA/ESA_METADATA
/root/METADATA/GRANULE_DESCRIPTION
/root/METADATA/ISO_METADATA
/root/METADATA/QA_STATISTICS
```

Where _root_ is the file itself or the outer level.
The geo-coordinates of the pixel corners are shown in Figure 6. Note that this choice follows the CF metadata standard [ER5, section 7.1].

### 8.1 S5p/TROPOMI L2 File Format

The file format used for all the L2 product is netCDF-4 [ER8]. This file format is very versatile and flexible and will be used for other Sentinel missions, e.g. S4 mission [RD33], as well as other ESA and NASA missions. The netCDF-4 library is built on top of NetCDF-3 and HDF-5 libraries and it allows a grouping mechanism as well as a wide collection of datatypes and other features tailored from the HDF-5 library. This permits the user to use either the netCDF-4 or HDF-5 APIs in order to read the data. Those APIs are written in many data-analysis packages such as IDL, NCO, Matlab, R, and Mathematica or in general programming languages including Python, Ruby, C, C++, Java and Fortran 90.

### 8.2 Dimensions and dimension ordering

All variables in a NetCDF-4 file use named and shared dimensions. This explicitly connects variables to dimensions, and to each other. A few of the dimension names were already shown in figure 5.

- **time** A time dimension. The length of this dimension is 1, at least for S5P. The reason this dimension is used are compatibility with Level 1B, and forward compatibility with Sentinel 4 and Level 3 output. Details are provided in sections 8.4.

- **scanline** The dimension that indicates the flight direction.

- **ground_pixel** The dimension perpendicular to the flight direction.

Other dimensions can be added as needed, but these names shall be the default for these roles.

The climate and forecast metadata conventions recommend a specific order for dimensions in a variable [ER5, section 2.4]. Spatiotemporal dimensions should appear in the relative order: “date or time” (T), “height or depth” (Z), “latitude” (Y), and “longitude” (X). Note that the ordering of the dimensions in CDL, our documentation and C/C++ is row-major: the last dimension is stored contiguously in memory.\(^2\)

\(^2\) Fortran uses column-major order, effectively reversing the dimensions in the code compared to the documentation.
Using straight latitude and longitude is fine with model parameters, but the S5P/TROPOMI Level 1B/Level 2 observation grid is not a regular grid. Because of the polar orbit, the across track dimension (‘ground_pixel’) corresponds most closely with the longitude, and therefore is associated with the X-dimension, while the along track dimensions (‘scanline’) corresponds most directly with latitude, and is therefore labelled as the Y-dimension.

However, in the CF conventions goes on to recommend that additional dimensions are added before the \((T,Z,Y,X)\) axes, that is to have contiguous \((T,Z,Y,X)\) hyperslabs, and spread out the data in other dimensions. We do not follow this recommendation. Instead we recommend to keep units that are likely to be accessed as a unit together in memory, but following the recommended order for \((T,Y,X)\). Note that we do not follow the CF conventions for profiles as they are more likely accessed as complete profiles rather than horizontal slices. A few examples will help:

**Tropospheric NO\(_2\) column** This variable contains a single value per ground pixel, and the dimensions are \((time, scanline, ground\_pixel)\).

The state\_vector\_length variable that accompanies the state\_vector\_length dimension is a string array, giving the names of the state vector elements.

### 8.3 Geolocation, pixel corners and angles

The latitude, longitude, pixel corner coordinates and related angles and satellite position in the level 2 files are copied from the level 1B input data [RD34, chapters 26 and 27]. Details about the definitions can be found there. Note that the latitude and longitude have not been corrected for the local surface altitude, but are instead given at the intersection of the line of sight with the WGS84 ellipsoid.

The geo-coordinates of the pixel corners are shown in Figure 6. Note that this choice follows the CF metadata standard [ER5, section 7.1].

![Figure 6: Pixel corner coordinates. The sequence \{0,1,2,3\} refers to the elements in the corner dimension.](image)

The azimuth angles, i.e. the solar azimuth angle \(\phi_0\) and the viewing azimuth angle \(\phi\) give the angle of the sun and the instrument respectively at the intersection of the line of sight with the WGS84 ellipsoid. Both angles are given as degrees east relative to the local north. This definition is identical to the definition of the azimuth angles in both the OMI and GOME-2 instruments, but requires some care when comparing to a radiative transfer model. A radiative transfer model will typically use \(\phi - \phi_0\) which differs by 180° as it follows the path of the light.

### 8.4 Time information

Time information is stored in two steps. We have the time dimension, which indicates the reference time. This reference time is defined to be UTC midnight before the start of the orbit, which itself is defined by spacecraft midnight. The `time` variable contains the reference time in seconds since 2010-01-01, UTC midnight.
Alternative representations of the reference time are listed in table 4. The offset of individual measurements within the granule is given in milliseconds with respect to this reference time in the variable delta_time.

The reason for this double reference is to more closely follow the CF conventions. Because the flight direction relates the latitude and the time within the orbit, we have $Y$ and $T$ dimensions that are closely related. By separating these into a time dimension of length 1 and a scanline dimension, we obtain independent $Y$ and $T$ dimensions. The actual observation time of an individual observation must be reconstructed from an offset and a time-delta.

As a service to the users, the time is also stored in the 'time_utc' variable. This variable is a string array, with each observation time stored as an ISO date string [RD35].

Table 4: Reference times available in a S5P L2 file. Types: (A) global attribute, (D) dimensional variable, (V) variable. All reference times ignore leap seconds.

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>time_reference</td>
<td>(A)</td>
<td>ISO date/time string [RD35]</td>
</tr>
<tr>
<td>time_reference_days_since_1950</td>
<td>(A)</td>
<td>The number of days since January first, 1950, UTC midnight, as used in several weather and climate models (ECMWF, TM5).</td>
</tr>
<tr>
<td>time_reference_julian_day</td>
<td>(A)</td>
<td>The Julian date of the reference time as used in astronomy. This is the reference time system as used in IDL.</td>
</tr>
<tr>
<td>time_reference_seconds_since_1970</td>
<td>(A)</td>
<td>The number of seconds since January first, 1970, UTC midnight. This is also known as the unix epoch. Time functions on many systems will accept this number.</td>
</tr>
<tr>
<td>time</td>
<td>(D)</td>
<td>This variable contains the number of seconds since 2010-01-01, UTC midnight.</td>
</tr>
<tr>
<td>time_utc</td>
<td>(V)</td>
<td>Array of ISO date/time strings [RD35], one for each observation, i.e. one for each element in the scanline dimension</td>
</tr>
</tbody>
</table>

8.5 Vertical coordinates

Different ATBD authors have specified different vertical grids for the retrieval, which means that the various Level 2 products are not consistent in this respect. There are several options, depending on the choice made by the authors of the retrieval algorithm. Some authors choose to use a vertical grid on a fixed height scale\(^3\), others use a grid that is defined in pressure relative to the surface pressure, similar to the ECMWF vertical grid.

The ECMWF vertical grid is a "atmosphere hybrid sigma pressure coordinate" in CF conventions terminology [ER5, appendix D].

$$p(n, k, j, i) = a_p(k) + b(k)p_s(n, j, i)$$

where $p(n, k, j, i)$ is the pressure at gridpoint $(n, k, j, i)$ on the $(T, Z, Y, X)$ axes; $a_p(k)$ and $b(k)$ the components of the hybrid coordinate at level $k$ and $p_s(n, j, i)$ the surface pressure at coordinate $(n, j, i)$. As a consequence the surface pressure must be added to the output file, otherwise the pressure levels on which the profiles are reported cannot be reconstructed. In addition the $a_p(k)$ and $b(k)$ coefficients must be added to the output as separate variables.

For the fixed height grid there is no reduced pressure grid available, and similarly calculating a height from the pressure profile requires some assumptions. In some cases the full four-dimensional pressure grid will be given.

9 Units

The units attribute originates from the NetCDF-4 users guide [ER7]. This means that the use of this attribute is integral to the use of NetCDF-4 itself, and that the use of the units attribute in the NetCDF-4 users guide is a hard requirement. The NetCDF-4 users guide [ER7] strongly suggests to use the UDUnits [ER9] package to handle units. The CF metadata conventions reinforce this requirement [ER5, sections 1.3 and 3.1].

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\(^3\) This is ‘height’ as defined by the CF conventions: distance above the surface; ‘altitude’ is the distance above the geoid or approximate sea level.
Making the UDUnits package [ER9] a requirement, and thereby forcing all units to be compliant with formal SI units\(^4\) is a good thing for consistency and will help avoid confusion in the long run. In the short term it will require adjustments within the earth observation community, as many of the units that the user community is accustomed to are not SI, and are therefore not available within the UDUnits package. The MAG has decided that Sentinel 5 precursor will represent all level 2 output in SI units. In particular, all column amounts will be given in \(\text{mol m}^{-2}\).

To make it easier for end-users to adjust to these ‘new’ units, conversion factors are attached to the appropriate variables.

- **multiplication_factor_to_convert_to_molecules_per_cm2** Multiply the contents of the variable with this scale factor \((6.02214 \times 10^{19})\) to obtain columns in \(\text{molecules cm}^{-2}\).

- **multiplication_factor_to_convert_to_DU** Multiply the contents of the variable with this scale factor \((2241.15)\) to obtain columns in DU.

- **multiplication_factor_to_convert_to_photons_per_second_per_nm_per_cm2_per_sr** Multiply the contents of the variable with this scale factor \((6.02214 \times 10^{19})\) to obtain a radiance in \(\text{photons s}^{-1} \text{nm}^{-1} \text{cm}^{-2} \text{sr}^{-1}\).

\(^4\) And some deeply entrenched non-SI units such as DU.

### 10 Quality Assurance parameters

The Level 2 output will include automated quality assurance parameters. These include ‘event counters’ for each of the flags defined in the processing quality flags, see tables 12 and 13. These processing quality flags are made uniform across all products, and include flags that may not be applicable to a particular algorithm. We still count all flags, so this list is the same for all products, a list is provided in table 5.

In addition to these ‘event counters’, we also store a histogram of the main parameters. Storing a histogram of retrieved values is easy during processing, and allows for continuous statistical quality monitoring of the retrieval. It also makes it easy to collect histograms of S5P/TROPOMI data for longer periods. The bins for the histogram depend on the parameter in the Level 2 product, and are defined in the configuration file.

In addition to the histogram an approximation of a probability density function can be created:

\[
 f_{pdf}(x_j) = \frac{1}{N} \sum_{i=0}^{N} \frac{\cos(\delta_{\text{geo},i})}{\sigma_i \sqrt{2\pi}} \exp \left[ \frac{(x_j - x_i)^2}{2\sigma_i^2} \right]
\]  

This is a discrete approximation of a continuous probability density function, for discrete values \(x_j\) for all successful retrievals \(i = 1, \ldots, N\). The value of \(\cos(\delta_{\text{geo},i})\) is used to make the result less sensitive to the relative oversampling of S5P at high latitude.

The mission performance center for Sentinel 5 precursor maintains a record of quality control/quality assurance parameters for monitoring purposes.
Table 5: Common quality assurance parameters. The actual integer values of incident occurrences are stored. Using percentages stored as integers will hide potential issues, especially given the total number of pixels in a SSP/TROPOMI granule.

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>number_of_groundpixels</td>
<td>Number of ground pixels in the file.</td>
</tr>
<tr>
<td>number_of_processed_pixels</td>
<td>Number of ground pixels where a retrieval was attempted. This is the number_of_groundpixels minus the pixels that were rejected on trivial grounds, such as the solar zenith angle.</td>
</tr>
<tr>
<td>number_of_successfully_processed_pixels</td>
<td>Number of ground pixels where a retrieval was successful.</td>
</tr>
<tr>
<td>number_of_rejected_pixels_not_enough_spectrum</td>
<td>Number of ground pixels where a retrieval was not attempted because too many spectral pixels were flagged as bad.</td>
</tr>
<tr>
<td>number_of_failed_retrievals</td>
<td>Number of pixels that were attempted but failed.</td>
</tr>
<tr>
<td>number_of_ground_pixels_with_warnings</td>
<td>Number of pixels with one or more warnings.</td>
</tr>
<tr>
<td>number_of_missing_scanlines</td>
<td>Number of scanlines that are missing from the input, presumably transmission errors.</td>
</tr>
<tr>
<td>number_of_radiance_missing_occurrences</td>
<td>Number of ground pixels where “the number of spectral pixels in the radiance due to flagging is too small to perform the fitting” occurred.</td>
</tr>
<tr>
<td>number_of_irradiance_missing_occurrences</td>
<td>Number of ground pixels where “the number of spectral pixels in the irradiance due to flagging is too small to perform the fitting” occurred.</td>
</tr>
<tr>
<td>number_of_input_spectrum_missing_occurrences</td>
<td>Number of ground pixels where “the reflectance spectrum does not contain enough points to perform the retrieval. This is different from (ir)radiance_ missing in that the missing points may not be aligned” occurred.</td>
</tr>
<tr>
<td>number_of_reflectance_range_error_occurrences</td>
<td>Number of ground pixels where “any of the reflectances is out of bounds (R &lt; 0 or R &gt; R_{max})” occurred.</td>
</tr>
<tr>
<td>number_of_ler_range_error_occurrences</td>
<td>Number of ground pixels where “lambert-equivalent reflectivity out of range error” occurred.</td>
</tr>
<tr>
<td>number_of_snr_range_error_occurrences</td>
<td>Number of ground pixels where “too low signal to noise to perform retrieval” occurred.</td>
</tr>
<tr>
<td>number_of_sza_range_error_occurrences</td>
<td>Number of ground pixels where “solar zenith angle out of range, maximum value from configuration” occurred.</td>
</tr>
<tr>
<td>number_of_vza_range_error_occurrences</td>
<td>Number of ground pixels where “viewing zenith angle out of range, maximum value from configuration” occurred.</td>
</tr>
<tr>
<td>number_of_lut_range_error_occurrences</td>
<td>Number of ground pixels where “extrapolation in lookup table (airmass factor, cloud radiances)” occurred.</td>
</tr>
</tbody>
</table>
Table 5: Common quality assurance parameters. (continued).

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>number_of_ozone_range_error_occurrences</td>
<td>Number of ground pixels where “ozone column significantly out of range of profile climatology” occurred.</td>
</tr>
<tr>
<td>number_of_wavelength_offset_error_occurrences</td>
<td>Number of ground pixels where “wavelength offset exceeds maximum from configuration” occurred.</td>
</tr>
<tr>
<td>number_of_initialization_error_occurrences</td>
<td>Number of ground pixels where “an error occurred during the processing of the pixel, no output was generated. The following errors raise this flag: Mismatch between irradiance and radiance wavelengths; The on-ground distance between band 1 and band 2 ground pixels exceeds a threshold set in the configuration. Derived a-priori information does not validate, no processing is possible” occurred.</td>
</tr>
<tr>
<td>number_of_memory_error_occurrences</td>
<td>Number of ground pixels where “memory allocation or deallocation error” occurred.</td>
</tr>
<tr>
<td>number_of_assertion_error_occurrences</td>
<td>Number of ground pixels where “error in algorithm detected during assertion” occurred.</td>
</tr>
<tr>
<td>number_of_io_error_occurrences</td>
<td>Number of ground pixels where “error detected during transfer of data between algorithm and framework” occurred.</td>
</tr>
<tr>
<td>number_of_numerical_error_occurrences</td>
<td>Number of ground pixels where “general fatal numerical error occurred during inversion” occurred.</td>
</tr>
<tr>
<td>number_of_lut_error_occurrences</td>
<td>Number of ground pixels where “error in accessing the lookup table” occurred.</td>
</tr>
<tr>
<td>number_of_ISRF_error_occurrences</td>
<td>Number of ground pixels where “error detected in the input instrument spectral response function input data” occurred.</td>
</tr>
<tr>
<td>number_of_convergence_error_occurrences</td>
<td>Number of ground pixels where “the main algorithm did not converge” occurred.</td>
</tr>
<tr>
<td>number_of_cloud_filter_convergence_error_occurrences</td>
<td>Number of ground pixels where “the cloud filter did not converge” occurred.</td>
</tr>
<tr>
<td>number_of_max_iteration_convergence_error_occurrences</td>
<td>Number of ground pixels where “no convergence because retrieval exceeds maximum number of iterations. Maximum value from configuration” occurred.</td>
</tr>
<tr>
<td>number_of_aot_lower_boundary_convergence_error_occurrences</td>
<td>Number of ground pixels where “no convergence because the aerosol optical thickness crosses lower boundary twice in succession” occurred.</td>
</tr>
<tr>
<td>number_of_other_boundary_convergence_error_occurrences</td>
<td>Number of ground pixels where “no convergence because a state vector element crosses boundary twice in succession. Note that a separate failure flag is defined for non-convergence due to crossing of lower AOT boundary” occurred.</td>
</tr>
<tr>
<td>Name</td>
<td>Description</td>
</tr>
<tr>
<td>-----------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>number_of_geolocation_error_occurrences</td>
<td>Number of ground pixels where “geolocation out of range” occurred.</td>
</tr>
<tr>
<td>number_of_ch4_noscat_zero_error_occurrences</td>
<td>Number of ground pixels where “the CH$_4$ column retrieved by the non-</td>
</tr>
<tr>
<td></td>
<td>scattering CO algorithm from the weak band or strong band is 0” occurred.</td>
</tr>
<tr>
<td>number_of_h2o_noscat_zero_error_occurrences</td>
<td>Number of ground pixels where “the H$_2$O column retrieved by the non-</td>
</tr>
<tr>
<td></td>
<td>scattering CO algorithm from the weak band or strong band is 0” occurred.</td>
</tr>
<tr>
<td>number_of_max_optical_thickness_error_occurrences</td>
<td>Number of ground pixels where “maximum optical thickness exceeded during</td>
</tr>
<tr>
<td></td>
<td>iterations” occurred.</td>
</tr>
<tr>
<td>number_of_aerosol_boundary_error_occurrences</td>
<td>Number of ground pixels where “boundary hit of aerosol parameters at last</td>
</tr>
<tr>
<td></td>
<td>iteration” occurred.</td>
</tr>
<tr>
<td>number_of_boundary_hit_error_occurrences</td>
<td>Number of ground pixels where “fatal boundary hit during iterations”</td>
</tr>
<tr>
<td></td>
<td>occurred.</td>
</tr>
<tr>
<td>number_of_chi2_error_occurrences</td>
<td>Number of ground pixels where “$\chi^2$ is not-a-number or larger than 10^{10}$” occurred.</td>
</tr>
<tr>
<td>number_of_svd_error_occurrences</td>
<td>Number of ground pixels where “singular value decomposition failure”</td>
</tr>
<tr>
<td></td>
<td>occurred.</td>
</tr>
<tr>
<td>number_of_dfs_error_occurrences</td>
<td>Number of ground pixels where “degree of freedom is not-a-number” occurred.</td>
</tr>
<tr>
<td>number_of_radiative_transfer_error_occurrences</td>
<td>Number of ground pixels where “errors occurred during the radiative transfer</td>
</tr>
<tr>
<td></td>
<td>computations, no processing possible” occurred.</td>
</tr>
<tr>
<td>number_of_optimal_estimation_error_occurrences</td>
<td>Number of ground pixels where “errors occurred during the optimal</td>
</tr>
<tr>
<td></td>
<td>estimation, processing has been terminated” occurred.</td>
</tr>
<tr>
<td>number_of_profile_error_occurrences</td>
<td>Number of ground pixels where “flag that indicates if there were any</td>
</tr>
<tr>
<td></td>
<td>errors during the computation of the ozone profile” occurred.</td>
</tr>
<tr>
<td>number_of_cloud_error_occurrences</td>
<td>Number of ground pixels where “no cloud data” occurred.</td>
</tr>
<tr>
<td>number_of_model_error_occurrences</td>
<td>Number of ground pixels where “forward model failure” occurred.</td>
</tr>
<tr>
<td>number_of_number_of_input_data_points_too_low_error_occurrences</td>
<td>Number of ground pixels where “not enough input ozone columns to calculate a tropospheric column” occurred.</td>
</tr>
<tr>
<td>number_of_cloud_pressure_spread_too_low_error_occurrences</td>
<td>Number of ground pixels where “cloud pressure variability to low to estimate a tropospheric column” occurred.</td>
</tr>
<tr>
<td>number_of_cloud_too_low_level_error_occurrences</td>
<td>Number of ground pixels where “clouds are too low in the atmosphere to</td>
</tr>
<tr>
<td></td>
<td>assume sufficient shielding” occurred.</td>
</tr>
<tr>
<td>number_of_generic_range_error_occurrences</td>
<td>Number of ground pixels where “generic range error” occurred.</td>
</tr>
<tr>
<td>number_of_generic_exception_occurrences</td>
<td>Number of ground pixels where “catch all generic error” occurred.</td>
</tr>
<tr>
<td>Name</td>
<td>Description</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>number_of_input_spectrum_alignment_error_occurrences</td>
<td>Number of ground pixels where “input radiance and irradiance spectra are not aligned correctly” occurred.</td>
</tr>
<tr>
<td>number_of_abort_error_occurrences</td>
<td>Number of ground pixels where “not processed because processor aborted prematurely (time out or user abort)” occurred.</td>
</tr>
<tr>
<td>number_of_wrong_input_type_error_occurrences</td>
<td>Number of ground pixels where “wrong input type error, mismatch between expectation and received data” occurred.</td>
</tr>
<tr>
<td>number_of_wavelength_calibration_error_occurrences</td>
<td>Number of ground pixels where “an error occurred in the wavelength calibration of this pixel” occurred.</td>
</tr>
<tr>
<td>number_of_coregistration_error_occurrences</td>
<td>Number of ground pixels where “no colocated pixels found in a supporting band” occurred.</td>
</tr>
<tr>
<td>number_of_slant_column_density_error_occurrences</td>
<td>Number of ground pixels where “slant column fit returned error, no values can be computed” occurred.</td>
</tr>
<tr>
<td>number_of_airmass_factor_error_occurrences</td>
<td>Number of ground pixels where “airmass factor could not be computed” occurred.</td>
</tr>
<tr>
<td>number_of_vertical_column_density_error_occurrences</td>
<td>Number of ground pixels where “vertical column density could not be computed” occurred.</td>
</tr>
<tr>
<td>number_of_signal_to_noise_ratio_error_occurrences</td>
<td>Number of ground pixels where “the signal to noise ratio for this spectrum is too low for processing” occurred.</td>
</tr>
<tr>
<td>number_of_configuration_error_occurrences</td>
<td>Number of ground pixels where “error while parsing the configuration” occurred.</td>
</tr>
<tr>
<td>number_of_key_error_occurrences</td>
<td>Number of ground pixels where “key does not exist” occurred.</td>
</tr>
<tr>
<td>number_of_saturation_error_occurrences</td>
<td>Number of ground pixels where “saturation in input spectrum” occurred.</td>
</tr>
<tr>
<td>number_of_max_num_outlier_exceeded_error_occurrences</td>
<td>Number of ground pixels where “the number of outliers detected in the DOAS fit exceeds a maximum set for healthy spectra.” occurred.</td>
</tr>
<tr>
<td>number_of_solar_eclipse_filter_occurrences</td>
<td>Number of ground pixels where “solar eclipse” occurred.</td>
</tr>
<tr>
<td>number_of_cloud_filter_occurrences</td>
<td>Number of ground pixels where “the cloud filter triggered causing the pixel to be skipped” occurred.</td>
</tr>
<tr>
<td>number_of_altitude_consistency_filter_occurrences</td>
<td>Number of ground pixels where “too large difference between ECMWF altitude and DEM altitude value” occurred.</td>
</tr>
<tr>
<td>number_of_altitude_roughness_filter_occurrences</td>
<td>Number of ground pixels where “too large standard deviation of altitude in DEM” occurred.</td>
</tr>
</tbody>
</table>
Table 5: Common quality assurance parameters. (continued).

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>number_of_sun_glint_filter_occurrences</td>
<td>Number of ground pixels where “for pixels over water, viewing direction inside sun glint region. Definition of sun glint angle and threshold value from ATBD” occurred.</td>
</tr>
<tr>
<td>number_of_mixed_surface_type_filter_occurrences</td>
<td>Number of ground pixels where “pixel contains land and water areas (e.g. coastal pixel)” occurred.</td>
</tr>
<tr>
<td>number_of_snow_ice_filter_occurrences</td>
<td>Number of ground pixels where “pixel contains snow/ice: Snow/ice flag according to dynamic input OR climatological surface albedo at VIS wavelength is larger than 0.5” occurred.</td>
</tr>
<tr>
<td>number_of_aai_filter_occurrences</td>
<td>Number of ground pixels where “AAI smaller than 2.0” occurred.</td>
</tr>
<tr>
<td>number_of_cloud_fraction_fresco_filter_occurrences</td>
<td>Number of ground pixels where “pixel contains clouds: The FRESCO effective cloud fraction is larger than threshold. Threshold value from ATBD” occurred.</td>
</tr>
<tr>
<td>number_of_aai_scene_albedo_filter_occurrences</td>
<td>Number of ground pixels where “pixel contains clouds: The difference between scene albedo at 380 nm from AAI calculation and the climatological surface albedo exceeds threshold. Threshold value from ATBD. This test filters out clouds” occurred.</td>
</tr>
<tr>
<td>number_of_small_pixel_radiance_std_filter_occurrences</td>
<td>Number of ground pixels where “pixel contains clouds: Standard deviation of radiances in small-pixel column exceeds threshold. Threshold value from ATBD” occurred.</td>
</tr>
<tr>
<td>number_of_cloud_fraction_viirs_filter_occurrences</td>
<td>Number of ground pixels where “pixel contains clouds: The cloud fraction from VIIRS / NPP exceeds threshold. Threshold value from ATBD” occurred.</td>
</tr>
<tr>
<td>number_of_cirrus_reflectance_viirs_filter_occurrences</td>
<td>Number of ground pixels where “pixel contains clouds: Cirrus reflectance from VIIRS / NPP exceeds threshold. Threshold value from ATBD” occurred.</td>
</tr>
<tr>
<td>number_of_cf_viirs_swir_ifov_filter_occurrences</td>
<td>Number of ground pixels where “fraction of cloudy VIIRS pixels within S5P SWIR ground pixel exceeds a priori threshold from configuration” occurred.</td>
</tr>
<tr>
<td>number_of_cf_viirs_swir_ofova_filter_occurrences</td>
<td>Number of ground pixels where “fraction of cloudy VIIRS pixels within S5P SWIR OFOVA exceeds a priori threshold from configuration” occurred.</td>
</tr>
<tr>
<td>number_of_cf_viirs_swir_ofovb_filter_occurrences</td>
<td>Number of ground pixels where “fraction of cloudy VIIRS pixels within S5P SWIR OFOVB exceeds a priori threshold from configuration” occurred.</td>
</tr>
<tr>
<td>number_of_cf_viirs_swir_ofovc_filter_occurrences</td>
<td>Number of ground pixels where “fraction of cloudy VIIRS pixels within S5P SWIR OFOVc exceeds a priori threshold from configuration” occurred.</td>
</tr>
<tr>
<td>number_of_cf_viirs_nir_ifov_filter_occurrences</td>
<td>Number of ground pixels where “fraction of cloudy VIIRS pixels within S5P NIR ground pixel exceeds a priori threshold from configuration” occurred.</td>
</tr>
<tr>
<td>Name</td>
<td>Description</td>
</tr>
<tr>
<td>------</td>
<td>-------------</td>
</tr>
<tr>
<td><code>number_of_cf_viirs_nir_ofova_filter_occurrences</code></td>
<td>Number of ground pixels where “fraction of cloudy VIIRS pixels within S5P NIR OFOVa exceeds a priori threshold from configuration” occurred.</td>
</tr>
<tr>
<td><code>number_of_cf_viirs_nir_ofovb_filter_occurrences</code></td>
<td>Number of ground pixels where “fraction of cloudy VIIRS pixels within S5P NIR OFOVb exceeds a priori threshold from configuration” occurred.</td>
</tr>
<tr>
<td><code>number_of_cf_viirs_nir_ofovc_filter_occurrences</code></td>
<td>Number of ground pixels where “fraction of cloudy VIIRS pixels within S5P NIR OFOVc exceeds a priori threshold from configuration” occurred.</td>
</tr>
<tr>
<td><code>number_of_refl_cirrus_viirs_swir_filter_occurrences</code></td>
<td>Number of ground pixels where “average VIIRS cirrus reflectance within SWIR ground pixel exceeds a priori threshold from configuration” occurred.</td>
</tr>
<tr>
<td><code>number_of_refl_cirrus_viirs_nir_filter_occurrences</code></td>
<td>Number of ground pixels where “average VIIRS cirrus reflectance within NIR ground pixel exceeds a priori threshold from configuration” occurred.</td>
</tr>
<tr>
<td><code>number_of_diff_refl_cirrus_viirs_filter_occurrences</code></td>
<td>Number of ground pixels where “difference in VIIRS average cirrus reflectance between SWIR and NIR ground pixel exceeds a priori threshold from configuration” occurred.</td>
</tr>
<tr>
<td><code>number_of_ch4_noscat_ratio_filter_occurrences</code></td>
<td>Number of ground pixels where “the ratio between $\text{[CH}<em>4\text{]}</em>{\text{weak}}$ and $\text{[CH}<em>4\text{]}</em>{\text{strong}}$ is below or exceeds a priori thresholds from configuration” occurred.</td>
</tr>
<tr>
<td><code>number_of_ch4_noscat_ratio_std_filter_occurrences</code></td>
<td>Number of ground pixels where “the standard deviation of $\text{[CH}<em>4\text{]}</em>{\text{weak}}/[\text{CH}<em>4\text{]}</em>{\text{strong}}$ within the SWIR pixel and the 8 neighbouring pixels exceeds a priori threshold from configuration” occurred.</td>
</tr>
<tr>
<td><code>number_of_h2o_noscat_ratio_filter_occurrences</code></td>
<td>Number of ground pixels where “the ratio between $\text{[H}<em>2\text{O}\text{]}</em>{\text{weak}}$ and $\text{[H}<em>2\text{O}\text{]}</em>{\text{strong}}$ is below or exceeds a priori thresholds from configuration” occurred.</td>
</tr>
<tr>
<td><code>number_of_h2o_noscat_ratio_std_filter_occurrences</code></td>
<td>Number of ground pixels where “the standard deviation of $\text{[H}<em>2\text{O}\text{]}</em>{\text{weak}}/[\text{H}<em>2\text{O}\text{]}</em>{\text{strong}}$ within the SWIR pixel and the 8 neighbouring pixels exceeds a priori threshold from configuration” occurred.</td>
</tr>
<tr>
<td><code>number_of_diff_psurf_fresco_ecmwf_filter_occurrences</code></td>
<td>Number of ground pixels where “difference between the FRESCO apparent surface pressure and the ECMWF surface pressure exceeds a priori threshold from configuration” occurred.</td>
</tr>
<tr>
<td><code>number_of_psurf_fresco_stdv_filter_occurrences</code></td>
<td>Number of ground pixels where “the standard deviation of the FRESCO apparent surface pressure in the NIR pixel and the 8 surrounding pixels exceeds a priori threshold from configuration” occurred.</td>
</tr>
<tr>
<td><code>number_of_ocean_filter_occurrences</code></td>
<td>Number of ground pixels where “the ground pixel is over ocean (and ocean glint retrievals are not switched on)” occurred.</td>
</tr>
<tr>
<td>Name</td>
<td>Description</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>number_of_time_range_filter_occurrences</td>
<td>Number of ground pixels where “time is out of the range that is to be processed” occurred.</td>
</tr>
<tr>
<td>number_of_pixel_or_scanline_index_filter_occurrences</td>
<td>Number of ground pixels where “not processed because pixel index does not match general selection criteria” occurred.</td>
</tr>
<tr>
<td>number_of_geographic_region_filter_occurrences</td>
<td>Number of ground pixels where “pixel falls outside the specified regions of interest” occurred.</td>
</tr>
<tr>
<td>number_of_input_spectrum_warning_occurrences</td>
<td>Number of ground pixels where “number of good pixels in radiance, irradiance or calculated reflectance below threshold from configuration” occurred.</td>
</tr>
<tr>
<td>number_of_wavelength_calibration_warning_occurrences</td>
<td>Number of ground pixels where “offset from wavelength fit is larger than limit set in configuration” occurred.</td>
</tr>
<tr>
<td>number_of_extrapolation_warning_occurrences</td>
<td>Number of ground pixels where “pressure or temperature outside cross section LUT range, other lookup table extrapolation” occurred.</td>
</tr>
<tr>
<td>number_of_sun_glint_warning_occurrences</td>
<td>Number of ground pixels where “sun glint possibility warning” occurred.</td>
</tr>
<tr>
<td>number_of_south_atlantic_anomaly_warning_occurrences</td>
<td>Number of ground pixels where “TROPOMI is inside the south Atlantic anomaly while taking these measurements” occurred.</td>
</tr>
<tr>
<td>number_of_sun_glint_correction_occurrences</td>
<td>Number of ground pixels where “A sun glint correction has been applied” occurred.</td>
</tr>
<tr>
<td>number_of_snow_ice_warning_occurrences</td>
<td>Number of ground pixels where “snow/ice flag is set, i.e. using scene data from the cloud support product” occurred.</td>
</tr>
<tr>
<td>number_of_cloud_warning_occurrences</td>
<td>Number of ground pixels where “cloud filter based on FRESCO apparent surface pressure (VIIRS not available), cloud fraction above threshold or cloud pressure adjusted to force cloud above surface. In case of Cloud product this flag indicates the possibility of ice-clouds” occurred.</td>
</tr>
<tr>
<td>number_of_AAI_warning_occurrences</td>
<td>Number of ground pixels where “possible aerosol contamination as either indicated by the AAI (O₃ profile) or other criteria (Cloud)” occurred.</td>
</tr>
<tr>
<td>number_of_pixel_level_input_data_missing_occurrences</td>
<td>Number of ground pixels where “dynamic auxiliary input data (e.g., cloud) is missing for this ground pixel. A fallback option is used” occurred.</td>
</tr>
<tr>
<td>Name</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>number_of_data_range_warning_occurrences</td>
<td>Number of ground pixels where “carbon monoxide column tends to negative values; Water column tends to negative values; Heavy water (HDO) column tends to negative values; others. In case of the O₃ product this flag indicates VCD or effective albedo values outside a valid range. In case of the SO₂ or the HCHO product this flag indicates AMF values outside a valid range” occurred.</td>
</tr>
<tr>
<td>number_of_low_cloud_fraction_warning_occurrences</td>
<td>Number of ground pixels where “low cloud fraction, therefore no cloud pressure retrieved” occurred.</td>
</tr>
<tr>
<td>number_of_altitude_consistency_warning_occurrences</td>
<td>Number of ground pixels where “difference between ECMWF surface elevation and high-resolution surface elevation exceeds threshold from configuration” occurred.</td>
</tr>
<tr>
<td>number_of_signal_to_noise_ratio_warning_occurrences</td>
<td>Number of ground pixels where “signal to noise ratio in SWIR and/or NIR band below threshold from configuration. For the O₃ and HCHO products this flag indicates an RMS above a certain threshold” occurred.</td>
</tr>
<tr>
<td>number_of_deconvolution_warning_occurrences</td>
<td>Number of ground pixels where “failed deconvolution irradiance spectrum (not pixel-specific, but row-specific)” occurred.</td>
</tr>
<tr>
<td>number_of_so2_volcanic_origin_likely_warning_occurrences</td>
<td>Number of ground pixels where “warning for SO₂ BL product, UTLS products: volcanic origin except for heavily polluted sites” occurred.</td>
</tr>
<tr>
<td>number_of_so2_volcanic_origin_certain_warning_occurrences</td>
<td>Number of ground pixels where “warning for SO₂ BL product, UTLS products: volcanic origin certain” occurred.</td>
</tr>
<tr>
<td>number_of_interpolation_warning_occurrences</td>
<td>Number of ground pixels where “warning for interpolation on partially missing data. In this case the valid available data is used, potentially leading to a bias” occurred.</td>
</tr>
<tr>
<td>number_of_saturation_warning_occurrences</td>
<td>Number of ground pixels where “saturation occurred spectrum, possibly causing biases in the retrieval” occurred.</td>
</tr>
<tr>
<td>number_of_high_sza_warning_occurrences</td>
<td>Number of ground pixels where “warning for high solar zenith angle. In this case, the processing can be performed with less final quality” occurred.</td>
</tr>
<tr>
<td>number_of_cloud_retrieval_warning_occurrences</td>
<td>Number of ground pixels where “warning occurring when the retrieval diagnostic indicates a degraded quality of the cloud retrieval” occurred.</td>
</tr>
<tr>
<td>number_of_cloud_inhomogeneity_warning_occurrences</td>
<td>Number of ground pixels where “the cloud coregistration inhomogeneity parameter is above a given threshold” occurred.</td>
</tr>
</tbody>
</table>
11 Generic metadata and attributes

Metadata gives information about the satellite, algorithms, configuration as well as other parameters useful for the interpretation of the processed data and tracing the production process of the level 2 files. The Sentinel 5 precursor product files, both for level 1B and level 2 contain a rich amount of metadata, both at the variable level and at the granule level. The full description of the metadata in the files for the Cloud product is given in the file format description, in section 13.2. Here we provide some background on what can be found in which location. The abbreviations listed in table 6 are used in the following part of this document to better identify the nature of the attributes.

**Table 6**: The abbreviations used in metadata descriptions to indicate the origin of a specific attribute, and the abbreviations used to indicate the type of an attribute.

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUG</td>
<td>netCDF-4 Users Guide [ER7]</td>
</tr>
<tr>
<td>CF</td>
<td>Climate and Forecast metadata conventions [ER5], which includes the COARDS [ER10] conventions</td>
</tr>
<tr>
<td>ISO</td>
<td>ISO standards 19115, 19115-2 and 19157 [RD27, RD28, RD29]</td>
</tr>
<tr>
<td>Inspire</td>
<td>Inspire directive [ER4]</td>
</tr>
<tr>
<td>ACDD</td>
<td>ESIP-ACDD Attribute convention for dataset discovery [ER6]</td>
</tr>
<tr>
<td>CCI</td>
<td>Attributes requested by the ESA climate change initiative project. These largely overlap with the ACDD attributes.</td>
</tr>
<tr>
<td>ESA</td>
<td>Fixed ESA Header [RD26]</td>
</tr>
<tr>
<td>SSP</td>
<td>Internal use – mostly for retrieval settings, possibly as an extension to ISO 19115 [RD27]</td>
</tr>
<tr>
<td>S</td>
<td>Attribute is a string attribute</td>
</tr>
<tr>
<td>P</td>
<td>Attribute has the data-type of the variable with which it is associated ('parent' data type).</td>
</tr>
<tr>
<td>I</td>
<td>Attribute is an integer value</td>
</tr>
<tr>
<td>F</td>
<td>Attribute is a floating point value (either 32-bit or 64-bit).</td>
</tr>
<tr>
<td>T</td>
<td>Attribute is a CCSDS-ASCII time representation (&quot;UTC=&quot; + ISO 8601 [RD35])</td>
</tr>
</tbody>
</table>

We follow several metadata conventions in the S5P level 2 files, as can be seen in table 6. These include ISO 19115-2 [RD28], OGC 10.157r3 [RD30], the ESA earth observation header [RD26] and the Climate and Forecast metadata conventions [ER5]. Following ISO 19115-2 also ensures compliance with the Inspire directive, with the provision that a few items that are optional in the ISO standard are required by Inspire. These metadata standards prescribe the generation of XML files as side-files to the main product file. These metadata standards are mostly intended for data discovery and data dissemination. This means that the metadata must be ingested by a server so that it can be stored in a database. This database will end users help to find the data they need. Ingestion of this metadata is facilitated by storing the metadata in a predefined XML format. While it is possible to store the required XML directly in a NetCDF variable or attribute, it is hard to use these directly to extract metadata. Using attributes for the individual metadata fields makes it far easier for users to read the metadata from their programs, as the interface becomes uniform: just netCDF-4.

Then the question becomes how to store the metadata for the ISO 19115-2, OGC 10.157r3 and the ESA earth observation header in the NetCDF datafile, in a way that facilitates automated creation of the XML side files for ingestion into the database for dissemination en discovery. Fortunately this problem has already been solved by the SSP L1B team, and a description can be found in the L1B input/output data specification and the metadata specification [RD2, RD32]. The short version is that the attributes in the data file can be exported as NcML [RD36], which can be translated into the desired output using an XSLT transformation. Support attributes are added to the data file to facilitate this. Creating such a transformation script has been declared out of scope for the level 1B and level 2 processor CFI providers.

11.1 The Climate and Forecast conventions

The CF metadata conventions [ER5] provide guidelines for attributes for variables so that the link between data and its geolocation and time of observation can be made automatically. Applying the CF-metadata conventions to the output products already limits the number of choices we will have to make. Units and other attributes are
already defined and some structure is provided by the CF-conventions, for instance in linking data fields with geolocation.

11.2 NetCDF User Guide Conventions

A full description of the conventions might be found in the NetCDF user manual [ER7]. In general, names starting with underscore character are always reserved for use by the NetCDF library. NUG conventions are a subset of the CF-conventions.

11.3 Global attributes

Global attributes that are present at the root level of a S5p L2 product as described in section 13. These are mostly string attributes.

11.4 ESA earth observation header

The ESA earth observations file format guidelines and tailoring for S5P [RD26, RD25] specify the creation of a header file with a basic description of the contents of an output file. This header file consists of a fixed part and a customizable variable part. The variable part contains the lineage of the product is repeated, see section 12.28.1.43 for a description the the attributes contained in this part of the header. The fixed header is described in tables 7 – 9.

<table>
<thead>
<tr>
<th>Name</th>
<th>Data type</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>File_Name</td>
<td>S</td>
<td>File name of the product without extension.</td>
</tr>
<tr>
<td>File_Description</td>
<td>S</td>
<td>Description of the file type.</td>
</tr>
<tr>
<td>Notes</td>
<td>S</td>
<td>Any type of notes/comments (multi-lines).</td>
</tr>
<tr>
<td>Mission</td>
<td>S</td>
<td>Description of the mission (Fixed to “S5P”)</td>
</tr>
<tr>
<td>File_Class</td>
<td>S</td>
<td>Description of the file class. It is redundant with the File Class element embedded in the File Name.(e.g., “NRTI”)</td>
</tr>
<tr>
<td>File_Type</td>
<td>S</td>
<td>Description of the file type, for the current product it is set to “L2_-Cloud”. It is redundant with the File Type element embedded in the File Name.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name</th>
<th>Data type</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Validity_Period</td>
<td>Group, see table 8</td>
<td>Time coverage of the data.</td>
</tr>
<tr>
<td>File_Version</td>
<td>I</td>
<td>It is redundant with the File Version element embedded in the File Name.</td>
</tr>
<tr>
<td>Source</td>
<td>Group, see table 9</td>
<td>Information about the ground segment facility where the product was generated.</td>
</tr>
</tbody>
</table>

Table 7: Metadata in the fixed header required by the ESA earth observation file format standard. The data types refer to the short list in table 6.

<table>
<thead>
<tr>
<th>Name</th>
<th>Data type</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Validity_Start</td>
<td>T</td>
<td>This is the UTC Validity Start Time, the same as the Validity Start Time in the File Name and the time_coverage_start global attribute.</td>
</tr>
<tr>
<td>Validity_Stop</td>
<td>T</td>
<td>This is the UTC Validity Stop Time, the same as the Validity Stop Time in the File Name and the time_coverage_end global attribute.</td>
</tr>
</tbody>
</table>

Table 8: Fields in the Validity_Period group. The data types refer to the short list in table 6.

<table>
<thead>
<tr>
<th>Name</th>
<th>Data type</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>System</td>
<td>S</td>
<td>Name of the Ground Segment element creating the file.</td>
</tr>
</tbody>
</table>
Table 9: Fields in the source group (continued).

<table>
<thead>
<tr>
<th>Name</th>
<th>Data type</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creator</td>
<td>S</td>
<td>Name of the facility or tool, within the Ground Segment element, creating the file.</td>
</tr>
<tr>
<td>Creator_Version</td>
<td>S</td>
<td>Version of the tool.</td>
</tr>
<tr>
<td>Creation_Date</td>
<td>T</td>
<td>This is the UTC Creation Date. This field also appears in the file name and in the date_created global attribute.</td>
</tr>
</tbody>
</table>

11.5 Inspire directive

INSPIRE is based on the infrastructures for spatial information established and operated by the 27 Member States of the European Union. The INSPIRE directive came into force on 15 May 2007 and will be developed in several stages until a complete release with due date set in 2019. The INSPIRE directive aims to create a European Union (EU) spatial data infrastructure. This will enable the sharing of environmental spatial information among public sector organizations and better facilitate public access to spatial information across Europe. The European Commission issued a Metadata Regulation [RD37] which aims at setting the requirements for the creation and maintenance of metadata for spatial data sets, spatial data set series and spatial data services corresponding to the themes listed in the annexes of the regulation.

Since many different standard are involved, collisions may occur. The INSPIRE Metadata Implementing Rules [RD38] define how the Regulation can be implemented using ISO 19115. As also reported in [RD32], the conclusion of the study pointed out the following:

1. The conformance of an ISO 19115 metadata set to the ISO 19115 Core does not guarantee the conformance to INSPIRE.

2. The use of these guidelines to create INSPIRE metadata ensures that the metadata is not in conflict with ISO 19115. However, full conformance to ISO 19115 implies the provision of additional metadata elements which are not required by INSPIRE.

11.6 ISO and OGC standards

Two ISOs standards useful for the description of collection of Earth Observation products and to the description of individual EO products are ISO 19115-2 [RD28] and ISO 19156 [RD39], respectively. However, these two ISOs do not provide any encoding syntax but they are merely conceptual models. On the other hand, standards that provide encoding and XML schema for describing, validating and exchanging metadata about geographic datasets and for observations and measurements are:

1. ISO 19139 [RD40]
2. OGC 10-025C [RD41]
3. OGC 10-157 [RD30]

Full description of all above mentioned standard is not part of this document. The S5p L01B evelopment team have addressed and analyzed the complex structure of the application of all those ISOs and OGC standard in the S5p L01B metadata specification [RD32].

11.7 Attributes

In Table 11 a list of attributes that can be appended to variables in S5p products. Not all of these attributes will be used on all variables, but for each variables an appropriate selection is made. The different types with their respective abbreviations are shown in Table 6. The NetCDF attribute _FillValue which represents missing or undefined data can assume the default values listed in Table 10.
Table 10: netCDF-4 type definitions and fill values. In order to avoid rounding errors, it is recommended to use the hexadecimal notation when specifying fill values for float and double types. Note that these are the netCDF-4 default fill values, there should be no need to specify these values explicitly. In some cases the fill value for float or double variables may fall within the valid range of a variable. For those cases an explicit fill value must be set, the value $-9.9692099683868690 \times 10^{36}$ (hex: $-0x1.ep+122$) is recommended for these cases.

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Fill value</th>
</tr>
</thead>
<tbody>
<tr>
<td>byte</td>
<td>8-bit signed integer</td>
<td>$-127$</td>
</tr>
<tr>
<td>ubyte</td>
<td>8-bit unsigned integer</td>
<td>$255$</td>
</tr>
<tr>
<td>short</td>
<td>16-bit signed integer</td>
<td>$-32767$</td>
</tr>
<tr>
<td>ushort</td>
<td>16-bit unsigned integer</td>
<td>$65535$</td>
</tr>
<tr>
<td>int</td>
<td>32-bit signed integer</td>
<td>$-2147483647$</td>
</tr>
<tr>
<td>uint</td>
<td>32-bit unsigned integer</td>
<td>$4294967295$</td>
</tr>
<tr>
<td>float</td>
<td>32-bit floating point</td>
<td>$9.9692099683868690 \times 10^{36}$ (hex: $0x1.ep+122$)</td>
</tr>
<tr>
<td>double</td>
<td>64-bit floating point</td>
<td>$9.9692099683868690 \times 10^{36}$ (hex: $0x1.ep+122$)</td>
</tr>
</tbody>
</table>

Table 11: Attributes for variables used in S5p netCDF-4 files. The data types refer to the short list in table 6.

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Std.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ancillary_variables</td>
<td>S</td>
<td>CF</td>
<td>Identifies a variable that contains closely associated data, e.g. the measurement uncertainties of instrument data.</td>
</tr>
<tr>
<td>bounds</td>
<td>S</td>
<td>CF</td>
<td>Connects a boundary variable to a coordinate variable.</td>
</tr>
<tr>
<td>cell_measures</td>
<td>S</td>
<td>CF</td>
<td>Identifies variables that contain cell areas or volumes. This can be used to connect approximate ground pixel coverage in km$^2$ to data-fields.</td>
</tr>
<tr>
<td>comment</td>
<td>S</td>
<td>CF</td>
<td>Miscellaneous information about the data or methods used to produce it.</td>
</tr>
<tr>
<td>coordinates</td>
<td>S</td>
<td>CF</td>
<td>Identifies auxiliary coordinate variables, providing a connection between data and geolocation, time.</td>
</tr>
<tr>
<td>_FillValue</td>
<td>P</td>
<td>NUG</td>
<td>Value to represent missing or undefined data. Recommended (default) values are given in table 10.</td>
</tr>
<tr>
<td>flag_masks</td>
<td>P</td>
<td>CF</td>
<td>Provides a list of bit fields expressing Boolean or enumerated flags.</td>
</tr>
<tr>
<td>flag_meanings</td>
<td>S</td>
<td>CF</td>
<td>Use in conjunction with flag_values to provide descriptive words or phrases for each flag value.</td>
</tr>
<tr>
<td>flag_values</td>
<td>P</td>
<td>CF</td>
<td>Provides a list of the flag values. Use in conjunction with flag_meanings.</td>
</tr>
<tr>
<td>formula</td>
<td>S</td>
<td>CF</td>
<td>Formula to calculate the values for an adaptive grid, for instance for a dimensionless vertical coordinate. Example: &quot;hyam hybm (mlev=hyam+hybm*aps)&quot;.</td>
</tr>
<tr>
<td>formula_terms</td>
<td>S</td>
<td>CF</td>
<td>Identifies variables that correspond to the terms in a formula, for instance for a dimensionless vertical coordinate. Example: &quot;ap: hyam b: hybm ps: aps&quot;</td>
</tr>
<tr>
<td>institution</td>
<td>S</td>
<td>CF</td>
<td>Specifies where the original data was produced.</td>
</tr>
<tr>
<td>long_name</td>
<td>S</td>
<td>CF</td>
<td>A descriptive name that indicates a variable’s content. This name is not standardized.</td>
</tr>
<tr>
<td>positive</td>
<td>S</td>
<td>CF</td>
<td>Direction of increasing vertical coordinate value (‘up’ for $z$ in m or ‘down’ for $p$ in hPa).</td>
</tr>
<tr>
<td>references</td>
<td>S</td>
<td>CF</td>
<td>References that describe the data or methods used to produce it.</td>
</tr>
<tr>
<td>source</td>
<td>S</td>
<td>CF</td>
<td>Method of production of the original data.</td>
</tr>
</tbody>
</table>
Table 11: Attributes for variables used in SSp netCDF-4 files (continued).

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Std.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>standard_error_multiplier</td>
<td>F</td>
<td>CF</td>
<td>If a data variable with a standard_name modifier of standard_error has this attribute, it indicates that the values are the stated multiple of one standard error. The only allowed value for SSp files is 1, used only to disambiguate.</td>
</tr>
<tr>
<td>standard_name</td>
<td>S</td>
<td>CF</td>
<td>A standard name that references a description of a variable’s content in the standard name table.</td>
</tr>
<tr>
<td>units</td>
<td>S</td>
<td>CF</td>
<td>Units of a variable’s content. See section 9 for a detailed discussion.</td>
</tr>
<tr>
<td>valid_max</td>
<td>P</td>
<td>NUG</td>
<td>Largest valid value of a variable.</td>
</tr>
<tr>
<td>valid_min</td>
<td>P</td>
<td>NUG</td>
<td>Smallest valid value of a variable.</td>
</tr>
<tr>
<td>valid_range</td>
<td>P[2]</td>
<td>NUG</td>
<td>Smallest and largest valid values of a variable. This attribute should not be combined with either valid_min or valid_max</td>
</tr>
</tbody>
</table>
12 Common elements in all S5P products

This section describes the elements that are common to all S5P/TROPOMI products. The product specific descriptions include references to this section. References to standards follow the abbreviations given in table 6.

12.1 Common file-level attributes

These are the file-level attributes.

Attributes in global

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventions</td>
<td>‘CF-1.7’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>Name of the conventions followed by the dataset. Note that while we try to follow the climate and forecast metadata conventions, there are some features – notably the use of groups to hierarchically organize the data – that are not part of version 1.6 of the CF metadata conventions. In those cases we try to follow the spirit of the conventions. This attribute originates from the NUG standard.</td>
<td></td>
</tr>
<tr>
<td>institution</td>
<td>‘%(institute)s’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>The institute where the original data was produced. The actual processing center is given in the ProcessingCenter attribute, here we would like to indicate the responsible parties. The value is a combination from BIRA, DLR, ESA, FMI, IUP, KNMI, MPIC, SRON, ... The actual value is a combination of the ATBD institute and the institute that developed the processor. This attribute originates from the NUG standard.</td>
<td></td>
</tr>
<tr>
<td>source</td>
<td>‘Sentinel 5 precursor, TROPOMI, space-borne remote sensing, L2’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>Method of production of the original data. Value includes instrument, generic description of retrieval, product level, and adds a short product name and processor version. This attribute originates from the CF standard.</td>
<td></td>
</tr>
<tr>
<td>history</td>
<td></td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>Provides an audit trail for modifications to the original data. Well-behaved generic netCDF filters will automatically append their name and the parameters with which they were invoked to the global history attribute of an input netCDF file. Each line shall begin with a timestamp indicating the date and time of day that the program was executed. This attribute originates from the NUG, CF standards.</td>
<td></td>
</tr>
<tr>
<td>summary</td>
<td></td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>Miscellaneous information about the data or methods used to produce it.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>If processing in a degraded mode occurred, then a note should be placed in this attribute. A degraded processing mode can occur for several reasons, for instance the use of static backup data for nominally dynamic input or an irradiance product that is older than a few days. A machine-parseable description is available in the “processing_status” attribute. This attribute originates from the CF standard.</td>
<td></td>
</tr>
<tr>
<td>tracking_id</td>
<td></td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>This unique tracking ID is proposed by the Climate Change Initiative – European Space Agency project. This ID is a UUID and allows files to be referenced, and linked up to processing description, input data, documentation, etc. The CCI-ESA project uses version 4 UUIDs (random number based) for consistency with CMIP5. This attribute originates from the CCI standard.</td>
<td></td>
</tr>
<tr>
<td>id</td>
<td>‘%(logical_filename)s’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>The “id” and “naming_authority” attributes are intended to provide a globally unique identification for each dataset. The “id” value should attempt to uniquely identify the dataset. The naming authority allows a further refinement of the “id”. The combination of the two should be globally unique for all time. We use the logical file name for the “id” attribute. This attribute originates from the CCI standard.</td>
<td></td>
</tr>
<tr>
<td>time_reference</td>
<td>‘YYYY-MM-DDT00:00:00Z’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>UTC time reference as an ISO 8601 [RD35] string. This corresponds to the UTC value in the time dimensional variable. By definition it indicates UTC midnight before the start of the granule.</td>
<td></td>
</tr>
<tr>
<td>Attribute</td>
<td>Value</td>
<td>Type</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>----------------------------------------------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>time_reference_days_since_1950</td>
<td>0 (dynamic)</td>
<td>NC_INT</td>
</tr>
<tr>
<td></td>
<td>The reference time expressed as the number of days since 1950-01-01. This is the reference time unit used by both TM5 and ECMWF.</td>
<td></td>
</tr>
<tr>
<td>time_reference_julian_day</td>
<td>0.0 (dynamic)</td>
<td>NC_DOUBLE</td>
</tr>
<tr>
<td></td>
<td>The reference time expressed as a Julian day number.</td>
<td></td>
</tr>
<tr>
<td>time_reference_seconds_since_1970</td>
<td>0 (dynamic)</td>
<td>NC_INT64</td>
</tr>
<tr>
<td></td>
<td>The reference time expressed as the number of seconds since 1970-01-01 00:00:00 UTC. This is the reference time unit used by Unix systems.</td>
<td></td>
</tr>
<tr>
<td>time_coverage_start</td>
<td>'YYYY-MM-DDTHH:MM:SS.mmmmmmmZ' (dynamic)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>Start of the data granule in UTC as an ISO 8601 [RD35] string. See the discussion of the delta_time variable on page 39 for details.</td>
<td></td>
</tr>
<tr>
<td>time_coverage_end</td>
<td>'YYYY-MM-DDTHH:MM:SS.mmmmmmmZ' (dynamic)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>End of the data granule in UTC as an ISO 8601 [RD35] string. See the discussion of the delta_time variable on page 39 for details.</td>
<td></td>
</tr>
<tr>
<td>time_coverage_duration</td>
<td>NC_STRING</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Duration of the data granule as an ISO 8601 [RD35] duration string (&quot;PT%(duration_seconds)sS&quot;). This attribute originates from the CCI standard.</td>
<td></td>
</tr>
<tr>
<td>time_coverage_resolution</td>
<td>NC_STRING</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Interval between measurements in the data granule as an ISO 8601 [RD35] duration string (&quot;PT%(interval_seconds)fS&quot;). For most products this is 840 or 1080 ms in nominal operation, except for &quot;L2__O3__PR&quot;, which uses 3240 ms due to coaddition. This attribute originates from the CCI standard.</td>
<td></td>
</tr>
<tr>
<td>orbit</td>
<td>0 (dynamic)</td>
<td>NC_INT</td>
</tr>
<tr>
<td></td>
<td>The absolute orbit number, starting at 1 – first ascending node crossing after spacecraft separation. For pre-launch testing this value should be set to &quot;−1&quot;.</td>
<td></td>
</tr>
<tr>
<td>references</td>
<td>'%(references)s' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>References that describe the data or methods used to produce it. This attribute originates from the CF standard.</td>
<td></td>
</tr>
<tr>
<td>processor_version</td>
<td>'%(version)s' (dynamic)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>The version of the data processor, as string of the form &quot;major.minor.patch&quot;.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The guidelines followed for the keywords attribute. We use the index terms published by the AGU.</td>
<td></td>
</tr>
<tr>
<td>keywords</td>
<td>'%(keywords_agu)s' (dynamic)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>Keywords from the &quot;keywords_vocabulary&quot; describing the contents of the file. To be provided by the ATBD authors.</td>
<td></td>
</tr>
<tr>
<td>standard_name_vocabulary</td>
<td>'NetCDF Climate and Forecast Metadata Conventions Standard Name Table (v29, 08 July 2015), <a href="http://cfcconventions.org/standard-names.html">http://cfcconventions.org/standard-names.html</a>' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>The table followed for the standard_name attributes.</td>
<td></td>
</tr>
<tr>
<td>naming_authority</td>
<td>'%(naming_authority)s' (dynamic)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>Specify who is giving out the id attribute. This attribute originates from the CCI standard.</td>
<td></td>
</tr>
<tr>
<td>cdm_data_type</td>
<td>'Swath' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>The THREDDS data type appropriate for this dataset, fixed to &quot;Swath&quot; for S5P level 2 products. This attribute originates from the CCI standard.</td>
<td></td>
</tr>
<tr>
<td>date_created</td>
<td>'YYYY-mm-ddTHH:MM:SS.ffffffZ' (dynamic)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>The date on which this file was created. This attribute originates from the CCI standard.</td>
<td></td>
</tr>
<tr>
<td>creator_name</td>
<td>'%(credit)s' (dynamic)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>
The name of the creator, equal to the value of the "gmd:credit" attribute. For S5P this attribute is set to "The Sentinel 5 Precursor TROPOMI Level 2 products are developed with funding from the European Space Agency (ESA), the Netherlands Space Office (NSO), the Belgian Science Policy Office, the German Aerospace Center (DLR) and the Bayerisches Staatsministerium für Wirtschaft und Medien, Energie und Technologie (StMWi)." This attribute originates from the CCI standard.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>creator_url</td>
<td>'<a href="http://www.tropomi.eu/">http://www.tropomi.eu/</a>'</td>
</tr>
<tr>
<td>creator_url</td>
<td>'<a href="mailto:EOSupport@Copernicus.esa.int">EOSupport@Copernicus.esa.int</a>'</td>
</tr>
<tr>
<td>project</td>
<td>'Sentinel 5 precursor/TROPOMI'</td>
</tr>
<tr>
<td>geospatial_lat_min</td>
<td>NC_FLOAT</td>
</tr>
<tr>
<td>geospatial_lat_max</td>
<td>NC_FLOAT</td>
</tr>
<tr>
<td>geospatial_lon_min</td>
<td>NC_FLOAT</td>
</tr>
<tr>
<td>geospatial_lon_max</td>
<td>NC_FLOAT</td>
</tr>
<tr>
<td>license</td>
<td>'No conditions apply'</td>
</tr>
<tr>
<td>platform</td>
<td>'S5P'</td>
</tr>
<tr>
<td>sensor</td>
<td>'TROPOMI'</td>
</tr>
<tr>
<td>spatial_resolution</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>cpp_compiler_version</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>cpp_compiler_flags</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>f90_compiler_version</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>f90_compiler_flags</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>exe_linker_flags</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>build_date</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>revision_control_identifier</td>
<td>'%(revision_control_source_identifier)s'</td>
</tr>
<tr>
<td>geolocation_grid_from_band</td>
<td>NC_INT</td>
</tr>
</tbody>
</table>
The band from which the geolocation was taken, useful for colocating the level 2 output with other products.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>identifier_product_doi</td>
<td>‘%(product_doi)s’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>identifier_product_doi_authority</td>
<td>‘<a href="http://dx.doi.org/%E2%80%99">http://dx.doi.org/’</a> (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

This is the DOI (“Digital Object Identifier”) of the current product. It allows to easily find download and background information, even if that location is moved after the file has been created.

This attribute defines the authoritative service for use with DOI values in resolving to the URL location.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>algorithm_version</td>
<td>‘%(algorithm_version)s’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>product_version</td>
<td>‘0.0.0’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>processing_status</td>
<td>Nominal (dynamic)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The algorithm version, separate from the processor (framework) version, to accommodate different release schedules for different products.

The product version, separate from the processor (framework) and algorithm version.

Description the processing status of the granule on a global level, mainly based on the availability of auxiliary input data.

Possible values: Nominal, Degraded

### 12.2 Common file-level attributes for DLR

These are the file-level attributes, DLR-L2 specific.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>cloud_mode</td>
<td></td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The attribute aims at identifying the source of the cloud parameter, either “cal” or “crb”.

Possible values: crb, cal

### 12.3 Status dynamic ECMWF auxiliary data

If the ECMWF dynamic auxiliary data is not available a fallback solution will be used. In this case the Level 2 output file will be flagged using the “Status_MET_2D” global attribute.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status_MET_2D</td>
<td></td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The status of ECMWF input, either “Nominal” or “Fallback”. Note that the “MET_2D” auxiliary input is used as an anchor point for all meteorological data (where applicable).

Possible values: Nominal, Fallback

### 12.4 Status dynamic NISE auxiliary data

If the NISE dynamic auxiliary data is not available a fallback solution will be used. In this case the Level 2 output file will be flagged using the “Status_NISE__” global attribute.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status_NISE__</td>
<td></td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The status of NISE input, either “Nominal” or “Fallback”.

Possible values: Nominal, Fallback

### 12.5 Status background correction auxiliary data

In case of unavailability of background correction auxiliary data, the correction will be not applied and the L2 output file will be flagged accordingly.
Name | Value | Type
---|---|---
Status_BG | | NC_STRING
The status of background correction input, either “Nominal” or “Fallback”.
Possible values: Nominal, Fallback

### 12.6 Status dynamic NPP-VIIRS auxiliary data

The NPP-VIIRS dynamic auxiliary data is written into the level-2 product and then later used by the background processors to generate the AUX_BGCLD_ and AUX_BGO3__ products. The availability does not affect the processing status of the current product.

Name | Value | Type
---|---|---
Status_NP_BD3 | | NC_STRING
The status of the NPP-VIIRS band 3 input, either “Nominal” or “Unavailable”.
Possible values: Nominal, Unavailable

### 12.7 Common dimensions

The dimensions that are common to all products. These are all located in the “PRODUCT” group, and can be accessed from that group and all sub-groups of the “PRODUCT” group, that is everywhere except the “METADATA” group.

- **Scanline**: The number of measurements along the swath, in the flight-direction.
  - **Size**: Unlimited.
  - **Mode**: Present in all modes.

- **Ground pixel**: The number of ground pixels across track. This depends on the product and will follow the dimension found in the main input Level 1B product.
  - **Size**: -1 (dynamic)
  - **Source**: L1B.
  - **Mode**: Present in all modes.

- **Time**: The time dimension. See the discussion of the associated dimensional variable on page 37 for details.
  - **Size**: 1 (fixed)
  - **Mode**: Present in all modes.

### 12.8 Coordinate variables

All dimensions have an associated variable. These variables give a meaning to the dimension, spanning the axis of other variables.

**Scanline**

- **Description**: The coordinate variable scanline refers to the along-track dimension of the measurement. The scanlines are time-ordered, meaning that “earlier” measurements have a lower index than “later” measurements. This variable merely contains an index to ensure that when indicating a pixel in a file the same index is used. This avoids the off-by-one confusion that frequently occurred in OMI discussions.

- **Dimensions**: scanline (coordinate variable).
- **Type**: NC_INT.
- **Source**: Processor.
- **Mode**: Present in all modes.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>‘1’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

Dimensionless, no physical quantity. This attribute originates from the CF standard.
**ground_pixel**

Description: The coordinate variable `ground_pixel` refers to the across-track dimension of the measurement. The `ground_pixel` ordering is from left to right with respect to the flight direction. For the Sentinel 5 precursor orbit this corresponds to west to east during the ascending part of the orbit, i.e. a higher index corresponds to a higher longitude. This variable merely contains an index to ensure that when indicating a pixel in a file the same index is used. This avoids the off-by-one confusion that frequently occurred in OMI discussions.

Dimensions: `ground_pixel` (coordinate variable).
Type: NC_INT.
Source: Processor.
Mode: Present in all modes.

Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>‘1’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>Dimensionless, no physical quantity. This attribute originates from the CF standard.</td>
<td></td>
</tr>
<tr>
<td>axis</td>
<td>‘X’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>long_name</td>
<td>‘across-track dimension index’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>comment</td>
<td>‘This coordinate variable defines the indices across track, from west to east; index starts at 0’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

**time**

Description: The variable `time(time)` is the reference time of the measurements. The reference time is set to YYYY-MM-DDT00:00:00 UTC, midnight UTC before spacecraft midnight, the formal start of the current orbit. The `delta_time(scanline)` variable indicates the time difference of the observations with the reference time. Thus combining the information of `time(time)` and `delta_time(scanline)` yields the measurement time for each scanline as UTC time. The reference `time(time)` corresponds to the global attribute `time_reference` which is specified as a UTC time specified as an ISO 8601 [RD35] date.

Dimensions: `time` (coordinate variable).
Type: NC_INT.
Source: Processor.
Mode: Present in all modes.

Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>‘seconds since 2010-01-01 00:00:00’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>standard_name</td>
<td>‘time’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>axis</td>
<td>‘T’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>long_name</td>
<td>‘reference time for the measurements’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>comment</td>
<td>‘The time in this variable corresponds to the time in the time_reference global attribute’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

### 12.9 Corner Dimension

All dimensions have an associated variable. Corner dimension is included in a separated file.
Description: An index for the pixel corners. We follow the CF-Metadata conventions [ER5, section 7.1]. The full coordinate system is right-handed, and the order of the pixel corners is counterclockwise, starting in the "lower-left" corner (i.e., the smallest value in both latitude and longitude on the ascending part of the orbit, or equivalently for TROPOMI the lowest value for both the ground_pixel and scanline indices). See figure 6 on page 16 for a graphical depiction of the corners.

Dimensions: corner (coordinate variable).

Type: NC_INT.

Source: Processor.

Mode: Present in all modes.

Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>‘1’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>long_name</td>
<td>‘pixel corner index’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>comment</td>
<td>‘This coordinate variable defines the indices for the pixel corners; index starts a 0 (counterclockwise, starting from south-western corner of the pixel in ascending part of the orbit).’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.10 The geolocation fields

The latitude and longitude. Used in all products, placed in the "PRODUCT" group.

latitude

Description: The latitude of the pixel centers of the ground pixels in the data. Latitude, longitude coordinates for the ground pixel center and the ground pixel corners are calculated at the WGS84 ellipsoid.

Dimensions: time, scanline, ground_pixel.

Type: NC_FLOAT.

Source: Processor.

Mode: Present in all modes.

Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>long_name</td>
<td>‘pixel center latitude’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>units</td>
<td>‘degrees_north’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>standard_name</td>
<td>‘latitude’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>valid_min</td>
<td>-90.0 (static)</td>
<td>NC_FLOAT</td>
</tr>
<tr>
<td>valid_max</td>
<td>90.0 (static)</td>
<td>NC_FLOAT</td>
</tr>
<tr>
<td>bounds</td>
<td>‘/PRODUCT/SUPPORT_DATA/GEOLocations/latitude_bounds’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

A link to the boundary coordinates, i.e., the pixel corners. Note that the use of group-names in this attribute is an extension of the climate and forecasting metadata conventions.

longitude

Description: The longitude of the pixel centers of the ground pixels in the data. Latitude, longitude coordinates for the ground pixel center and the ground pixel corners are calculated at the WGS84 ellipsoid.

Dimensions: time, scanline, ground_pixel.

Type: NC_FLOAT.

Source: Processor.

Mode: Present in all modes.

Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>long_name</td>
<td>‘pixel center longitude’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>units</td>
<td>‘degrees_west’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>
12.11 Common product fields

**delta_time**

Description: The `delta_time(scanline)` variable indicates the time difference with the reference `time(time)` (see page 37). Thus combining the information of `time(time)` and `delta_time(scanline)` yields the start of the measurement time for each scanline as TAI2010 time. Combining the information in the global attribute `time_reference` with `delta_time(scanline)` yields the start of the measurement time in UTC time. The UTC time derived for the first scanline corresponds to the global attribute `time_coverage_start`. However, the UTC time derived for the last scanline does not correspond to global attribute `time_coverage_end`. One scanline measurement is the result of adding independent measurements during one coaddition period. The scanline measurement is given the measurement time of the first sample in this co-addition. It is the measurement time of the last sample in the coaddition period of the last scanline that corresponds to `time_coverage_end`. This variable gives the time offset in ms accuracy.

Dimensions: time, scanline, ground_pixel.

Type: NC_INT.

Source: Processor.

Mode: Present in all modes.

Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>long_name</td>
<td>'offset from reference start time of measurement' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>units</td>
<td>'milliseconds since %(ref_time)s' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

**time_utc**

Description: The time of observation expressed as ISO 8601 [RD35] date-time string.

Dimensions: time, scanline.

Type: NC_STRING.

Source: Processor.

Mode: Present in all modes.

Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>long_name</td>
<td>'Time of observation as ISO 8601 date-time string' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

**qa_value**

Description: A continuous quality descriptor, varying between 0 (no data) and 1 (full quality data). The value will change based on observation conditions and retrieval flags. Detailed quality flags are provided in the `processing_quality_flags` elsewhere in the product.

Dimensions: time, scanline, ground_pixel.

Type: NC_UBYTE.

Source: Processor.
12.12 Main CAL Cloud Product

Variables in main_cloud_product_cal

cloud_fraction
Description: Retrieved effective radiometric cloud fraction using the OCRA/ROCINN CAL model.
Dimensions: time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>‘1’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>long_name</td>
<td>‘effective radiometric cloud fraction’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>source</td>
<td>‘cal’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>comment</td>
<td>‘Coregistered effective radiometric cloud fraction using the OCRA/ROCINN CAL model.’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
<td>‘/PRODUCT/longitude /PRODUCT/latitude’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

cloud_fraction_precision
Description: Error of the retrieved effective radiometric cloud fraction using the OCRA/ROCINN CAL model.
Dimensions: time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>‘1’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>long_name</td>
<td>‘effective radiometric cloud fraction precision’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>source</td>
<td>‘cal’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>
### cloud_top_pressure

**Description:** Retrieved atmospheric pressure at the level of cloud top using the OCRA/ROCINN CAL model.

**Dimensions:** time, scanline, ground_pixel.

**Type:** NC_FLOAT.

**Source:** Processor.

**Mode:** Present in all modes.

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>units</td>
<td>‘Pa’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>standard_name</td>
<td>‘air_pressure_at_cloud_top’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>long_name</td>
<td>‘cloud optical centroid top pressure’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>source</td>
<td>‘cal’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>comment</td>
<td>‘Coregistered and converted atmospheric pressure at the level of cloud top using the OCRA/ROCINN CAL model.’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

**coordinates**

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

### cloud_top_pressure_precision

**Description:** Error of the retrieved atmospheric pressure at the level of cloud top using the OCRA/ROCINN CAL model.

**Dimensions:** time, scanline, ground_pixel.

**Type:** NC_FLOAT.

**Source:** Processor.

**Mode:** Present in all modes.

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>units</td>
<td>‘Pa’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>standard_name</td>
<td>‘air_pressure_at_cloud_top standard_error’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>long_name</td>
<td>‘cloud optical centroid top pressure precision’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>source</td>
<td>‘cal’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>comment</td>
<td>‘Error of the coregistered and converted atmospheric pressure at the level of cloud top using the OCRA/ROCINN CAL model.’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

**coordinates**

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

### cloud_base_pressure

**Description:** Cloud base pressure calculated using the OCRA/ROCINN CAL model.

**Dimensions:** time, scanline, ground_pixel.

**Type:** NC_FLOAT.

**Source:** Processor.

**Mode:** Present in all modes.
### cloud_base_pressure_precision

Description: Error of the cloud base pressure calculated using the OCRA/ROCINN CAL model.

Dimensions: time, scanline, ground_pixel.

Type: NC_FLOAT.

Source: Processor.

Mode: Present in all modes.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>'Pa' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>standard_name</td>
<td>'air_pressure_at_cloud_base' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>long_name</td>
<td>'cloud base pressure precision assumed in ROCINN retrieval' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>source</td>
<td>'cal' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>comment</td>
<td>'Error of the coregistered and converted cloud base pressure retrieved using the OCRA/ROCINN CAL model.' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
<td>'/PRODUCT/longitude /PRODUCT/latitude' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

### cloud_top_height

Description: Retrieved vertical distance of the cloud top above the surface w.r.t. the geoid/MSL using the OCRA/ROCINN CAL model.

Dimensions: time, scanline, ground_pixel.

Type: NC_FLOAT.

Source: Processor.

Mode: Present in all modes.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>'m' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>long_name</td>
<td>'cloud top height' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>source</td>
<td>'cal' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>comment</td>
<td>'Coregistered vertical distance of the cloud top above the surface w.r.t. the geoid/MSL using the OCRA/ROCINN CAL model.' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
<td>'/PRODUCT/longitude /PRODUCT/latitude' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

### cloud_top_height_precision
**cloud_top_height**

Description: Error of the retrieved vertical distance of the cloud top above the surface w.r.t. the geoid/MSL using the OCRA/ROCINN CAL model.

Dimensions: time, scanline, ground_pixel.

Type: NC_FLOAT.

Source: Processor.

Mode: Present in all modes.

Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>'m' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>long_name</td>
<td>'cloud top height precision' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>source</td>
<td>'cal' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>comment</td>
<td>'Error of the coregistered vertical distance of the cloud top above the surface w.r.t. the geoid/MSL using the OCRA/ROCINN CAL model.' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
<td>'/PRODUCT/longitude /PRODUCT/latitude' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

**cloud_base_height**

Description: Cloud base height calculated w.r.t. the geoid/MSL using the OCRA/ROCINN CAL model.

Dimensions: time, scanline, ground_pixel.

Type: NC_FLOAT.

Source: Processor.

Mode: Present in all modes.

Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>'m' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>long_name</td>
<td>'cloud base height assumed in ROCINN retrieval' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>source</td>
<td>'cal' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>comment</td>
<td>'Coregistered cloud base height w.r.t. the geoid/MSL using the OCRA/ROCINN CAL model.' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
<td>'/PRODUCT/longitude /PRODUCT/latitude' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

**cloud_base_height_precision**

Description: Error of the cloud base height calculated w.r.t. the geoid/MSL using the OCRA/ROCINN CAL model.

Dimensions: time, scanline, ground_pixel.

Type: NC_FLOAT.

Source: Processor.

Mode: Present in all modes.

Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>'m' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>long_name</td>
<td>'cloud base height precision assumed in ROCINN retrieval' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>source</td>
<td>'cal' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>comment</td>
<td>'Error of the coregistered cloud base height w.r.t. the geoid/MSL using the OCRA/ROCINN CAL model.' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
<td>'/PRODUCT/longitude /PRODUCT/latitude' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>
The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

**cloud_optical_thickness**

Description: Cloud Optical Thickness using the OCRA/ROCINN CAL model.

Dimensions: time, scanline, ground_pixel.

Type: NC_FLOAT.

Source: Processor.

Mode: Present in all modes.

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>units</td>
<td>‘1’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>standard_name</td>
<td>‘atmosphere_optical_thickness_due_to_cloud’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>long_name</td>
<td>‘cloud optical thickness’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>source</td>
<td>‘cal’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>comment</td>
<td>‘Coregistered cloud optical thickness based on the OCRA/ROCINN CAL model.’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>coordinates</td>
<td>‘/PRODUCT/longitude /PRODUCT/latitude’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

**cloud_optical_thickness_precision**

Description: Error of the cloud Optical Thickness using the OCRA/ROCINN CAL model.

Dimensions: time, scanline, ground_pixel.

Type: NC_FLOAT.

Source: Processor.

Mode: Present in all modes.

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>units</td>
<td>‘1’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>standard_name</td>
<td>‘atmosphere_optical_thickness_due_to_cloud_standard_error’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>long_name</td>
<td>‘cloud optical thickness precision coregistered using the OCRA/ROCINN CAL model.’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>source</td>
<td>‘cal’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>comment</td>
<td>‘Error of the coregistered cloud optical thickness based on the OCRA/ROCINN CAL model.’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>coordinates</td>
<td>‘/PRODUCT/longitude /PRODUCT/latitude’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

### 12.13 Additional geolocation support fields

**satellite_latitude**

Description: Latitude of the geodetic sub satellite point on the WGS84 reference ellipsoid.

Dimensions: time, scanline.

Type: NC_FLOAT.

Source: L1B.

Mode: Present in all modes.

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>long_name</td>
<td>‘sub satellite latitude’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>
### satellite_longitude

Description: Longitude of the geodetic sub satellite point on the WGS84 reference ellipsoid.

Dimensions: time, scanline.

Type: NC_FLOAT.

Source: L1B.

Mode: Present in all modes.

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>long_name</td>
<td>'satellite_longitude'  (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>units</td>
<td>'degrees_east' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>comment</td>
<td>'Longitude of the geodetic sub satellite point on the WGS84 reference ellipsoid' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>valid_min</td>
<td>-180.0 (static)</td>
<td>NC_FLOAT</td>
</tr>
<tr>
<td>valid_max</td>
<td>180.0 (static)</td>
<td>NC_FLOAT</td>
</tr>
</tbody>
</table>

### satellite_altitude

Description: The altitude of the satellite with respect to the geodetic sub satellite point on the WGS84 reference ellipsoid.

Dimensions: time, scanline.

Type: NC_FLOAT.

Source: L1B.

Mode: Present in all modes.

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>long_name</td>
<td>'satellite altitude'  (static)</td>
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</tr>
<tr>
<td>units</td>
<td>'m' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>comment</td>
<td>'The altitude of the satellite with respect to the geodetic sub satellite point on the WGS84 reference ellipsoid' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>valid_min</td>
<td>700000.0 (static)</td>
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<tr>
<td>valid_max</td>
<td>900000.0 (static)</td>
<td>NC_FLOAT</td>
</tr>
</tbody>
</table>

### satellite_orbit_phase

Description: Relative offset [0.0, ..., 1.0] of the measurement in the orbit.

Dimensions: time, scanline.

Type: NC_FLOAT.

Source: L1B.

Mode: Present in all modes.

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
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<td>units</td>
<td>'1' (static)</td>
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</tr>
<tr>
<td>comment</td>
<td>'Relative offset [0.0, ..., 1.0] of the measurement in the orbit' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>valid_min</td>
<td>-0.02 (static)</td>
<td>NC_FLOAT</td>
</tr>
<tr>
<td>valid_max</td>
<td>1.02 (static)</td>
<td>NC_FLOAT</td>
</tr>
</tbody>
</table>

### solar_zenith_angle
Description: Solar zenith angle $\vartheta_0$ at the ground pixel location on the reference ellipsoid. Angle is measured away from the vertical. ESA definition of day side: $\vartheta_0 < 92^\circ$. Pixels are processed when $\vartheta_0 \leq \vartheta_0^{\text{max}}$ with $80^\circ \leq \vartheta_0^{\text{max}} \leq 88^\circ$, depending on the algorithm. The actual value for $\vartheta_0^{\text{max}}$ can be found in the algorithm metadata settings.

Dimensions: time, scanline, ground_pixel.

Type: NC_FLOAT.

Source: L1B.

Mode: Present in all modes.

Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
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<td>long_name</td>
<td>'solar zenith angle' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>standard_name</td>
<td>'solar zenith angle' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>units</td>
<td>'degree' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>valid_min</td>
<td>0.0 (static)</td>
<td>NC_FLOAT</td>
</tr>
<tr>
<td>valid_max</td>
<td>180.0 (static)</td>
<td>NC_FLOAT</td>
</tr>
<tr>
<td>coordinates</td>
<td>'/PRODUCT/longitude /PRODUCT/latitude' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The latitude and longitude are in a different group. How to specify the related geospatial coordinates in this case is not specified in the climate and forecast metadata conventions [ER5].

comment 'Solar zenith angle at the ground pixel location on the reference ellipsoid. Angle is measured away from the vertical' (static) NC_STRING

solar_azimuth_angle

Description: The solar azimuth angle at the ground pixel location on the reference ellipsoid. The angle is measured clockwise from the North ($\text{North} = 0^\circ$, East = $90^\circ$, South = $180^\circ$, West = $270^\circ$). This is the same definition that is used in both OMI and GOME-2 level 1B files. See the note on the viewing_azimuth_angle on the calculation of the relative azimuth angle as used in radiative transfer calculations.

Dimensions: time, scanline, ground_pixel.

Type: NC_FLOAT.

Source: L1B.

Mode: Present in all modes.

Attributes:

<table>
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<td>NC_STRING</td>
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<tr>
<td>units</td>
<td>'degree' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>valid_min</td>
<td>-180.0 (static)</td>
<td>NC_FLOAT</td>
</tr>
<tr>
<td>valid_max</td>
<td>180.0 (static)</td>
<td>NC_FLOAT</td>
</tr>
<tr>
<td>coordinates</td>
<td>'/PRODUCT/longitude /PRODUCT/latitude' (static)</td>
<td>NC_STRING</td>
</tr>
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</table>

The latitude and longitude are in a different group. How to specify the related geospatial coordinates in this case is not specified in the climate and forecast metadata conventions [ER5].

comment 'Solar azimuth angle at the ground pixel location on the reference ellipsoid. Angle is measured clockwise from the North (East = 90, South = 180, West = 270)' (static) NC_STRING

viewing_zenith_angle

Description: Zenith angle of the satellite $\vartheta$ at the ground pixel location on the reference ellipsoid. Angle is measured away from the vertical.

Dimensions: time, scanline, ground_pixel.

Type: NC_FLOAT.
### viewing_zenith_angle

**Description:** The satellite zenith angle at the ground pixel location on the reference ellipsoid. Angle is measured away from the vertical (satellite). Angle is measured clockwise from the North (East = 90°, South = 180°, West = 270°).

To calculate the zenith difference $\varphi - \varphi_0$, it is not sufficient to just subtract solar_zenith_angle from viewing_zenith_angle. The angle needed for radiative transfer calculations is $(180^\circ - (\varphi - \varphi_0)) \mod 360^\circ$.

**Dimensions:** time, scanline, ground_pixel.

**Type:** NC_FLOAT.

**Source:** L1B.

**Mode:** Present in all modes.

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
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<td>NC_STRING</td>
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<tr>
<td>standard_name</td>
<td>viewing_zenith_angle</td>
<td>(static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>units</td>
<td>degree</td>
<td>(static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>valid_min</td>
<td>0.0</td>
<td>(static)</td>
<td>NC_FLOAT</td>
</tr>
<tr>
<td>valid_max</td>
<td>180.0</td>
<td>(static)</td>
<td>NC_FLOAT</td>
</tr>
<tr>
<td>coordinates</td>
<td>PRODUCT/longitude</td>
<td>/PRODUCT/latitude</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The latitude and longitude are in a different group. How to specify the related geospatial coordinates in this case is not specified in the climate and forecast metadata conventions [ER5].

### latitude_bounds

**Description:** The latitude of the pixel corners of the ground pixels in the data. Latitude, longitude coordinates for the ground pixel center and the ground pixel corners are calculated at the WGS84 ellipsoid. The order of the pixel corners follows the CF-metadata conventions [ER5, section 7.1], i.e. the ordering is counter-clockwise when viewed from above. A graphical representation is given in figure 6.

**Dimensions:** time, scanline, ground_pixel, corner.

**Type:** NC_FLOAT.

**Source:** Processor.

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Name</th>
<th>Value</th>
<th>Type</th>
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<tbody>
<tr>
<td>long_name</td>
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<td>(static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>standard_name</td>
<td>viewing_zenith_angle</td>
<td>(static)</td>
<td>NC_STRING</td>
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<tr>
<td>units</td>
<td>degree</td>
<td>(static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>valid_min</td>
<td>-180.0</td>
<td>(static)</td>
<td>NC_FLOAT</td>
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<tr>
<td>valid_max</td>
<td>180.0</td>
<td>(static)</td>
<td>NC_FLOAT</td>
</tr>
<tr>
<td>coordinates</td>
<td>PRODUCT/longitude</td>
<td>/PRODUCT/latitude</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The latitude and longitude are in a different group. How to specify the related geospatial coordinates in this case is not specified in the climate and forecast metadata conventions [ER5].

**comment**

"Satellite azimuth angle at the ground pixel location on the reference ellipsoid. Angle is measured clockwise from the North (East = 90°, South = 180°, West = 270°)" (static)
### Mode:
Present in all modes.

### Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>‘degrees_north’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

#### longitude_bounds

**Description:**
The longitude of the pixel corners of the ground pixels in the data. Latitude, longitude coordinates for the ground pixel center and the ground pixel corners are calculated at the WGS84 ellipsoid.

The order of the pixel corners follows the CF-metadata conventions [ER5, section 7.1], i.e. the ordering is counter-clockwise when viewed from above. A graphical representation is given in figure 6.

**Dimensions:**
time, scanline, ground_pixel, corner.

**Type:**
NC_FLOAT.

**Source:**
Processor.

**Mode:**
Present in all modes.

### Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>‘degrees_east’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

#### geolocation_flags

**Description:**
Additional flags describing the ground pixel, including the influence of a solar eclipse, the possibility of sun glint, whether we are in the descending part of the orbit, whether we are on the night side of the orbit, whether the pixel crosses the dateline (useful for plotting), or if there was some geolocation error.

**Dimensions:**
time, scanline, ground_pixel.

**Type:**
NC_UBYTE.

**Source:**
Processor.

**Mode:**
Present in all modes.

### Attributes:

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<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
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<td>_FillValue</td>
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</tr>
<tr>
<td>coordinates</td>
<td>‘/PRODUCT/longitude /PRODUCT/latitude’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>flag_masks</td>
<td>0, 1, 2, 4, 8, 16, 128 (static)</td>
<td>NC_UBYTE</td>
</tr>
<tr>
<td>flag_meanings</td>
<td>‘no_error solar_eclipse sun_glint_possible descending night geo_boundary_crossing geolocation_error’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>flag_values</td>
<td>0, 1, 2, 4, 8, 16, 128 (static)</td>
<td>NC_UBYTE</td>
</tr>
<tr>
<td>long_name</td>
<td>‘ground pixel quality flag’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>max_val</td>
<td>254 (static)</td>
<td>NC_UBYTE</td>
</tr>
<tr>
<td>min_val</td>
<td>0 (static)</td>
<td>NC_UBYTE</td>
</tr>
<tr>
<td>units</td>
<td>‘1’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

### 12.14 Main fields for Cloud Product based on CRB model

#### cloud_fraction_crb

**Description:**
Retrieved effective radiometric cloud fraction using the OCRA/ROCINN CRB model.

**Dimensions:**
time, scanline, ground_pixel.

**Type:**
NC_FLOAT.

**Source:**
Processor.

**Mode:**
Present in all modes.
<table>
<thead>
<tr>
<th>Attributes:</th>
<th>Name</th>
<th>Value</th>
<th>Type</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>units</td>
<td>‘1’ (static)</td>
<td>NC_STRING</td>
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<tr>
<td></td>
<td>Dimensionless unit. This attribute originates from the NUG, CF standards.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>standard_name</td>
<td>‘TBD’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>long_name</td>
<td>‘effective radiometric cloud fraction from the CRB model’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>source</td>
<td>‘crb’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>comment</td>
<td>‘Coregistered effective radiometric cloud fraction using the OCRA/ROCINN CRB model.’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>coordinates</td>
<td>‘/PRODUCT/longitude /PRODUCT/latitude’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**cloud_fraction_crb_precision**

Description: Error of the retrieved effective radiometric cloud fraction using the OCRA/ROCINN CRB model.

Dimensions: time, scanline, ground_pixel.

Type: NC_FLOAT.

Source: Processor.

Mode: Present in all modes.

<table>
<thead>
<tr>
<th>Attributes:</th>
<th>Name</th>
<th>Value</th>
<th>Type</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>units</td>
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<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>Dimensionless unit. This attribute originates from the NUG, CF standards.</td>
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<td></td>
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<tr>
<td></td>
<td>standard_name</td>
<td>‘TBD’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>long_name</td>
<td>‘effective radiometric cloud fraction precision from the CRB model’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>source</td>
<td>‘crb’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>comment</td>
<td>‘Error of the coregistered effective radiometric cloud fraction using the OCRA/ROCINN CRB model.’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>coordinates</td>
<td>‘/PRODUCT/longitude /PRODUCT/latitude’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**cloud_pressure_crb**

Description: Retrieved atmospheric pressure at the level of cloud using the OCRA/ROCINN CRB model.

Dimensions: time, scanline, ground_pixel.

Type: NC_FLOAT.

Source: Processor.

Mode: Present in all modes.

<table>
<thead>
<tr>
<th>Attributes:</th>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
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<td>units</td>
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<td></td>
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<tr>
<td></td>
<td>standard_name</td>
<td>‘TBD’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>long_name</td>
<td>‘cloud radiometric optical centroid pressure from the CRB model’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>source</td>
<td>‘crb’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>comment</td>
<td>‘Coregistered and converted atmospheric pressure at the level of cloud using the OCRA/ROCINN CRB model.’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>coordinates</td>
<td>‘/PRODUCT/longitude /PRODUCT/latitude’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>
The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

### cloud_pressure_crb_precision

**Description:** Error of the retrieved atmospheric pressure at the level of cloud using the OCRA/ROCINN CRB model.

**Dimensions:** time, scanline, ground_pixel.

**Type:** NC_FLOAT.

**Source:** Processor.

**Mode:** Present in all modes.

**Attributes:**

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td><code>Pa</code> (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>standard_name</td>
<td><code>TBD</code> (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>long_name</td>
<td>'cloud radiometric optical centroid pressure precision from the CRB model' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>source</td>
<td><code>crb</code> (static)</td>
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</tr>
<tr>
<td>comment</td>
<td>'Error of the coregistered and converted atmospheric pressure at the level of cloud using the OCRA/ROCINN CRB model.' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
<td><code>/PRODUCT/longitude /PRODUCT/latitude</code></td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

### cloud_height_crb

**Description:** Retrieved height at the level of cloud w.r.t. the geoid/MSL using the OCRA/ROCINN CRB model.

**Dimensions:** time, scanline, ground_pixel.

**Type:** NC_FLOAT.

**Source:** Processor.

**Mode:** Present in all modes.

**Attributes:**

<table>
<thead>
<tr>
<th>Name</th>
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<th>Type</th>
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</thead>
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</tr>
<tr>
<td>standard_name</td>
<td><code>TBD</code> (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>long_name</td>
<td>'cloud radiometric optical centroid height from the CRB model' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>source</td>
<td><code>crb</code> (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>comment</td>
<td>'Coregistered height at the level of cloud w.r.t. the geoid/MSL using the OCRA/ROCINN CRB model.' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
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<td>NC_STRING</td>
</tr>
</tbody>
</table>

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

### cloud_height_crb_precision

**Description:** Error of the retrieved height at the level of cloud w.r.t. the geoid/MSL using the OCRA/ROCINN CRB model.

**Dimensions:** time, scanline, ground_pixel.

**Type:** NC_FLOAT.

**Source:** Processor.

**Mode:** Present in all modes.

**Attributes:**

<table>
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<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td><code>m</code> (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>
standard_name | 'TBD' (static) | NC_STRING
long_name | 'cloud radiometric optical centroid height precision from the CRB model' (static) | NC_STRING
source | 'crb' (static) | NC_STRING
comment | 'Error of the coregistered height at the level of cloud w.r.t. the geoid/MSL using the OCRA/ROCINN CRB model.' (static) | NC_STRING
coordinates | '/PRODUCT/longitude /PRODUCT/latitude' (static) | NC_STRING

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

cloud_albedo_crb
Description: Albedo of cloud using the OCRA/ROCINN CRB model.
Dimensions: time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Name</th>
<th>Value</th>
<th>Type</th>
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</tr>
<tr>
<td>long_name</td>
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<td></td>
</tr>
<tr>
<td>source</td>
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</tr>
<tr>
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<td>'Coregistered cloud albedo based on the OCRA/ROCINN CRB model.' (static)</td>
<td>NC_STRING</td>
<td></td>
</tr>
<tr>
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<td>'/PRODUCT/longitude /PRODUCT/latitude' (static)</td>
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</table>

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

cloud_albedo_crb_precision
Description: Error of the albedo of cloud using the OCRA/ROCINN CRB model.
Dimensions: time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.

<table>
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<th>Name</th>
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<th>Type</th>
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<tr>
<td>long_name</td>
<td>'cloud albedo precision from the CRB model' (static)</td>
<td>NC_STRING</td>
<td></td>
</tr>
<tr>
<td>source</td>
<td>'crb' (static)</td>
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</tr>
<tr>
<td>comment</td>
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The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

12.15 Detailed Results related to OCRA/ROCINN CAL Cloud Product
Variables in detailed_results_cloud_product_cal

**surface_albedo_fitted**
Description: Surface albedo fitted using the OCRA/ROCINN CAL model.
Dimensions: time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.

<table>
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<tr>
<td>standard_name</td>
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<tr>
<td>long_name</td>
<td>‘surface albedo fitted’ (static)</td>
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<td>‘cal’ (static)</td>
<td>NC_STRING</td>
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<tr>
<td>comment</td>
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<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
<td>‘/PRODUCT/longitude /PRODUCT/latitude’ (static)</td>
<td>NC_STRING</td>
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</table>

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

**surface_albedo_fitted_precision**
Description: Error of the fitted surface albedo calculated using the OCRA/ROCINN CAL model.
Dimensions: time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.

<table>
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<th>Type</th>
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<td>NC_STRING</td>
</tr>
<tr>
<td>long_name</td>
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<td>NC_STRING</td>
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<tr>
<td>source</td>
<td>‘cal’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>units</td>
<td>‘1’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>comment</td>
<td>Error of the coregistered surface albedo fitted using the OCRA/ROCINN CAL model. (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
<td>‘/PRODUCT/longitude /PRODUCT/latitude’ (static)</td>
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The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

12.16 Detailed Results related to the NIR variables of the Cloud Product

Variables in detailed_results_cloud_product_nir

**cloud_fraction_apriori_nir**
Description: A Priori Cloud Fraction coregistered by the OCRA/ROCINN model.
Dimensions: time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
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</table>
units          ‘1’ (static)                NC_STRING
long_name      ‘effective radiometric cloud fraction a priori’ (static)    NC_STRING
comment        ‘Coregistered radiometric cloud fraction based on the OCRA model.’ (static)    NC_STRING
coordinates   ‘/PRODUCT/longitude_nir /PRODUCT/latitude_nir’ (static)    NC_STRING

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

cloud_top_height_nir
Description:  Retrieved vertical distance of the cloud top above the surface w.r.t. the geoid/MSL using the OCRA/ROCINN CAL model.
Dimensions:   time, scanline, ground_pixel.
Type:         NC_FLOAT.
Source:       Processor.
Mode:         Present in all modes.
Attributes:   Name          Value                                 Type
units         ‘m’ (static)                              NC_STRING
long_name     ‘cloud top height’ (static)             NC_STRING
source        ‘cal’ (static)                           NC_STRING
comment       ‘Retrieved vertical distance of the cloud top above the surface w.r.t. the geoid/MSL using the OCRA/ROCINN CAL model.’ (static) NC_STRING
coordinates   ‘/PRODUCT/longitude_nir /PRODUCT/latitude_nir’ (static) NC_STRING

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

cloud_optical_thickness_nir
Description:  Cloud Optical Thickness using the OCRA/ROCINN CAL model.
Dimensions:   time, scanline, ground_pixel.
Type:         NC_FLOAT.
Source:       Processor.
Mode:         Present in all modes.
Attributes:   Name          Value                               Type
units         ‘1’ (static)                               NC_STRING
standard_name ‘atmosphere_optical_thickness_due_to_cloud’ (static)  NC_STRING
long_name     ‘cloud optical thickness’ (static)        NC_STRING
source        ‘cal’ (static)                            NC_STRING
comment       ‘Retrieved cloud optical thickness based on the OCRA/ROCINN CAL model.’ (static) NC_STRING
coordinates   ‘/PRODUCT/longitude_nir /PRODUCT/latitude_nir’ (static) NC_STRING

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

cloud_fraction_nir
Description:  Retrieved effective radiometric cloud fraction using the OCRA/ROCINN CAL model.
Dimensions:   time, scanline, ground_pixel.
Type:         NC_FLOAT.
Source:       Processor.
**Mode:** Present in all modes.

**Attributes:**

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<tr>
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<td>‘cal’ (static)</td>
<td>NC_STRING</td>
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<tr>
<td><strong>comment</strong></td>
<td>‘Retrieved effective radiometric cloud fraction using the OCRA/ROCINN CAL model.’ (static)</td>
<td>NC_STRING</td>
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<td>The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.</td>
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</table>

**surface_albedo_fitted_nir**

**Description:** Surface albedo fitted using the OCRA/ROCINN CAL model.

**Dimensions:** time, scanline, ground_pixel.

**Type:** NC_FLOAT.

**Source:** Processor.

**Mode:** Present in all modes.

**Attributes:**

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<td><strong>long_name</strong></td>
<td>‘surface albedo fitted’ (static)</td>
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<tr>
<td><strong>source</strong></td>
<td>‘cal’ (static)</td>
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</tr>
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<td><strong>comment</strong></td>
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<td><strong>coordinates</strong></td>
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<td>The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.</td>
<td></td>
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</table>

**cloud_top_height_precision_nir**

**Description:** Error of the retrieved vertical distance of the cloud top above the surface w.r.t. the geoid/MSL using the OCRA/ROCINN CAL model.

**Dimensions:** time, scanline, ground_pixel.

**Type:** NC_FLOAT.

**Source:** Processor.

**Mode:** Present in all modes.

**Attributes:**

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<td>NC_STRING</td>
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<tr>
<td><strong>comment</strong></td>
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<td><strong>coordinates</strong></td>
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<td>NC_STRING</td>
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<tr>
<td>The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.</td>
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</table>

**cloud_optical_thickness_precision_nir**
**cloud_fraction_precision_nir**

Description: Error of the retrieved effective radiometric cloud fraction using the OCRA/ROCINN CAL model.

Dimensions: time, scanline, ground_pixel.

Type: NC_FLOAT.

Source: Processor.

Mode: Present in all modes.

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<tr>
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</table>

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

**surface_albedo_fitted_precision_nir**

Description: Error of the fitted surface albedo calculated using the OCRA/ROCINN CAL model.

Dimensions: time, scanline, ground_pixel.

Type: NC_FLOAT.

Source: Processor.

Mode: Present in all modes.

<table>
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<tr>
<td>long_name</td>
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<tr>
<td>units</td>
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<td>NC_STRING</td>
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Dimensionless unit. This attribute originates from the NUG, CF standards.
comment

"Error of the fitted surface albedo calculated using the OCRA/ROCINN CAL model."

coordinates

'/PRODUCT/longitude_nir /PRODUCT/latitude_nir'

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

regularization_parameter_nir

Description: Regularization parameter of the rocinn inversion using the CAL model.
Dimensions: time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.

<table>
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<td>(static)</td>
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<tr>
<td>coordinates</td>
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The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

condition_number_nir

Description: Final condition number of the rocinn inversion using the CAL model.
Dimensions: time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.

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<td>coordinates</td>
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The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

degrees_of_freedom_nir

Description: Final Degrees of freedom of the rocinn inversion using the CAL model.
Dimensions: time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.

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<tr>
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<td>'cal'</td>
<td>(static)</td>
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<tr>
<td>coordinates</td>
<td>'/PRODUCT/longitude_nir /PRODUCT/latitude_nir'</td>
<td>(static)</td>
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</tbody>
</table>
The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

### shannon_information_content_nir

**Description:** Final Shannon information content of the rocinn inversion using the CAL model.

**Dimensions:** time, scanline, ground_pixel.

**Type:** NC_FLOAT.

**Source:** Processor.

**Mode:** Present in all modes.

**Attributes:**

<table>
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<td>coordinates</td>
<td>'/PRODUCT/longitude_nir /PRODUCT/latitude_nir' (static)</td>
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The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

### number_of_iterations_nir

**Description:** Number of rocinn iterations for the CAL model.

**Dimensions:** time, scanline, ground_pixel.

**Type:** NC_USHORT.

**Source:** Processor.

**Mode:** Present in all modes.

**Attributes:**

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The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

### fitted_root_mean_square_nir

**Description:** Final root mean square residual of the rocinn inversion using the CAL model.

**Dimensions:** time, scanline, ground_pixel.

**Type:** NC_FLOAT.

**Source:** Processor.

**Mode:** Present in all modes.

**Attributes:**

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</table>

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

### convergence_flag_nir

**Description:** Flag signaling the convergence of the rocinn inversion using the CAL model.

**Dimensions:** time, scanline, ground_pixel.
**fitted_state_vector_nir**

**Description:** Fitting vector results from the CAL ROCINN retrieval.

**Dimensions:** time, scanline, ground_pixel, number_fitting_parameter.

**Type:** NC_FLOAT.

**Source:** Processor.

**Mode:** Present in all modes.

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The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

**index_meaning**

This attribute provides the meaning of the indexes for the current variable. Indexes are supposed to be divided by a blank space.

**covariance_matrix_diagonal_nir**

**Description:** Diagonal of the covariance matrix from the CAL ROCINN retrieval.

**Dimensions:** time, scanline, ground_pixel, number_fitting_parameter.

**Type:** NC_FLOAT.

**Source:** Processor.

**Mode:** Present in all modes.

<table>
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The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

**index_meaning**

This attribute provides the meaning of the indexes for the current variable. Indexes are supposed to be divided by a blank space.

**cloud_height_crb_nir**
Description: Retrieved height at the level of cloud w.r.t. the geoid/MSL using the OCRA/ROCINN CRB model.
Dimensions: time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.

Attributes:

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The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

cloud_albedo_crb_nir

Description: Albedo of cloud using the OCRA/ROCINN CRB model.
Dimensions: time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.

Attributes:

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The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

cloud_fraction_crb_nir

Description: Retrieved effective radiometric cloud fraction using the OCRA/ROCINN CRB model.
Dimensions: time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.

Attributes:

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### surface_albedo_fitted_crb_nir

**Description:** Surface albedo fitted using the OCRA/ROCINN CRB model.

**Dimensions:** time, scanline, ground_pixel.

**Type:** NC_FLOAT.

**Source:** Processor.

**Mode:** Present in all modes.

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The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

### cloud_height_crb_precision_nir

**Description:** Error of the retrieved height at the level of cloud w.r.t. the geoid/MSL using the OCRA/ROCINN CRB model.

**Dimensions:** time, scanline, ground_pixel.

**Type:** NC_FLOAT.

**Source:** Processor.

**Mode:** Present in all modes.

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The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

### cloud_albedo_crb_precision_nir

**Description:** Error of the albedo of cloud using the OCRA/ROCINN CRB model.

**Dimensions:** time, scanline, ground_pixel.

**Type:** NC_FLOAT.

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The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.
**Source:** Processor.
**Mode:** Present in all modes.

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The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

**cloud_fraction_crb_precision_nir**
Description: Error of the retrieved effective radiometric cloud fraction using the OCRA/ROCINN CRB model.

| Dimensions: | time, scanline, ground_pixel. |
| Type:       | NC_FLOAT. |
| Source:     | Processor. |
| Mode:       | Present in all modes. |

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The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

**surface_albedo_fitted_crb_precision_nir**
Description: Error of the fitted surface albedo calculated using the OCRA/ROCINN CRB model.

| Dimensions: | time, scanline, ground_pixel. |
| Type:       | NC_FLOAT. |
| Source:     | Processor. |
| Mode:       | Present in all modes. |

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<td></td>
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comment 'Error of the fitted surface albedo calculated using the OCCA/ROCINN CRB model.' (static)

coordinates '/PRODUCT/longitude_nir /PRODUCT/latitude_nir' (static)

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

regularization_parameter_crb_nir
Description: Regularization parameter of the rocinn inversion using the CRB model.
Dimensions: time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.

Attributes: Name Value Type
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long_name 'regularization parameter of the rocinn inversion using the CRB model' (static)
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The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

condition_number_crb_nir
Description: Final condition number of the rocinn inversion using the CRB model.
Dimensions: time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.

Attributes: Name Value Type
units '1' (static) NC_STRING
long_name 'final condition number of the rocinn inversion using the CRB model' (static)
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The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

degrees_of_freedom_crb_nir
Description: Final Degrees of freedom of the rocinn inversion using the CRB model.
Dimensions: time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.

Attributes: Name Value Type
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coordinates '/PRODUCT/longitude_nir /PRODUCT/latitude_nir' (static)

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.
The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

**shannon_information_content_crb_nir**

Description: Final Shannon information content of the rocinn inversion using the CRB model.

Dimensions: time, scanline, ground_pixel.

Type: NC_FLOAT.

Source: Processor.

Mode: Present in all modes.

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**number_of_iterations_crb_nir**

Description: Number of rocinn iterations for the CRB model.

Dimensions: time, scanline, ground_pixel.

Type: NC_USHORT.

Source: Processor.

Mode: Present in all modes.

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**fitted_root_mean_square_crb_nir**

Description: Final root mean square residual of the rocinn inversion using the CRB model.

Dimensions: time, scanline, ground_pixel.

Type: NC_FLOAT.

Source: Processor.

Mode: Present in all modes.

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**convergence_flag_crb_nir**

Description: Flag signaling the convergence of the rocinn inversion using the CRB model.
Dimensions: time, scanline, ground_pixel.
Type: NC_UBYTE.
Source: Processor.
Mode: Present in all modes.

Attributes:

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The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

fitted_state_vector_crb_nir

Description: Fitting vector results from the CRB ROCINN retrieval.

Dimensions: time, scanline, ground_pixel, number_fitting_parameter_crb.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.

Attributes:

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The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

index_meaning

This attribute provides the meaning of the indexes for the current variable. Indexes are supposed to be divided by a blank space.

covariance_matrix_diagonal_crb_nir

Description: Diagonal of the covariance matrix from the CRB ROCINN retrieval.

Dimensions: time, scanline, ground_pixel, number_fitting_parameter_crb.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.

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The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

index_meaning

This attribute provides the meaning of the indexes for the current variable. Indexes are supposed to be divided by a blank space.

effective_scene_height_nir
**Description:** Retrieved effective scene height w.r.t. the geoid/MSL using the OCRA/ROCINN CRB model.

**Dimensions:** time, scanline, ground_pixel.

**Type:** NC_FLOAT.

**Source:** Processor.

**Mode:** Present in all modes.

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<td>coordinates</td>
<td>'/PRODUCT/longitude_nir /PRODUCT/latitude_nir' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

---

**effective_scene_albedo_nir**

**Description:** Albedo of effective scene using the OCRA/ROCINN CRB model.

**Dimensions:** time, scanline, ground_pixel.

**Type:** NC_FLOAT.

**Source:** Processor.

**Mode:** Present in all modes.

### Attributes:

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<th>Value Description</th>
<th>Type</th>
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</thead>
<tbody>
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<td>standard_name</td>
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<td>'effective scene albedo from the CRB model' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>source</td>
<td>'crb' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>comment</td>
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</table>

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

---

**effective_scene_height_precision_nir**

**Description:** Error of the retrieved scene height w.r.t. the geoid/MSL using the OCRA/ROCINN CRB model.

**Dimensions:** time, scanline, ground_pixel.

**Type:** NC_FLOAT.

**Source:** Processor.

**Mode:** Present in all modes.

### Attributes:

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<tr>
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<td>'crb' (static)</td>
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</table>
comment  
‘Error of the retrieved effective scene height w.r.t. the geoid/MSL using the OCRA/ROCINN CRB model.’ (static)

coordinates  
’/PRODUCT/longitude_nir /PRODUCT/latitude_nir’

The latitude and longitude coordinates of the TROPOMI swath are not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

effective_scene_albedo_precision_nir
Description: Error of the albedo of effective scene using the OCRA/ROCINN CRB model.
Dimensions: time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.

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<td>‘crb’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>comment</td>
<td>‘Error of the retrieved albedo of effective scene based on the OCRA/ROCINN CRB model.’ (static)</td>
<td>NC_STRING</td>
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<tr>
<td>coordinates</td>
<td>’/PRODUCT/longitude_nir /PRODUCT/latitude_nir’ (static)</td>
<td>NC_STRING</td>
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</table>

The latitude and longitude coordinates of the TROPOMI swath are not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

condition_number_ge_nir
Description: Final condition number of the rocinn inversion using the CRB model for the effective scene.
Dimensions: time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.

Attributes:
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<th>Name</th>
<th>Value</th>
<th>Type</th>
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</thead>
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<td>NC_STRING</td>
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The latitude and longitude coordinates of the TROPOMI swath are not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

degrees_of_freedom_ge_nir
Description: Final Degrees of freedom of the rocinn inversion using the CRB model for the effective scene.
Dimensions: time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.

Attributes:
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<th>Type</th>
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<tr>
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<td>NC_STRING</td>
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</table>

The latitude and longitude coordinates of the TROPOMI swath are not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.
The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

**shannon_information_content_ge_nir**

Description: Final Shannon information content of the rocinn inversion using the CRB model for the effective scene.

Dimensions: time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.

Attributes:

<table>
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<td>'crb' (static)</td>
</tr>
<tr>
<td>coordinates</td>
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</table>

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

**number_of_iterations_ge_nir**

Description: Number of rocinn iterations for the CRB model for the effective scene.

Dimensions: time, scanline, ground_pixel.
Type: NC_USHORT.
Source: Processor.
Mode: Present in all modes.

Attributes:

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<tr>
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</table>

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

**fitted_root_mean_square_ge_nir**

Description: Final root mean square residual of the rocinn inversion using the CRB model for the effective scene.

Dimensions: time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.

Attributes:

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<tr>
<td>coordinates</td>
<td>'/PRODUCT/longitude_nir /PRODUCT/latitude_nir' (static)</td>
</tr>
</tbody>
</table>
The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

### 12.17 Additional detailed results fields

**processing_quality_flags**

Description: Processing quality flag. This flag indicates processing errors or reasons for not processing a particular pixel (collectively 'errors', leading to a fill value in the output) and warnings that occurred while processing this pixel (warnings which may affect the quality of the retrieval result). A detailed description is provided in appendix A.

Dimensions: time, scanline, ground_pixel.

Type: NC_UINT.

Source: Processor.

Mode: Present in all modes.

Attributes:

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<tbody>
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<tr>
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<td>NC_STRING</td>
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<tr>
<td>comment</td>
<td>'Flags indicating conditions that affect quality of the retrieval.' (static)</td>
<td>NC_STRING</td>
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flag_meanings
'success radiance_missing irradiance_missing input_spectrum_missing reflectance_range_error
ler_range_error snr_range_error sza_range_error
evza_range_error lut_range_error ozone_range_error
wavelength_offset_error initialization_error
memory_error assertion_error io_error numerical_error
lut_error ISRF_error convergence_error
cloud_filter_convergence_error max_iteration_error
convergence_error aot_lower_boundary_convergence_error
other_boundary_convergence_error geolocation_error ch4_noscat_zero_error h2o_noscat_zero_error
max_optical_thickness_error aerosol_boundary_error boundary_hit_error chi2_error
svd_error dfs_error radiative_transfer_error
optimal_estimation_error profile_error cloud_error
model_error number_of_input_data_points_too_low_error
cloud_pressure_spread_too_low_error cloud_too_low_level_error
generic_range_error generic_exception input_spectrum_alignment_error
abort_error wrong_input_type_error wavelength_calibration_error
co-registration_error slant_column_density_error airmass_factor_error
vertical_column_density_error signal_to_noise_ratio_error
configuration_error key_error saturation_error solar_eclipse_filter cloud_filter
altitude_consistency_filter altitude_roughness_filter
sun_glint_filter mixed_surface_type_filter snow_ice_filter
aaifilter cloud_fraction_fresco_filter
aaifilter cloud_fraction_viirs_filter cirrus_reflectance_viirs_filter
refl_viirs_swir_ifov_filter refl_viirs_swir_ofovc_filter refl_viirs_swir_ofovb_filter
refl_viirs_nir_ofovc_filter refl_viirs_nir_ofovb_filter
refl_cirrus_viirs_swir_filter refl_cirrus_viirs_nir_filter
diff_refl_cirrus_viirs_filter ch4_noscat_ratio_filter ch4_noscat_ratio_std_filter
h2o_noscat_ratio_filter h2o_noscat_ratio_std_filter
diff_psurf_fresco_ecmwf_filter psurf_fresco_stdv_filter
ocean_filter time_range_filter pixel_or_scanline_index_filter
geographic_region_filter input_spectrum_warning wavelength_calibration_warning
extrapolation_warning sun_glint_warning
south_atlantic_anomaly_warning sun_glint_correction
snow_ice_warning cloud_warning
AAI_warning pixel_level_input_data_missing data_range_warning
low_cloud_fraction_warning altitude_consistency_warning
signal_to_noise_ratio_warning deconvolution_warning
so2_volcanic_origin_likely_warning so2_volcanic_origin_certain_warning
interpolation_warning saturation_warning high_sza_warning cloud_retrieval_warning
cloud_inhomogeneity_warning'
12.18 Debug fields for UPAS

direct_upas2_levels_1  Level Dim for debugging porpuse.
  size -1 (fixed)
  mode Present in all modes.

direct_upas2_float1D
  Description: Debug field, not available in operational environment.
  Dimensions: time, scanline.
  Type: NC_FLOAT.
  Source: Processor.
  Mode: Present in all modes.
  Attributes: Name Value Type
  units '1' (static) NC_STRING
  coordinates '/PRODUCT/longitude /PRODUCT/latitude' (static) NC_STRING

direct_upas2_double1D
  Description: Debug field, not available in operational environment.
  Dimensions: time, scanline.
  Type: NC_DOUBLE.
  Source: Processor.
  Mode: Present in all modes.
### debug_upas2_int1D
- **Description:** Debug field, not available in operational environment.
- **Dimensions:** time, scanline.
- **Type:** NC_INT.
- **Source:** Processor.
- **Mode:** Present in all modes.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>‘1’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
<td>‘/PRODUCT/longitude /PRODUCT/latitude’ (static)</td>
<td>NC_STRING</td>
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</tbody>
</table>

### debug_upas2_ubyte1D
- **Description:** Debug field, not available in operational environment.
- **Dimensions:** time, scanline.
- **Type:** NC_UBYTE.
- **Source:** Processor.
- **Mode:** Present in all modes.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>‘1’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
<td>‘/PRODUCT/longitude /PRODUCT/latitude’ (static)</td>
<td>NC_STRING</td>
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</tbody>
</table>

### debug_upas2_byte1D
- **Description:** Debug field, not available in operational environment.
- **Dimensions:** time, scanline.
- **Type:** NC_BYTE.
- **Source:** Processor.
- **Mode:** Present in all modes.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
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<tbody>
<tr>
<td>units</td>
<td>‘1’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
<td>‘/PRODUCT/longitude /PRODUCT/latitude’ (static)</td>
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### debug_upas2_ushort1D
- **Description:** Debug field, not available in operational environment.
- **Dimensions:** time, scanline.
- **Type:** NC_USHORT.
- **Source:** Processor.
- **Mode:** Present in all modes.

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<tbody>
<tr>
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</tr>
<tr>
<td>coordinates</td>
<td>‘/PRODUCT/longitude /PRODUCT/latitude’ (static)</td>
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</table>

### debug_upas2_float2D_1
- **Description:** Debug field, not available in operational environment.
- **Dimensions:** time, scanline, ground_pixel.
- **Type:** NC_FLOAT.
- **Source:** Processor.
- **Mode:** Present in all modes.

<table>
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<th>Name</th>
<th>Value</th>
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<tbody>
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</tr>
<tr>
<td>coordinates</td>
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<td>Source</td>
<td>Processor.</td>
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<td>Mode</td>
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<table>
<thead>
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<th>Value</th>
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<td><code>units</code></td>
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<td>NC_STRING</td>
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<td><code>coordinates</code></td>
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### debug_upas2_float2D_3

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<tr>
<td>Mode</td>
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<th>Value</th>
<th>Type</th>
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<td>‘1’</td>
<td>NC_STRING</td>
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<td><code>coordinates</code></td>
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### debug_upas2_double2D_1

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<th>Value</th>
<th>Type</th>
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### debug_upas2_double2D_3

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<th>Name</th>
<th>Value</th>
<th>Type</th>
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<td>‘1’</td>
<td>NC_STRING</td>
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Dimensions: time, scanline, ground_pixel.
Type: NC_INT.
Source: Processor.
Mode: Present in all modes.

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<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
<td>'/PRODUCT/longitude /PRODUCT/latitude' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

depend_upas2_int2D_2
Description: Debug field, not available in operational environment.
Dimensions: time, scanline, ground_pixel.
Type: NC_INT.
Source: Processor.
Mode: Present in all modes.

Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>‘1’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
<td>'/PRODUCT/longitude /PRODUCT/latitude' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

depend_upas2_int2D_3
Description: Debug field, not available in operational environment.
Dimensions: time, scanline, ground_pixel.
Type: NC_INT.
Source: Processor.
Mode: Present in all modes.

Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>‘1’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
<td>'/PRODUCT/longitude /PRODUCT/latitude' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

depend_upas2_ubyte2D_1
Description: Debug field, not available in operational environment.
Dimensions: time, scanline, ground_pixel.
Type: NC_UBYTE.
Source: Processor.
Mode: Present in all modes.

Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>‘1’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
<td>'/PRODUCT/longitude /PRODUCT/latitude' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

depend_upas2_ubyte2D_2
Description: Debug field, not available in operational environment.
Dimensions: time, scanline, ground_pixel.
Type: NC_UBYTE.
Source: Processor.
Mode: Present in all modes.

Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>‘1’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
<td>'/PRODUCT/longitude /PRODUCT/latitude' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

depend_upas2_ubyte2D_3
Description: Debug field, not available in operational environment.
Dimensions: time, scanline, ground_pixel.
<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>‘1’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
<td>‘/PRODUCT/longitude /PRODUCT/latitude’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

**debug_upas2_byte2D_1**

Description: Debug field, not available in operational environment.

Dimensions: time, scanline, ground_pixel.

Type: NC_BYTE.

Source: Processor.

Mode: Present in all modes.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>‘1’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
<td>‘/PRODUCT/longitude /PRODUCT/latitude’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

**debug_upas2_byte2D_2**

Description: Debug field, not available in operational environment.

Dimensions: time, scanline, ground_pixel.

Type: NC_BYTE.

Source: Processor.

Mode: Present in all modes.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>‘1’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
<td>‘/PRODUCT/longitude /PRODUCT/latitude’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

**debug_upas2_byte2D_3**

Description: Debug field, not available in operational environment.

Dimensions: time, scanline, ground_pixel.

Type: NC_BYTE.

Source: Processor.

Mode: Present in all modes.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>‘1’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
<td>‘/PRODUCT/longitude /PRODUCT/latitude’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

**debug_upas2_ushort2D_1**

Description: Debug field, not available in operational environment.

Dimensions: time, scanline, ground_pixel.

Type: NC_USHORT.

Source: Processor.

Mode: Present in all modes.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>‘1’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
<td>‘/PRODUCT/longitude /PRODUCT/latitude’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

**debug_upas2_ushort2D_2**

Description: Debug field, not available in operational environment.

Dimensions: time, scanline, ground_pixel.

Type: NC_USHORT.

Source: Processor.
| Mode: | Present in all modes. |
| Attributes: | Name | Value | Type |
| units | ‘1’ (static) | NC_STRING |
| coordinates | ‘/PRODUCT/longitude /PRODUCT/latitude’ (static) | NC_STRING |

**debug_upas2_ushort2D_3**
- Description: Debug field, not available in operational environment.
- Dimensions: time, scanline, ground_pixel.
- Type: NC_USHORT.
- Source: Processor.
- Mode: Present in all modes.

**debug_upas2_float3D_1**
- Description: Debug field, not available in operational environment.
- Dimensions: time, scanline, ground_pixel, debug_upas2_levels_1.
- Type: NC_FLOAT.
- Source: Processor.
- Mode: Present in all modes.

**debug_upas2_float3D_2**
- Description: Debug field, not available in operational environment.
- Dimensions: time, scanline, ground_pixel, debug_upas2_levels_1.
- Type: NC_FLOAT.
- Source: Processor.
- Mode: Present in all modes.

**debug_upas2_float3D_3**
- Description: Debug field, not available in operational environment.
- Dimensions: time, scanline, ground_pixel, debug_upas2_levels_1.
- Type: NC_FLOAT.
- Source: Processor.
- Mode: Present in all modes.

**debug_upas2_float3D_4**
- Description: Debug field, not available in operational environment.
- Dimensions: time, scanline, ground_pixel, debug_upas2_levels_1.
- Type: NC_FLOAT.
- Source: Processor.
- Mode: Present in all modes.
Wavelength calibrations are written in the product.

### 12.19 Computed polynomials and shift/squeeze values

Wavelength calibrations are written in the product.

#### 12.19.1 Group “WAVELENGTH_CALIBRATIONS”

**Dimensions in WAVELENGTH_CALIBRATIONS**

- **number_of_calibrations** The number of the calibrations depending on the solar spectrum.
  - size 1 (dynamic)
  - source Processor.
  - mode Present in all modes.

- **degrees_of_polynomial_shift** Dimension relative to the degrees of the polynomial shift. It may have multiple windows.
  - size 1 (dynamic)
  - source Processor.
  - mode Present in all modes.

- **number_of_subwindows** The number of subwindows used in order to calculate the shift. It may have multiple windows.
  - size 1 (dynamic)
  - source Processor.
  - mode Present in all modes.

**Variables in WAVELENGTH_CALIBRATIONS**

```
<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>'1' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
<td>'/PRODUCT/longitude /PRODUCT/latitude' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>
```

```
**calibration_polynomial_coefficients** in WAVELENGTH_CALIBRATIONS

Description: Computed coefficients of the polynomial function. It may have multiple windows.


Type: NC_FLOAT.

Source: Processor.

Mode: Present in all modes.

Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>'1' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>long_name</td>
<td>'computed coefficients of the polynomial function' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>standard_name</td>
<td>'TBA' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

**calibration_subwindows_shift** in WAVELENGTH_CALIBRATIONS

Description: Computed wavelengths shift values per subwindow. It may have multiple windows.


Type: NC_FLOAT.

Source: Processor.

Mode: Present in all modes.

Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>'nm' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>long_name</td>
<td>'irradiance wavelengths shift fitted values per subwindow' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>standard_name</td>
<td>'TBA' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

**calibration_subwindows_squeeze** in WAVELENGTH_CALIBRATIONS

Description: Computed wavelengths squeeze values per subwindow. It may have multiple windows.


Type: NC_FLOAT.

Source: Processor.

Mode: Present in all modes.

Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>'1' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>long_name</td>
<td>'irradiance wavelengths squeeze fitted values per subwindow' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>standard_name</td>
<td>'TBA' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

**calibration_subwindows_root_mean_square** in WAVELENGTH_CALIBRATIONS

Description: Computed RMS values per subwindow. It may have multiple windows.


Type: NC_FLOAT.

Source: Processor.

Mode: Present in all modes.

Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>'1' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>long_name</td>
<td>'calibration rms per subwindow' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>standard_name</td>
<td>'TBA' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

**calibration_subwindows_wavelength** in WAVELENGTH_CALIBRATIONS

Description: Calibration wavelength center in each subwindow. It may have multiple windows.

Dimensions: number_of_subwindows.

Type: NC_FLOAT.

Source: Processor.
12.20 Additional data support fields

**surface_altitude**

**Description:** The mean of the sub-pixels of the surface altitude above the reference geoid (WGS84) within the approximate field of view, based on the GMTED2010 surface elevation database.

**Dimensions:** time, scanline, ground_pixel.

**Type:** NC_FLOAT.

**Source:** surface elevation database.

**Mode:** Present in all modes.

**Attributes:**

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>long_name</td>
<td>'surface_altitude' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>standard_name</td>
<td>'surface_altitude' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>units</td>
<td>'m' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
<td>'/PRODUCT/longitude /PRODUCT/latitude' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>source</td>
<td>'<a href="http://topotools.cr.usgs.gov/gmted_viewer/">http://topotools.cr.usgs.gov/gmted_viewer/</a>' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>comment</td>
<td>'The mean of the sub-pixels of the surface altitude above the reference geoid (WGS84) within the approximate field of view, based on the GMTED2010 surface elevation database' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

**surface_altitude_precision**

**Description:** The standard deviation of sub-pixels used in calculating the mean surface altitude above the reference geoid (WGS84) within the approximate field of view, based on the GMTED2010 surface elevation database.

**Dimensions:** time, scanline, ground_pixel.

**Type:** NC_FLOAT.

**Source:** surface elevation database.

**Mode:** Present in all modes.

**Attributes:**

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>long_name</td>
<td>'surface_altitude precision' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>standard_name</td>
<td>'surface_altitude standard_error' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>units</td>
<td>'m' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>standard_error_multiplier</td>
<td>1.0 (static)</td>
<td>NC_FLOAT</td>
</tr>
<tr>
<td>coordinates</td>
<td>'/PRODUCT/longitude /PRODUCT/latitude' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>source</td>
<td>'<a href="http://topotools.cr.usgs.gov/gmted_viewer/">http://topotools.cr.usgs.gov/gmted_viewer/</a>' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>comment</td>
<td>'The mean of the sub-pixels of the surface altitude above the reference geoid (WGS84) within the approximate field of view, based on the GMTED2010 surface elevation database' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>
**comment**

The standard deviation of sub-pixels used in calculating the mean surface altitude above the reference geoid (WGS84) within the approximate field of view, based on the GMTED2010 surface elevation database

**surface_classification**

**Description:**
This is a combined land/water mask and surface classification data field.

**Dimensions:**
time, scanline, ground_pixel.

**Type:**
NC_UBYTE.

**Source:**
surface elevation database (including flag attributes).

**Mode:**
Present in all modes.

**Attributes:**

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>'1' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>long_name</td>
<td>'land-water mask' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>comment</td>
<td>'flag indicating land/water and further surface classifications for the ground pixel' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>source</td>
<td>'USGS (<a href="http://edc2.usgs.gov/glcc/globdoc2_0.php">http://edc2.usgs.gov/glcc/globdoc2_0.php</a>) and NASA SDP toolkit (<a href="http://newsroom.gsfc.nasa.gov/sdptoolkit/toolkit.html">http://newsroom.gsfc.nasa.gov/sdptoolkit/toolkit.html</a>)' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>flag_meanings</td>
<td>'land, water, some_water, coast, value_covers_majority_of_pixel, water+shallow_ocean, water+shallow_inland_water, water+ocean_ -coastline-lake_shoreline, water+intermittent_water, water+deep_inland_water, water+continental_-shelf_ocean, water+deep_ocean, land+urban_-and_built-up_land, land+dryland_cropland_and_-pasture, land+irrigated_cropland_and_pasture, land+mixed_dryland-irrigated_cropland_and_-pasture, land+cropland-grassland_mosaic, land+cropland-woodland_mosaic, land+grassland, land+shrubland, land+mixed_shrubland- grassland, land+savanna, land+deciduous_-broadleaf_forest, land+deciduous_needleleaf_-forest, land+evergreen_broadleaf_forest, land+evergreen_needleleaf_forest, land+mixed_-forest, land+herbaceous_wetland, land+wooded_-wetland, land+barren_or_sparsely_vegetated, land+herbaceous_tundra, land+wooded_tundra, land+mixed_tundra, land+bare_ground_tundra, land+snow_or_ice' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>flag_values</td>
<td>0, 1, 2, 3, 4, 9, 17, 25, 33, 41, 49, 57, 8, 16, 24, 32, 40, 48, 56, 64, 72, 80, 88, 96, 104, 112, 120, 128, 136, 144, 152, 160, 168, 176, 184 (static)</td>
<td>NC_UBYTE</td>
</tr>
<tr>
<td>flag_masks</td>
<td>3, 3, 3, 4, 249, 249, 249, 249, 249, 249, 249, 249, 249, 249, 249, 249, 249, 249, 249, 249, 249, 249, 249, 249, 249, 249, 249, 249 (static)</td>
<td>NC_UBYTE</td>
</tr>
<tr>
<td>coordinates</td>
<td>'/PRODUCT/longitude /PRODUCT/latitude' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The latitude and longitude are in a different group. How to specify the related geospatial coordinates in this case is not specified in the climate and forecast metadata conventions [ER5].

**instrument_configuration_identifier**
Description: The IcID from the instrument configuration in the Level 1B data product. The TROPOMI instrument has many configurable parameters. For example, the exposure time, co-addition period, gains and (for UVN-DEM) the binning factors can be varied. As a result, the instrument can be operated in many different modes or configurations. Each combination of instrument settings is referred to as an instrument configuration and is identified by an instrument configuration ID, a number in the range $[1, 65535]$. This instrument configuration ID, or IcID, is primarily used by the instrument, where it identifies an entry in the instrument configuration tables. On ground, the IcID is used to determine the intended purpose of a measurement and is used in the L0 to 1b data processing to determine the processing path.

Dimensions: time, scanline.
Type: NC_INT.
Source: L1B.
Mode: Present in all modes.

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>long_name</td>
<td>'IcID' (static)</td>
<td></td>
<td>NC_STRING</td>
</tr>
<tr>
<td>comment</td>
<td>'The Instrument Configuration ID defines the type of measurement and its purpose. The number of instrument configuration IDs will increase over the mission as new types of measurements are created and used' (static)</td>
<td>NC_STRING</td>
<td></td>
</tr>
</tbody>
</table>

**instrument_configuration_version**

Description: For an IcID (see the instrument_configuration_identifier above), it is possible to have multiple versions, identified by the instrument configuration version or IcVersion. The combination of IcID and IcVersion uniquely identifies the set of configuration settings of the instrument. At a given time, only one IcVersion of an IcID can be active within the instrument. The IcVersion allows to have multiple versions of a measurement with the same purpose, but with different settings. As a result of, for example, instrument degradation, it may be required to change the settings for a measurement. In that case, it is not necessary to create a new IcID, instead the same IcID can be used with a new IcVersion.

Dimensions: time, scanline.
Type: NC_SHORT.
Source: L1B.
Mode: Present in all modes.

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>long_name</td>
<td>'IcVersion' (static)</td>
<td></td>
<td>NC_STRING</td>
</tr>
<tr>
<td>comment</td>
<td>'Version of the instrument_configuration_identifier' (static)</td>
<td>NC_STRING</td>
<td></td>
</tr>
</tbody>
</table>

**scaled_small_pixel_variance**

Description: The scaled variance of the small pixel values for each ground pixel.

$$
\langle R(t,r,c) \rangle = \frac{1}{N_{\text{small pixels}}^{-1}} \sum_{i=0}^{N_{\text{small pixels}}^{-1}} R(t,r,c,i) \quad (3)
$$

$$
V(t,r,c) = \frac{1}{N_{\text{small pixels}}^{-1}} \sum_{i=0}^{N_{\text{small pixels}}^{-1}} (R(t,r,c,i) - \langle R(t,r,c) \rangle)^2 \quad (4)
$$

$$
V_{\text{scaled}}(t,r,c) = \frac{V(t,r,c)}{(\langle R(t,r,c) \rangle)^2} \quad (5)
$$

with $\langle R(t,r,c) \rangle$ the mean reflectance for small pixels of ground pixel $(t,r,c)$, $V(t,r,c)$ the variance of the small pixels, $V_{\text{scaled}}(t,r,c)$ the scaled small pixel variance, and $R(t,r,c,i)$ with $i = [0, \ldots, N_{\text{small pixels}} - 1]$ the small pixel reflectance of ground pixel $(t,r,c)$. The reflectance $R$ is calculated as $R = (\pi f) / (\mu_0 E_0)$, with $f$ the radiance, $E_0$ the irradiance and $\mu_0 = \cos(\vartheta_0)$, where $\vartheta_0$ is the solar zenith angle.
Dimensions: time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.

Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>long_name</td>
<td>'scaled small pixel variance' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>units</td>
<td>'1' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
<td>'/PRODUCT/longitude /PRODUCT/latitude' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>comment</td>
<td>'The scaled variance of the reflectances of the small pixels' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>radiation_wavelength</td>
<td>The approximate wavelength of the small pixel column in nm. Note that due to the spectral smile this wavelength will depend on the ground_pixel index.</td>
<td>NC_FLOAT</td>
</tr>
</tbody>
</table>

12.21 Input data common to all the L2 DLR products

Variables in input_data
The variables described in section 12.20 "Additional data support fields" on page 78 are included in the output at this location.

surface_pressure
Description: Surface pressure from ECMWF model data.
Dimensions: time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.

Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>'Pa' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>standard_name</td>
<td>'surface_air_pressure' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>long_name</td>
<td>'surface_air_pressure' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>source</td>
<td></td>
<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
<td>'/PRODUCT/longitude /PRODUCT/latitude' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>comment</td>
<td>The latitude and longitude are in a different group. How to specify the related geospatial coordinates in this case is not specified in the climate and forecast metadata conventions [ER5].</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

northward_wind
Description: 10 meter V wind component
Dimensions: time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.

Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>'m s-1' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>standard_name</td>
<td>'northward_wind' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>
long_name  'Northward wind from ECMWF at 10 meter height level' (static)  NC_STRING
coordinates  '/PRODUCT/longitude /PRODUCT/latitude' (static)  NC_STRING

The latitude and longitude are in a different group. How to specify the related geospatial coordinates in this case is not specified in the climate and forecast metadata conventions [ERS].

eastward_wind
Description: 10 meter U wind component
Dimensions: time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.

Attributes:
<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>'m s^{-1}' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>Velocity in meters per second This attribute originates from the NUG, CF standards.</td>
<td></td>
</tr>
<tr>
<td>standard_name</td>
<td>'eastward_wind' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>long_name</td>
<td>'Eastward wind from ECMWF at 10 meter height level' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
<td>'/PRODUCT/longitude /PRODUCT/latitude' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The latitude and longitude are in a different group. How to specify the related geospatial coordinates in this case is not specified in the climate and forecast metadata conventions [ERS].

12.21.1 Group “PROCESSOR”

The processing_configuration attribute of the PROCESSOR group aims at tracking the original configuration used for processing the current L2 product. It is also used in the latest version of the S5P L1b product.

Attributes in PROCESSOR

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>processing_configuration</td>
<td>'Processing configuration used to generate the current product' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.22 Original and computed snow-ice flag

Variables in snow_ice_flag_var

snow_ice_flag_nise
Description: This is the original snow/ice classification data field from NSIDC/NISE. In case this auxiliary data was not available while processing, only FillValue are present in the data.
Dimensions: time, scanline, ground_pixel.
Type: NC_UBYTE.
Source: Processor.
Mode: Present in all modes.

Attributes:
<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>'1' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>long_name</td>
<td>'snow-ice mask' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>_FillValue</td>
<td>'254UB' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>comment</td>
<td>'flag indicating snow/ice at center of ground pixel' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>source</td>
<td>'NSIDC/NISE' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>flag_meanings</td>
<td>'snow-free_land sea_ice_1_percent sea_ice_2_percent sea_ice_3_percent sea_ice_4_percent sea_ice_5_percent sea_ice_6_percent sea_ice_7_percent sea_ice_8_percent sea_ice_9_percent sea_ice_10_percent sea_ice_11_percent sea_ice_12_percent sea_ice_13_percent sea_ice_14_percent sea_ice_15_percent sea_ice_16_percent sea_ice_17_percent sea_ice_18_percent sea_ice_19_percent sea_ice_20_percent sea_ice_21_percent sea_ice_22_percent sea_ice_23_percent sea_ice_24_percent sea_ice_25_percent sea_ice_26_percent sea_ice_27_percent sea_ice_28_percent sea_ice_29_percent sea_ice_30_percent sea_ice_31_percent sea_ice_32_percent sea_ice_33_percent sea_ice_34_percent sea_ice_35_percent sea_ice_36_percent sea_ice_37_percent sea_ice_38_percent sea_ice_39_percent sea_ice_40_percent sea_ice_41_percent sea_ice_42_percent sea_ice_43_percent sea_ice_44_percent sea_ice_45_percent sea_ice_46_percent sea_ice_47_percent sea_ice_48_percent sea_ice_49_percent sea_ice_50_percent sea_ice_51_percent sea_ice_52_percent sea_ice_53_percent sea_ice_54_percent sea_ice_55_percent sea_ice_56_percent sea_ice_57_percent sea_ice_58_percent sea_ice_59_percent sea_ice_60_percent sea_ice_61_percent sea_ice_62_percent sea_ice_63_percent sea_ice_64_percent sea_ice_65_percent sea_ice_66_percent sea_ice_67_percent sea_ice_68_percent sea_ice_69_percent sea_ice_70_percent sea_ice_71_percent sea_ice_72_percent sea_ice_73_percent sea_ice_74_percent sea_ice_75_percent sea_ice_76_percent sea_ice_77_percent sea_ice_78_percent sea_ice_79_percent sea_ice_80_percent sea_ice_81_percent sea_ice_82_percent sea_ice_83_percent sea_ice_84_percent sea_ice_85_percent sea_ice_86_percent sea_ice_87_percent sea_ice_88_percent sea_ice_89_percent sea_ice_90_percent sea_ice_91_percent sea_ice_92_percent sea_ice_93_percent sea_ice_94_percent sea_ice_95_percent sea_ice_96_percent sea_ice_97_percent sea_ice_98_percent sea_ice_99_percent sea_ice_100_percent permanent_ice snow mixed_pixels_at_coastlines suspect_ice_value corners ocean' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>
**flag_values**

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 103, 252, 253, 254, 255 (static)</td>
<td>NC_UBYTE</td>
</tr>
</tbody>
</table>

**coordinates**

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>'/PRODUCT/longitude /PRODUCT/latitude' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The latitude and longitude are in a different group. How to specify the related geospatial coordinates in this case is not specified in the climate and forecast metadata conventions [ER5].

**snow_ice_flag**

**Description:** This is binary snow/ice classification flag. It is computed internally in the processor based on external dynamic data (e.g. NSIDC/NISE or climatology). In case the original value of the pixel is greater than 30 percent, the flag is set to 1 (snow/ice presence), otherwise 0 (snow/ice free).

**Dimensions:** time, scanline, ground_pixel.

**Type:** NC_UBYTE.

**Source:** Processor.

**Mode:** Present in all modes.

**Attributes:**

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>'1' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>threshold</td>
<td>'0.3' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>comment</td>
<td>'flag indicating snow/ice at center of ground pixel' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

**source**

Possible values: NSIDC/NISE, Fallback_climatology

**flag_meanings**

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>'snow_free snow_ice' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

**flag_values**

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0, 1 (static)</td>
<td>NC_UBYTE</td>
</tr>
</tbody>
</table>

**coordinates**

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>'/PRODUCT/longitude /PRODUCT/latitude' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The latitude and longitude are in a different group. How to specify the related geospatial coordinates in this case is not specified in the climate and forecast metadata conventions [ER5].

**snow_cover**

**Description:** The snow cover in the region of the pixel

**Dimensions:** time, scanline, ground_pixel.

**Type:** NC_FLOAT.

**Source:** Processor.

**Mode:** Present in all modes.

**Attributes:**

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>'1' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>long_name</td>
<td>'snow-cover' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>source</td>
<td>'ECMWF' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

**coordinates**

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>'/PRODUCT/longitude /PRODUCT/latitude' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>
The latitude and longitude are in a different group. How to specify the related geospatial coordinates in this case is not specified in the climate and forecast metadata conventions [ER5].

**sea_ice_cover**

**Description:** The sea-ice cover in the region of the pixel

**Dimensions:** time, scanline, ground_pixel.

**Type:** NC_FLOAT.

**Source:** Processor.

**Mode:** Present in all modes.

**Attributes:**

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>'1' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>long_name</td>
<td>'sea-ice-cover' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>source</td>
<td>'ECMWF' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
<td>'/PRODUCT/longitude /PRODUCT/latitude' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The latitude and longitude are in a different group. How to specify the related geospatial coordinates in this case is not specified in the climate and forecast metadata conventions [ER5].

## 12.23 Quality assurance statistics

Quality assurance statistics are gathered in variables located in this group. These can include histograms of the main parameters and event occurrence statistics. The contents of this group is under discussion. Note that the QA statistics may be stored as scalar variables rather than attributes. The former allow attributes to be attached to them, providing a more meaningful description than just the name.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>number_of_groundpixels</td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
<tr>
<td>Number of ground pixels in the file.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_processed_pixels</td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
<tr>
<td>Number of ground pixels where a retrieval was attempted. This is the number_of_groundpixels minus the pixels that were rejected based on time or configuration (range and step-size in scanline or ground_pixel index).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_successfully_processed_pixels</td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
<tr>
<td>Number of ground pixels where a retrieval was successful.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_rejected_pixels_not_enough_spectrum</td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
<tr>
<td>Number of pixels where processing was not attempted because after filtering for bad and missing pixels there were not enough spectral pixels left in either the radiance, irradiance or after calculating the reflectance.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_failed_retrievals</td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
<tr>
<td>Number of pixels where processing failed for whatever reason.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_ground_pixels_with_warnings</td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
<tr>
<td>Number of pixels with one or more warnings.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_radiance_missing_occurrences</td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
<tr>
<td>Number of ground pixels where processing error “the number of spectral pixels in the radiance due to flagging is too small to perform the fitting” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “1”.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Ground Pixels Where Processing Error Occurred</td>
<td>Value</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------------------------------------------</td>
<td>-------</td>
<td>-------------</td>
</tr>
<tr>
<td>number_of_irradiance_missing_occurrences</td>
<td>0 (static) NC_INT</td>
<td>Number of ground pixels where processing error “the number of spectral pixels in the irradiance due to flagging is too small to perform the fitting” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “2”.</td>
</tr>
<tr>
<td>number_of_input_spectrum_missing_occurrences</td>
<td>0 (static) NC_INT</td>
<td>Number of ground pixels where processing error “the reflectance spectrum does not contain enough points to perform the retrieval. This is different from (ir)radiance_missing in that the missing points may not be aligned” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “3”.</td>
</tr>
<tr>
<td>number_of_reflectance_range_error_occurrences</td>
<td>0 (static) NC_INT</td>
<td>Number of ground pixels where processing error “lambert-equivalent reflectivity out of range error” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “5”.</td>
</tr>
<tr>
<td>number_of_snr_range_error_occurrences</td>
<td>0 (static) NC_INT</td>
<td>Number of ground pixels where processing error “too low signal to noise to perform retrieval” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “6”.</td>
</tr>
<tr>
<td>number_of_sza_range_error_occurrences</td>
<td>0 (static) NC_INT</td>
<td>Number of ground pixels where processing error “solar zenith angle out of range, maximum value from configuration” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “7”.</td>
</tr>
<tr>
<td>number_of_vza_range_error_occurrences</td>
<td>0 (static) NC_INT</td>
<td>Number of ground pixels where processing error “viewing zenith angle out of range, maximum value from configuration” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “8”.</td>
</tr>
<tr>
<td>number_of_lut_range_error_occurrences</td>
<td>0 (static) NC_INT</td>
<td>Number of ground pixels where processing error “extrapolation in lookup table (airmass factor, cloud radiances)” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “9”.</td>
</tr>
<tr>
<td>number_of_ozone_range_error_occurrences</td>
<td>0 (static) NC_INT</td>
<td>Number of ground pixels where processing error “ozone column significantly out of range of profile climatology” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “10”.</td>
</tr>
<tr>
<td>number_of_wavelength_offset_error_occurrences</td>
<td>0 (static) NC_INT</td>
<td>Number of ground pixels where processing error “wavelength offset exceeds maximum from configuration” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “11”.</td>
</tr>
<tr>
<td>number_of_initialization_error_occurrences</td>
<td>0 (static) NC_INT</td>
<td>Number of ground pixels where processing error “an error occurred during the processing of the pixel, no output was generated. The following errors raise this flag: Mismatch between irradiance and radiance wavelengths; The on-ground distance between band 1 and band 2 ground pixels exceeds a threshold set in the configuration. Derived a-priori information does not validate, no processing is possible” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “12”.</td>
</tr>
<tr>
<td>number_of_memory_error_occurrences</td>
<td>0 (static) NC_INT</td>
<td>Number of ground pixels where processing error “the number of spectral pixels in the irradiance due to flagging is too small to perform the fitting” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “2”.</td>
</tr>
</tbody>
</table>
Number of ground pixels where processing error "memory allocation or deallocation error" occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value “13”.

| number_of_assertion_error_occurrences | 0 (static) | NC_INT |

Number of ground pixels where processing error "error in algorithm detected during assertion" occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value “14”.

| number_of_io_error_occurrences | 0 (static) | NC_INT |

Number of ground pixels where processing error "error detected during transfer of data between algorithm and framework" occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value “15”.

| number_of_numerical_error_occurrences | 0 (static) | NC_INT |

Number of ground pixels where processing error "general fatal numerical error occurred during inversion" occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value “16”.

| number_of_lut_error_occurrences | 0 (static) | NC_INT |

Number of ground pixels where processing error "error in accessing the lookup table" occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value “17”.

| number_of_ISRF_error_occurrences | 0 (static) | NC_INT |

Number of ground pixels where processing error "error detected in the input instrument spectral response function input data" occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value “18”.

| number_of_convergence_error_occurrences | 0 (static) | NC_INT |

Number of ground pixels where processing error "the main algorithm did not converge" occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value “19”.

| number_of_cloud_filter_convergence_error_occurrences | 0 (static) | NC_INT |

Number of ground pixels where processing error "the cloud filter did not converge" occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value “20”.

| number_of_max_iteration_convergence_error_occurrences | 0 (static) | NC_INT |

Number of ground pixels where processing error "no convergence because retrieval exceeds maximum number of iterations. Maximum value from configuration" occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value “21”.

| number_of_aot_lower_boundary_convergence_error_occurrences | 0 (static) | NC_INT |

Number of ground pixels where processing error "no convergence because the aerosol optical thickness crosses lower boundary twice in succession" occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value “22”.

| number_of_other_boundary_convergence_error_occurrences | 0 (static) | NC_INT |

Number of ground pixels where processing error "no convergence because a state vector element crosses boundary twice in succession. Note that a separate failure flag is defined for non-convergence due to crossing of lower AOT boundary" occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value “23”.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Default</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>number_of_geolocation_error_occurrences</td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
<tr>
<td>Number of ground pixels where processing error “geolocation out of range” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “24”.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_ch4_noscat_zero_error_occurrences</td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
<tr>
<td>Number of ground pixels where processing error “the CH₄ column retrieved by the non-scattering CO algorithm from the weak band or strong band is 0” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “25”.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_h2o_noscat_zero_error_occurrences</td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
<tr>
<td>Number of ground pixels where processing error “the H₂O column retrieved by the non-scattering CO algorithm from the weak band or strong band is 0” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “26”.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_max_optical_thickness_error_occurrences</td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
<tr>
<td>Number of ground pixels where processing error “maximum optical thickness exceeded during iterations” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “27”.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_aerosol_boundary_error_occurrences</td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
<tr>
<td>Number of ground pixels where processing error “boundary hit of aerosol parameters at last iteration” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “28”.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_boundary_hit_error_occurrences</td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
<tr>
<td>Number of ground pixels where processing error “fatal boundary hit during iterations” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “29”.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_chi2_error_occurrences</td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
<tr>
<td>Number of ground pixels where processing error “χ² is not-a-number or larger than 10¹⁰” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “30”.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_svd_error_occurrences</td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
<tr>
<td>Number of ground pixels where processing error “singular value decomposition failure” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “31”.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_dfs_error_occurrences</td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
<tr>
<td>Number of ground pixels where processing error “degree of freedom is not-a-number” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “32”.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_radiative_transfer_error_occurrences</td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
<tr>
<td>Number of ground pixels where processing error “errors occurred during the radiative transfer computations, no processing possible” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “33”.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_optimal_estimation_error_occurrences</td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
<tr>
<td>Number of ground pixels where processing error “errors occurred during the optimal estimation, processing has been terminated” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “34”.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_profile_error_occurrences</td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
</tbody>
</table>
Number of ground pixels where processing error “flag that indicates if there were any errors during the
computation of the ozone profile” occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value “35”.

<table>
<thead>
<tr>
<th>number_of_cloud_error_occurrences</th>
<th>0 (static)</th>
<th>NC_INT</th>
</tr>
</thead>
</table>

Number of ground pixels where processing error “no cloud data” occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value “36”.

<table>
<thead>
<tr>
<th>number_of_model_error_occurrences</th>
<th>0 (static)</th>
<th>NC_INT</th>
</tr>
</thead>
</table>

Number of ground pixels where processing error “forward model failure” occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value “37”.

<table>
<thead>
<tr>
<th>number_of_number_of_input_data_points_too_low_error_occurrences</th>
<th>0 (static)</th>
<th>NC_INT</th>
</tr>
</thead>
</table>

Number of ground pixels where processing error “not enough input ozone columns to calculate a tropospheric column” occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value “38”.

<table>
<thead>
<tr>
<th>number_of_cloud_pressure_spread_too_low_error_occurrences</th>
<th>0 (static)</th>
<th>NC_INT</th>
</tr>
</thead>
</table>

Number of ground pixels where processing error “cloud pressure variability to low to estimate a tropospheric column” occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value “39”.

<table>
<thead>
<tr>
<th>number_of_cloud_too_low_level_error_occurrences</th>
<th>0 (static)</th>
<th>NC_INT</th>
</tr>
</thead>
</table>

Number of ground pixels where processing error “clouds are too low in the atmosphere to assume sufficient shielding” occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value “40”.

<table>
<thead>
<tr>
<th>number_of_generic_range_error_occurrences</th>
<th>0 (static)</th>
<th>NC_INT</th>
</tr>
</thead>
</table>

Number of ground pixels where processing error “generic range error” occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value “41”.

<table>
<thead>
<tr>
<th>number_of_generic_exception_occurrences</th>
<th>0 (static)</th>
<th>NC_INT</th>
</tr>
</thead>
</table>

Number of ground pixels where processing error “catch all generic error” occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value “42”.

<table>
<thead>
<tr>
<th>number_of_input_spectrum_alignment_error_occurrences</th>
<th>0 (static)</th>
<th>NC_INT</th>
</tr>
</thead>
</table>

Number of ground pixels where processing error “input radiance and irradiance spectra are not aligned correctly” occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value “43”.

<table>
<thead>
<tr>
<th>number_of_abort_error_occurrences</th>
<th>0 (static)</th>
<th>NC_INT</th>
</tr>
</thead>
</table>

Number of ground pixels where processing error “not processed because processor aborted prematurely (time out or user abort)” occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value “44”.

<table>
<thead>
<tr>
<th>number_of_wrong_input_type_error_occurrences</th>
<th>0 (static)</th>
<th>NC_INT</th>
</tr>
</thead>
</table>

Number of ground pixels where processing error “wrong input type error, mismatch between expectation and received data” occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value “45”.

<table>
<thead>
<tr>
<th>number_of_wavelength_calibration_error_occurrences</th>
<th>0 (static)</th>
<th>NC_INT</th>
</tr>
</thead>
</table>
Number of ground pixels where processing error "an error occurred in the wavelength calibration of this pixe" occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value "46".

<table>
<thead>
<tr>
<th>Error Type</th>
<th>Count</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>number_of_coregistration_error_occurrences</code></td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
</tbody>
</table>

Number of ground pixels where processing error "no colocated pixels found in a supporting ban" occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value "47".

<table>
<thead>
<tr>
<th>Error Type</th>
<th>Count</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>number_of_slant_column_density_error_occurrences</code></td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
</tbody>
</table>

Number of ground pixels where processing error "slant column fit returned error, no values can be compute" occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value "48".

<table>
<thead>
<tr>
<th>Error Type</th>
<th>Count</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>number_of_airmass_factor_error_occurrences</code></td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
</tbody>
</table>

Number of ground pixels where processing error "airmass factor could not be compute" occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value "49".

<table>
<thead>
<tr>
<th>Error Type</th>
<th>Count</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>number_of_vertical_column_density_error_occurrences</code></td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
</tbody>
</table>

Number of ground pixels where processing error "vertical column density could not be compute" occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value "50".

<table>
<thead>
<tr>
<th>Error Type</th>
<th>Count</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>number_of_signal_to_noise_ratio_error_occurrences</code></td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
</tbody>
</table>

Number of ground pixels where processing error "the signal to noise ratio for this spectrum is too low for processin" occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value "51".

<table>
<thead>
<tr>
<th>Error Type</th>
<th>Count</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>number_of_configuration_error_occurrences</code></td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
</tbody>
</table>

Number of ground pixels where processing error "error while parsing the configuratio" occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value "52".

<table>
<thead>
<tr>
<th>Error Type</th>
<th>Count</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>number_of_key_error_occurrences</code></td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
</tbody>
</table>

Number of ground pixels where processing error "key does not exis" occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value "53".

<table>
<thead>
<tr>
<th>Error Type</th>
<th>Count</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>number_of_saturation_error_occurrences</code></td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
</tbody>
</table>

Number of ground pixels where processing error "saturation in input spectru" occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value "54".

<table>
<thead>
<tr>
<th>Error Type</th>
<th>Count</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>number_of_solar_eclipse_filter_occurrences</code></td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
</tbody>
</table>

Number of ground pixels where input filter "solar eclipse" occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value "64".

<table>
<thead>
<tr>
<th>Error Type</th>
<th>Count</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>number_of_cloud_filter_occurrences</code></td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
</tbody>
</table>

Number of ground pixels where input filter "the cloud filter triggered causing the pixel to be skipped" occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value "65".

<table>
<thead>
<tr>
<th>Error Type</th>
<th>Count</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>number_of_altitude_consistency_filter_occurrences</code></td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
</tbody>
</table>

Number of ground pixels where input filter “too large difference between ECMWF altitude and DEM altitude value” occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value "66".

<table>
<thead>
<tr>
<th>Error Type</th>
<th>Count</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>number_of_altitude_roughness_filter_occurrences</code></td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
<tr>
<td>Property</td>
<td>Value</td>
<td>Type</td>
</tr>
<tr>
<td>---------------------------------------------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>number_of_sun_glint_filter_occurrences</td>
<td>0</td>
<td>NC_INT</td>
</tr>
<tr>
<td>Number of ground pixels where input filter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“for pixels over water, viewing direction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>inside sun glint region.” occurred, i.e.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>where the lower 8 bits of the</td>
<td></td>
<td></td>
</tr>
<tr>
<td>processing_quality_flags have the value</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“68”.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_mixed_surface_type_filter_</td>
<td>0</td>
<td>NC_INT</td>
</tr>
<tr>
<td>occurrences</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of ground pixels where input filter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“pixel contains land and water areas (e.g.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>coastal pixel)” occurred, i.e. where the</td>
<td></td>
<td></td>
</tr>
<tr>
<td>lower 8 bits of the processing_quality_flags have the value “69”.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_snow_ice_filter_occurrences</td>
<td>0</td>
<td>NC_INT</td>
</tr>
<tr>
<td>Number of ground pixels where input filter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“pixel contains snow/ice: Snow/ice flag</td>
<td></td>
<td></td>
</tr>
<tr>
<td>according to dynamic input OR climatological</td>
<td></td>
<td></td>
</tr>
<tr>
<td>surface albedo at VIS wavelength is larger</td>
<td></td>
<td></td>
</tr>
<tr>
<td>than 0.5” occurred, i.e. where the lower 8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>bits of the processing_quality_flags have</td>
<td></td>
<td></td>
</tr>
<tr>
<td>the value “70”.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_aai_filter_occurrences</td>
<td>0</td>
<td>NC_INT</td>
</tr>
<tr>
<td>Number of ground pixels where input filter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“aAI smaller than 2.0” occurred, i.e. where</td>
<td></td>
<td></td>
</tr>
<tr>
<td>the lower 8 bits of the</td>
<td></td>
<td></td>
</tr>
<tr>
<td>processing_quality_flags have the value</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“71”.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_cloud_fraction_fresco_filter_</td>
<td>0</td>
<td>NC_INT</td>
</tr>
<tr>
<td>occurrences</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of ground pixels where input filter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“pixel contains clouds: The FRESCO effective</td>
<td></td>
<td></td>
</tr>
<tr>
<td>cloud fraction is larger than threshold.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Threshold value from ATBD” occurred, i.e.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>where the lower 8 bits of the</td>
<td></td>
<td></td>
</tr>
<tr>
<td>processing_quality_flags have the value</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“72”.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_aai_scene_albedo_filter_occurrences</td>
<td>0</td>
<td>NC_INT</td>
</tr>
<tr>
<td>Number of ground pixels where input filter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“pixel contains clouds: The difference</td>
<td></td>
<td></td>
</tr>
<tr>
<td>between scene albedo at 380 nm from AAI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>calculation and the climatological surface</td>
<td></td>
<td></td>
</tr>
<tr>
<td>albedo exceeds threshold. Threshold value</td>
<td></td>
<td></td>
</tr>
<tr>
<td>from ATBD. This test filters out clouds”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>occurred, i.e. where the lower 8 bits of the</td>
<td></td>
<td></td>
</tr>
<tr>
<td>processing_quality_flags have the value</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“73”.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_small_pixel_radiance_std_filter_</td>
<td>0</td>
<td>NC_INT</td>
</tr>
<tr>
<td>occurrences</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of ground pixels where input filter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“pixel contains clouds: Standard deviation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>of radiances in small-pixel column exceeds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>threshold. Threshold value from ATBD”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>occurred, i.e. where the lower 8 bits of the</td>
<td></td>
<td></td>
</tr>
<tr>
<td>processing_quality_flags have the value</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“74”.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_cloud_fraction_viirs_filter_</td>
<td>0</td>
<td>NC_INT</td>
</tr>
<tr>
<td>occurrences</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of ground pixels where input filter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“pixel contains clouds: The cloud fraction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>from VIIRS / NPP exceeds threshold.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Threshold value from ATBD” occurred, i.e.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>where the lower 8 bits of the</td>
<td></td>
<td></td>
</tr>
<tr>
<td>processing_quality_flags have the value</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“75”.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_cirrus_reflectance_viirs_filter_</td>
<td>0</td>
<td>NC_INT</td>
</tr>
<tr>
<td>occurrences</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of ground pixels where input filter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“pixel contains clouds: Cirrus reflectance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>from VIIRS / NPP exceeds threshold.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Threshold value from ATBD” occurred, i.e.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>where the lower 8 bits of the</td>
<td></td>
<td></td>
</tr>
<tr>
<td>processing_quality_flags have the value</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“76”.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_cf_viirs_swir_ifov_filter_</td>
<td>0</td>
<td>NC_INT</td>
</tr>
<tr>
<td>occurrences</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of ground pixels where input filter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“fraction of cloudy VIIRS pixels within S5P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SWIR ground pixel exceeds a priori threshold</td>
<td></td>
<td></td>
</tr>
<tr>
<td>from configuration” occurred, i.e. where the</td>
<td></td>
<td></td>
</tr>
<tr>
<td>lower 8 bits of the processing_quality_flags have the value “77”.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_cf_viirs_swir_ofova_filter_</td>
<td>0</td>
<td>NC_INT</td>
</tr>
<tr>
<td>occurrences</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Number of ground pixels where input filter “fraction of cloudy VIIRS pixels within S5P SWIR OFOVa exceeds a priori threshold from configuration” occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value “78”.

| number_of_cf_viirs_swir_ofovb_filter_occurrences | 0 (static) | NC_INT |

Number of ground pixels where input filter “fraction of cloudy VIIRS pixels within S5P SWIR OFOVb exceeds a priori threshold from configuration” occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value “79”.

| number_of_cf_viirs_swir_ofovc_filter_occurrences | 0 (static) | NC_INT |

Number of ground pixels where input filter “fraction of cloudy VIIRS pixels within S5P SWIR OFOVc exceeds a priori threshold from configuration” occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value “80”.

| number_of_cf_viirs_nir_ifov_filter_occurrences | 0 (static) | NC_INT |

Number of ground pixels where input filter “fraction of cloudy VIIRS pixels within S5P NIR ground pixel exceeds a priori threshold from configuration” occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value “81”.

| number_of_cf_viirs_nir_ofova_filter_occurrences | 0 (static) | NC_INT |

Number of ground pixels where input filter “fraction of cloudy VIIRS pixels within S5P NIR OFOVa exceeds a priori threshold from configuration” occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value “82”.

| number_of_cf_viirs_nir_ofovb_filter_occurrences | 0 (static) | NC_INT |

Number of ground pixels where input filter “fraction of cloudy VIIRS pixels within S5P NIR OFOVb exceeds a priori threshold from configuration” occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value “83”.

| number_of_cf_viirs_nir_ofovc_filter_occurrences | 0 (static) | NC_INT |

Number of ground pixels where input filter “fraction of cloudy VIIRS pixels within S5P NIR OFOVc exceeds a priori threshold from configuration” occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value “84”.

| number_of_refl_cirrus_viirs_swir_filter_occurrences | 0 (static) | NC_INT |

Number of ground pixels where input filter “average VIIRS cirrus reflectance within SWIR ground pixel exceeds a priori threshold from configuration” occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value “85”.

| number_of_refl_cirrus_viirs_nir_filter_occurrences | 0 (static) | NC_INT |

Number of ground pixels where input filter “average VIIRS cirrus reflectance within NIR ground pixel exceeds a priori threshold from configuration” occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value “86”.

| number_of_diff_refl_cirrus_viirs_filter_occurrences | 0 (static) | NC_INT |

Number of ground pixels where input filter “difference in VIIRS average cirrus reflectance between SWIR and NIR ground pixel exceeds a priori threshold from configuration” occurred, i.e. where the lower 8 bits of the `processing_quality_flags` have the value “87”.

| number_of_ch4_noscat_ratio_filter_occurrences | 0 (static) | NC_INT |
Number of ground pixels where input filter “the ratio between [CH₄]_{weak} and [CH₄]_{strong} is below or exceeds a priori thresholds from configuration” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “88”.

| number_of_ch4_noscat_ratio_std_filter_occurrences | 0 (static) | NC_INT |

Number of ground pixels where input filter “the standard deviation of [CH₄]_{weak}/[CH₄]_{strong} within the SWIR pixel and the 8 neighbouring pixels exceeds a priori threshold from configuration” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “89”.

| number_of_h2o_noscat_ratio_std_filter_occurrences | 0 (static) | NC_INT |

Number of ground pixels where input filter “the ratio between [H₂O]_{weak} and [H₂O]_{strong} is below or exceeds a priori thresholds from configuration” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “90”.

| number_of_h2o_noscat_ratio_std_filter_occurrences | 0 (static) | NC_INT |

Number of ground pixels where input filter “the standard deviation of [H₂O]_{weak}/[H₂O]_{strong} within the SWIR pixel and the 8 neigbouring pixels exceeds a priori threshold from configuration” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “91”.

| number_of_diff_psurf_fresco_ecmwf_filter_occurrences | 0 (static) | NC_INT |

Number of ground pixels where input filter “difference between the FRESCO apparent surface pressure and the ECMWF surface pressure exceeds a priori threshold from configuration” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “92”.

| number_of_psurf_fresco_stdy_filter_occurrences | 0 (static) | NC_INT |

Number of ground pixels where input filter “the standard deviation of the FRESCO apparent surface pressure in the NIR pixel and the 8 surrounding pixels exceeds a priori threshold from configuration” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “93”.

| number_of_ocean_filter_occurrences | 0 (static) | NC_INT |

Number of ground pixels where input filter “the ground pixel is over ocean (and ocean glint retrievals are not switched on)” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “94”.

| number_of_time_range_filter_occurrences | 0 (static) | NC_INT |

Number of ground pixels where input filter “time is out of the range that is to be processed” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “95”.

| number_of_pixel_or_scanline_index_filter_occurrences | 0 (static) | NC_INT |

Number of ground pixels where input filter “not processed because pixel index does not match general selection criteria” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “96”.

| number_of_geographic_region_filter_occurrences | 0 (static) | NC_INT |

Number of ground pixels where input filter “pixel falls outside the specified regions of interest” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “97”.

| number_of_input_spectrump_warning_occurrences | 0 (static) | NC_INT |

Number of ground pixels where processing warning “number of good pixels in radiance, irradiance or calculated reflectance below threshold from configuration” occurred, i.e. where bit 8 in the processing_quality_flags is set to “1”.

Number of ground pixels where input filter “the standard deviation of [CH₄]_{weak}/[CH₄]_{strong} within the SWIR pixel and the 8 neighbouring pixels exceeds a priori threshold from configuration” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “89”.

| number_of_h2o_noscat_ratio_std_filter_occurrences | 0 (static) | NC_INT |

Number of ground pixels where input filter “the ratio between [H₂O]_{weak} and [H₂O]_{strong} is below or exceeds a priori thresholds from configuration” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “90”.

| number_of_h2o_noscat_ratio_std_filter_occurrences | 0 (static) | NC_INT |

Number of ground pixels where input filter “the standard deviation of [H₂O]_{weak}/[H₂O]_{strong} within the SWIR pixel and the 8 neigbouring pixels exceeds a priori threshold from configuration” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “91”.

| number_of_geo_psurf_filter_occurrences | 0 (static) | NC_INT |

Number of ground pixels where input filter “pixel falls outside the specified regions of interest” occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value “97”.

| number_of_input_spectrum_warning_occurrences | 0 (static) | NC_INT |

Number of ground pixels where processing warning “number of good pixels in radiance, irradiance or calculated reflectance below threshold from configuration” occurred, i.e. where bit 8 in the processing_quality_flags is set to “1”.
<table>
<thead>
<tr>
<th>Feature</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>number_of_wavelength_calibration_warning_occurrences</td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
<tr>
<td>Number of ground pixels where processing warning “offset from wavelength fit is larger than limit set in configuration” occurred, i.e. where bit 9 in the processing_quality_flags is set to “1”.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_extrapolation_warning_occurrences</td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
<tr>
<td>Number of ground pixels where processing warning “pressure or temperature outside cross section LUT range, other lookup table extrapolation” occurred, i.e. where bit 10 in the processing_quality_flags is set to “1”.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_sun_glint_warning_occurrences</td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
<tr>
<td>Number of ground pixels where processing warning “sun glint possibility warning” occurred, i.e. where bit 11 in the processing_quality_flags is set to “1”.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_south_atlantic_anomaly_warning_occurrences</td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
<tr>
<td>Number of ground pixels where processing warning “TROPOMI is inside the south Atlantic anomaly while taking these measurements” occurred, i.e. where bit 12 in the processing_quality_flags is set to “1”.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_sun_glint_correction_occurrences</td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
<tr>
<td>Number of ground pixels where processing warning “a sun glint correction has been applied” occurred, i.e. where bit 13 in the processing_quality_flags is set to “1”.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_snow_ice_warning_occurrences</td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
<tr>
<td>Number of ground pixels where processing warning “snow/ice flag is set, i.e. using scene data from the cloud support product” occurred, i.e. where bit 14 in the processing_quality_flags is set to “1”.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_cloud_warning_occurrences</td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
<tr>
<td>Number of ground pixels where processing warning “cloud filter based on FRESCO apparent surface pressure (VIIRS not available), cloud fraction above threshold or cloud pressure adjusted to force cloud above surface” occurred, i.e. where bit 15 in the processing_quality_flags is set to “1”.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_AAI_warning_occurrences</td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
<tr>
<td>Number of ground pixels where processing warning “possible aerosol contamination as indicated by the AAI” occurred, i.e. where bit 16 in the processing_quality_flags is set to “1”.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_pixel_level_input_data_missing_occurrences</td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
<tr>
<td>Number of ground pixels where processing warning “dynamic auxiliary input data (e.g. cloud) is missing for this ground pixel. A fallback option is used” occurred, i.e. where bit 17 in the processing_quality_flags is set to “1”.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_data_range_warning_occurrences</td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
<tr>
<td>Number of ground pixels where processing warning “carbon monoxide column tends to negative values; water column tends to negative values; Heavy water (HDO) column tends to negative values; others” occurred, i.e. where bit 18 in the processing_quality_flags is set to “1”.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number_of_low_cloud_fraction_warning_occurrences</td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
<tr>
<td>Number of ground pixels where processing warning “low cloud fraction, therefore no cloud pressure retrieved” occurred, i.e. where bit 19 in the processing_quality_flags is set to “1”.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Altitude Consistency Warning Occurrences</td>
<td>0 (static)</td>
<td>NC_INT</td>
</tr>
<tr>
<td>-------------------------------------------------</td>
<td>------------</td>
<td>--------</td>
</tr>
<tr>
<td>Number of ground pixels where processing warning “difference between ECMWF surface elevation and high-resolution surface elevation exceeds threshold from configuration” occurred, i.e. where bit 20 in the <code>processing_quality_flags</code> is set to “1”.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of Signal to Noise Ratio Warning Occurrences</th>
<th>0 (static)</th>
<th>NC_INT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of ground pixels where processing warning “signal to noise ratio in SWIR and/or NIR band below threshold from configuration” occurred, i.e. where bit 21 in the <code>processing_quality_flags</code> is set to “1”.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of Deconvolution Warning Occurrences</th>
<th>0 (static)</th>
<th>NC_INT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of ground pixels where processing warning “failed deconvolution irradiance spectrum (not pixel-specific, but row-specific)” occurred, i.e. where bit 22 in the <code>processing_quality_flags</code> is set to “1”.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of SO2 Volcanic Origin Likely Warning Occurrences</th>
<th>0 (static)</th>
<th>NC_INT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of ground pixels where processing warning “warning for SO2 BL product, UTLS products: volcanic origin except for heavily polluted sites” occurred, i.e. where bit 23 in the <code>processing_quality_flags</code> is set to “1”.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of SO2 Volcanic Origin Certain Warning Occurrences</th>
<th>0 (static)</th>
<th>NC_INT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of ground pixels where processing warning “warning for SO2 BL product, UTLS products: volcanic origin certain” occurred, i.e. where bit 24 in the <code>processing_quality_flags</code> is set to “1”.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of Interpolation Warning Occurrences</th>
<th>0 (static)</th>
<th>NC_INT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of ground pixels where processing warning “warning for interpolation on partially missing data. In this case the valid available data is used, potentially leading to a bias” occurred, i.e. where bit 25 in the <code>processing_quality_flags</code> is set to “1”.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of Saturation Warning Occurrences</th>
<th>0 (static)</th>
<th>NC_INT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of ground pixels where processing warning “saturation occurred spectrum, possibly causing biases in the retrieval” occurred, i.e. where bit 26 in the <code>processing_quality_flags</code> is set to “1”.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of High SZA Warning Occurrences</th>
<th>0 (static)</th>
<th>NC_INT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of ground pixels where processing warning “warning for high solar zenith angle. In this case, the processing can be performed with less final quality” occurred, i.e. where bit 27 in the <code>processing_quality_flags</code> is set to “1”.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of Cloud Retrieval Warning Occurrences</th>
<th>0 (static)</th>
<th>NC_INT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of ground pixels where processing warning “warning occurring when the retrieval diagnostic indicates a degraded quality of the cloud retrieval” occurred, i.e. where bit 28 in the <code>processing_quality_flags</code> is set to “1”.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of Cloud Inhomogeneity Warning Occurrences</th>
<th>0 (static)</th>
<th>NC_INT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of ground pixels where processing warning “the cloud coregistration inhomogeneity parameter is above a given threshold” occurred, i.e. where bit 29 in the <code>processing_quality_flags</code> is set to “1”.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### global_processing_warnings

All warning messages, separated by newlines, with duplicates removed.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>global_processing_warnings</td>
<td>'None' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

### time_for_algorithm_initialization

Time in seconds needed for initialization.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>time_for_algorithm_initialization</td>
<td>-1.0 (static)</td>
<td>NC_DOUBLE</td>
</tr>
</tbody>
</table>

### time_for_processing

Time in seconds needed for processing.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>time_for_processing</td>
<td>-1.0 (static)</td>
<td>NC_DOUBLE</td>
</tr>
</tbody>
</table>

### time_per_pixel

Time per pixel in seconds needed for processing.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>time_per_pixel</td>
<td>-1.0 (static)</td>
<td>NC_DOUBLE</td>
</tr>
</tbody>
</table>

### time_standard_deviation_per_pixel

Standard deviation of the time per pixel in seconds needed for processing.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>time_standard_deviation_per_pixel</td>
<td>-1.0 (static)</td>
<td>NC_DOUBLE</td>
</tr>
</tbody>
</table>

### vertices

For the histogram boundaries.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>size</td>
<td>2 (fixed)</td>
<td></td>
</tr>
<tr>
<td>mode</td>
<td>Present in all modes.</td>
<td></td>
</tr>
</tbody>
</table>

### histogram_axis

Histogram axis.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>size</td>
<td>100 (fixed)</td>
<td></td>
</tr>
<tr>
<td>mode</td>
<td>Present in all modes.</td>
<td></td>
</tr>
</tbody>
</table>

### pdf_axis

Probability density function axis.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>size</td>
<td>400 (fixed)</td>
<td></td>
</tr>
<tr>
<td>mode</td>
<td>Present in all modes.</td>
<td></td>
</tr>
</tbody>
</table>

### histogram_axis

Description: Horizontal axis for the histograms of the main parameter.

Dimensions: histogram_axis (coordinate variable).

Type: NC_FLOAT.

Source: Processor.

Mode: Present in all modes.

Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>'1' (dynamic)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

Same unit as the main parameter. Other attributes – standard_name, long_name – are to be copied from the main parameter as well. This attribute originates from the CF standard.

### pdf_axis

Description: Horizontal axis for the probability distribution functions of the main parameter.

Dimensions: pdf_axis (coordinate variable).

Type: NC_FLOAT.

Source: Processor.

Mode: Present in all modes.

Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>'1' (dynamic)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

Same unit as the main parameter. Other attributes – standard_name, long_name – are to be copied from the main parameter as well. This attribute originates from the CF standard.
12.24 Algorithm settings

The algorithm settings are attached as attributes to this group. The current settings are listed here, each item in the list is a string attribute.

12.25 Granule metadata

Common granule level metadata.

Attributes in GRANULE_METADATA

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>GranuleStart</td>
<td>Start of the granule as ISO date/time string in UTC: YYYY-MM-DDTHH:MM:SS.mmmmmmmmmmmZ. The formal definition of ISO date/time strings is given in [RD35].</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>GranuleEnd</td>
<td>End of the granule as ISO date/time string in UTC: YYYY-MM-DDTHH:MM:SS.mmmmmmmmmmmZ. The formal definition of ISO date/time strings is given in [RD35].</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>InstrumentName</td>
<td>‘TROPOMI’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>The name of the instrument, fixed to “TROPOMI”.</td>
<td></td>
</tr>
<tr>
<td>MissionName</td>
<td>‘Sentinel-5 precursor’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>The name of the mission, fixed to “Sentinel-5 precursor”.</td>
<td></td>
</tr>
<tr>
<td>MissionShortName</td>
<td>‘S5P’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>The short name of the mission, fixed to “S5P”.</td>
<td></td>
</tr>
<tr>
<td>ProcessLevel</td>
<td>‘2’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>This is a level 2 product.</td>
<td></td>
</tr>
<tr>
<td>ProcessingCenter</td>
<td>‘%(processingcenter)s’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>Where was the processor run? The source is the probably the joborder, the most likely value for operational use is “DLR/Oberpfaffenhofen”.</td>
<td></td>
</tr>
<tr>
<td>ProcessingNode</td>
<td>NC_STRING</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The name of the machine that processed the data. This may aid in diagnosing failures in the processing.</td>
<td></td>
</tr>
<tr>
<td>ProcessorVersion</td>
<td>‘%(version)s’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>The version number of the processor used to produce the file. This is a string formatted as “major.minor.bugfix”.</td>
<td></td>
</tr>
<tr>
<td>ProductFormatVersion</td>
<td>1 (static)</td>
<td>NC_INT</td>
</tr>
<tr>
<td></td>
<td>The version of the format of the product file. This should be incremented whenever a datafield is added to the files.</td>
<td></td>
</tr>
<tr>
<td>ProcessingMode</td>
<td>NC_STRING</td>
<td></td>
</tr>
<tr>
<td></td>
<td>This attribute indicates the mode of the processor.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Possible values: Near-realtime, Offline, Reprocessing, Test, SyntheticTest</td>
<td></td>
</tr>
</tbody>
</table>

12.26 ESA metadata

12.26.1 Group “ESA_METADATA”

Metadata defined in the ESA file format standard [RD26].

12.26.1.1 Group “earth_explorer_header” in “ESA_METADATA”

Attributes in ESA_METADATA/earth_explorer_header
Group attributes attached to earth_explorer_header

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>objectType</td>
<td>‘Earth_Explorer_Header’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.26.1.2 Group “fixed_header” in “earth_explorer_header”

The fixed header. We do not use a variable header, so only the fixed header is present.

Attributes in ESA_METADATA/earth_explorer_header/fixed_header

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>objectType</td>
<td>‘Fixed_Header’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>File_Name</td>
<td>‘%(logical_filename)s’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>Notes</td>
<td>This is a copy of the global “title” attribute.</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>Mission</td>
<td>‘S5P’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>File_Class</td>
<td>‘%(mode)s’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>File_Type</td>
<td>‘%(shortname)s’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>File_Version</td>
<td>0 (dynamic)</td>
<td>NC_INT</td>
</tr>
</tbody>
</table>

12.26.1.3 Group “validity_period” in “fixed_header”

Attributes in ESA_METADATA/earth_explorer_header/fixed_header/validity_period

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>objectType</td>
<td>‘Validity_Period’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>Validity_Start</td>
<td>The value is the string &quot;UTC=&quot; concatenated with the time_coverage_start global attribute. This attribute corresponds to the “Validity_Start” element in the “Validity_Period” XML structure in the header file.</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>Validity_Stop</td>
<td>The value is the string &quot;UTC=&quot; concatenated with the time_coverage_end global attribute. This attribute corresponds to the “Validity_Stop” element in the “Validity_Period” XML structure in the header file.</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.26.1.4 Group “source” in “fixed_header”

Attributes in ESA_METADATA/earth_explorer_header/fixed_header/source
Group attributes attached to source

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>objectType</td>
<td>'Source' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>System</td>
<td>‘%(processingcenter)s’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

Name of the Ground Segment element creating the file. For Level 2 files, this is the PDGS, but for testing a different value may be used. This attribute corresponds to the “System” element in the “Source” XML structure in the header file.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creator</td>
<td>‘%(processor_name)s’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

Name of the facility or tool, within the Ground Segment element, creating the file. This attribute corresponds to the “Creator” element in the “Source” XML structure in the header file.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creator_Version</td>
<td>‘%(version)s’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

Version number of the tool that created the file. This attribute corresponds to the “Creator_Version” element in the “Source” XML structure in the header file.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creation_Date</td>
<td></td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The start date and time of processing, as a string: "UTC=YYYY-MM-DDThh:mm:ss". This attribute corresponds to the “Creator_Date” element in the “Source” XML structure in the header file.

12.26.1.5 Group “variable_header” in “earth_explorer_header”

Attributes in ESA_METADATA/earth_explorer_header/variable_header

Group attributes attached to variable_header

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>objectType</td>
<td>‘Variable_Header’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.26.1.6 Group “gmd:lineage” in “variable_header”

Non-quantitative quality information about the lineage of the data specified by the scope.

Attributes in ESA_METADATA/earth_explorer_header/variable_header/gmd:lineage

Group attributes attached to gmd:lineage

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>objectType</td>
<td>‘gmd:L1_Lineage’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>gmd:statement</td>
<td>‘L2 %product%s dataset produced by %processingcenter%s from the SSP/TROPOMI L1B product’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

General explanation of the data producer's knowledge about the lineage of a dataset. Insert short description of the actual Level 2 product in this string (at the %(...)s).

12.26.1.7 Group “gmd:processStep” in “gmd:lineage”

Information about an event or transformation in the life of the dataset including details of the algorithm and software used for processing.

Attributes in ESA_METADATA/earth_explorer_header/variable_header/gmd:lineage/gmd:processStep

Group attributes attached to gmd:processStep

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>objectType</td>
<td>‘gmi:LE_ProcessStep’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>gmd:description</td>
<td>‘Processing of L1b to L2 %product%s data for orbit %orbit%d using the %institute%s processor version %version%s’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>
Description of the event, including related parameters or tolerances. Insert short description of the actual Level 2 product, the orbit number, the name of the institute responsible for the CFI and the software version in this string (at the respective %(. . . )s and %(. . . )d).

### 12.26.1.8 Group “gmi:output” in “gmd:processStep”

Description of the output.

Attributes in ESA_METADATA/earth_explorer_header/variable_header/gmd:lineage/gmd:processStep/gmi:output

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:description</td>
<td>Short description of the output, a copy of the global ‘title’ attribute.</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmi:LE_Source’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

### 12.26.1.9 Group “gmd:sourceCitation” in “gmi:output”

Reference to the actual filename of the output data and production date and time.

Attributes in ESA_METADATA/earth_explorer_header/variable_header/gmd:lineage/gmd:processStep/gmi:output/gmd:sourceCitation

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:title</td>
<td>‘%(logical_filename)s’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:CI_Citation’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

### 12.26.1.10 Group “gmd:date” in “gmd:sourceCitation”

Production date and time of the output file.

Attributes in ESA_METADATA/earth_explorer_header/variable_header/gmd:lineage/gmd:processStep/gmi:output/gmd:sourceCitation/gmd:date

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:date</td>
<td>Production date and time of the output file. Note that the definition in the XML schema appears to allow the use of a “CI_DateTime” instead of a “CI_Date”.</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:CI_DateTime’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

### 12.26.1.11 Group “gmd:dateType” in “gmd:date”

Meaning of the reference date for the cited resource.

Attributes in ESA_METADATA/earth_explorer_header/variable_header/gmd:lineage/gmd:processStep/gmi:output/gmd:sourceCitation/gmd:date/gmd:dateType

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>codeList</td>
<td>‘<a href="http://www.isotc211.org/2005/resources/Codelist/gmxCodelist.xml#CI_DateTypeCode%E2%80%99">http://www.isotc211.org/2005/resources/Codelist/gmxCodelist.xml#CI_DateTypeCode’</a> (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>codeListValue</td>
<td>‘creation’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:CI_DateTypeCode’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>
12.26.1.12 Group “gmd:identifier” in “gmd:sourceCitation”

Identification of the output product.

Attributes in ESA_METADATA/earth_explorer_header/variable_header/gmd:lineage/gmd:processStep/gmi:output/gmd:sourceCitation/gmd:identifier

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:code</td>
<td>‘%(shortname)s’ (dynamic) NC_STRING</td>
<td></td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:MD_Identifier’ (static) NC_STRING</td>
<td></td>
</tr>
</tbody>
</table>

12.26.1.13 Group “gmi:processedLevel” in “gmi:output”

Process level of the output file.

Attributes in ESA_METADATA/earth_explorer_header/variable_header/gmd:lineage/gmd:processStep/gmi:output/gmi:processedLevel

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:code</td>
<td>‘L2’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:MD_Identifier’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>


Description of the processor in more detail.

Attributes in ESA_METADATA/earth_explorer_header/variable_header/gmd:lineage/gmd:processStep/gmi:processingInformation

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>objectType</td>
<td>‘gmi:LE_Processing’ (static) NC_STRING</td>
<td></td>
</tr>
</tbody>
</table>

12.26.1.15 Group “gmi:identifier” in “gmi:processingInformation”

Identification of the processor.

Attributes in ESA_METADATA/earth_explorer_header/variable_header/gmd:lineage/gmd:processStep/gmi:processingInformation/gmi:identifier

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:code</td>
<td>‘%(institute)s L2 %(product)s processor, version %(version)s’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:MD_Identifier’ (static) NC_STRING</td>
<td></td>
</tr>
</tbody>
</table>

12.26.1.16 Group “gmi:softwareReference” in “gmi:processingInformation”

Reference to document describing processing software.

Attributes in ESA_METADATA/earth_explorer_header/variable_header/gmd:lineage/gmd:processStep/gmi:processingInformation/gmi:softwareReference
Group attributes attached to gmi:softwareReference

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:title</td>
<td>'L2 %(product)s processor description' (dynamic)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>'gmd:CI_Citation' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>


Release date (compile date) of the processor.


Group attributes attached to gmd:date

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:date</td>
<td>Release date of the processor expressed as an ISO 8601 date string [RD35].</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>'gmd:CI_DateTime' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.26.1.18 Group “gmd:dateType” in “gmd:date”

Confirm that this is the release date of the processor.


Group attributes attached to gmd:dateType

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>codeList</td>
<td>‘<a href="http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_DateTypeCode%E2%80%99">http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_DateTypeCode’</a> (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>codeListValue</td>
<td>'creation' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>'gmd:CI_DateTypeCode' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.26.1.19 Group “gmi:documentation#1” in “gmi:processingInformation”

Reference to the ATBD of the product.


Group attributes attached to gmi:documentation#1

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>objectType</td>
<td>'gmd:CI_Citation' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>gmd:title</td>
<td>'%(title_atbd)s' (dynamic)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The filename of the current release of the ATBD of the current product.

12.26.1.20 Group “gmd:date” in “gmi:documentation#1”

Release date of the ATBD.

Attributes in ESA_METADATA/earth_explorer_header/variable_header/gmd:lineage/gmd:processStep/gmi:processingInformation/gmi:documentation#1/gmd:date

Group attributes attached to gmd:date

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:date</td>
<td>'%(date_atbd)s' (dynamic)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

Release date of the ATBD expressed as an ISO 8601 date string [RD35].
12.26.1.21 Group “gmd:dateType” in “gmd:date”

Confirm that this is the date of publication.

Attributes in ESA_METADATA/earth_explorer_header/variable_header/gmd:lineage/gmd:processStep/gmi:processingInformation/gmi:documentation#1/gmd:date/gmd:dateType

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>codeList</td>
<td>‘<a href="http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_DateTypeCode%E2%80%99">http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_DateTypeCode’</a> (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>codeListValue</td>
<td>‘publication’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:CI_DateTypeCode’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.26.1.22 Group “gmi:documentation#2” in “gmi:processingInformation”

Reference to the PUM of the product.

Attributes in ESA_METADATA/earth_explorer_header/variable_header/gmd:lineage/gmd:processStep/gmi:processingInformation/gmi:documentation#2

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>objectType</td>
<td>‘gmd:CI_Citation’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>gmd:title</td>
<td>‘%(title_pum)s’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The filename of the current release of the PUM of the current product.

12.26.1.23 Group “gmd:date” in “gmi:documentation#2”

Release date of the PUM.

Attributes in ESA_METADATA/earth_explorer_header/variable_header/gmd:lineage/gmd:processStep/gmi:processingInformation/gmi:documentation#2/gmd:date

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:date</td>
<td>‘%(date_pum)s’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

Release date of the PUM expressed as an ISO 8601 date string [RD35].

12.26.1.24 Group “gmd:dateType” in “gmd:date”

Confirm that this is the date of publication.

Attributes in ESA_METADATA/earth_explorer_header/variable_header/gmd:lineage/gmd:processStep/gmi:processingInformation/gmi:documentation#2/gmd:date/gmd:dateType

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>codeList</td>
<td>‘<a href="http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_DateTypeCode%E2%80%99">http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_DateTypeCode’</a> (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>codeListValue</td>
<td>‘publication’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:CI_DateTypeCode’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

Short report of what occurred during the process step.

Attributes in ESA_METADATA/earth_explorer_header/variable_header/gmd:lineage/gmd:processStep/gmi:report

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmi:description</td>
<td>‘Sentinel 5-precursor TROPOMI L1b processed to L2 data using the %(institute)s L2 %%(product)s processor’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

Textual description of what occurred during the process step. Replace %(...)s as indicated.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmi:fileType</td>
<td>‘netCDF-4’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>gmi:name</td>
<td>‘%(logical_filename)s.nc’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmi:LE_ProcessStepReport’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.26.1.26 Group “gmd:source#1” in “gmd:processStep”

Information about the source data used in creating the data specified by the scope. Repeat group as needed, incrementing the number of the source (after the # mark).

Attributes in ESA_METADATA/earth_explorer_header/variable_header/gmd:lineage/gmd:processStep/gmd:source#1

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>objectType</td>
<td>‘gmi:LE_Source’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>gmd:description</td>
<td>Description of the input data, including L1B, L2, dynamic auxiliary input data and semi-static auxiliary input data. Base strings are “TROPOMI L1B %s radiance product”, “TROPOMI L1B %s irradiance product”, “TROPOMI L2 %s product”, “Auxiliary ECMWF %s Meteorological forecast data”, “Processor %s configuration file”, “Auxiliary %s reference data”, “Auxiliary %s algorithm lookup table”, “Auxiliary CTM %s model input data”, “Auxiliary snow and ice input data” and “Auxiliary NPP/VIIRS cloud screening input data”. The %s to be replaced with specific descriptors.</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.26.1.27 Group “gmi:processedLevel” in “gmd:source#1”

Attributes in ESA_METADATA/earth_explorer_header/variable_header/gmd:lineage/gmd:processStep/gmd:source#1/gmi:processedLevel

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:code</td>
<td>Empty!</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:MD_Identifier’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.26.1.28 Group “gmd:sourceCitation” in “gmd:source#1”

Reference to the actual filename of the input data.

Attributes in ESA_METADATA/earth_explorer_header/variable_header/gmd:lineage/gmd:processStep/gmd:source#1/gmd:sourceCitation
### Group attributes attached to gmd:sourceCitation

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>objectType</td>
<td>'gmd:CI_Citation' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

#### 12.26.1.29 Group “gmd:date” in “gmd:sourceCitation”

Attributes in ESA_METADATA/earth_explorer_header/variable_header/gmd:lineage/gmd:processStep/gmd:source#1/gmd:sourceCitation/gmd:date

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:date</td>
<td></td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>Production date and time of the input file(s) in this group expressed as an ISO 8601 date-time string [RD35]. Note that the definition in the XML schema appears to allow the use of a “CI_DateTime” instead of a “CI_Date”.</td>
<td></td>
</tr>
<tr>
<td>objectType</td>
<td>'gmd:CI_Date' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

#### 12.26.1.30 Group “gmd:dateType” in “gmd:date”

Meaning of the reference date for the cited resource.

Attributes in ESA_METADATA/earth_explorer_header/variable_header/gmd:lineage/gmd:processStep/gmd:source#1/gmd:sourceCitation/gmd:date/gmd:dateType

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>codeList</td>
<td>'<a href="http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_DateTypeCode">http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_DateTypeCode</a>' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>codeListValue</td>
<td>'creation' (static)</td>
<td></td>
</tr>
<tr>
<td>objectType</td>
<td>'gmd:CI_DateTypeCode' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

#### 12.26.1.31 Group “gmd:title” in “gmd:sourceCitation”

Attributes in ESA_METADATA/earth_explorer_header/variable_header/gmd:lineage/gmd:processStep/gmd:source#1/gmd:sourceCitation/gmd:title

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gco:characterString</td>
<td>Textual description of the input file group (same as the “gmd:description” attribute in the “gmi:LE_Source” object).</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

#### 12.26.1.32 Group “gmd:alternateTitle#1” in “gmd:sourceCitation”

All filenames in this group, in case more files of a particular file type are delivered, for instance for meteorological or model input. Repeat group as needed, incrementing the number of the input file (after the # mark).

Attributes in ESA_METADATA/earth_explorer_header/variable_header/gmd:lineage/gmd:processStep/gmd:source#1/gmd:sourceCitation/gmd:alternateTitle#1

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmx:FileName</td>
<td>The basename of the input file.</td>
<td>Empty!</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gco:characterString</td>
<td>Textual description of the input file group (same as the “gmd:description” attribute in the “gmi:LE_Source” object).</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

#### 12.26.1.33 Group “gmd:alternateTitle#2” in “gmd:sourceCitation”

All filenames in this group, in case more files of a particular file type are delivered, for instance for meteorological or model input. Repeat group as needed, incrementing the number of the input file (after the # mark).

Attributes in ESA_METADATA/earth_explorer_header/variable_header/gmd:lineage/gmd:processStep/gmd:source#1/gmd:sourceCitation/gmd:alternateTitle#2

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmx:FileName</td>
<td>The basename of the input file.</td>
<td>Empty!</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gco:characterString</td>
<td>Textual description of the input file group (same as the “gmd:description” attribute in the “gmi:LE_Source” object).</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>
12.27 EOP metadata

12.27.1 Group “EOP_METADATA”

Based on the OGC 10-025 standard for Observations & Measurements [RD42], an Earth Observation Product (EOP) schema was developed which refines an observation into the feature type earth observation. This schema was then extended with sensor-specific thematic schemas.

Attributes in EOP_METADATA

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gml:id</td>
<td>‘%(logical_filename)s.ID’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘atm:EarthObservation’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.27.1.1 Group “om:phenomenonTime” in “EOP_METADATA”

Time coverage of the granule.

Attributes in EOP_METADATA/om:phenomenonTime

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gml:beginPosition</td>
<td></td>
<td>NC_STRING</td>
</tr>
<tr>
<td>gml:endPosition</td>
<td></td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gml:TimePeriod’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.27.1.2 Group “om:procedure” in “EOP_METADATA”

Platform, instrument and sensor used for the acquisition and the acquisition parameters.

Attributes in EOP_METADATA/om:procedure

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gml:id</td>
<td>‘%(logical_filename)s.EOE’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘eop:EarthObservationEquipment’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.27.1.3 Group “eop:platform” in “om:procedure”

Platform name and orbit type.

Attributes in EOP_METADATA/om:procedure/eop:platform

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>eop:shortName</td>
<td>‘Sentinel-5p’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘eop:Platform’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>
12.27.1.4 Group “eop:instrument” in “om:procedure”
Instrument descriptor.

Attributes in EOP_METADATA/om:procedure/eop:instrument

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>eop:shortName</td>
<td>‘TROPOMI’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘eop:Instrument’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.27.1.5 Group “eop:sensor” in “om:procedure”
Sensor description.

Attributes in EOP_METADATA/om:procedure/eop:sensor

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>eop:sensorType</td>
<td>‘ATMOSPHERIC’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘eop:Sensor’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.27.1.6 Group “eop:acquisitionParameters” in “om:procedure”
Additional parameters describing the data acquisition. Only an orbit number is used here.

Attributes in EOP_METADATA/om:procedure/eop:acquisitionParameters

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>eop:orbitNumber</td>
<td>%(orbit)d (dynamic)</td>
<td>NC_INT</td>
</tr>
<tr>
<td>objectType</td>
<td>‘eop:Acquisition’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.27.1.7 Group “om:observedProperty” in “EOP_METADATA”
An xlink to the observed property definition.

Attributes in EOP_METADATA/om:observedProperty

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>nilReason</td>
<td>‘inapplicable’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

This element should use the attribute ‘nilReason=”inapplicable”’.

12.27.1.8 Group “om:featureOfInterest” in “EOP_METADATA”

Attributes in EOP_METADATA/om:featureOfInterest

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>objectType</td>
<td>‘eop:FootPrint’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>gml:id</td>
<td>‘%(logical_filename)s.FP’</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

Unique ID for this “eop:FootPrint” object. Constructed from the logical output filename and the extension “FP” separated by a dot.
12.27.1.9  Group “eop:multiExtentOf” in “om:featureOfInterest”
Acquisition footprint coordinates, described by a closed polygon – the last point is equal to the first point, using
latitude, longitude pairs. The expected structure is “gml:Polygon/gml:exterior/gml:LinearRing/gml:posList”.

Attributes in EOP_METADATA/om:featureOfInterest/eop:multiExtentOf

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>objectType</td>
<td>‘gml:MultiSurface’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.27.1.10 Group “gml:surfaceMembers” in “eop:multiExtentOf”

Attributes in EOP_METADATA/om:featureOfInterest/eop:multiExtentOf/gml:surfaceMembers

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>objectType</td>
<td>‘gml:Polygon’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.27.1.11 Group “gml:exterior” in “gml:surfaceMembers”

Attributes in EOP_METADATA/om:featureOfInterest/eop:multiExtentOf/gml:surfaceMembers/gml:exterior

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gml:posList</td>
<td></td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The Polygon geometry shall be encoded in the EPSG:4326 geographic coordinate reference system (WGS-84) and
the coordinate pairs shall be ordered as latitude/longitude. Polygons enclose areas with points listed in
counter-clockwise direction.

| objectType | ‘gml:LinearRing’ (static)                | NC_STRING     |

12.27.1.12 Group “eop:metaDataProperty” in “EOP_METADATA”

This group contains all the metadata relative to the Earth observation product that do not fit inside one of the
other groups, i.e. metadata that do not describe the time, the mechanism, the location or the result of the
observation.

These metadata are mainly the EarthObservation identifier, the acquisition type and information relative to
the downlink and archiving centers.

Attributes in EOP_METADATA/eop:metaDataProperty

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>objectType</td>
<td>‘eop:EarthObservationMetaData’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>eop:acquisitionType</td>
<td>‘NOMINAL’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

Used to distinguish at a high level the appropriateness of the acquisition for “general” use, whether the
product is a nominal acquisition, special calibration product or other. Copy from L1b. For Level 2 this should
always be ‘NOMINAL’.

| eop:identifier | ‘%logical_filename’ (dynamic) | NC_STRING     |

Logical file name.

| eop:doi | ‘%product_doi’ (dynamic) | NC_STRING     |

Digital Object Identifier identifying the product (see http://www.datacite.org for DOIs for datasets).
unique collection identifier for metadata file, see the Level 1B metadata specification [RD32, table 5] for a discussion of the value.

This is a copy of the "gmd:fileIdentifier" attribute in the "/METADATA/ISO_METADATA" group.

eop:productType

Product type identifier. Replace %mode)s with the operational mode the processor is running in ('NRTI', 'OFFL' or 'RPRO', as per [RD25]) and %product)s with the 10 character output file name semantic descriptors as given in section ??, the DLR IODD [RD43, section 3.2.2] and the RAL IODD [RD44, section 4.7].

eop:status

Refers to product status. Values listed in the standard: 'ARCHIVED', 'ACQUIRED', 'CANCELLED', 'FAILED', 'PLANNED', 'POTENTIAL', 'REJECTED', 'QUALITY-DEGRADED'. Copied from L1B.

eop:productQualityStatus

Indicator that specifies whether the product quality is degraded or not. Allowed values: 'DEGRADED', 'NOMINAL'.

eop:productQualityDegradationTag

Contains further textual information concerning the quality degradation. According to the metadata standards it shall be provided only if "eop:productQualityStatus" value is set to 'DEGRADED'. Because the way we generate output files, this attribute will always be present, even when "eop:productQualityStatus" value is 'NOMINAL'. In those cases the value shall be set to "NOT APPLICABLE". Possible values are "MISSING AUXILIARY INPUT" and "NOT APPLICABLE". Note that Level 1B does not set this value, so only problems detectable in the processor are covered.

12.27.1.13 Group "eop:processing" in "eop:metaDataProperty"

Processing information.

Attributes in EOP_METADATA/eop:metaDataProperty/eop:processing

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>objectType</td>
<td>'eop:ProcessingInformation'</td>
<td>(static)</td>
</tr>
<tr>
<td>eop:processingCenter</td>
<td>%(processingcenter)s</td>
<td>(dynamic)</td>
</tr>
<tr>
<td>eop:processingDate</td>
<td>'YYYY-mm-ddTHH:MM:SSZ'</td>
<td>(dynamic)</td>
</tr>
<tr>
<td>eop:processingLevel</td>
<td>'L2'</td>
<td>(static)</td>
</tr>
<tr>
<td>eop:processorName</td>
<td>%(processor_name)s</td>
<td>(static)</td>
</tr>
<tr>
<td>eop:processorVersion</td>
<td>%(version)s</td>
<td>(dynamic)</td>
</tr>
<tr>
<td>eop:nativeProductFormat</td>
<td>'netCDF-4'</td>
<td>(static)</td>
</tr>
<tr>
<td>eop:processingMode</td>
<td>%(mode)s</td>
<td>(dynamic)</td>
</tr>
</tbody>
</table>

Processing mode taken from mission specific code list. For S5P we use the File Class identifiers [RD25, section 4.1.2]: 'TEST', 'OGCA', 'GSOV', 'OPER', 'NRTI', 'OFFL', 'RPRO'.

12.28 ISO metadata
12.28.1 Group “ISO_METADATA”

Metadata that is structured following the ISO metadata standards [RD27, RD40], especially part 2. The metadata in this group is structured using the methods from Level 1B, which is described in the Level 1B metadata specification [RD32].

All “objectType” attributes indicate the XML object when generating an ISO 19139 [RD40] compliant XML metadata file.

Note that this group is meant to be treated as a ‘black box’. The information is collected here so that it can be extracted into XML side-files for ingestion into data search tools and metadata collections.

Attributes in ISO_METADATA

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:dateStamp</td>
<td>’2015-10-16’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>gmd:fileIdentifier</td>
<td>‘urn:ogc:def:EOP:ESA:SENTINEL.S5P_TROP_- %shortname)s’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>gmd:hierarchyLevelName</td>
<td>‘EO Product Collection’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>gmd:metadataStandardName</td>
<td>‘ISO 19115-2 Geographic Information · Metadata Part 2 Extensions for imagery and gridded data’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>gmd:metadataStandardVersion</td>
<td>‘ISO 19115-2-2009(E), S5P profile’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmi:MI_Metadata’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>gmd:language</td>
<td></td>
<td></td>
</tr>
<tr>
<td>codeList</td>
<td>’<a href="http://www.loc.gov/standards/iso639-2/%E2%80%98">http://www.loc.gov/standards/iso639-2/‘</a> (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>codeListValue</td>
<td>’eng’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:LanguageCode’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.1 Group “gmd:language” in “ISO_METADATA”

Language used for the metadata, fixed to English.

Attributes in ISO_METADATA/gmd:language

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>codeList</td>
<td>’<a href="http://www.loc.gov/standards/iso639-2/%E2%80%98">http://www.loc.gov/standards/iso639-2/‘</a> (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>codeListValue</td>
<td>’eng’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:LanguageCode’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.2 Group “gmd:characterSet” in “ISO_METADATA”

The character encoding used for the metadata. This is fixed to UTF-8, but the climate and forecasting conventions, version 1.6 limits this further to 7-bit ASCII (which is a subset of UTF-8).

Attributes in ISO_METADATA/gmd:characterSet

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>codeList</td>
<td>’<a href="http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#MD_CharacterSetCode%E2%80%99">http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#MD_CharacterSetCode’</a> (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>
12.28.1.3 Group “gmd:hierarchyLevel” in “ISO_METADATA”

Scope to which metadata applies.

Attributes in ISO_METADATA/gmd:hierarchyLevel

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>codeList</td>
<td>‘<a href="http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#MD_ScopeCode%E2%80%99">http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#MD_ScopeCode’</a> (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>codeListValue</td>
<td>‘series’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:MD_ScopeCode’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.4 Group “gmd:contact” in “ISO_METADATA”

Contact information for the product.

Attributes in ISO_METADATA/gmd:contact

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:organisationName</td>
<td>‘Copernicus Space Component Data Access System, ESA, Services Coordinated Interface’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:CI_ResponsibleParty’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.5 Group “gmd:contactInfo” in “gmd:contact”

The detailed contact information.

Attributes in ISO_METADATA/gmd:contact/gmd:contactInfo

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>objectType</td>
<td>‘gmd:CI_Contact’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.6 Group “gmd:address” in “gmd:contactInfo”

The actual email address.

Attributes in ISO_METADATA/gmd:contact/gmd:contactInfo/gmd:address

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:electronicMailAddress</td>
<td>‘<a href="mailto:EOSupport@copernicus.esa.int">EOSupport@copernicus.esa.int</a>’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:CI_Address’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.7 Group “gmd:role” in “gmd:contact”

The role of the address provided in this group.

Attributes in ISO_METADATA/gmd:contact/gmd:role
12.28.1.8 Group “gmd:identificationInfo” in “ISO_METADATA”

Identification information contains information to uniquely identify the data. Identification information includes information about the citation for the resource, an abstract, the purpose, credit, the status and points of contact. The MD_Identification entity is mandatory. The MD_Identification entity is specified (subclassd) as MD_DataIdentification because in this case it is used to identify data.

Attributes in ISO_METADATA/gmd:identificationInfo

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:abstract</td>
<td></td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>
Brief narrative summary of the content of the resource. This is product specific.

**L2__AER_AI (KNMI)** Aerosol index with a spatial resolution of either 7.0 × 3.5 km² or 5.5 × 3.5 km² (for the small pixels since 6th of August 2019) observed at about 13:30 local solar time from spectra measured by TROPOMI

**L2__AER_LH (KNMI)** Altitude of elevated aerosol layer for cloud-free observations with a spatial resolution of either 7.0 × 3.5 km² or 5.5 × 3.5 km² (for the small pixels since 6th of August 2019) observed at about 13:30 local solar time from spectra measured by TROPOMI

**L2__NO2__ (KNMI)** Nitrogen dioxide tropospheric column with a spatial resolution of either 7.0 × 3.5 km² or 5.5 × 3.5 km² (for the small pixels since 6th of August 2019) observed at about 13:30 local solar time from spectra measured by TROPOMI

**L2__O3__PR (KNMI)** Ozone profile with a vertical resolution of 6 km and a horizontal resolution of 28 × 21 km² observed at about 13:30 local solar time from spectra measured by TROPOMI

**L2__O3__TPR (KNMI)** Tropospheric ozone profile with a vertical resolution of 6 km and a horizontal resolution of either 7.0 × 3.5 km² or 5.5 × 3.5 km² (for the small pixels since 6th of August 2019) observed at about 13:30 local solar time from spectra measured by TROPOMI

**L2__CH4__ (SRON)** Dry-air mixing ratio of methane for cloud-free observations over land with a spatial resolution of either 7.0 × 3.5 km² or 5.5 × 3.5 km² (for the small pixels since 6th of August 2019) observed at about 13:30 local solar time from spectra measured by TROPOMI

**L2__CO__ (SRON)** Carbon monoxide column over land with a spatial resolution of either 7.0 × 3.5 km² or 5.5 × 3.5 km² (for the small pixels since 6th of August 2019) observed at about 13:30 local solar time from spectra measured by TROPOMI

**L2__FRESKO (KNMI)** Cloud fraction and cloud pressure with a spatial resolution of either 7.0 × 3.5 km² or 5.5 × 3.5 km² (for the small pixels since 6th of August 2019) observed at about 13:30 local solar time from spectra measured by TROPOMI (KNMI cloud support product)

**L2__CLOUD__ (DLR)** Cloud fraction, cloud pressure and cloud albedo with a spatial resolution of either 7.0 × 3.5 km² or 5.5 × 3.5 km² (for the small pixels since 6th of August 2019) observed at about 13:30 local solar time from spectra measured by TROPOMI

**L2__HCHO__ (BIRA)** Formaldehyde tropospheric column with a spatial resolution of either 7.0 × 3.5 km² or 5.5 × 3.5 km² (for the small pixels since 6th of August 2019) observed at about 13:30 local solar time from spectra measured by TROPOMI

**L2__O3__ (DLR/BIRA)** Ozone total column with a spatial resolution of either 7.0 × 3.5 km² or 5.5 × 3.5 km² (for the small pixels since 6th of August 2019) observed at about 13:30 local solar time from spectra measured by TROPOMI

**L2__O3__TCL (DLR/IUP)** Tropospheric ozone with a spatial resolution of either 7.0 × 3.5 km² or 5.5 × 3.5 km² (for the small pixels since 6th of August 2019) observed at about 13:30 local solar time from spectra measured by TROPOMI

**L2__SO2__ (BIRA)** Sulfur dioxide column with a spatial resolution of either 7.0 × 3.5 km² or 5.5 × 3.5 km² (for the small pixels since 6th of August 2019) observed at about 13:30 local solar time from spectra measured by TROPOMI

**L2__NP_BD(3,6,7)** Regridded NPP-VIIRS data with a spatial resolution of either 7.0 × 3.5 km² or 5.5 × 3.5 km² (for the small pixels since 6th of August 2019)

---

**gmd:credit** ‘%(credit)s’ (static) NC_STRING

Recognition of those who contributed to the resource(s).

**gmd:language** ‘eng’ (static) NC_STRING

**gmd:topicCategory** ‘climatologyMeteorologyAtmosphere’ (static) NC_STRING

Main theme(s) of the dataset.
12.28.1.9 Group “gmd:citation” in “gmd:identificationInfo”

Citation data for the resource.

Attributes in ISO_METADATA/gmd:identificationInfo/gmd:citation

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:title</td>
<td>Name by which the cited resource is known. This is the same as the global “title” attribute.</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.10 Group “gmd:date” in “gmd:citation”

Attributes in ISO_METADATA/gmd:identificationInfo/gmd:citation/gmd:date

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:date</td>
<td>“%(processor_release_date)s” (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:CI_Date’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.11 Group “gmd:dateType” in “gmd:date”

Event used for reference date.

Attributes in ISO_METADATA/gmd:identificationInfo/gmd:citation/gmd:date/gmd:dateType

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>codeList</td>
<td>‘<a href="http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_DateTypeCode%E2%80%99">http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_DateTypeCode’</a> (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>codeListValue</td>
<td>‘creation’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:CI_DateTypeCode’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.12 Group “gmd:identifier” in “gmd:citation”

Unique identifier for metadata file, see the Level 1B metadata specification [RD32, table 5] for a discussion of the value.

Attributes in ISO_METADATA/gmd:identificationInfo/gmd:citation/gmd:identifier

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:code</td>
<td>‘urn:ogc:def:EOP:ESA:SENTINEL.S5P_TROP-%(shortname)s’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

Replace “%(shortname)s” with the “ProductShortName” value from the Level 2 “/METADATA/GRANULE_DESCRIPTION” metadata group.
12.28.1.13 Group “gmd:pointOfContact” in “gmd:identificationInfo”

See description of the “gmd:contact” attribute above.

Attributes in ISO_METADATA/gmd:identificationInfo/gmd:pointOfContact

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:organisationName</td>
<td>‘Copernicus Space Component Data Access System, ESA, Services Coordinated Interface’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:CI_ResponsibleParty’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.14 Group “gmd:contactInfo” in “gmd:pointOfContact”

Attributes in ISO_METADATA/gmd:identificationInfo/gmd:pointOfContact/gmd:contactInfo

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>objectType</td>
<td>‘gmd:CI_Contact’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.15 Group “gmd:address” in “gmd:contactInfo”

Attributes in ISO_METADATA/gmd:identificationInfo/gmd:pointOfContact/gmd:contactInfo/gmd:address

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:electronicMailAddress</td>
<td>‘<a href="mailto:EOSupport@copernicus.esa.int">EOSupport@copernicus.esa.int</a>’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:CI_Address’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.16 Group “gmd:role” in “gmd:pointOfContact”

Attributes in ISO_METADATA/gmd:identificationInfo/gmd:pointOfContact/gmd:role

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>codeList</td>
<td>‘<a href="http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_RoleCode%E2%80%99">http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_RoleCode’</a> (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>codeListValue</td>
<td>‘distributor’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:CI_RoleCode’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.17 Group “gmd:descriptiveKeywords#1” in “gmd:identificationInfo”

Provides category keywords, their type, and reference source. Within the framework of GEMET the choice of keywords is very limited. More meaningful keywords can be derived from the Climate and Forecast metadata conventions’ standard name list, see “gmd:descriptiveKeywords#2” below.

Attributes in ISO_METADATA/gmd:identificationInfo/gmd:descriptiveKeywords#1

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:keyword#1</td>
<td>‘Atmospheric conditions’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:MD_Keywords’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>
12.28.1.18 Group “gmd:type” in “gmd:descriptiveKeywords#1”

Subject matter used to group similar keywords.

Attributes in ISO_METADATA/gmd:identificationInfo/gmd:descriptiveKeywords#1/gmd:type

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>codeList</td>
<td>‘<a href="http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#MD_KeywordTypeCode%E2%80%99">http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#MD_KeywordTypeCode’</a> (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>codeListValue</td>
<td>‘theme’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:MD_KeywordTypeCode’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.19 Group “gmd:thesaurusName” in “gmd:descriptiveKeywords#1”

Name by which the cited resource is known.

Attributes in ISO_METADATA/gmd:identificationInfo/gmd:descriptiveKeywords#1/gmd:thesaurusName

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:title</td>
<td>‘GEMET - INSPIRE themes, version 1.0’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:CI_Citation’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.20 Group “gmd:date” in “gmd:thesaurusName”

Reference date for the cited resource.

Attributes in ISO_METADATA/gmd:identificationInfo/gmd:descriptiveKeywords#1/gmd:thesaurusName/gmd:date

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:date</td>
<td>’2008-06-01’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:CI_Date’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.21 Group “gmd:dateType” in “gmd:date”

What date is used for the reference date.

Attributes in ISO_METADATA/gmd:identificationInfo/gmd:descriptiveKeywords#1/gmd:thesaurusName/gmd:date/gmd:dateType

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>codeList</td>
<td>‘<a href="http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_DateTypeCode%E2%80%99">http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_DateTypeCode’</a> (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>codeListValue</td>
<td>‘publication’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:CI_DateTypeCode’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.22 Group “gmd:descriptiveKeywords#2” in “gmd:identificationInfo”

Provides category keywords, their type, and reference source. These keywords are taken from the Climate and Forecast metadata conventions’ standard name list [ERS]. The keywords listed below identify the most important parameters in the product.

L2__AER_AI (KNMI) ultraviolet_aerosol_index

L2__AER_LH (KNMI) height_of_elevated_aerosol_layer
L2__NO2__ (KNMI) troposphere_mole_content_of_nitrogen_dioxide, stratosphere_mole_content_of_nitrogen_dioxide, atmosphere_mole_content_of_nitrogen_dioxide

L2__O3__PR (KNMI) mole_fraction_of_ozone_in_air

L2__O3__TPR (KNMI) mole_fraction_of_ozone_in_air

L2__CH4__ (SRON) atmosphere_mole_fraction_of_methane_in_dry_air

L2__CO__ (SRON) atmosphere_mole_content_of_carbon_monoxide

L2__FRESCO (KNMI)

L2__CLOUD__ (DLR)

L2__HCHO__ (BIRA) troposphere_mole_content_of_formaldehyde

L2__O3__ (DLR/BI) atmosphere_mole_content_of_ozone

L2__O3__TCL (DLR/IUP) troposphere_mole_content_of_ozone

L2__SO2__ (BIRA) atmosphere_mole_content_of_sulfur_dioxide

L2__NP_BDx (RAL)

Attributes in ISO_METADATA/gmd:identificationInfo/gmd:descriptiveKeywords#2

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:keyword#1</td>
<td></td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:MD_Keywords’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.23 Group “gmd:thesaurusName” in “gmd:descriptiveKeywords#2”

Name by which the cited resource is known.

Attributes in ISO_METADATA/gmd:identificationInfo/gmd:descriptiveKeywords#2/gmd:thesaurusName

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:title</td>
<td>‘CF Standard Name Table v29’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>xlink:href</td>
<td>‘<a href="http://cfconventions.org/standard-names.html%E2%80%99">http://cfconventions.org/standard-names.html’</a> (dynamic)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:CI_Citation’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.24 Group “gmd:date” in “gmd:thesaurusName”

Reference date for the cited resource.

Attributes in ISO_METADATA/gmd:identificationInfo/gmd:descriptiveKeywords#2/gmd:thesaurusName/gmd:date

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:date</td>
<td>‘2015-07-08’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:CI_Date’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.25 Group “gmd:dateType” in “gmd:date”

What date is used for the reference date.

Attributes in ISO_METADATA/gmd:identificationInfo/gmd:descriptiveKeywords#2/gmd:thesaurusName/
gmd:date/gmd:dateType

Group attributes attached to gmd:dateType

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>codeList</td>
<td>‘<a href="http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_DateTypeCode%E2%80%99">http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_DateTypeCode’</a> (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>codeListValue</td>
<td>‘publication’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:CI_DateTypeCode’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.26 Group “gmd:resourceConstraints” in “gmd:identificationInfo”

Provides information about constraints which apply to the resource.

Attributes in ISO_METADATA/gmd:identificationInfo/gmd:resourceConstraints

Group attributes attached to gmd:resourceConstraints

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:useLimitation</td>
<td>‘no conditions apply’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>Limitation affecting the fitness for use of the resource or metadata.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:MD_LegalConstraints’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.27 Group “gmd:accessConstraints” in “gmd:resourceConstraints”

Access constraints applied to assure the protection of privacy or intellectual property, and any special restrictions or limitations on obtaining the resource or metadata.

Attributes in ISO_METADATA/gmd:identificationInfo/gmd:resourceConstraints/gmd:accessConstraints

Group attributes attached to gmd:accessConstraints

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>codeList</td>
<td>‘<a href="http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#MD_RestrictionCode%E2%80%99">http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#MD_RestrictionCode’</a> (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>codeListValue</td>
<td>‘copyright’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:MD_RestrictionCode’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.28 Group “gmd:spatialRepresentationType” in “gmd:identificationInfo”

Method used to spatially represent geographic information.

Attributes in ISO_METADATA/gmd:identificationInfo/gmd:spatialRepresentationType

Group attributes attached to gmd:spatialRepresentationType

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>codeList</td>
<td>‘<a href="http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#MD_SpatialRepresentationTypeCode%E2%80%99">http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#MD_SpatialRepresentationTypeCode’</a> (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>codeListValue</td>
<td>‘grid’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:MD_SpatialRepresentationTypeCode’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.29 Group “gmd:spatialResolution” in “gmd:identificationInfo”

Ground sample distance.

Attributes in ISO_METADATA/gmd:identificationInfo/gmd:spatialResolution

Group attributes attached to gmd:spatialResolution

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
</table>
12.28.1.30 Group “gmd:characterSet” in “gmd:identificationInfo”

Attributes in ISO_METADATA/gmd:identificationInfo/gmd:characterSet

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>codeList</td>
<td>‘<a href="http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#MD_CharacterSetCode%E2%80%99">http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#MD_CharacterSetCode’</a> (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>codeListValue</td>
<td>‘utf8’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:MD_CharacterSetCode’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.31 Group “gmd:extent” in “gmd:identificationInfo”

Extent information including the bounding box, bounding polygon, vertical, and temporal extent of the dataset.

Attributes in ISO_METADATA/gmd:identificationInfo/gmd:extent

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>objectType</td>
<td>‘gmd:EX_Extent’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.32 Group “gmd:geographicElement” in “gmd:extent”

Geographic position of the granule. This is only an approximate reference so specifying the coordinate reference system is unnecessary. The usual limitations apply: $-180^\circ \leq \vartheta \leq 180^\circ$ and $-90^\circ \leq \delta \leq 90^\circ$. Note that for full orbits these values provide little information as at lease one pole will be present in the data, ensuring full longitudinal coverage.

Attributes in ISO_METADATA/gmd:identificationInfo/gmd:extent/gmd:geographicElement

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:eastBoundLongitude</td>
<td>180.0 (dynamic)</td>
<td>NC_FLOAT</td>
</tr>
<tr>
<td>gmd:northBoundLatitude</td>
<td>90.0 (dynamic)</td>
<td>NC_FLOAT</td>
</tr>
<tr>
<td>gmd:southBoundLatitude</td>
<td>-90.0 (dynamic)</td>
<td>NC_FLOAT</td>
</tr>
<tr>
<td>gmd:westBoundLongitude</td>
<td>-180.0 (dynamic)</td>
<td>NC_FLOAT</td>
</tr>
<tr>
<td>gmd:extentTypeCode</td>
<td>‘true’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:EX_GeographicBoundingBox’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.33 Group “gmd:temporalElement” in “gmd:extent”


<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>objectType</td>
<td>‘gmd:EX_TemporalExtent’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>
12.28.1.34 Group “gmd:extent” in “gmd:temporalElement”

Time period covered by the content of the dataset.


<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gml:beginPosition</td>
<td>'2014-11-14T19:58:00' (dynamic)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>gml:endPosition</td>
<td>'2014-11-14T20:08:00' (dynamic)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.35 Group “gmd:dataQualityInfo” in “ISO_METADATA”

This group contains a general assessment of the quality of the dataset. In addition, the package contains information about the sources and production processes used in producing a dataset, which is of particular importance for imagery and gridded data.

For the TROPOMI 2 products the use of the contained class LI_Lineage (group “gmd:lineage”, section 12.28.1.43 on page 122) is important for describing the sources which are either used or produced (output) in a series of process steps. The sources refer to the various L1b data products used as inputs (and the L0 products used in producing those products) and the auxiliary data (static and especially dynamic) when producing the L2 products.

Attributes in ISO_METADATA/gmd:dataQualityInfo

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>objectType</td>
<td>'gmd:DQ_DataQuality' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.36 Group “gmd:scope” in “gmd:dataQualityInfo”

The specific data to which the data quality information applies.

Attributes in ISO_METADATA/gmd:dataQualityInfo/gmd:scope

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>objectType</td>
<td>'gmd:DQ_Scope’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.37 Group “gmd:level” in “gmd:scope”

Hierarchical level of the data specified by the scope.

Attributes in ISO_METADATA/gmd:dataQualityInfo/gmd:scope/gmd:level

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>codeList</td>
<td>'<a href="http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#MD_ScopeCode">http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#MD_ScopeCode</a>' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>codeListValue</td>
<td>'dataset' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.38 Group “gmd:report” in “gmd:dataQualityInfo”

Value (or set of values) obtained from applying a data quality measure or the outcome of evaluating the obtained value (or set of values) against a specified acceptable conformance quality level.
### Attributes in ISO_METADATA/gmd:dataQualityInfo/gmd:report

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>objectType</td>
<td>'gmd:DQ_DomainConsistency' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

#### 12.28.1.39 Group “gmd:result” in “gmd:report”

Value (or set of values) obtained from applying a data quality measure or the outcome of evaluating the obtained value (or set of values) against a specified acceptable conformance quality level.

#### Attributes in ISO_METADATA/gmd:dataQualityInfo/gmd:report/gmd:result

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>objectType</td>
<td>'gmd:DQ_ConformanceResult' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>gmd:pass</td>
<td>'true' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

- Indication of conformance result. The value “true” indicates “pass”.

| gmd:explanation    | 'INSPIRE Data specification for orthoimagery is not yet officially published so conformity has not yet been evaluated” (static) | NC_STRING |

- Explanation of the meaning of conformance for this result. Within the context of INSPIRE conformance can currently not be determined.

#### 12.28.1.40 Group “gmd:specification” in “gmd:result”

Citation of product specification or user requirement against which data is being evaluated.

#### Attributes in ISO_METADATA/gmd:dataQualityInfo/gmd:report/gmd:result/gmd:specification

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>objectType</td>
<td>'gmd:CI_Citation' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>gmd:title</td>
<td>'INSPIRE Data Specification on Orthoimagery - Guidelines, version 3.0rc3' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

#### 12.28.1.41 Group “gmd:date” in “gmd:specification”

Reference date for the cited resource.


<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:date</td>
<td>'2013-02-04' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>'gmd:CI_Date' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

#### 12.28.1.42 Group “gmd:dateType” in “gmd:date”

Meaning of the reference date for the cited resource.


<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>codeList</td>
<td>'<a href="http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_DateTypeCode">http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_DateTypeCode</a>' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>
12.28.1.43 Group “gmd:lineage” in “gmd:dataQualityInfo”

Non-quantitative quality information about the lineage of the data specified by the scope.

Attributes in ISO_METADATA/gmd:dataQualityInfo/gmd:lineage

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>objectType</td>
<td>‘gmd:LI_Lineage’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>gmd:statement</td>
<td>‘L2 %(product)s dataset produced by %(processingcenter)s from the S5P/TROPOMI L1B product’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

General explanation of the data producer's knowledge about the lineage of a dataset. Insert short description of the actual Level 2 product in this string (at the %(. . .)s).

12.28.1.44 Group “gmd:processStep” in “gmd:lineage”

Information about an event or transformation in the life of the dataset including details of the algorithm and software used for processing.

Attributes in ISO_METADATA/gmd:dataQualityInfo/gmd:lineage/gmd:processStep

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>objectType</td>
<td>‘gmi:LE_ProcessStep’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>gmd:description</td>
<td>‘Processing of L1b to L2 %(product)s data for orbit %(orbit)d using the %(institute)s processor version %(version)s’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

Description of the event, including related parameters or tolerances. Insert short description of the actual Level 2 product, the orbit number, the name of the institute responsible for the CFI and the software version in this string (at the respective %(. . .)s and %(. . .)d).

12.28.1.45 Group “gmi:output” in “gmd:processStep”

Description of the output.


<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:description</td>
<td>Short description of the output, a copy of the global ‘title’ attribute.</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmi:LE_Source’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.46 Group “gmd:sourceCitation” in “gmi:output”

Reference to the actual filename of the output data and production date and time.

Attributes in ISO_METADATA/gmd:dataQualityInfo/gmd:lineage/gmd:processStep/gmi:output/gmd:sourceCitation

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:title</td>
<td>‘%(logical_filename)s’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:CI_Citation’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>
12.28.1.47  Group “gmd:date” in “gmd:sourceCitation”

Production date and time of the output file.

Attributes in ISO_METADATA/gmd:sourceCitation

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:date</td>
<td>Production date and time of the output file. Note that the definition in the XML schema appears to allow the use of a “CI_DateTime” instead of a “CI_Date”.</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:CI_DateTime’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.48  Group “gmd:dateType” in “gmd:date”

Meaning of the reference date for the cited resource.

Attributes in ISO_METADATA/gmd:sourceCitation

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>codeList</td>
<td>‘<a href="http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_DateTypeCode%E2%80%99">http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_DateTypeCode’</a> (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>codeListValue</td>
<td>‘creation’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:CI_DateTypeCode’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.49  Group “gmd:identifier” in “gmd:sourceCitation”

Identification of the output product.

Attributes in ISO_METADATA/gmd:sourceCitation

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:code</td>
<td>‘%(shortname)s’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:MD_Identifier’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.50  Group “gmi:processedLevel” in “gmi:output”

Process level of the output file.

Attributes in ISO_METADATA/gmd:sourceCitation

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:code</td>
<td>‘L2’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:MD_Identifier’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.51  Group “gmi:processingInformation” in “gmd:processStep”

Description of the processor in more detail.

Attributes in ISO_METADATA/gmd:sourceCitation

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
</table>
12.28.1.52 Group “gmi:identifier” in “gmi:processingInformation”

Identification of the processor.


<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:code</td>
<td>%{institute}s L2 %(product)s processor, version %{version}s' (dynamic)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

Descriptive name of the processor, with the %(. . . )s placeholders replaced with the responsible institute's name, product name and software release version.

12.28.1.53 Group “gmi:softwareReference” in “gmi:processingInformation”

Reference to document describing processing software.


<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:title</td>
<td>‘L2 %(product)s processor description’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

Title of processor description.

12.28.1.54 Group “gmd:date” in “gmi:softwareReference”

Release date (compile date) of the processor.


<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:date</td>
<td></td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

Release date of the processor expressed as an ISO 8601 date string [RD35].

12.28.1.55 Group “gmd:dateType” in “gmd:date”

Confirm that this is the release date of the processor.


<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>codeList</td>
<td>‘<a href="http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_DateTypeCode%E2%80%99">http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_DateTypeCode’</a> (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

| codeListValue | ‘creation’ (static)                                   | NC_STRING |
12.28.1.56 Group “gmi:documentation#1” in “gmi:processingInformation”

Reference to the ATBD of the product.

Attributes in ISO_METADATA/gmd:dataQualityInfo/gmd:lineage/gmd:processStep/gmi:processingInformation/gmi:documentation#1

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>objectType</td>
<td>‘gmd:CI_Citation’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>gmd:title</td>
<td>‘%(title_atbd)s’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>doi</td>
<td>‘%(atbd_doi)s’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The filename of the current release of the ATBD of the current product.

DOI for the algorithm theoretical basis document.

12.28.1.57 Group “gmd:date” in “gmi:documentation#1”

Release date of the ATBD.


<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:date</td>
<td>‘%(date_atbd)s’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:CI_Date’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

Release date of the ATBD expressed as an ISO 8601 date string [RD35].

12.28.1.58 Group “gmd:dateType” in “gmd:date”

Confirm that this is the date of publication.


<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>codeList</td>
<td>‘<a href="http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_DateTypeCode%E2%80%99">http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_DateTypeCode’</a> (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>codeListValue</td>
<td>‘publication’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:CI_DateTypeCode’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.59 Group “gmi:documentation#2” in “gmi:processingInformation”

Reference to the PUM of the product.


<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>objectType</td>
<td>‘gmd:CI_Citation’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>gmd:title</td>
<td>‘%(title_pum)s’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The filename of the current release of the PUM of the current product.
12.28.1.60 Group “gmd:date” in “gmi:documentation#2”

Release date of the PUM.


<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmd:date</td>
<td>‘%(date_pum)s’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>Release date of the PUM expressed as an ISO 8601 date string [RD35].</td>
<td></td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:CI_Date’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.61 Group “gmd:dateType” in “gmd:date”

Confirm that this is the date of publication.


<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>codeList</td>
<td>‘<a href="http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_DateTypeCode%E2%80%99">http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_DateTypeCode’</a> (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>codeListValue</td>
<td>‘publication’ (static)</td>
<td></td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmd:CI_DateTypeCode’ (static)</td>
<td></td>
</tr>
</tbody>
</table>


Short report of what occurred during the process step.


<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmi:description</td>
<td>‘Sentinel 5-precursor TROPOMI L1b processed to L2 data using the %%(institute)s L2 %%(product)s processor’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>gmi:fileType</td>
<td>‘netCDF-4’ (static)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Type of file that contains the processing report, in our case the processing report is contained in the main output file.</td>
<td></td>
</tr>
<tr>
<td>gmi:name</td>
<td>‘%(logical_filename)s.nc’ (dynamic)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td>‘gmi:LE_ProcessStepReport’ (dynamic)</td>
<td></td>
</tr>
</tbody>
</table>

12.28.1.63 Group “gmd:source#1” in “gmd:processStep”

Information about the source data used in creating the data specified by the scope. Repeat group as needed, incrementing the number of the source (after the # mark).

Attributes in ISO_METADATA/gmd:dataQualityInfo/gmd:lineage/gmd:processStep/gmd:source#1
Group attributes attached to `gmd:source#1`

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>objectType</code></td>
<td>'gmi:LE_Source' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td><code>gmd:description</code></td>
<td></td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

Description of the input data, including L1B, L2, dynamic auxiliary input data and semi-static auxiliary input data. Base strings are “TROPOMI L1B %s radiance product”, “TROPOMI L1B %s irradiance product”, “TROPOMI L2 %s product”, “Auxiliary ECMWF %s Meteorological forecast data”, “Processor %s configuration file”, “Auxiliary %s reference data”, “Auxiliary %s algorithm lookup table”, “Auxiliary CTM %s model input data”, “Auxiliary snow and ice input data” and “Auxiliary NPP/VIIRS cloud screening input data”. The %s to be replaced with specific descriptors.

### 12.28.1.64 Group “gmi:processedLevel” in “gmd:source#1”


Group attributes attached to `gmi:processedLevel`

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>gmd:code</code></td>
<td>Empty!</td>
<td>NC_STRING</td>
</tr>
<tr>
<td><code>objectType</code></td>
<td>'gmd:MD_Identifier' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

### 12.28.1.65 Group “gmd:sourceCitation” in “gmd:source#1”

Reference to the actual filename of the input data.

Attributes in `ISO_METADATA/gmd:dataQualityInfo/gmd:lineage/gmd:processStep/gmd:source#1/gmd:sourceCitation`

Group attributes attached to `gmd:sourceCitation`

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>objectType</code></td>
<td>'gmd:CI_Citation' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

### 12.28.1.66 Group “gmd:date” in “gmd:sourceCitation”

Attributes in `ISO_METADATA/gmd:dataQualityInfo/gmd:lineage/gmd:processStep/gmd:source#1/gmd:sourceCitation/gmd:date`

Group attributes attached to `gmd:date`

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>gmd:date</code></td>
<td></td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

Production date and time of the input file(s) in this group expressed as an ISO 8601 date-time string [RD35]. Note that the definition in the XML schema appears to allow the use of a “CI_DateTime” instead of a “CI_Date”.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>objectType</code></td>
<td>'gmd:CI_Date' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

### 12.28.1.67 Group “gmd:dateType” in “gmd:date”

Meaning of the reference date for the cited resource.

Attributes in `ISO_METADATA/gmd:dataQualityInfo/gmd:lineage/gmd:processStep/gmd:source#1/gmd:sourceCitation/gmd:date/gmd:dateType`

Group attributes attached to `gmd:dateType`

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>codeList</code></td>
<td>'<a href="http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_DateTypeCode">http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_DateTypeCode</a>' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

Note that the definition in the XML schema appears to allow the use of a “CI_DateTime” instead of a “CI_Date”.
12.28.1.68 Group “gmd:title” in “gmd:sourceCitation”

Attributes in ISO_METADATA/gmd:lineage/gmd:processStep/gmd:source#1/gmd:sourceCitation/gmd:title

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gco:characterString</td>
<td></td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

Textual description of the input file group (same as the "gmd:description" attribute in the "gmi:LE_Source" object).

12.28.1.69 Group “gmd:alternateTitle#1” in “gmd:sourceCitation”

All filenames in this group, in case more files of a particular file type are delivered, for instance for meteorological or model input. Repeat group as needed, incrementing the number of the input file (after the # mark).

Attributes in ISO_METADATA/gmd:lineage/gmd:processStep/gmd:source#1/gmd:sourceCitation/gmd:alternateTitle#1

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmx:FileName</td>
<td>Empty!</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The basename of the input file.

12.28.1.70 Group “gmi:acquisitionInformation” in “ISO_METADATA”

Metadata regarding the acquisition of the original data.

Attributes in ISO_METADATA/gmi:acquisitionInformation

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>objectType</td>
<td></td>
<td>gmi:MI_AcquisitionInformation (static) NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.71 Group “gmi:platform” in “gmi:acquisitionInformation”

The platform we are on.

Attributes in ISO_METADATA/gmi:acquisitionInformation/gmi:platform

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmi:description</td>
<td></td>
<td>Sentinel 5 Precursor (static) NC_STRING</td>
</tr>
<tr>
<td>objectType</td>
<td></td>
<td>gmi:MI_Platform (static) NC_STRING</td>
</tr>
</tbody>
</table>

12.28.1.72 Group “gmi:identifier” in “gmi:platform”

Short identifier of the platform.

Attributes in ISO_METADATA/gmi:acquisitionInformation/gmi:platform/gmi:identifier
12.28.1.73 Group “gmi:instrument” in “gmi:platform”

The instrument used for the observations.

Attributes in ISO_METADATA/gmi:acquisitionInformation/gmi:platform/gmi:instrument

12.28.1.74 Group “gmi:identifier” in “gmi:instrument”

Unique identifier for the instrument.

Attributes in ISO_METADATA/gmi:acquisitionInformation/gmi:platform/gmi:instrument/gmi:identifier

13 Description of Cloud product

Global attributes in CLOUD_

The attributes described in section 13 “Common file-level attributes” on page 129 are included in the output at this location.

The attributes described in section 12.2 “Common file-level attributes for DLR” on page 35 are included in the output at this location.

The attributes described in section 12.3 “Status dynamic ECMWF auxiliary data” on page 35 are included in the output at this location.

The attributes described in section 12.4 “Status dynamic NISE auxiliary data” on page 35 are included in the output at this location.

The attributes described in section 12.5 “Status background correction auxiliary data” on page 36 are included in the output at this location.

The attributes described in section 12.6 “Status dynamic NPP-VIIRS auxiliary data” on page 36 are included in the output at this location.
13.1 Group “PRODUCT” in “CLOUD_”

This is the main group containing the Cloud product. At this level the dimensions are defined, the actual data can be found one level deeper.

Dimensions in CLOUD_/PRODUCT
The dimensions described in section 12.7 “Common dimensions” on page 36 are included in the output at this location.

Variables in CLOUD_/PRODUCT
The variables described in section 12.8 “Coordinate variables” on page 36 are included in the output at this location.

latitude_nir in CLOUD_/PRODUCT
Description: The latitude of the pixel centers of the ground pixels in the data. Latitude, longitude coordinates for the ground pixel center and the ground pixel corners are calculated at the WGS84 ellipsoid.

Dimensions: time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>long_name</td>
<td>‘pixel center latitude’ (static)</td>
<td>NC_STRING</td>
<td></td>
</tr>
<tr>
<td>units</td>
<td>‘degrees_north’ (static)</td>
<td>NC_STRING</td>
<td></td>
</tr>
<tr>
<td>standard_name</td>
<td>‘latitude’ (static)</td>
<td>NC_STRING</td>
<td></td>
</tr>
<tr>
<td>valid_min</td>
<td>-90.0 (static)</td>
<td>NC_FLOAT</td>
<td></td>
</tr>
<tr>
<td>valid_max</td>
<td>90.0 (static)</td>
<td>NC_FLOAT</td>
<td></td>
</tr>
<tr>
<td>bounds</td>
<td>‘/PRODUCT/SUPPORT_DATA/GEOLOCATIONS/latitude_bounds_nir’ (static)</td>
<td>NC_STRING</td>
<td></td>
</tr>
</tbody>
</table>

A link to the boundary coordinates, i.e. the pixel corners. Note that the use of group-names in this attribute is an extension of the climate and forecasting metadata conventions.

longitude_nir in CLOUD_/PRODUCT
Description: The longitude of the pixel centers of the ground pixels in the data. Latitude, longitude coordinates for the ground pixel center and the ground pixel corners are calculated at the WGS84 ellipsoid.

Dimensions: time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>long_name</td>
<td>‘pixel center longitude’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>units</td>
<td>‘degrees_east’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>standard_name</td>
<td>‘longitude’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>valid_min</td>
<td>-180.0 (static)</td>
<td>NC_FLOAT</td>
</tr>
<tr>
<td></td>
<td>valid_max</td>
<td>180.0 (static)</td>
<td>NC_FLOAT</td>
</tr>
<tr>
<td></td>
<td>bounds</td>
<td>'/PRODUCT/SUPPORT_DATA/GEOLOCATIONS/longitude_bounds_nir' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

A link to the boundary coordinates, i.e. the pixel corners. Note that the use of group-names in this attribute is an extension of the climate and forecasting metadata conventions.

13.1.1 Group “SUPPORT_DATA” in “PRODUCT”

13.1.1.1 Group “GEOLOCATIONS” in “SUPPORT_DATA”

Variables in CLOUD_/PRODUCT/SUPPORT_DATA/GEOLOCATIONS
The variables described in section 12.13 “Additional geolocation support fields” on page 44 are included in the output at this location.

solar_zenith_angle_nir in CLOUD_/PRODUCT/SUPPORT_DATA/GEOLOCATIONS
Description: Solar zenith angle $\Theta _0$ at the ground pixel location on the reference ellipsoid. Angle is measured away from the vertical. ESA definition of day side: $\Theta _0 < 92^\circ$. Pixels are processed when $\Theta _0 \leq \Theta _0^{max}$ with $80^\circ \leq \Theta _0^{max} \leq 88^\circ$, depending on the algorithm. The actual value for $\Theta _0^{max}$ can be found in the algorithm metadata settings.

Dimensions: time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: L1B.
Mode: Present in all modes.

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>long_name</td>
<td>‘solar zenith angle’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>standard_name</td>
<td>‘solar_zenith_angle’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>units</td>
<td>‘degree’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>valid_min</td>
<td>0.0 (static)</td>
<td>NC_FLOAT</td>
</tr>
<tr>
<td></td>
<td>valid_max</td>
<td>180.0 (static)</td>
<td>NC_FLOAT</td>
</tr>
<tr>
<td></td>
<td>coordinates</td>
<td>'/PRODUCT/longitude_nir /PRODUCT/latitude_nir' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The latitude and longitude are in a different group. How to specify the related geospatial coordinates in this case is not specified in the climate and forecast metadata conventions [ER5].

comment
‘Solar zenith angle at the ground pixel location on the reference ellipsoid. Angle is measured away from the vertical’ (static)

solar_azimuth_angle_nir in CLOUD_/PRODUCT/SUPPORT_DATA/GEOLOCATIONS
Description: The solar azimuth angle at the ground pixel location on the reference ellipsoid. The angle is measured clockwise from the North (North = 0°, East = 90°, South = 180°, West = 270°). This is the same definition that is use in both OMI and GOME-2 level 1B files.
See the note on the `viewing_azimuth_angle` on the calculation of the relative azimuth angle as used in radiative transfer calculations.

**Dimensions:** time, scanline, ground_pixel.

**Type:** NC_FLOAT.

**Source:** L1B.

**Mode:** Present in all modes.

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>long_name</code></td>
<td>'solar azimuth angle'</td>
<td>(static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td><code>standard_name</code></td>
<td>'solar_azimuth_angle'</td>
<td>(static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td><code>units</code></td>
<td>'degree'</td>
<td>(static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td><code>valid_min</code></td>
<td>-180.0</td>
<td>(static)</td>
<td>NC_FLOAT</td>
</tr>
<tr>
<td><code>valid_max</code></td>
<td>180.0</td>
<td>(static)</td>
<td>NC_FLOAT</td>
</tr>
<tr>
<td><code>coordinates</code></td>
<td>'/PRODUCT/longitude_nir /PRODUCT/latitude_nir'</td>
<td>(static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The latitude and longitude are in a different group. How to specify the related geospatial coordinates in this case is not specified in the climate and forecast metadata conventions [ER5].

**Comment:** 'Solar azimuth angle at the ground pixel location on the reference ellipsoid. Angle is measured clockwise from the North (East = 90, South = 180, West = 270)' (static)

**viewing_zenith_angle_nir** in CLOUD_/PRODUCT/SUPPORT_DATA/GEOLOCATIONS

**Description:** Zenith angle of the satellite $\theta$ at the ground pixel location on the reference ellipsoid. Angle is measured away from the vertical.

**Dimensions:** time, scanline, ground_pixel.

**Type:** NC_FLOAT.

**Source:** L1B.

**Mode:** Present in all modes.

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>long_name</code></td>
<td>'viewing zenith angle'</td>
<td>(static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td><code>standard_name</code></td>
<td>'viewing_zenith_angle'</td>
<td>(static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td><code>units</code></td>
<td>'degree'</td>
<td>(static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td><code>valid_min</code></td>
<td>0.0</td>
<td>(static)</td>
<td>NC_FLOAT</td>
</tr>
<tr>
<td><code>valid_max</code></td>
<td>180.0</td>
<td>(static)</td>
<td>NC_FLOAT</td>
</tr>
<tr>
<td><code>coordinates</code></td>
<td>'/PRODUCT/longitude_nir /PRODUCT/latitude_nir'</td>
<td>(static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The latitude and longitude are in a different group. How to specify the related geospatial coordinates in this case is not specified in the climate and forecast metadata conventions [ER5].

**Comment:** 'Zenith angle of the satellite at the ground pixel location on the reference ellipsoid. Angle is measured away from the vertical'

**viewing_azimuth_angle_nir** in CLOUD_/PRODUCT/SUPPORT_DATA/GEOLOCATIONS

**Description:** The satellite azimuth angle at the ground pixel location on the reference ellipsoid. The angle is measured clockwise from the North (North = 0°, East = 90°, South = 180°, West = 270°). This is the same definition that is used in both OMI and GOME-2 level 1B files.

To calculate the azimuth difference $\varphi - \varphi_0$ it is not sufficient to just subtract `solar_azimuth_angle` from `viewing_azimuth_angle`. The angle needed for radiative transfer calculations is $(180° - (\varphi - \varphi_0)) \mod 360°$.

**Dimensions:** time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: L1B.
Mode: Present in all modes.

Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>long_name</td>
<td>'viewing azimuth angle' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>standard_name</td>
<td>'viewing_azimuth_angle' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>units</td>
<td>'degree' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>valid_min</td>
<td>-180.0 (static)</td>
<td>NC_FLOAT</td>
</tr>
<tr>
<td>valid_max</td>
<td>180.0 (static)</td>
<td>NC_FLOAT</td>
</tr>
<tr>
<td>coordinates</td>
<td>'/PRODUCT/longitude_nir /PRODUCT/latitude_nir' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The latitude and longitude are in a different group. How to specify the related geospatial coordinates in this case is not specified in the climate and forecast metadata conventions [ER5].

comment
'Satellite azimuth angle at the ground pixel location on the reference ellipsoid. Angle is measured clockwise from the North (East = 90, South = 180, West = 270)' (static)

latitude_bounds_nir in CLOUD_/PRODUCT/SUPPORT_DATA/GEOLOCATIONS
Description: The latitude of the pixel corners of the ground pixels in the data. Latitude, longitude coordinates for the ground pixel center and the ground pixel corners are calculated at the WGS84 ellipsoid.
The order of the pixel corners follows the CF-metadata conventions [ER5, section 7.1], i.e. the ordering is counter-clockwise when viewed from above. A graphical representation is given in figure 6.
Dimensions: time, scanline, ground_pixel, corner.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.

Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>'degrees_north' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

longitude_bounds_nir in CLOUD_/PRODUCT/SUPPORT_DATA/GEOLOCATIONS
Description: The longitude of the pixel corners of the ground pixels in the data. Latitude, longitude coordinates for the ground pixel center and the ground pixel corners are calculated at the WGS84 ellipsoid.
The order of the pixel corners follows the CF-metadata conventions [ER5, section 7.1], i.e. the ordering is counter-clockwise when viewed from above. A graphical representation is given in figure 6.
Dimensions: time, scanline, ground_pixel, corner.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.

Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>'degrees_east' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

geolocation_flags_nir in CLOUD_/PRODUCT/SUPPORT_DATA/GEOLOCATIONS
Description: Additional flags describing the ground pixel, including the influence of a solar eclipse, the possibility of sun glint, whether we are in the descending part of the orbit, whether we are on the night side of the orbit, whether the pixel crosses the dateline (useful for plotting), or if there was some geolocation error.
Dimensions: time, scanline, ground_pixel.
Type: NC_UBYTE.
Source: Processor.
Mode: Present in all modes.

Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>_FillValue</td>
<td>255 (static)</td>
<td>NC_UBYTE</td>
</tr>
<tr>
<td>coordinates</td>
<td>'/PRODUCT/longitude_nir /PRODUCT/latitude_nir' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>flag_masks</td>
<td>0, 1, 2, 4, 8, 16, 128 (static)</td>
<td>NC_UBYTE</td>
</tr>
<tr>
<td>flag_meanings</td>
<td>'no_error solar_eclipse sun_glint_possible descending night geo_boundary_crossing geolocation_error' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>flag_values</td>
<td>0, 1, 2, 4, 8, 16, 128 (static)</td>
<td>NC_UBYTE</td>
</tr>
<tr>
<td>long_name</td>
<td>'ground pixel quality flag' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>max_val</td>
<td>254 (static)</td>
<td>NC_UBYTE</td>
</tr>
<tr>
<td>min_val</td>
<td>0 (static)</td>
<td>NC_UBYTE</td>
</tr>
<tr>
<td>units</td>
<td>'1' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

13.1.1.2 Group “DETAILED_RESULTS” in “SUPPORT_DATA”

The groups described in section 12.18 “Debug fields for UPAS” on page 70 are included in the output at this location.

The groups described in section 12.19 “Computed polynomials and shift/squeeze values” on page 76 are included in the output at this location.

Dimensions in CLOUD_/PRODUCT/SUPPORT_DATA/DETAILED_RESULTS

number_fitting_parameter_ge  The number of fitting parameters used in the ROCINN effective scene retrieval.

- size 1 (dynamic)
- source Processor.
- mode Present in all modes.

number_fitting_parameter_crb  The number of fitting parameters used in the ROCINN CRB cloud retrieval.

- size 1 (dynamic)
- source Processor.
- mode Present in all modes.

number_fitting_parameter  The number of fitting parameters used in the ROCINN CAL cloud retrieval.

- size 1 (dynamic)
- source Processor.
- mode Present in all modes.

Variables in CLOUD_/PRODUCT/SUPPORT_DATA/DETAILED_RESULTS

The variables described in section 12.14 “Main fields for Cloud Product based on CRB model” on page 48 are included in the output at this location.

The variables described in section 12.15 “Detailed Results related to OCRA/ROCINN CAL Cloud Product” on page 51 are included in the output at this location.

The variables described in section 12.16 “Detailed Results related to the NIR variables of the Cloud Product” on page 52 are included in the output at this location.

The variables described in section 12.17 “Additional detailed results fields” on page 68 are included in the output at this location.

The variables described in section 12.17 “Additional detailed results fields” on page 68 are included in the output at this location.
**surface_albedo_fitted_crb** in CLOUD:/PRODUCT/SUPPORT_DATA/DETAILED_RESULTS  
**Description:** Surface albedo fitted using the OCRA/ROCINN CRB model.  
**Dimensions:** time, scanline, ground_pixel.  
**Type:** NC_FLOAT.  
**Source:** Processor.  
**Mode:** Present in all modes.  
**Attributes:**

<table>
<thead>
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<tr>
<td>source</td>
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</tr>
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<tr>
<td>coordinates</td>
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</table>

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

**surface_albedo_fitted_crb_precision** in CLOUD:/PRODUCT/SUPPORT_DATA/DETAILED_RESULTS  
**Description:** Error of the fitted surface albedo calculated using the OCRA/ROCINN CRB model.  
**Dimensions:** time, scanline, ground_pixel.  
**Type:** NC_FLOAT.  
**Source:** Processor.  
**Mode:** Present in all modes.  
**Attributes:**

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<th>Value</th>
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</tr>
<tr>
<td>source</td>
<td>'crb' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>comment</td>
<td>'Error of the coregistered surface albedo fitted using the OCRA/ROCINN CRB model.' (static)</td>
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</table>

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

**sun_glint_flag** in CLOUD:/PRODUCT/SUPPORT_DATA/DETAILED_RESULTS  
**Description:** Flag describing the possibility of occurrence of sunglint.  
**Dimensions:** time, scanline, ground_pixel.  
**Type:** NC_UBYTE.  
**Source:** Processor.  
**Mode:** Present in all modes.  
**Attributes:**

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</table>

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.
### cloud_top_temperature

**Description:** Atmospheric temperature at cloud top level using the OCRA/ROCINN CAL model.

**Dimensions:** time, scanline, ground_pixel.

**Type:** NC_FLOAT.

**Source:** Processor.

**Mode:** Present in all modes.

<table>
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<td>source</td>
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<tr>
<td>comment</td>
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</table>

**coordinates** /

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

### cloud_phase

**Description:** Phase of the retrieved cloud

**Dimensions:** time, scanline, ground_pixel.

**Type:** NC_UBYTE.

**Source:** Processor.

**Mode:** Present in all modes.

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</table>
| coordinates   | /

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

### cloud_fraction_apriori

**Description:** A Priori Cloud Fraction computed by the OCRA/ROCINN model.

**Dimensions:** time, scanline, ground_pixel.

**Type:** NC_FLOAT.

**Source:** Processor.

**Mode:** Present in all modes.

<table>
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<th>Name</th>
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<th>Type</th>
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</table>

**coordinates** /

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

### wavelength_shift

**Description:** Wavelength shift fitted using the OCRA/ROCINN CAL model.

**Dimensions:** time, scanline, ground_pixel.

**Type:** NC_FLOAT.

**Source:** Processor.
**Mode:** Present in all modes.

**Attributes:**

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<tr>
<th>Name</th>
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<td>NC_STRING</td>
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<tr>
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The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

**wavelength_shift_precision** in CLOUD_/PRODUCT/SUPPORT_DATA/DETAILED_RESULTS

Description: Error of the fitted wavelength shift using the OCRA/ROCINN CAL model.

Dimensions: time, scanline, ground_pixel.

Type: NC_FLOAT.

Source: Processor.

Mode: Present in all modes.

**Attributes:**

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The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

**wavelength_shift_crb** in CLOUD_/PRODUCT/SUPPORT_DATA/DETAILED_RESULTS

Description: Wavelength shift fitted using the OCRA/ROCINN CRB model.

Dimensions: time, scanline, ground_pixel.

Type: NC_FLOAT.

Source: Processor.

Mode: Present in all modes.

**Attributes:**

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<tr>
<th>Name</th>
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<th>Type</th>
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The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

**wavelength_shift_crb_precision** in CLOUD_/PRODUCT/SUPPORT_DATA/DETAILED_RESULTS

Description: Error of the fitted wavelength shift using the OCRA/ROCINN CRB model.

Dimensions: time, scanline, ground_pixel.

Type: NC_FLOAT.

Source: Processor.

Mode: Present in all modes.

**Attributes:**

<table>
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<tr>
<th>Name</th>
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The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

**number_of_iterations** in CLOUD_/PRODUCT/SUPPORT_DATA/DETAILED_RESULTS
**Description**: Number of rocinn iterations for the CAL model.

**Dimensions**: time, scanline, ground_pixel.

**Type**: NC_FLOAT.

**Source**: Processor.

**Mode**: Present in all modes.

<table>
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The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

**number_of_iterations_crb** in CLOUD_/PRODUCT/SUPPORT_DATA/DETAILED_RESULTS

**Description**: Number of rocinn iterations for the CRB model.

**Dimensions**: time, scanline, ground_pixel.

**Type**: NC_FLOAT.

**Source**: Processor.

**Mode**: Present in all modes.

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<td>long_name</td>
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The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

**fitted_root_mean_square** in CLOUD_/PRODUCT/SUPPORT_DATA/DETAILED_RESULTS

**Description**: Final root mean square residual of the rocinn inversion using the CAL model.

**Dimensions**: time, scanline, ground_pixel.

**Type**: NC_FLOAT.

**Source**: Processor.

**Mode**: Present in all modes.

<table>
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<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
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<tr>
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The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

**fitted_root_mean_square_crb** in CLOUD_/PRODUCT/SUPPORT_DATA/DETAILED_RESULTS

**Description**: Final root mean square residual of the rocinn inversion using the CRB model.

**Dimensions**: time, scanline, ground_pixel.

**Type**: NC_FLOAT.

**Source**: Processor.

**Mode**: Present in all modes.

<table>
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<th>Type</th>
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The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.
**degrees_of_freedom** in CLOUD_/PRODUCT/SUPPORT_DATA/DETAILED_RESULTS

Description: Final Degrees of freedom of the rocinn inversion using the CAL model.
Dimensions: time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.

Attributes:

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The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

**degrees_of_freedom_crb** in CLOUD_/PRODUCT/SUPPORT_DATA/DETAILED_RESULTS

Description: Final Degrees of freedom of the rocinn inversion using the CRB model.
Dimensions: time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.

Attributes:

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<th>Name</th>
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The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

**number_of_spectral_points_in_retrieval** in CLOUD_/PRODUCT/SUPPORT_DATA/DETAILED_RESULTS

Description: The number of points in the spectrum that were used in the CAL retrieval.
Dimensions: time, scanline, ground_pixel.
Type: NC_USHORT.
Source: Processor.
Mode: Present in all modes.

Attributes:

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The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.
The latitude and longitude are in a different group. How to specify the related geospatial coordinates in this case is not specified in the climate and forecast metadata conventions [ER5].

effective_scene_height in CLOUD_/PRODUCT/SUPPORT_DATA/DETAILED_RESULTS
Description: Retrieved effective scene height w.r.t. the geoid/MSL using the OCRA/ROCINN CRB model.
Dimensions: time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.
Attributes:

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<th>Name</th>
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<th>Type</th>
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<tr>
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<tr>
<td>standard_name</td>
<td>'TBD' (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>long_name</td>
<td>'effective scene height from the CRB model' (static)</td>
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</tr>
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<td>source</td>
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<tr>
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<tr>
<td>coordinates</td>
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The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

effective_scene_height_precision in CLOUD_/PRODUCT/SUPPORT_DATA/DETAILED_RESULTS
Description: Error of the retrieved scene height w.r.t. the geoid/MSL using the OCRA/ROCINN CRB model.
Dimensions: time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.
Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
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<tbody>
<tr>
<td>units</td>
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<td>standard_name</td>
<td>'TBD' (static)</td>
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<tr>
<td>source</td>
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<td>NC_STRING</td>
</tr>
<tr>
<td>comment</td>
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<td>NC_STRING</td>
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<tr>
<td>coordinates</td>
<td>'/PRODUCT/longitude /PRODUCT/latitude' (static)</td>
<td>NC_STRING</td>
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</table>

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.
effective_scene_pressure in CLOUD_/PRODUCT/SUPPORT_DATA/DETAILED_RESULTS
Description: Retrieved effective scene atmospheric pressure using the OCRA/ROCINN CRB model.
Dimensions: time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.
Attributes:

<table>
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<th>Type</th>
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<tr>
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<td>standard_name</td>
<td>'TBD' (static)</td>
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**effective_scene_pressure_precision** in CLOUD_/PRODUCT/SUPPORT_DATA/DETAILED_RESULTS

Description: Error of the retrieved effective scene atmospheric pressure using the OCRA/ROCINN CRB model.

Dimensions: time, scanline, ground_pixel.

Type: NC_FLOAT.

Source: Processor.

Mode: Present in all modes.

<table>
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<td>units</td>
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<td>NC_STRING</td>
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<td>source</td>
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<tr>
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<td>comment</td>
<td>‘Error of the coregistered and converted effective scene atmospheric pressure retrieved using the OCRA/ROCINN CRB model.’ (static)</td>
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<tr>
<td></td>
<td>coordinates</td>
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</table>

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

**coregistration_weight_sums_nir** in CLOUD_/PRODUCT/SUPPORT_DATA/DETAILED_RESULTS

Description: Value describing the sum of the weights of the linear coregistration from band 3/4 to band 6 for each pixel.

Dimensions: time, scanline, ground_pixel.

Type: NC_FLOAT.

Source: Processor.

Mode: Present in all modes.

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>units</td>
<td>‘1’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>long_name</td>
<td>‘coregistration weight sums nir’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>coordinates</td>
<td>’/PRODUCT/longitude_nir /PRODUCT/latitude_nir’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

**coregistration_weight_sums_crb** in CLOUD_/PRODUCT/SUPPORT_DATA/DETAILED_RESULTS

Description: Value describing the sum of the weights of the linear coregistration from band 6 to band 3/4 for values from the CRB retrieval for each pixel.

Dimensions: time, scanline, ground_pixel.

Type: NC_FLOAT.

Source: Processor.

Mode: Present in all modes.
Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>’1’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>long_name</td>
<td>’coregistration weight sums crb’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
<td>'/PRODUCT/longitude /PRODUCT/latitude' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

**coregistration_weight_sums_cal** in CLOUD_/PRODUCT/SUPPORT_DATA/DETAILED_RESULTS

Description: Value describing the sum of the weights of the linear coregistration from band 6 to band 3/4 for values from the CAL retrieval for each pixel.

Dimensions: time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.

Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>’1’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>long_name</td>
<td>’coregistration weight sums cal’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
<td>'/PRODUCT/longitude /PRODUCT/latitude' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

**coregistration_weight_sums_ge** in CLOUD_/PRODUCT/SUPPORT_DATA/DETAILED_RESULTS

Description: Value describing the sum of the weights of the linear coregistration from band 6 to band 3/4 for values from the effective scene retrieval for each pixel.

Dimensions: time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.

Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>’1’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>long_name</td>
<td>’coregistration weight sums ge’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
<td>'/PRODUCT/longitude /PRODUCT/latitude' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.

**cloud_coregistration_inhomogeneity_parameter** in CLOUD_/PRODUCT/SUPPORT_DATA/DETAILED_RESULTS

Description: Value describing the cloud inhomogeneity based on the coregistration table provided by KNMI. The value range is [0,1] where high values indicate inhomogenous scenes.

Dimensions: time, scanline, ground_pixel.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.

Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>’1’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>long_name</td>
<td>’cloud coregistration inhomogeneity parameter’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
<td>'/PRODUCT/longitude /PRODUCT/latitude' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. This attribute originates from the CF standard.
13.1.1.3 Group “INPUT_DATA” in “SUPPORT_DATA”

The groups described in section 12.21 “Input data common to all the L2 DLR products” on page 81 are included in the output at this location.

**Dimensions in CLOUD_/PRODUCT/SUPPORT_DATA/INPUT_DATA**

**reflectances** The number of ocra reflectances.

- **size**: 3 (fixed)
- **source**: Processor.
- **mode**: Present in all modes.

**Variables in CLOUD_/PRODUCT/SUPPORT_DATA/INPUT_DATA**

The variables described in section 12.22 “Original and computed snow-ice flag” on page 82 are included in the output at this location.

---

**reflectances_ocra** in CLOUD_/PRODUCT/SUPPORT_DATA/INPUT_DATA

- **Description**: OCRA reflectance at wavelength ranges R, G, B.
- **Dimensions**: time, scanline, ground_pixel, reflectances.
- **Type**: NC_FLOAT.
- **Source**: Processor.
- **Mode**: Present in all modes.

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>comment</td>
<td>‘Colors used in the OCRA model. Index 0 is color B, index 1 is color G and index 2 is fill_value (color R is not used for TROPOMI).’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>units</td>
<td>‘1’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>standard_name</td>
<td>‘toa_bidirectional_reflectance’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>long_name</td>
<td>‘toa bidirectional ocra rgb reflectances’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>coordinates</td>
<td>‘/PRODUCT/longitude /PRODUCT/latitude’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The latitude and longitude are in a different group. How to specify the related geospatial coordinates in this case is not specified in the climate and forecast metadata conventions [ER5].

---

**continuum_reflectance_oxygen_Aband** in CLOUD_/PRODUCT/SUPPORT_DATA/INPUT_DATA

- **Description**: Reflectance at first pixel of O2 A-band fitting window.
- **Dimensions**: time, scanline, ground_pixel.
- **Type**: NC_FLOAT.
- **Source**: Processor.
- **Mode**: Present in all modes.

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>units</td>
<td>‘1’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>standard_name</td>
<td>‘toa_bidirectional_reflectance’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>long_name</td>
<td>‘toa bidirectional o2a continuum reflectance’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td></td>
<td>coordinates</td>
<td>‘/PRODUCT/longitude_nir /PRODUCT/latitude_nir’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The latitude and longitude are in a different group. How to specify the related geospatial coordinates in this case is not specified in the climate and forecast metadata conventions [ER5].

---

**viirs_cloud_fraction** in CLOUD_/PRODUCT/SUPPORT_DATA/INPUT_DATA

- **Description**: Ratio of VIIRS pixels classified as CONFIDENTLY_CLOUDY_in_the_UV / VIS
Dimensions: time, scanline, ground_pixel.

Type: NC_SHORT.

Source: Processor.

Mode: Present in all modes.

Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>‘1’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>scale_factor</td>
<td>0.0001 (static)</td>
<td>NC_FLOAT</td>
</tr>
<tr>
<td>standard_name</td>
<td>‘viirs_cloud_fraction_uvis’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>long_name</td>
<td>‘Ratio of VIIRS pixels classified as CONFIDENTLY_CLOUDY in the UV/VIS’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
<td>‘/PRODUCT/longitude /PRODUCT/latitude’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

viirs_cloud_fraction_nir in CLOUD_/PRODUCT/SUPPORT_DATA/INPUT_DATA

Description: Ratio of VIIRS pixels classified as CONFIDENTLY_CLOUDY in the near infrared

Dimensions: time, scanline, ground_pixel.

Type: NC_SHORT.

Source: Processor.

Mode: Present in all modes.

Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>‘1’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>scale_factor</td>
<td>0.0001 (static)</td>
<td>NC_FLOAT</td>
</tr>
<tr>
<td>standard_name</td>
<td>‘viirs_cloud_fraction_nir’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>long_name</td>
<td>‘Ratio of VIIRS pixels classified as CONFIDENTLY_CLOUDY in the near infrared’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
<td>‘/PRODUCT/longitude_nir /PRODUCT/latitude_nir’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

surface_albedo_nir in CLOUD_/PRODUCT/SUPPORT_DATA/INPUT_DATA

Description: The used surface albedo (either from a climatology or retrieved) for the retrieval of the cloud parameters of the pixel

Dimensions: time, scanline, ground_pixel.

Type: NC_FLOAT.

Source: Processor.

Mode: Present in all modes.

Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>long_name</td>
<td>‘surface albedo nir’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>standard_name</td>
<td>‘surface_albedo_nir’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>units</td>
<td>‘1’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
<td>‘/PRODUCT/longitude_nir /PRODUCT/latitude_nir’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The latitude and longitude are in a different group. How to specify the related geospatial coordinates in this case is not specified in the climate and forecast metadata conventions [ER5].
### surface_altitude_nir

**Description:** The mean of the sub-pixels of the surface altitude above the reference geoid (WGS84) within the approximate field of view, based on the GMTED2010 surface elevation database.

**Dimensions:** time, scanline, ground_pixel.

**Type:** NC_FLOAT.

**Source:** surface elevation database.

**Mode:** Present in all modes.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>long_name</td>
<td>‘surface altitude’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>standard_name</td>
<td>‘surface_altitude’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>units</td>
<td>‘m’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>coordinates</td>
<td>'/PRODUCT/longitude_nir /PRODUCT/latitude_nir' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The latitude and longitude are in a different group. How to specify the related geospatial coordinates in this case is not specified in the climate and forecast metadata conventions [ER5].

**Source:**

'"http://topotools.cr.usgs.gov/gmted_viewer/' (static) NC_STRING

**Comment:**

‘The mean of the sub-pixels of the surface altitude above the reference geoid (WGS84) within the approximate field of view, based on the GMTED2010 surface elevation database’ (static)

### surface_pressure_nir

**Description:** Surface pressure from ECMWF model data.

**Dimensions:** time, scanline, ground_pixel.

**Type:** NC_FLOAT.

**Source:** Processor.

**Mode:** Present in all modes.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>‘Pa’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>standard_name</td>
<td>‘surface_air_pressure’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>long_name</td>
<td>‘surface_air_pressure’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>source</td>
<td></td>
<td></td>
</tr>
<tr>
<td>coordinates</td>
<td>'/PRODUCT/longitude_nir /PRODUCT/latitude_nir' (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The latitude and longitude are in a different group. How to specify the related geospatial coordinates in this case is not specified in the climate and forecast metadata conventions [ER5].

### surface_classification_nir

**Description:** This is a combined land/water mask and surface classification data field.

**Dimensions:** time, scanline, ground_pixel.

**Type:** NC_UBYTE.

**Source:** surface elevation database (including flag attributes).

**Mode:** Present in all modes.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>‘1’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>long_name</td>
<td>‘land-water mask’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>comment</td>
<td>‘flag indicating land/water and further surface classifications for the ground pixel’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>
source: ‘USGS (http://edc2.usgs.gov/glcc/globdoc2_0.php) and NASA SDP toolkit (http://newsroom.gsfc.nasa.gov/sdptoolkit/toolkit.html)’

flag_meanings: ‘land, water, some_water, coast, value_covers_majority_of_pixel, water+shallow_ocean, water+shallow_inland_water, water+ocean_coastline-lake_shoreline, water+intermittent_water, water+deep_inland_water, water+continental_shelf_ocean, water+deep_ocean, land+urban_and_built-up_land, land+dryland_cropland_and_pasture, land+irrigated_cropland_and_pasture, land+mixed_dryland_irrigated_cropland_and_pasture, land+cropland-grassland_mosaic, land+cropland-woodland_mosaic, land+grassland, land+shrubland, land+mixed_shrubland-grassland, land+savanna, land+deciduous_broadleaf_forest, land+deciduous_needleleaf_forest, land+evergreen_broadleaf_forest, land+evergreen_needleleaf_forest, land+mixed_forest, land+herbaceous_wetland, land+wooded_wetland, land+barren_or_sparingly_vegetated, land+herbaceous_tundra, land+wooded_tundra, land+mixed_tundra, land+bare_ground_tundra, land+snow_or_ice’

flag_values: 0, 1, 2, 3, 4, 9, 17, 25, 33, 41, 49, 57, 8, 16, 24, 32, 40, 48, 56, 64, 72, 80, 88, 96, 104, 112, 120, 128, 136, 144, 152, 160, 168, 176, 184

flag_masks: 3, 3, 3, 3, 4, 249, 249, 249, 249, 249, 249, 249, 249, 249, 249, 249, 249, 249, 249, 249, 249, 249, 249, 249, 249, 249, 249, 249, 249, 249

coordinates: ‘/PRODUCT/longitude_nir /PRODUCT/latitude_nir’

The latitude and longitude are in a different group. How to specify the related geospatial coordinates in this case is not specified in the climate and forecast metadata conventions [ER5].

snow_ice_flag_nir in CLOUD_/PRODUCT/SUPPORT_DATA/INPUT_DATA

Description: This is binary snow/ice classification flag. It is computed internally in the processor based on external dynamic data (e.g. NSIDC/NISE or climatology). In case the original value of the pixel is greater than 30 percent, the flag is set to 1 (snow/ice presence), otherwise 0 (snow/ice free).

Dimensions: time, scanline, ground_pixel.

Type: NC_UBYTE.

Source: Processor.

Mode: Present in all modes.

Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>units</td>
<td>‘1’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>threshold</td>
<td>‘0.3’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>long_name</td>
<td>‘snow-ice mask’ (static)</td>
<td>NC_STRING</td>
</tr>
<tr>
<td>_FillValue</td>
<td>‘254UB’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>
comment: ‘flag indicating snow/ice at center of ground pixel’ (static)

source: NC_STRING

Possible values: NSIDC/NISE, Fallback_climatology

flag_meansings: ‘snow_free snow_ice’ (static)

flag_values: 0, 1 (static)

coordinates: ‘/PRODUCT/longitude_nir /PRODUCT/latitude_nir’ (static)

The latitude and longitude are in a different group. How to specify the related geospatial coordinates in this case is not specified in the climate and forecast metadata conventions [ER5].

13.2 Group “METADATA” in “CLOUD_”

This is a group to collect metadata items, such as the items that also appear in the header file and items required by Inspire [ER4]. Most metadata will be stored as attributes. Grouping attributes that belong to a specific standard is done by using sub-groups in the Metadata group.

Included in this group are the granule description and quality assurance parameters. Note that some metadata attributes are required to be attached to the global level by convention, such as the CF-Metadata convention [ER5] and the NetCDF user guide [ER7]. The groups described in section 12.26 “ESA metadata” on page 97 are included in the output at this location.

The groups described in section 12.27 “EOP metadata” on page 105 are included in the output at this location.

The groups described in section 12.28 “ISO metadata” on page 109 are included in the output at this location.

13.2.1 Group “QA_STATISTICS” in “METADATA”

The groups described in section 12.23 “Quality assurance statistics” on page 85 are included in the output at this location.

Variables in CLOUD_/METADATA/QA_STATISTICS

cloud_histogram in CLOUD_/METADATA/QA_STATISTICS
Description: Histogram of the cloud values in the current granule.
Dimensions: histogram_axis.
Type: NC_INT.
Source: Processor.
Mode: Present in all modes.
Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>comment</td>
<td>‘Histogram of cloud data in the current granule’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

cloud_pdf in CLOUD_/METADATA/QA_STATISTICS
Description: Probability density function of cloud values in the current granule. The values are weighted with $\cos(\delta_{geo})$ and spread out using the error estimate.
Dimensions: pdf_axis.
Type: NC_FLOAT.
Source: Processor.
Mode: Present in all modes.
Attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>comment</td>
<td>‘Probability density function of cloud data in the current granule’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>
13.2.2 Group “ALGORITHM_SETTINGS” in “METADATA”

13.2.3 Group “GRANULE_DESCRIPTION” in “METADATA”

Attributes in CLOUD_/METADATA/GRANULE_DESCRIPTION
The attributes described in section 12.25 “Granule metadata” on page 96 are included in the output at this location.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>ProductShortName</td>
<td>‘L2__CLOUD_’ (static)</td>
<td>NC_STRING</td>
</tr>
</tbody>
</table>

The short product name. For the Cloud product this is fixed to “L2__CLOUD_”.

A Flag descriptions

The following tables describe the Measurement flags, Processing quality flags (processing failures and filter conditions, errors and warnings) and Surface classifications.

Please be aware that this section is work in progress and the flags are not included in the product yet. The aim of this section is for review only.
Table 12: Processing quality flags, errors, processing failures and filter conditions for S5P Level 2. Warnings are listed in table 13. The value in the first column is the result of a bitwise ‘and’ of 255 (0xFF) and the value in the “processing_quality_flags” variable.

<table>
<thead>
<tr>
<th>#</th>
<th>Short name</th>
<th>Description</th>
<th>Algorithm</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>success</td>
<td>No failures, output contains value. Warnings still possible.</td>
<td>All</td>
</tr>
<tr>
<td>1</td>
<td>radiance_missing</td>
<td>The number of spectral pixels in the radiance due to flagging is too small to perform the fitting.</td>
<td>All</td>
</tr>
<tr>
<td>2</td>
<td>irradiance_missing</td>
<td>The number of spectral pixels in the irradiance due to flagging is too small to perform the fitting.</td>
<td>All</td>
</tr>
<tr>
<td>3</td>
<td>input_spectrum_missing</td>
<td>The reflectance spectrum does not contain enough points to perform the retrieval. This is different from (ir)radiance_missing in that the missing points may not be aligned.</td>
<td>All</td>
</tr>
<tr>
<td>4</td>
<td>reflectance_range_error</td>
<td>Any of the reflectances is out of bounds ($R &lt; 0$ or $R &gt; R_{\text{max}}$).</td>
<td>FRESCO</td>
</tr>
<tr>
<td>5</td>
<td>ler_range_error</td>
<td>Lambert-equivalent reflectivity out of range error.</td>
<td>CO, CH₄</td>
</tr>
<tr>
<td>6</td>
<td>snr_range_error</td>
<td>Too low signal to noise to perform retrieval.</td>
<td>CO</td>
</tr>
<tr>
<td>7</td>
<td>sza_range_error</td>
<td>Solar zenith angle out of range, maximum value from configuration.</td>
<td>All</td>
</tr>
<tr>
<td>8</td>
<td>vza_range_error</td>
<td>Viewing zenith angle out of range, maximum value from configuration.</td>
<td>Development phase only</td>
</tr>
<tr>
<td>9</td>
<td>lut_range_error</td>
<td>Extrapolation in lookup table (airmass factor, cloud radiances).</td>
<td>NO₂</td>
</tr>
<tr>
<td>10</td>
<td>ozone_range_error</td>
<td>Ozone column significantly out of range of profile climatology.</td>
<td>Total O₃ column</td>
</tr>
<tr>
<td>11</td>
<td>wavelength_offset_error</td>
<td>Wavelength offset exceeds maximum from configuration.</td>
<td>FRESCO, NO₂</td>
</tr>
<tr>
<td>12</td>
<td>initialization_error</td>
<td>An error occurred during the processing of the pixel, no output was generated. The following errors raise this flag: Mismatch between irradiance and radiance wavelengths; The on-ground distance between band 1 and band 2 ground pixels exceeds a threshold set in the configuration. Derived a-priori information does not validate, no processing is possible.</td>
<td>All</td>
</tr>
<tr>
<td>13</td>
<td>memory_error</td>
<td>Memory allocation or deallocation error.</td>
<td>CO, CH₄</td>
</tr>
<tr>
<td>14</td>
<td>assertion_error</td>
<td>Error in algorithm detected during assertion.</td>
<td>CO</td>
</tr>
<tr>
<td>15</td>
<td>io_error</td>
<td>Error detected during transfer of data between algorithm and framework.</td>
<td>CO, ALH, CH₄, O₃ profile</td>
</tr>
<tr>
<td>16</td>
<td>numerical_error</td>
<td>General fatal numerical error occurred during inversion.</td>
<td>CO, FRESCO</td>
</tr>
<tr>
<td>17</td>
<td>lut_error</td>
<td>Error in accessing the lookup table.</td>
<td>CH₄</td>
</tr>
<tr>
<td>18</td>
<td>ISRF_error</td>
<td>Error detected in the input instrument spectral response function input data.</td>
<td>CH₄</td>
</tr>
<tr>
<td>19</td>
<td>convergence_error</td>
<td>The main algorithm did not converge.</td>
<td>All</td>
</tr>
<tr>
<td>20</td>
<td>cloud_filter_convergence_error</td>
<td>The cloud filter did not converge.</td>
<td>CO</td>
</tr>
<tr>
<td>#</td>
<td>Short name</td>
<td>Description</td>
<td>Algorithm</td>
</tr>
<tr>
<td>-----</td>
<td>-----------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>21</td>
<td>max_iteration_convergence_error</td>
<td>No convergence because retrieval exceeds maximum number of iterations. Maximum value from configuration.</td>
<td>ALH</td>
</tr>
<tr>
<td>22</td>
<td>aot_lower_boundary_convergence_error</td>
<td>No convergence because the aerosol optical thickness crosses lower boundary twice in succession.</td>
<td>ALH</td>
</tr>
<tr>
<td>23</td>
<td>other_boundary_convergence_error</td>
<td>No convergence because a state vector element crosses boundary twice in succession. Note that a separate failure flag is defined for non-convergence due to crossing of lower AOT boundary.</td>
<td>ALH</td>
</tr>
<tr>
<td>25</td>
<td>ch4_noscat_zero_error</td>
<td>The CH₄ column retrieved by the non-scattering CO algorithm from the weak band or strong band is 0.</td>
<td>CH₄</td>
</tr>
<tr>
<td>26</td>
<td>h2o_noscat_zero_error</td>
<td>The H₂O column retrieved by the non-scattering CO algorithm from the weak band or strong band is 0.</td>
<td>CH₄</td>
</tr>
<tr>
<td>27</td>
<td>max_optical_thickness_error</td>
<td>Maximum optical thickness exceeded during iterations.</td>
<td>CH₄</td>
</tr>
<tr>
<td>28</td>
<td>aerosol_boundary_error</td>
<td>Boundary hit of aerosol parameters at last iteration.</td>
<td>CH₄</td>
</tr>
<tr>
<td>29</td>
<td>boundary_hit_error</td>
<td>Fatal boundary hit during iterations.</td>
<td>CH₄</td>
</tr>
<tr>
<td>30</td>
<td>chi2_error</td>
<td>$\chi^2$ is not-a-number or larger than $10^{10}$.</td>
<td>CH₄</td>
</tr>
<tr>
<td>31</td>
<td>svd_error</td>
<td>Singular value decomposition failure.</td>
<td>CH₄</td>
</tr>
<tr>
<td>32</td>
<td>dfs_error</td>
<td>Degree of freedom is not-a-number.</td>
<td>CH₄</td>
</tr>
<tr>
<td>33</td>
<td>radiative_transfer_error</td>
<td>Errors occurred during the radiative transfer computations, no processing possible.</td>
<td>O₃ profile</td>
</tr>
<tr>
<td>34</td>
<td>optimal_estimation_error</td>
<td>Errors occurred during the optimal estimation, processing has been terminated.</td>
<td>O₃ profile</td>
</tr>
<tr>
<td>35</td>
<td>profile_error</td>
<td>Flag that indicates if there were any errors during the computation of the ozone profile.</td>
<td>O₃ profile</td>
</tr>
<tr>
<td>36</td>
<td>cloud_error</td>
<td>No cloud data.</td>
<td>Cloud</td>
</tr>
<tr>
<td>37</td>
<td>model_error</td>
<td>Forward model failure.</td>
<td>Cloud, Total O₃ column</td>
</tr>
<tr>
<td>38</td>
<td>number_of_input_data_points_too_low_error</td>
<td>Not enough input ozone columns to calculate a tropospheric column.</td>
<td>Tropospheric O₃ column</td>
</tr>
<tr>
<td>39</td>
<td>cloud_pressure_spread_too_low_error</td>
<td>Cloud pressure variability too low to estimate a tropospheric column.</td>
<td>Tropospheric O₃ column</td>
</tr>
<tr>
<td>40</td>
<td>cloud_too_low_level_error</td>
<td>Clouds are too low in the atmosphere to assume sufficient shielding.</td>
<td>Tropospheric O₃ column</td>
</tr>
<tr>
<td>41</td>
<td>generic_range_error</td>
<td>Generic range error.</td>
<td>All</td>
</tr>
<tr>
<td>42</td>
<td>generic_exception</td>
<td>Catch all generic errors.</td>
<td>All</td>
</tr>
<tr>
<td>43</td>
<td>input_spectrum_alignment_error</td>
<td>Input radiance and irradiance spectra are not aligned correctly.</td>
<td>All</td>
</tr>
<tr>
<td>44</td>
<td>abort_error</td>
<td>Not processed because processor aborted prematurely (time out or user abort)</td>
<td>All</td>
</tr>
</tbody>
</table>
### Table 12: Processing quality flags, errors, processing failures and filter conditions for S5P Level 2 (continued).

<table>
<thead>
<tr>
<th>#</th>
<th>Short name</th>
<th>Description</th>
<th>Algorithm</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
<td>wrong_input_type_error</td>
<td>Wrong input type error, mismatch between expectation and received data.</td>
<td>All</td>
</tr>
<tr>
<td>46</td>
<td>wavelength_calibration_error</td>
<td>An error occurred in the wavelength calibration of this pixel</td>
<td>All</td>
</tr>
<tr>
<td>47</td>
<td>coregistration_error</td>
<td>No colocated pixels found in a supporting band</td>
<td>All</td>
</tr>
<tr>
<td>51</td>
<td>signal_to_noise_ratio_error</td>
<td>The signal to noise ratio for this spectrum is too low for processing</td>
<td>All</td>
</tr>
<tr>
<td>52</td>
<td>configuration_error</td>
<td>Error while parsing the configuration</td>
<td>All</td>
</tr>
<tr>
<td>53</td>
<td>key_error</td>
<td>Key does not exist</td>
<td>All</td>
</tr>
<tr>
<td>54</td>
<td>saturation_error</td>
<td>Saturation in input spectrum</td>
<td>All</td>
</tr>
<tr>
<td>55</td>
<td>max_num_outlier_exceeded_error</td>
<td>The number of outliers detected in the DOAS fit exceeds a maximum set for healthy spectra.</td>
<td>NO₂</td>
</tr>
<tr>
<td>64</td>
<td>solar_eclipse_filter</td>
<td>Solar eclipse.</td>
<td>All</td>
</tr>
<tr>
<td>65</td>
<td>cloud_filter</td>
<td>The cloud filter triggered causing the pixel to be skipped.</td>
<td>CO, ALH, CH₄</td>
</tr>
<tr>
<td>66</td>
<td>altitude_consistency_filter</td>
<td>Too large difference between ECMWF altitude and DEM altitude value.</td>
<td>CO, CH₄</td>
</tr>
<tr>
<td>67</td>
<td>altitude_roughness_filter</td>
<td>Too large standard deviation of altitude in DEM.</td>
<td>CO, ALH, CH₄</td>
</tr>
<tr>
<td>68</td>
<td>sun_glint_filter</td>
<td>For pixels over water, viewing direction inside sun glint region. Definition of sun glint angle and threshold value from ATBD.</td>
<td>ALH</td>
</tr>
<tr>
<td>69</td>
<td>mixed_surface_type_filter</td>
<td>Pixel contains land and water areas (e.g. coastal pixel).</td>
<td>ALH</td>
</tr>
<tr>
<td>70</td>
<td>snow_ice_filter</td>
<td>Pixel contains snow/ice: Snow/ice flag according to dynamic input OR climatological surface albedo.</td>
<td>ALH</td>
</tr>
<tr>
<td>71</td>
<td>aai_filter</td>
<td>AAI smaller than 2.0.</td>
<td>ALH</td>
</tr>
<tr>
<td>72</td>
<td>cloud_fraction_fresco_filter</td>
<td>Pixel contains clouds: The FRESCO effective cloud fraction is larger than threshold.</td>
<td>ALH</td>
</tr>
<tr>
<td>73</td>
<td>aai_scene_albedo_filter</td>
<td>Pixel contains clouds: The difference between scene albedo at 380 nm from AAI calculation and the climatological surface albedo exceeds threshold.</td>
<td>ALH</td>
</tr>
<tr>
<td>74</td>
<td>small_pixel_radiance_std_filter</td>
<td>Pixel contains clouds: Standard deviation of radiances in small-pixel column exceeds threshold.</td>
<td>ALH, CH₄</td>
</tr>
<tr>
<td>75</td>
<td>cloud_fraction_viirs_filter</td>
<td>Pixel contains clouds: The cloud fraction from VIIRS / NPP exceeds threshold.</td>
<td>ALH</td>
</tr>
<tr>
<td>76</td>
<td>cirrus_reflectance_viirs_filter</td>
<td>Pixel contains clouds: Cirrus reflectance from VIIRS / NPP exceeds threshold.</td>
<td>ALH</td>
</tr>
<tr>
<td>#</td>
<td>Short name</td>
<td>Description</td>
<td>Algorithm</td>
</tr>
<tr>
<td>----</td>
<td>-------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>77</td>
<td>cf_viirs_swir_ifov_filter</td>
<td>Fraction of cloudy VIIRS pixels within S5P SWIR ground pixel exceeds a priori threshold from configuration.</td>
<td>CH₄</td>
</tr>
<tr>
<td>78</td>
<td>cf_viirs_swir_ofova_filter</td>
<td>Fraction of cloudy VIIRS pixels within S5P SWIR OFOVa exceeds a priori threshold from configuration.</td>
<td>CH₄</td>
</tr>
<tr>
<td>79</td>
<td>cf_viirs_swir_ofovb_filter</td>
<td>Fraction of cloudy VIIRS pixels within S5P SWIR OFOVb exceeds a priori threshold from configuration.</td>
<td>CH₄</td>
</tr>
<tr>
<td>80</td>
<td>cf_viirs_swir_ofovc_filter</td>
<td>Fraction of cloudy VIIRS pixels within S5P SWIR OFOVc exceeds a priori threshold from configuration.</td>
<td>CH₄</td>
</tr>
<tr>
<td>81</td>
<td>cf_viirs_nir_ifov_filter</td>
<td>Fraction of cloudy VIIRS pixels within S5P NIR ground pixel exceeds a priori threshold from configuration.</td>
<td>CH₄</td>
</tr>
<tr>
<td>82</td>
<td>cf_viirs_nir_ofova_filter</td>
<td>Fraction of cloudy VIIRS pixels within S5P NIR OFOVa exceeds a priori threshold from configuration.</td>
<td>CH₄</td>
</tr>
<tr>
<td>83</td>
<td>cf_viirs_nir_ofovb_filter</td>
<td>Fraction of cloudy VIIRS pixels within S5P NIR OFOVb exceeds a priori threshold from configuration.</td>
<td>CH₄</td>
</tr>
<tr>
<td>84</td>
<td>cf_viirs_nir_ofovc_filter</td>
<td>Fraction of cloudy VIIRS pixels within S5P NIR OFOVc exceeds a priori threshold from configuration.</td>
<td>CH₄</td>
</tr>
<tr>
<td>85</td>
<td>refl_cirrus_viirs_swir_filter</td>
<td>Average VIIRS cirrus reflectance within SWIR ground pixel exceeds a priori threshold from configuration.</td>
<td>CH₄</td>
</tr>
<tr>
<td>86</td>
<td>refl_cirrus_viirs_nir_filter</td>
<td>Average VIIRS cirrus reflectance within NIR ground pixel exceeds a priori threshold from configuration.</td>
<td>CH₄</td>
</tr>
<tr>
<td>87</td>
<td>diff_refl_cirrus_viirs_filter</td>
<td>Difference in VIIRS average cirrus reflectance between SWIR and NIR ground pixel exceeds a priori threshold from configuration.</td>
<td>CH₄</td>
</tr>
<tr>
<td>88</td>
<td>ch4_noscat_ratio_filter</td>
<td>The ratio between ([\text{CH}<em>4]</em>{\text{weak}}) and ([\text{CH}<em>4]</em>{\text{strong}}) is below or exceeds a priori thresholds from configuration.</td>
<td>CH₄</td>
</tr>
<tr>
<td>89</td>
<td>ch4_noscat_ratio_std_filter</td>
<td>The standard deviation of ([\text{CH}<em>4]</em>{\text{weak}}/\text{CH}<em>4]</em>{\text{strong}}) within the SWIR pixel and the 8 neighbouring pixels exceeds a priori threshold from configuration.</td>
<td>CH₄</td>
</tr>
<tr>
<td>90</td>
<td>h2o_noscat_ratio_filter</td>
<td>The ratio between ([\text{H}<em>2\text{O}]</em>{\text{weak}}) and ([\text{H}<em>2\text{O}]</em>{\text{strong}}) is below or exceeds a priori thresholds from configuration.</td>
<td>CH₄</td>
</tr>
<tr>
<td>91</td>
<td>h2o_noscat_ratio_std_filter</td>
<td>The standard deviation of ([\text{H}<em>2\text{O}]</em>{\text{weak}}/\text{H}<em>2\text{O}]</em>{\text{strong}}) within the SWIR pixel and the 8 neighbouring pixels exceeds a priori threshold from configuration.</td>
<td>CH₄</td>
</tr>
</tbody>
</table>
Table 12: Processing quality flags, errors, processing failures and filter conditions for S5P Level 2 (continued).

<table>
<thead>
<tr>
<th>#</th>
<th>Short name</th>
<th>Description</th>
<th>Algorithm</th>
</tr>
</thead>
<tbody>
<tr>
<td>92</td>
<td>diff_psurf_fresco_ecmwf_filter</td>
<td>Difference between the FRESCO apparent surface pressure and the ECMWF surface pressure exceeds a priori threshold from configuration.</td>
<td>CH₄</td>
</tr>
<tr>
<td>93</td>
<td>psurf_fresco_stdv_filter</td>
<td>The standard deviation of the FRESCO apparent surface pressure in the NIR pixel and the 8 surrounding pixels exceeds a priori threshold from configuration.</td>
<td>CH₄</td>
</tr>
<tr>
<td>94</td>
<td>ocean_filter</td>
<td>The ground pixel is over ocean (and ocean glint retrievals are not switched on).</td>
<td>CH₄</td>
</tr>
<tr>
<td>95</td>
<td>time_range_filter</td>
<td>Time is out of the range that is to be processed.</td>
<td>All</td>
</tr>
<tr>
<td>96</td>
<td>pixel_or_scanline_index_filter</td>
<td>Not processed because pixel index does not match general selection criteria.</td>
<td>All</td>
</tr>
<tr>
<td>97</td>
<td>geographic_region_filter</td>
<td>Pixel falls outside the specified regions of interest.</td>
<td>All</td>
</tr>
</tbody>
</table>

Table 13: Processing quality flags, warnings for S5P Level 2. Errors, processing failures and filter conditions are listed in table 12. If a bitwise ‘and’ of the mask value and the value in the “processing_quality_flags” variable is not zero, then the warning applies to the specific retrieval.

<table>
<thead>
<tr>
<th>Bit #</th>
<th>Mask (hex)</th>
<th>Short name</th>
<th>Description</th>
<th>Algorithm</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–7</td>
<td>0x000000FF</td>
<td>error</td>
<td>If non-zero an error has occurred when processing the pixel, see table 12 for details.</td>
<td>All</td>
</tr>
<tr>
<td>8</td>
<td>0x00001000</td>
<td>input_spectrum_warning</td>
<td>Number of good pixels in radiance, irradiance or calculated reflectance below threshold from configuration.</td>
<td>All</td>
</tr>
<tr>
<td>9</td>
<td>0x00002000</td>
<td>wavelength_calibration_warning</td>
<td>Offset from wavelength fit is larger than limit set in configuration.</td>
<td>Most</td>
</tr>
<tr>
<td>10</td>
<td>0x00004000</td>
<td>extrapolation_warning</td>
<td>Pressure or temperature outside cross section LUT range, other lookup table extrapolation.</td>
<td>CO, CH₄</td>
</tr>
<tr>
<td>11</td>
<td>0x00008000</td>
<td>sun_glint_warning</td>
<td>Sun glint possibility warning.</td>
<td>All</td>
</tr>
<tr>
<td>12</td>
<td>0x00010000</td>
<td>south_atlantic_anomaly_warning</td>
<td>TROPOMI is inside the south Atlantic anomaly while taking these measurements.</td>
<td>All</td>
</tr>
<tr>
<td>13</td>
<td>0x00020000</td>
<td>sun_glint_correction</td>
<td>A sun glint correction has been applied.</td>
<td>Cloud</td>
</tr>
<tr>
<td>14</td>
<td>0x00040000</td>
<td>snow_ice_warning</td>
<td>Snow/ice flag is set, i.e. using scene data from the cloud support product.</td>
<td>NO₂, Cloud</td>
</tr>
<tr>
<td>15</td>
<td>0x00080000</td>
<td>cloud_warning</td>
<td>Cloud filter based on FRESCO apparent surface pressure (VIIRS not available), cloud fraction above threshold or cloud pressure adjusted to force cloud above surface. In case of Cloud product this flag indicates the possibility of ice-clouds.</td>
<td>CH₄, O₃ profile, Cloud</td>
</tr>
<tr>
<td>16</td>
<td>0x00100000</td>
<td>AAI_warning</td>
<td>Possible aerosol contamination as indicated by the AAI (O₃ profile).</td>
<td>O₃ profile</td>
</tr>
<tr>
<td>Bit #</td>
<td>Mask (hex)</td>
<td>Short name</td>
<td>Description</td>
<td>Algorithm</td>
</tr>
<tr>
<td>-------</td>
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<td>-------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>17</td>
<td>0x00020000</td>
<td>pixel_level_input_data_missing</td>
<td>Dynamic auxiliary input data (e.g., cloud) is missing for this ground pixel. A fallback option is used.</td>
<td>All</td>
</tr>
<tr>
<td>18</td>
<td>0x00040000</td>
<td>data_range_warning</td>
<td>Carbon monoxide column tends to negative values; Water column tends to negative values; Heavy water (HDO) column tends to negative values; others. In case of the O₃ product this flag indicates VCD or effective albedo values outside a valid range.</td>
<td>CO, CH₄, O₃, SO₂, HCHO</td>
</tr>
<tr>
<td>19</td>
<td>0x00080000</td>
<td>low_cloud_fraction_warning</td>
<td>Low cloud fraction, therefore no cloud pressure retrieved.</td>
<td>Cloud</td>
</tr>
<tr>
<td>20</td>
<td>0x00100000</td>
<td>altitude_consistency_warning</td>
<td>Difference between ECMWF surface elevation and high-resolution surface elevation exceeds threshold from configuration.</td>
<td>CH₄</td>
</tr>
<tr>
<td>21</td>
<td>0x00200000</td>
<td>signal_to_noise_ratio_warning</td>
<td>Signal to noise ratio in SWIR and/or NIR band below threshold from configuration. For the O₃ and HCHO products this flag indicates an RMS above a certain threshold.</td>
<td>CH₄, O₃, HCHO</td>
</tr>
<tr>
<td>22</td>
<td>0x00400000</td>
<td>deconvolution_warning</td>
<td>Failed deconvolution irradiance spectrum (not pixel-specific, but row-specific).</td>
<td>CO, CH₄</td>
</tr>
<tr>
<td>23</td>
<td>0x00800000</td>
<td>so2_volcanic_origin_likely_warning</td>
<td>Warning for SO₂ BL product, UTLS products: volcanic origin except for heavily polluted sites.</td>
<td>SO₂</td>
</tr>
<tr>
<td>24</td>
<td>0x01000000</td>
<td>so2_volcanic_origin_certain_warning</td>
<td>Warning for SO₂ BL product, UTLS products: volcanic origin certain.</td>
<td>SO₂</td>
</tr>
<tr>
<td>25</td>
<td>0x02000000</td>
<td>interpolation_warning</td>
<td>Warning for interpolation on partially missing data. In this case the valid available data is used, potentially leading to a bias.</td>
<td>All</td>
</tr>
<tr>
<td>26</td>
<td>0x04000000</td>
<td>saturation_warning</td>
<td>Saturation occurred spectrum, possibly causing biases in the retrieval.</td>
<td>All</td>
</tr>
<tr>
<td>27</td>
<td>0x08000000</td>
<td>high_sza_warning</td>
<td>Warning for high solar zenith angle. In this case, the processing can be performed with less final quality.</td>
<td>All</td>
</tr>
<tr>
<td>28</td>
<td>0x10000000</td>
<td>cloud_retrieval_warning</td>
<td>Warning occurring when the retrieval diagnostic indicates a degraded quality of the cloud retrieval.</td>
<td>Cloud</td>
</tr>
<tr>
<td>29</td>
<td>0x20000000</td>
<td>cloud_inhomogeneity_warning</td>
<td>The cloud coregistration inhomogeneity parameter is above a given threshold. Also when the coregistration_weight_sums are less than 1.</td>
<td>Cloud</td>
</tr>
</tbody>
</table>
Table 14: Surface classification for S5P Level 2. This is a combined land/water mask and surface classification data field. For land the “Global Land Cover Characteristics Data Base Version 2.0” is used [ER11], specifically the “USGS Land Use/Land Cover System (Modified Level 2)” classification. Over water the classification from the NASA SDP toolkit [ER12], which is based on [RD45].

<table>
<thead>
<tr>
<th>Bit #</th>
<th>Mask (hex)</th>
<th>Short name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0x03</td>
<td>Land</td>
<td>The pixel is over land, for more than 50%</td>
</tr>
<tr>
<td>1</td>
<td>0x03</td>
<td>Water</td>
<td>The pixel is over water, for more than 50%</td>
</tr>
<tr>
<td>2</td>
<td>0x03</td>
<td>some_water</td>
<td>Pixel contains water (however small the fraction), i.e. at least one of the 15 x 15 arcsecond subpixels in the SDP dataset is classified as water</td>
</tr>
<tr>
<td>3</td>
<td>0x03</td>
<td>coastline</td>
<td>Pixel is water, but contains land (coastline)</td>
</tr>
<tr>
<td>0</td>
<td>0x04</td>
<td>mixed_surface</td>
<td>Pixel has a mixed surface type. Classification is result of highest bin, not overwhelming majority, i.e. type covers less than 50% of pixel surface</td>
</tr>
<tr>
<td>4</td>
<td>0x04</td>
<td>value_covers_majority_of_pixel</td>
<td>Pixel is dominated by surface type, i.e. type covers more than 50% of pixel surface</td>
</tr>
<tr>
<td>9</td>
<td>0xF9</td>
<td>Water+Shallow_Ocean</td>
<td>Water, shallow ocean</td>
</tr>
<tr>
<td>17</td>
<td>0xF9</td>
<td>Water+Shallow_Inland_Water</td>
<td>Water, shallow inland water (lake)</td>
</tr>
<tr>
<td>25</td>
<td>0xF9</td>
<td>Water+Ocean_Coastline-Lake_Shoreline</td>
<td>Water, mixed with land; coastline</td>
</tr>
<tr>
<td>33</td>
<td>0xF9</td>
<td>Water+Intermittent_Water</td>
<td>Intermittent water, for instance the Wadden Sea</td>
</tr>
<tr>
<td>41</td>
<td>0xF9</td>
<td>Water+Deep_Inland_Water</td>
<td>Deep inland water</td>
</tr>
<tr>
<td>49</td>
<td>0xF9</td>
<td>Water+Continental_Shelf_Ocean</td>
<td>Water, continental shelf ocean</td>
</tr>
<tr>
<td>57</td>
<td>0xF9</td>
<td>Water+Deep_Ocean</td>
<td>Water, deep ocean</td>
</tr>
<tr>
<td>8</td>
<td>0xF9</td>
<td>Land+Urban_And_Built-up_Land</td>
<td>Land, urban areas</td>
</tr>
<tr>
<td>16</td>
<td>0xF9</td>
<td>Land+Dryland_Cropland_And_Pasture</td>
<td>Land, Dryland Cropland and Pasture</td>
</tr>
<tr>
<td>24</td>
<td>0xF9</td>
<td>Land+Irrigated_Cropland_And_Pasture</td>
<td>Land, Irrigated Cropland and Pasture</td>
</tr>
<tr>
<td>32</td>
<td>0xF9</td>
<td>Land+Mixed_Dryland-irrigated_Cropland_And_Pasture</td>
<td>Land, Mixed Dryland/Irrigated Cropland and Pasture</td>
</tr>
<tr>
<td>40</td>
<td>0xF9</td>
<td>Land+Cropland-grassland_Mosaic</td>
<td>Land, Cropland/Grassland Mosaic</td>
</tr>
<tr>
<td>48</td>
<td>0xF9</td>
<td>Land+Cropland-woodland_Mosaic</td>
<td>Land, Cropland/Woodland Mosaic</td>
</tr>
<tr>
<td>56</td>
<td>0xF9</td>
<td>Land+Grassland</td>
<td>Land, Grassland</td>
</tr>
<tr>
<td>64</td>
<td>0xF9</td>
<td>Land+Shrubland</td>
<td>Land, Shrubland</td>
</tr>
<tr>
<td>72</td>
<td>0xF9</td>
<td>Land+Mixed_Shrubland-grassland</td>
<td>Land, Mixed Shrubland/Grassland</td>
</tr>
<tr>
<td>80</td>
<td>0xF9</td>
<td>Land+Savanna</td>
<td>Land, Savanna</td>
</tr>
<tr>
<td>88</td>
<td>0xF9</td>
<td>Land+Deciduous_Broadleaf_Forest</td>
<td>Land, Deciduous Broadleaf Forest</td>
</tr>
</tbody>
</table>
Table 14: Surface classification for S5P Level 2 (continued).

<table>
<thead>
<tr>
<th>Bit #</th>
<th>Mask (hex)</th>
<th>Short name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>96</td>
<td>0xF9</td>
<td>Land+Deciduous_Needleleaf_Forest</td>
<td>Land, Deciduous Needleleaf Forest</td>
</tr>
<tr>
<td>104</td>
<td>0xF9</td>
<td>Land+Evergreen_Broadleaf_Forest</td>
<td>Land, Evergreen Broadleaf Forest</td>
</tr>
<tr>
<td>112</td>
<td>0xF9</td>
<td>Land+Evergreen_Needleleaf_Forest</td>
<td>Land, Evergreen Needleleaf Forest</td>
</tr>
<tr>
<td>120</td>
<td>0xF9</td>
<td>Land+Mixed_Forest</td>
<td>Land, Mixed Forest</td>
</tr>
<tr>
<td>128</td>
<td>0xF9</td>
<td>Land+Herbaceous_Wetland</td>
<td>Land, Herbaceous Wetland</td>
</tr>
<tr>
<td>136</td>
<td>0xF9</td>
<td>Land+Wooded_Wetland</td>
<td>Land, Wooded Wetland</td>
</tr>
<tr>
<td>144</td>
<td>0xF9</td>
<td>Land+Barren_Or_Sparsely_Vegetated</td>
<td>Land, Barren or Sparsely Vegetated</td>
</tr>
<tr>
<td>152</td>
<td>0xF9</td>
<td>Land+Herbaceous_Tundra</td>
<td>Land, Herbaceous Tundra</td>
</tr>
<tr>
<td>160</td>
<td>0xF9</td>
<td>Land+Wooded_Tundra</td>
<td>Land, Wooded Tundra</td>
</tr>
<tr>
<td>168</td>
<td>0xF9</td>
<td>Land+Mixed_Tundra</td>
<td>Land, Mixed Tundra</td>
</tr>
<tr>
<td>176</td>
<td>0xF9</td>
<td>Land+Bare_Ground_Tundra</td>
<td>Land, Bare Ground Tundra</td>
</tr>
<tr>
<td>184</td>
<td>0xF9</td>
<td>Land+Snow_Or_Ice</td>
<td>Land, Snow or Ice</td>
</tr>
</tbody>
</table>