

# Sentinel-5 precursor/TROPOMI Level 2 Product User Manual Sulphur Dioxide SO<sub>2</sub>





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### 1 Introduction

# Document change record

issue	date	item	comments		
0.0.1	2014-05-12	All	Initial version		
0.1.0	2014-10-14	All	Document ported to LATEX		
		Sect. 4	CDR RID #8 solved		
		All	Reorder of the docs: generic part first and specific sections after. CDR RID #9 solved.		
		All	One single template is now used for all the PUMs. CDR RID #12 and #13 solved.		
		Sec. 8	Added figure explaining geocoordinates order and reference in the text. (CDR RID #5)		
0.7.0	2015-03-27	All	Document totally revised: Sections moved and added. Description of the product updated		
0.7.1	2015-06-09		Added example figures for a preliminary release (AI only)		
0.8.0	2015-09-07		Prepared for preliminary, limited, release		
0.9.1	2015-12-15		PUMs updated. File descriptors in line with the last product defini- tion		
0.10.0	2016-03-31		Product descriptions updated for 0.10.0 release		
00.10.01	2016-07-15		Product descriptions updated for DLR 00.10.01 release		
00.11.00	2016-11-15	All	Product descriptions updated for DLR 00.11.01 release		
		All	Variables names changed in the context of the MPC variables harmonization		
01.01.01	2018-07-16	Sec. 7	The chapter containing the specific description of Sulphur Dioxide SO <sub>2</sub> has been totally revised and updated with the latest information available		
		Sec. 12	The file format definition of Sulphur Dioxide $SO_2$ has been aligned with version 1.1.1 of UPAS		
01.01.02	2018-10-16	Sec. 12	SO <sub>2</sub> product: the definition of the sulfurdioxide detection_flag has been updated		

#### 1.1 Identification

This document, identified as S5P-L2-DLR-PUM-400E, 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 Sulphur Dioxide SO<sub>2</sub>.

#### 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 Sulphur Dioxide SO<sub>2</sub> 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 Sulphur Dioxide  $SO_2$  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 Sulphur Dioxide  $SO_2$  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

[AD1] Tailoring of the Earth Observation File Format Standard for the Sentinel 5 precursor Ground Segment. 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

- [RD1] J. P. Veefkind, I. Aben, K. McMullan *et al.*; TROPOMI on the ESA Sentinel-5 Precursor: A GMES mission for global observations of the atmospheric composition for climate, air quality and ozone layer applications. *Remote Sens. Environ.*; **120** (2012), 70; 10.1016/j.rse.2011.09.027.
- [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.
- [RD3] S5P/TROPOMI ATBD Cloud Products. source: DLR; ref: S5P-DLR-L2-ATBD-400l; issue: 1.5.0; date: 2018-04-30.
- [RD4] Sentinel-5 precursor/TROPOMI Level 2 Product User Manual Cloud. source: DLR; ref: S5P-L2-DLR-PUM-400I; issue: 1.0.0; date: 2018-04-30.
- [RD5] S5P-NPP Cloud Processor ATBD. source: RAL Space; ref: S5P-NPPC-RAL-ATBD-0001; issue: 0.11.0; date: 2014-05-15.
- [RD6] S5P/TROPOMI HCHO ATBD. source: BIRA; ref: S5P-BIRA-L2-400F-ATBD; issue: 1.0.0; date: 2016-02-05.
- [RD7] Sentinel-5 precursor/TROPOMI Level 2 Product User Manual HCHO. source: DLR; ref: S5P-L2-DLR-PUM-400F; issue: 1.0.0; date: 2018-04-30.
- [RD8] S5P/TROPOMI SO<sub>2</sub> ATBD. source: BIRA; ref: S5P-BIRA-L2-400E-ATBD; issue: 1.0.0; date: 2016-02-05.
- [RD9] S5P/TROPOMI Total ozone ATBD. source: DLR/BIRA; ref: S5P-L2-DLR-ATBD-400A; issue: 1.0.0; date: 2016-02-01.
- [RD10] Sentinel-5 precursor/TROPOMI Level 2 Product User Manual Total Ozone Column. source: DLR; ref: S5P-L2-DLR-PUM-400A; issue: 1.0.0; date: 2018-04-30.
- [RD11] TROPOMI ATBD of tropospheric ozone data products. source: DLR/IUP; ref: S5P-DLR-IUP-L2-400C; issue: 1.5.0; date: 2018-04-30.
- [RD12] Sentinel-5 precursor/TROPOMI Level 2 Product User Manual Ozone Tropospheric Column. source: DLR; ref: S5P-L2-DLR-PUM-400C; issue: 1.0.0; date: 2018-04-30.
- [RD13] TROPOMI ATBD of the Aerosol Layer Height product. source: KNMI; ref: S5P-KNMI-L2-0006-RP; issue: 1.0.0; date: 2016-01-29.
- [RD14] Sentinel-5 precursor/TROPOMI Level 2 Product User Manual Aerosol Layer Height. 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.
- [RD16] Sentinel-5 precursor/TROPOMI Level 2 Product User Manual Aerosol Index. 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. [RD18] Sentinel-5 precursor/TROPOMI Level 2 Product User Manual Ozone Profile and Tropospheric Ozone Profile. 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<sub>2</sub> data products. source: KNMI; ref: S5P-KNMI-L2-0005-RP; issue: 1.0.0; date: 2016-02-05. [RD20] Sentinel-5 precursor/TROPOMI Level 2 Product User Manual Nitrogen Dioxide. source: KNMI; ref: S5P-KNMI-L2-0021-MA; issue: 0.0.2dr; date: 2014-10-16. [RD21] Algorithm Theoretical Baseline Document for Sentinel-5 Precursor: Carbon Monoxide Total Column Retrieval. source: SRON; ref: SRON-S5P-LEV2-RP-002; issue: 1.0.0; date: 2016-02-05. [RD22] Sentinel-5 precursor/TROPOMI Level 2 Product User Manual Carbon Monoxide Column. source: SRON/KNMI; ref: SRON-S5P-LEV2-MA-002; issue: 0.0.2dr; date: 2014-10-16. [RD23] Algorithm Theoretical Baseline Document for Sentinel-5 Precursor methane retrieval. source: SRON; ref: SRON-S5P-LEV2-RP-001; issue: 1.0.0; date: 2016-02-05. [RD24] Sentinel-5 precursor/TROPOMI Level 2 Product User Manual Methane. source: SRON/KNMI; ref: SRON-S5P-LEV2-MA-001; issue: 0.0.2dr; date: 2014-10-16. [RD25] Tailoring of the Earth Observation File Format Standard for the Sentinel 5 precursor Ground Segment. source: ESA/ESTEC; ref: S5P-TN-ESA-GS-106; issue: 2.2; date: 2015-02-20. [RD26] Earth Observation – Ground segment file format standard. source: ESA/ESTEC; ref: PE-TN-ESA-GS-0001; issue: 2.0; date: 2012-05-03. [RD27] Geographic information – Metadata. source: ISO; ref: ISO 19115:2003(E); issue: 1; date: 2003-05-01. [RD28] Geographic information – Metadata – Part 2: Extensions for imagery and gridded data. source: ISO; ref: ISO 19115-2:2009(E); issue: 1; date: 2009-02-12. [RD29] Geographic information – Data quality. source: ISO; ref: ISO 19157; issue: 1; date: 2013-10-10. [RD30] Earth Observation Metadata profile of Observations & Measurements. 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. [RD32] Metadata specification for the TROPOMI L1b products. 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. [RD35] Data elements and interchange formats - Information interchange - Representation of dates and times. source: ISO; ref: ISO 8601:2004(E); issue: 3; date: 2004-12-01. [RD36] John Caron; Annotated Schema for NcML (2011). URL http://www.unidata.ucar.edu/ software/netcdf/ncml/v2.2/AnnotatedSchema4.html.

- [RD37] INSPIRE Metadata Regulation, Commission Regulation (EC), No1205/2008. source: EC; ref: Commission Regulation (EC) No 1205/2008; date: 2008-12-03.
- [RD38] INSPIRE Metadata Implementing Rules: Technical Guidelines based on EN ISO 19115 and EN ISO 19119.

source: EC JRC; ref: MD\_IR\_and\_ISO\_v1\_2\_20100616; issue: 1.2; date: 2010-06-16.

- [RD39] Geographic Information Observations and Measurements. source: ISO; ref: ISO 19156:2011(E); date: 2011-12-20.
- [RD40] Geographic information Metadata XML schema implementation. source: ISO; ref: ISO 19139:2007(E); issue: 1; date: 2010-12-13.
- [RD41] Observations and Measurements XML Implementation. source: OGC; ref: OGC 10-025r1; issue: 2.0; date: 2011-03-22.
- [RD42] Observations and Measurements XML Implementation.. source: Open Geospatial Consortium; ref: OGC 10-025r1; issue: 2.0; date: 2011-03-22.
- [RD43] Sentinel 5 precursor/TROPOMI KNMI and SRON level 2 Input Output Data Definition. source: KNMI; ref: S5P-KNMI-L2-0009-SD; issue: 5.0.0; date: 2016-04-19.
- [RD44] Sentinel-5 Precursor Level 2 UPAS Processor Input/Output Definition Document. source: DLR-IMF; ref: S5P-L2-DLR-IODD-3002; issue: 3.3.0; date: 2017-06-01.
- [RD45] S5P-NPP Cloud Processor IODD. source: RAL; ref: S5P-NPPC-RAL-IODD-0001; issue: 0.10.0; date: 2014-05-28.
- [RD46] M.L. Carroll, J.R. Townshend, C.M. DiMiceli *et al.*; A new global raster water mask at 250 m resolution. International Journal of Digital Earth; **2** (2009) (4), 291; 10.1080/17538940902951401.

#### 2.4 Electronic references

- [ER1] Tropomi official website. URL http://www.tropomi.eu.
- [ER2] S5P official website. URL https://sentinel.esa.int/web/sentinel/missions/ sentinel-5p.
- [ER3] Robert B. Schmunk; Panoply netCDF, HDF and GRIB Data Viewer. URL http://www.giss.nasa. gov/tools/panoply/.
- [ER4] Infrastructure for Spatial Information in the European Community (INSPIRE) Directive 2007/2/EC. URL http://inspire.jrc.ec.europa.eu/.
- [ER5] Brian Eaton, Jonathan Gregory, Bob Drach et al.; NetCDF Climate and Forecast (CF) Metadata Conventions. Lawrence Livermore National Laboratory (2014). Version 1.7 draft; URL http:// cfconventions.org.
- [ER6] ESIP; Attribute Conventions for Dataset Discovery (ACDD). 1st edition (2013). URL http://wiki. esipfed.org/index.php/Attribute\_Convention\_for\_Data\_Discovery\_(ACDD).
- [ER7] NetCDF Users Guide (2011). URL http://www.unidata.ucar.edu/software/netcdf/docs/ netcdf.html.
- [ER8] Unidata; NetCDF library and documentation. URL http://www.unidata.ucar.edu/software/ netcdf/.
- [ER9] UDUNITS 2 Manual (2011). URL http://www.unidata.ucar.edu/software/udunits/.
- [ER10] Cooperative Ocean/Atmosphere Research Data Service; Conventions for the standardization of NetCDF files (1995). URL http://ferret.wrc.noaa.gov/noaa\_coop/coop\_cdf\_profile. html.
- [ER11] USGS; Global Land Cover Characteristics Data Base Version 2.0 (2012). Website last visited on March 6, 2017; URL https://lta.cr.usgs.gov/glcc/globdoc2\_0.

[ER12] The ECS SDP Toolkit (2012). DEM and land-sea mask data itself is available from ftp:// edhsl.gsfc.nasa.gov/edhs/sdptk/DEMdata; URL http://newsroom.gsfc.nasa.gov/ sdptoolkit/TKDownload.html.

### 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
PUM	Product User Manual
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 made available at a later date.

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

Product	ATBD	PUM	Identifier	Institution
Cloud	[RD3]	[RD4]	L2CLOUD_	DLR
NPP-VIIRS Clouds	[RD5]	[RD5]	L2NP_BDx	RAL
НСНО	[RD6]	[RD7]	L2HCHO	<b>BIRA/DLR</b>
SO <sub>2</sub>	[RD8]	This document	L2S02	<b>BIRA/DLR</b>
O <sub>3</sub> Total Column	[RD9]	[RD10]	L203	<b>BIRA/DLR</b>
O <sub>3</sub> Tropospheric Column	[RD11]	[RD12]	L203_TCL	IUP/DLR
Aerosol layer height	[RD13]	[RD14]	L2AER_LH	KNMI
Ultra violet aerosol index	[RD15]	[RD16]	L2AER_AI	KNMI
O <sub>3</sub> Full Profile	[RD17]	[RD18]	L203PR	KNMI
O <sub>3</sub> Troposheric Profile	[RD17]	[RD18]	L203_TPR	KNMI
Tropospheric NO <sub>2</sub>	[RD19]	[RD20]	L2NO2	KNMI
CO	[RD21]	[RD22]	L2C0	SRON/KNMI
CH <sub>4</sub>	[RD23]	[RD24]	L2CH4	SRON/KNMI

#### 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 Sulphur Dioxide SO<sub>2</sub> product is described and an example of the full real name is as following:

S5P\_NRTI\_L2\_S02\_\_\_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.

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

## 5 Data Distribution

<TBA #1> In this chapter, data distribution of TROPOMI Sulphur Dioxide SO<sub>2</sub> will be detailed during Phase E2.

## 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.

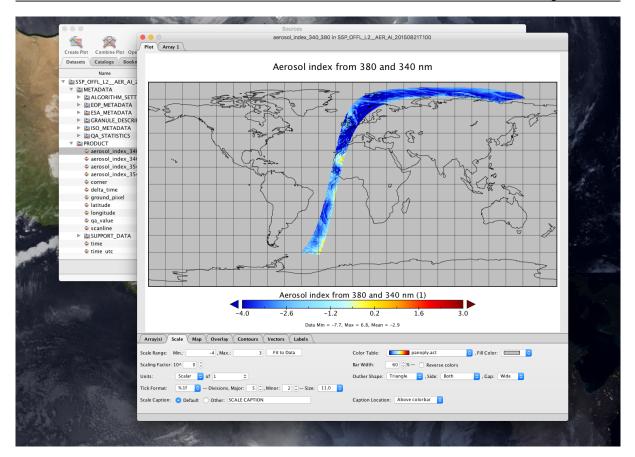


Figure 1: Panoply

- Save plots to disk GIF, JPEG, PNG or TIFF bitmap images or as PDF or PostScript graphics files.
- Export lon-lat map plots in KMZ format.
- Export animations as AVI or MOV video or as a collection of invididual frame images.

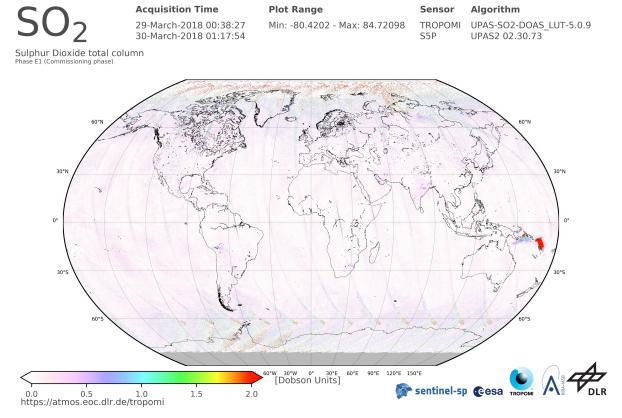


Figure 2: A full day plot of the Sulphur Dioxide SO<sub>2</sub> product acquired on 29th March 2018. Further quicklooks may be found here: https://atmos.eoc.dlr.de/tropomi

# 7 S5p/TROPOMI L2 Sulphur Dioxide SO<sub>2</sub> Product Description

Sulphur dioxide (SO<sub>2</sub>) enters the Earth's atmosphere through both natural and anthropogenic processes. It plays a role in chemistry on a local and global scale and its impact ranges from short term pollution to effects on climate. Only about 30% of the emitted SO<sub>2</sub> comes from natural sources; the majority is of anthropogenic origin. SO<sub>2</sub> emissions affect human and animal health and air quality. SO<sub>2</sub> has an effect on climate through radiative forcing, via the formation of sulphate aerosols. Volcanic SO<sub>2</sub> emissions may also pose a threat to aviation, along with volcanic ash. The S5p sensor TROPOMI samples the Earth's surface with a revisit time of one day and with an unprecedented spatial resolution of  $7x3.5 \text{ km}^2$ . This allows the resolution of fine details and S5p will arguably be a valuable tool to better study anthropogenic SO<sub>2</sub> emissions but also volcanic emissions, from degassing to eruptive processes.

The retrieval of SO<sub>2</sub> vertical column is performed in near-real time (i.e. typically 3 hours after measurement) based on the DOAS technique, involving two main steps: First, the effective slant column amount N<sub>s</sub> (corresponding to the integrated SO<sub>2</sub> concentration along the mean atmospheric optical path) is derived through a least-squares fit of the measured Earth reflectance spectrum to laboratory absorption cross-sections. Second, slant columns are converted into vertical columns by means of air mass factors (AMF) obtained from suitable radiative transfer calculations, accounting for the presence of clouds and aerosols, surface properties and best-guess SO<sub>2</sub> vertical profiles [RD8].

Refer to the specific ATBD [RD8] documentation for further information about the L2 Sulphur Dioxide SO<sub>2</sub>.

#### 7.1 Data Product Examples

Quicklooks are reported in this section as a data product examples of the Sulphur Dioxide SO<sub>2</sub> product. The Sulphur Dioxide SO<sub>2</sub> total vertical column is shown in Figure 2. A zoom-in of the Ambae and Kadovar volcanos is reported in Figure 4 and 3, respectively. Further quicklooks may be found here: https://atmos.eoc.dlr.de/tropomi



**Acquisition Time** 29-March-2018 00:38:27 30-March-2018 01:17:54

**Plot Range** 

Min: -80.4202 - Max: 84.72098

Algorithm Sensor

TROPOMI S5P

UPAS-SO2-DOAS\_LUT-5.0.9 UPAS2 02.30.73

Kadovar

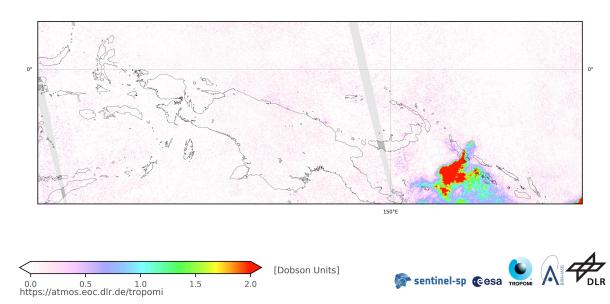


Figure 3: The eruption of Kadovar Volcano acquired on 29th March 2018. Further quicklooks may be found here: https://atmos.eoc.dlr.de/tropomi



Sulphur Dioxide total column

Ambae

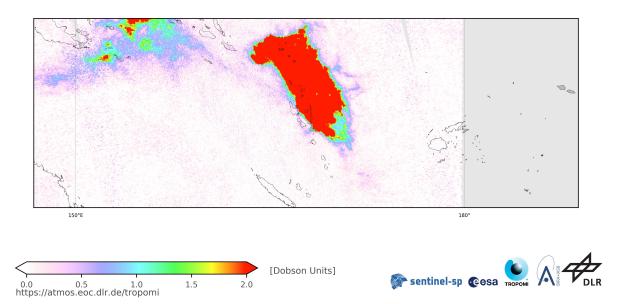


Figure 4: The eruption of Ambae Volcano acquired on 29th March 2018. Further quicklooks may be found here: https://atmos.eoc.dlr.de/tropomi

#### 7.2 Product Geophysical Validation

A reference of the Readme file of Sulphur Dioxide  $SO_2$  will be added as soon as the validation process will start and this document will be issued.

**<TBA #2>** To add references of the Validation Readme document as soon as the validation process for Sulphur Dioxide SO<sub>2</sub> will start.

#### 7.3 History of product changes

This manual describes the current version of the L2 Sulphur Dioxide  $SO_2$  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 Sulphur Dioxide SO2

Version	Description
1.1	Flagging of enhanced SO2 levels has been implemented ( <i>sulfurdioxide_detection_flag</i> )
1.1	New kernels variables added due to updated prototype algorithms
1.1	Added BACKGROUND_CORRECTION group including the information of the AUX_BGSO2_file
0.12	Official version for E2 delivery

#### 7.4 Using the S5p/TROPOMI L2 Sulphur Dioxide SO<sub>2</sub>

<TBA #3> Specific aspects of the Sulphur Dioxide SO<sub>2</sub> product to be filled during Phase E2.

### 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 8.3 - 8.2 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 Sulphur Dioxide SO<sub>2</sub> 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 are 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<sup>1</sup>.

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.

<sup>&</sup>lt;sup>1</sup> More detailed processing flags indicating precisely why the 100% value isn't reached, are available elsewhere in the product.

tinel 5P Level 2 product Global attributes
RODUCT
main precision qa_value
latitude longitude delta_time
(scanline) ground_pixel (/ time / ) (////)
GEOLOCATIONS SZA
DETAILED_RESULTS processing_quality_flags
INPUT_DATA (surface_pressure) ()
IETADATA
ALGORITHM_SETTINGS Attributes
GRANULE_DESCRIPTION Attributes
QA_STATISTICS
Attributes
Histogram_axis Histogram
ESA_METADATA (Attributes
ISO_METADATA (Attributes and sub-groups)
gend           Root level         First level group         Second level group
Third level group     Variable     Attributes       Image: Optimized state     Image: Optimized state     Image: Optimized state

**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 Sulphur Dioxide SO<sub>2</sub> 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/METADATA
/root/METADATA/ALGORITHM\_SETTINGS
/root/METADATA/GRANULE\_DESCRIPTION
/root/METADATA/ISO\_METADATA
/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 Geolocation, pixel corners and angles

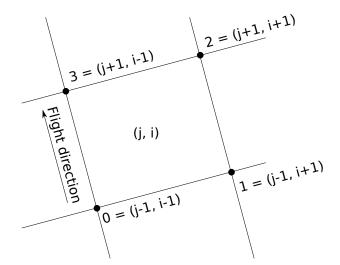
The latitude, longitude, pixel corner coordinates and related angles and satellite position in the level 2 files are copied from the level 1B input data [RD34, chapters 26 and 27]. Details about the definitions can be found there. Note that the latitude and longitude have not been corrected for the local 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].

The azimuth angles, i.e. the solar azimuth angle  $\varphi_0$  and the viewing azimuth angle  $\varphi$  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  $\varphi - \varphi_0$  which differs by 180° as it follows the path of the light.

#### 8.3 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.



**Figure 6**: Pixel corner coordinates. The sequence  $\{0, 1, 2, 3\}$  refers to the elements in the corner dimension.

**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<sup>2</sup>.

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<sub>2</sub> 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.

#### 8.4 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.

<sup>&</sup>lt;sup>2</sup> Fortran uses column-major order, effectively reversing the dimensions in the code compared to the documentation.

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.

Name	Туре	Description
time_reference	(A)	ISO date/time string [RD35]
time_reference_days_since_1950	(A)	The number of days since January first, 1950, UTC mid- night, as used in several weather and climate models (ECMWF, TM5).
time_reference_julian_day	(A)	The Julian date of the reference time as used in astronomy. This is the reference time system as used in IDL.
time_reference_seconds_since_1970	(A)	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.
time	(D)	This variable contains the number of seconds since 2010-01.01, UTC midnight.
time_utc	(V)	Array of ISO date/time strings [RD35], one for each obser- vation, i.e. one for each element in the scanline dimension

#### 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<sup>3</sup>, 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].

$$p(n,k,j,i) = a_{\mathsf{p}}(k) + b(k)p_{\mathsf{s}}(n,j,i) \tag{1}$$

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].

Making the UDUnits package [ER9] a requirement, and thereby forcing all units to be compliant with formal SI units<sup>4</sup> is a good thing for consistency and will help avoid confusion in the long run. In the short term it will

<sup>&</sup>lt;sup>3</sup> This is 'height' as defined by the CF conventions: distance above the surface; 'altitude' is the distance above the geoid or approximate sea level. <sup>4</sup> And some deeply entrenched non-SI units such as DU.

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 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\_percm2 Multiply the contents of the variable with this scale factor  $(6.02214 \times 10^{+19})$  to obtain columns in molecules cm<sup>-2</sup>
- **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\_persecond\_pernm\_percm2\_persr Multiply the contents of the variable with this scale factor  $(6.02214 \times 10^{+19})$  to obtain a radiance in photons s<sup>-1</sup> nm<sup>-1</sup> cm<sup>-2</sup> sr<sup>-1</sup>.

### 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:

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

This is a discrete approximation of a continuous probability density function, for discrete values  $x_j$  for all successful retrievals i = 1, ..., N. The value of  $\cos(\delta_{geo,i})$  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 S5P/TROPOMI granule.

Name	Description
number_of_groundpixels	Number of ground pixels in the file.
number_of_processed_pixels	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.
number_of_successfully_processed_pixels	Number of ground pixels where a retrieval was successful.
number_of_rejected_pixels_not_enough_spectrum	Number of ground pixels where a retrieval was not attempted because too many spectral pixels were flagged as bad.
number_of_failed_retrievals	Number of pixels that were attempted but failed.
number_of_radiance_missing_occurrences	Number of ground pixels where "the number of spectral pixels in the radiance due to flagging is too small to perform the fitting" occurred.
number_of_irradiance_missing_occurrences	Number of ground pixels where "the number of spectral pixels in the irradiance due to flagging is too small to perform the fitting" occurred.
number_of_input_spectrum_missing_occurrences	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.
<pre>number_of_reflectance_range_error_occurrences</pre>	Number of ground pixels where "any of the reflectances is out of bounds $(R < 0 \text{ or } R > R_{max})$ " occurred.
number_of_ler_range_error_occurrences	Number of ground pixels where "lambert-equivalent reflectivity out of range error" occurred.
number_of_snr_range_error_occurrences	Number of ground pixels where "too low signal to noise to perform retrieval" occurred.
number_of_sza_range_error_occurrences	Number of ground pixels where "solar zenith angle out of range, maximum value from configuration" occurred.
number_of_vza_range_error_occurrences	Number of ground pixels where "viewing zenith angle out of range, maximum value from configuration" occurred.
number_of_lut_range_error_occurrences	Number of ground pixels where "extrapolation in lookup table (airmass factor, cloud radiances)" occurred.
number_of_ozone_range_error_occurrences	Number of ground pixels where "ozone column significantly out of range of profile climatology" occurred.

Name	Description
number_of_wavelength_offset_error_occurrences	Number of ground pixels where "wavelength offset exceeds maximum from configuration" occurred.
<pre>number_of_initialization_error_occurrences</pre>	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.
number_of_memory_error_occurrences	Number of ground pixels where "memory allocation or deallocation error" occurred.
number_of_assertion_error_occurrences	Number of ground pixels where "error in algorithm detected during assertion" occurred.
number_of_io_error_occurrences	Number of ground pixels where "error detected during transfer of data between algorithm and framework" occurred.
number_of_numerical_error_occurrences	Number of ground pixels where "general fatal numerical error occurred during inversion" occurred.
number_of_lut_error_occurrences	Number of ground pixels where "error in accessing the lookup table" occurred.
number_of_ISRF_error_occurrences	Number of ground pixels where "error detected in the input instrument spectral response function input data" occurred.
number_of_convergence_error_occurrences	Number of ground pixels where "the main algorithm did not converge" oc- curred.
number_of_cloud_filter_convergence_error_occurrences	Number of ground pixels where "the cloud filter did not converge" occurred.
<pre>number_of_max_iteration_convergence_error_occurrences</pre>	Number of ground pixels where "no convergence because retrieval exceeds maximum number of iterations. Maximum value from configuration" occurred.
<pre>number_of_aot_lower_boundary_convergence_error_occurrences</pre>	Number of ground pixels where "no convergence because the aerosol optical thickness crosses lower boundary twice in succession" occurred.
number_of_other_boundary_convergence_error_occurrences	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.
number_of_geolocation_error_occurrences	Number of ground pixels where "geolocation out of range" occurred.

Name	Description
number_of_ch4_noscat_zero_error_occurrences	Number of ground pixels where "the CH <sub>4</sub> column retrieved by the non- scattering CO algorithm from the weak band or strong band is 0" occurred.
<pre>number_of_h2o_noscat_zero_error_occurrences</pre>	Number of ground pixels where "the H <sub>2</sub> O column retrieved by the non- scattering CO algorithm from the weak band or strong band is 0" occurred.
<pre>number_of_max_optical_thickness_error_occurrences</pre>	Number of ground pixels where "maximum optical thickness exceeded during iterations" occurred.
number_of_aerosol_boundary_error_occurrences	Number of ground pixels where "boundary hit of aerosol parameters at last iteration" occurred.
number_of_boundary_hit_error_occurrences	Number of ground pixels where "fatal boundary hit during iterations" occurred.
number_of_chi2_error_occurrences	Number of ground pixels where " $\chi^2$ is not-a-number or larger than $10^{10}$ " occurred.
number_of_svd_error_occurrences	Number of ground pixels where "singular value decomposition failure" oc- curred.
number_of_dfs_error_occurrences	Number of ground pixels where "degree of freedom is not-a-number" occurred.
number_of_radiative_transfer_error_occurrences	Number of ground pixels where "errors occurred during the radiative transfer computations, no processing possible" occurred.
number_of_optimal_estimation_error_occurrences	Number of ground pixels where "errors occurred during the optimal estimation, processing has been terminated" occurred.
number_of_profile_error_occurrences	Number of ground pixels where "flag that indicates if there were any errors during the computation of the ozone profile" occurred.
number_of_cloud_error_occurrences	Number of ground pixels where "no cloud data" occurred.
number_of_model_error_occurrences	Number of ground pixels where "forward model failure" occurred.
<pre>number_of_input_data_points_too_low_error_occurrences</pre>	Number of ground pixels where "not enough input ozone columns to calculate a tropospheric column" occurred.
<pre>number_of_cloud_pressure_spread_too_low_error_occurrences</pre>	Number of ground pixels where "cloud pressure variability to low to estimate a tropospheric column" occurred.
number_of_cloud_too_low_level_error_occurrences	Number of ground pixels where "clouds are too low in the atmosphere to assume sufficient shielding" occurred.
number_of_generic_range_error_occurrences	Number of ground pixels where "generic range error" occurred.
number_of_generic_exception_occurrences	Number of ground pixels where "catch all generic error" occurred.

Name	Description
number_of_input_spectrum_alignment_error_occurrences	Number of ground pixels where "input radiance and irradiance spectra are not aligned correctly" occurred.
number_of_abort_error_occurrences	Number of ground pixels where "not processed because processor aborted prematurely (time out or user abort)" occurred.
number_of_wrong_input_type_error_occurrences	Number of ground pixels where "wrong input type error, mismatch between expectation and received data" occurred.
<pre>number_of_wavelength_calibration_error_occurrences</pre>	Number of ground pixels where "an error occurred in the wavelength calibra- tion of this pixel" occurred.
number_of_coregistration_error_occurrences	Number of ground pixels where "no colocated pixels found in a supporting band" occurred.
<pre>number_of_slant_column_density_error_occurrences</pre>	Number of ground pixels where "slant column fit returned error, no values can be computed" occurred.
number_of_airmass_factor_error_occurrences	Number of ground pixels where "airmass factor could not be computed" oc- curred.
<pre>number_of_vertical_column_density_error_occurrences</pre>	Number of ground pixels where "vertical column density could not be com- puted" occurred.
<pre>number_of_signal_to_noise_ratio_error_occurrences</pre>	Number of ground pixels where "the signal to noise ratio for this spectrum is too low for processing" occurred.
number_of_configuration_error_occurrences	Number of ground pixels where "error while parsing the configuration" oc- curred.
number_of_key_error_occurrences	Number of ground pixels where "key does not exist" occurred.
number_of_saturation_error_occurrences	Number of ground pixels where "saturation in input spectrum" occurred.
number_of_solar_eclipse_filter_occurrences	Number of ground pixels where "solar eclipse" occurred.
number_of_cloud_filter_occurrences	Number of ground pixels where "the cloud filter triggered causing the pixel to be skipped" occurred.
number_of_altitude_consistency_filter_occurrences	Number of ground pixels where "too large difference between ECMWF altitude and DEM altitude value" occurred.
number_of_altitude_roughness_filter_occurrences	Number of ground pixels where "too large standard deviation of altitude in DEM" occurred.

Name	Description
number_of_sun_glint_filter_occurrences	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.
<pre>number_of_mixed_surface_type_filter_occurrences</pre>	Number of ground pixels where "pixel contains land and water areas (e.g. coastal pixel)" occurred.
number_of_snow_ice_filter_occurrences	Number of ground pixels where "pixel contains snow/ice: Snow/ice flag ac- cording to dynamic input OR climatological surface albedo at VIS wavelength is larger than 0.5" occurred.
number_of_aai_filter_occurrences	Number of ground pixels where "AAI smaller than 2.0" occurred.
<pre>number_of_cloud_fraction_fresco_filter_occurrences</pre>	Number of ground pixels where "pixel contains clouds: The FRESCO effective cloud fraction is larger than threshold. Threshold value from ATBD" occurred.
number_of_aai_scene_albedo_filter_occurrences	Number of ground pixels where "pixel contains clouds: The difference between scene albedo at 380 nm from AAI calculation and the climatologcal surface albedo exceeds threshold. Threshold value from ATBD. This test filters out clouds" occurred.
<pre>number_of_small_pixel_radiance_std_filter_occurrences</pre>	Number of ground pixels where "pixel contains clouds: Standard deviation of radiances in small-pixel column exceeds threshold. Threshold value from ATBD" occurred.
<pre>number_of_cloud_fraction_viirs_filter_occurrences</pre>	Number of ground pixels where "pixel contains clouds: The cloud fraction from VIIRS / NPP exceeds theshold. Threshold value from ATBD" occurred.
<pre>number_of_cirrus_reflectance_viirs_filter_occurrences</pre>	Number of ground pixels where "pixel contains clouds: Cirrus reflectance from VIIRS / NPP exceeds threshold. Threshold value from ATBD" occurred.
number_of_cf_viirs_swir_ifov_filter_occurrences	Number of ground pixels where "fraction of cloudy VIIRS pixels wihtin S5P SWIR ground pixel exceeds a priori threshold from configuration" occurred.
number_of_cf_viirs_swir_ofova_filter_occurrences	Number of ground pixels where "fraction of cloudy VIIRS pixels wihtin S5P SWIR OFOVa exceeds a priori threshold from configuration" occurred.
number_of_cf_viirs_swir_ofovb_filter_occurrences	Number of ground pixels where "fraction of cloudy VIIRS pixels wihtin S5P SWIR OFOVb exceeds a priori threshold from configuration" occurred.
number_of_cf_viirs_swir_ofovc_filter_occurrences	Number of ground pixels where "fraction of cloudy VIIRS pixels wihtin S5P SWIR OFOVc exceeds a priori threshold from configuration" occurred.
number_of_cf_viirs_nir_ifov_filter_occurrences	Number of ground pixels where "fraction of cloudy VIIRS pixels wihtin S5P NIR ground pixel exceeds a priori threshold from configuration" occurred.

Name	Description
number_of_cf_viirs_nir_ofova_filter_occurrences	Number of ground pixels where "fraction of cloudy VIIRS pixels wihtin S5P NIR OFOVa exceeds a priori threshold from configuration" occurred.
<pre>number_of_cf_viirs_nir_ofovb_filter_occurrences</pre>	Number of ground pixels where "fraction of cloudy VIIRS pixels wihtin S5P NIR OFOVb exceeds a priori threshold from configuration" occurred.
number_of_cf_viirs_nir_ofovc_filter_occurrences	Number of ground pixels where "fraction of cloudy VIIRS pixels wihtin S5P NIR OFOVc exceeds a priori threshold from configuration" occurred.
<pre>number_of_refl_cirrus_viirs_swir_filter_occurrences</pre>	Number of ground pixels where "average VIIRS cirrus reflectance within SWIR ground pixel exceeds a priori threshold from configuration" occurred.
<pre>number_of_refl_cirrus_viirs_nir_filter_occurrences</pre>	Number of ground pixels where "average VIIRS cirrus reflectance within NIR ground pixel exceeds a priori threshold from configuration" occurred.
<pre>number_of_diff_refl_cirrus_viirs_filter_occurrences</pre>	Number of ground pixels where "difference in VIIRS average cirrus reflect- ance between SWIR and NIR ground pixel exceeds a priori threshold from configuration" occurred.
<pre>number_of_ch4_noscat_ratio_filter_occurrences</pre>	Number of ground pixels where "the ratio between [CH <sub>4</sub> ] <sub>weak</sub> and [CH <sub>4</sub> ] <sub>strong</sub> is below or exceeds a priori thresholds from configuration" occurred.
<pre>number_of_ch4_noscat_ratio_std_filter_occurrences</pre>	Number of ground pixels where "the standard deviation of [CH <sub>4</sub> ] <sub>weak</sub> /[CH <sub>4</sub> ] <sub>strong</sub> within the SWIR pixel and the 8 neighbouring pixels exceeds a priori threshold from configuration" occurred.
<pre>number_of_h2o_noscat_ratio_filter_occurrences</pre>	Number of ground pixels where "the ratio between $[H_2O]_{weak}$ and $[H_2O]_{strong}$ is below or exceeds a priori thresholds from configuration" occurred.
<pre>number_of_h2o_noscat_ratio_std_filter_occurrences</pre>	Number of ground pixels where "the standard deviation of $[H_2O]_{weak}/[H_2O]_{strong}$ within the SWIR pixel and the 8 neigbouring pixels exceeds a priori threshold from configuration" occurred.
<pre>number_of_diff_psurf_fresco_ecmwf_filter_occurrences</pre>	Number of ground pixels where "difference between the FRESCO apparent surface pressure and the ECMWF surface pressure exceeds a priori threshold from configuration" occurred.
number_of_psurf_fresco_stdv_filter_occurrences	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.
number_of_ocean_filter_occurrences	Number of ground pixels where "the ground pixel is over ocean (and ocean glint retrievals are not switched on)" occurred.

Name	Description
number_of_time_range_filter_occurrences	Number of ground pixels where "time is out of the range that is to be processed" occurred.
<pre>number_of_pixel_or_scanline_index_filter_occurrences</pre>	Number of ground pixels where "not processed because pixel index does not match general selection criteria" occurred.
<pre>number_of_geographic_region_filter_occurrences</pre>	Number of ground pixels where "pixel falls outside the specified regions of interest" occurred.
number_of_input_spectrum_warning_occurrences	Number of ground pixels where "number of good pixels in radiance, irradiance or calculated reflectance below threshold from configuration" occurred.
number_of_wavelength_calibration_warning_occurrences	Number of ground pixels where "offset from wavelength fit is larger than limit set in configuration" occurred.
number_of_extrapolation_warning_occurrences	Number of ground pixels where "pressure or temperature outside cross section LUT range, other lookup table extrapolation" occurred.
number_of_sun_glint_warning_occurrences	Number of ground pixels where "sun glint posibility warning" occurred.
number_of_south_atlantic_anomaly_warning_occurrences	Number of ground pixels where "TROPOMI is inside the south Atlantic anom- aly while taking these measurements" occurred.
number_of_sun_glint_correction_occurrences	Number of ground pixels where "A sun glint correction has been applied" occurred.
number_of_snow_ice_warning_occurrences	Number of ground pixels where "snow/ice flag is set, i.e. using scene data from the cloud support product" occurred.
number_of_cloud_warning_occurrences	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" occurred.
number_of_AAI_warning_occurrences	Number of ground pixels where "possible aerosol contamination as indicated by the AAI" occurred.
number_of_pixel_level_input_data_missing_occurrences	Number of ground pixels where "dynamic auxiliary input data (e.g cloud) is missing for this ground pixel. A fallback option is used" occurred.
number_of_data_range_warning_occurrences	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" occurred.
<pre>number_of_low_cloud_fraction_warning_occurrences</pre>	Number of ground pixels where "low cloud fraction, therefore no cloud pres- sure retrieved" occurred.

Name	Description
number_of_altitude_consistency_warning_occurrences	Number of ground pixels where "difference between ECMWF surface elevation and high-resolution surface elevation exceeds threshold from configuration" occurred.
<pre>number_of_signal_to_noise_ratio_warning_occurrences</pre>	Number of ground pixels where "signal to noise ratio in SWIR and/or NIR band below threshold from configuration" occurred.
number_of_deconvolution_warning_occurrences	Number of ground pixels where "failed deconvolution irradiance spectrum (not pixel-specific, but row-specific)" occurred.
<pre>number_of_so2_volcanic_origin_likely_warning_occurrences</pre>	Number of ground pixels where "warning for SO <sub>2</sub> BL product, UTLS products: volcanic origin except for heavily polluted sites" occurred.
<pre>number_of_so2_volcanic_origin_certain_warning_occurrences</pre>	Number of ground pixels where "warning for SO <sub>2</sub> BL product, UTLS products: volcanic origin certain" occurred.
number_of_interpolation_warning_occurrences	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.
number_of_saturation_warning_occurrences	Number of ground pixels where "saturation occurred spectrum, possibly caus- ing biases in the retrieval" occurred.
number_of_high_sza_warning_occurrences	Number of ground pixels where "warning for high solar zenith angle. In this case, the processing can be performed with less final quality" occurred.
<pre>number_of_cloud_retrieval_warning_occurrences</pre>	Number of ground pixels where "warning occurring when the retrieval dia- gnostic indicates a degraded quality of the cloud retrieval" occurred.
<pre>number_of_cloud_inhomogeneity_warning_occurrences</pre>	Number of ground pixels where "the cloud coregistration inhomogeneity para- meter is above a given threshold" occurred.

### 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 Sulphur Dioxide SO<sub>2</sub> product is given in the file format description, in section **??**. 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.

Abbreviation	Description
NUG	netCDF-4 Users Guide [ER7]
CF	Climate and Forecast metadata conventions [ER5], which includes the COARDS [ER10] conventions
ISO	ISO standards 19115, 19115-2 and 19157 [RD27, RD28, RD29]
Inspire	Inspire directive [ER4]
ACDD	ESIP-ACDD Attribute convention for dataset discovery [ER6]
CCI	Attributes requested by the ESA climate change initiative project. These largely overlap with the ACDD attributes.
ESA	Fixed ESA Header [RD26]
S5P	Internal use – mostly for retrieval settings, possibly as an extension to ISO 19115 [RD27]
S	Attribute is a string attribute
Р	Attribute has the data-type of the variable with which it is associated ('parent' data type).
I	Attribute is an integer value
F	Attribute is a floating point value (either 32-bit or 64-bit).
Т	Attribute is a CCSDS-ASCII time representation ("UTC=" + ISO 8601 [RD35])

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.

The then 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 S5P 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 12.1. 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 12.30.1.43 for a description the the attributes contained in this part of the header. The fixed header is described in tables 7-9.

Table 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.

Name	Data type	Definition
File_Name	S	File name of the product without extension.
File_Description	S	Description of the file type.
Notes	S	Any type of notes/comments (multi-lines).
Mission	S	Description of the mission (Fixed to "S5P")
File_Class	S	Description of the file class. It is redundant with the File Class element embedded in the File Name.(e.g., "NRTI")
File_Type	S	Description of the file type, for the current product it is set to "L2 Sulphur Dioxide SO <sub>2</sub> ". It is redundant with the File Type element embedded in the File Name.
Validity_Period	Group, see table 8	Time coverage of the data.
File_Version	I	It is redundant with the File Version element embedded in the File Name.
Source	Group, see table 9	Information about the ground segment facility where the product was generated.

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

Name	Data type	Definition
Validity_Start	Т	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.
Validity_Stop	Т	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.

**Table 9**: Fields in the source group. The data types refer to the short list in table 6.

Name	Data type	Definition
System	S	Name of the Ground Segment element creating the file.

Name	Data type	Definition
Creator	S	Name of the facility or tool, within the Ground Segment element, creating the file.
Creator_Version	S	Version of the tool.
Creation_Date	Т	This is the UTC Creation Date. This field also appears in the file name and in the date_created global attribute.

Table 9: Fields in the source group (continued).

#### 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:  $-0 \times 1.ep+122$ ) is recommended for these cases.

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

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

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

Name	Туре	Std.	Description
standard_error_multiplier	F	CF	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 S5p files is 1, used only to disambiguate.
standard_name	S	CF	A standard name that references a description of a variable's content in the standard name table.
units	S	CF	Units of a variable's content. See section 9 for a detailed discussion.
valid_max	Р	NUG	Largest valid value of a variable.
valid_min	Р	NUG	Smallest valid value of a variable.
valid_range	P[2]	NUG	Smallest and largest valid values of a variable. This attribute should not be combined with either valid_min or valid_max

 Table 11: Attributes for variables used in S5p netCDF-4 files (continued).

# 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

Group attributes attached t	o global	
Name	Value	Туре
Conventions	'CF-1.7' (static)	NC_STRING
metadata conventions, the data – that are not part of v	ollowed by the dataset. Note that while we re are some features – notably the use of version 1.6 of the CF metadata convention his attribute originates from the NUG stand	groups to hierarchicaly organize the s. In those cases we try to follow the
institution	'%(institute)s' (dynamic)	NC_STRING
ProcessingCenter <mark>attril</mark> combination from BIRA, DL	original data was produced. The actual bute, here we would like to indicate the _R, ESA, FMI, IUP, KNMI, MPIC, SRON, he institute that developed the processor. T	responsible parties. The value is a The actual value is a combination
source	'Sentinel 5 precursor, TROPOMI, s sensing, L2' (dynamic)	pace-borne remote NC_STRING
•	original data. Value includes instrument, go duct name and processor version. This attri	
history		NC_STRING
automatically append their attribute of an input netCDF	modifications to the original data. Well- r name and the parameters with which the file. Each line shall begin with a timestam uted. This attribute originates from the NU	ey were invoked to the global history op indicating the date and time of day
summary		NC_STRING
Miscellaneous information	about the data or methods used to produc	e it.
processing mode can occu dynamic input or an irradia	ed mode occured, then a note should be ur for several reasons, for instance the us unce product that is older than a few days. .ng_status" attribute. This attribute origin	e of static backup data for nominally A machine-parseable description is
tracking_id		NC_STRING
This ID is a UUID and allo documentation, etc. The C	proposed by the Climate Change Initiative ws files to be referenced, and linked up to CI-ESA project uses version 4 UUIDs (rar originates from the CCI standard.	o processing description, input data
id	'%(logical_filename)s' (dynamic)	NC_STRING
dataset. The "id" value shou refinement of the "id". The o	ority" attributes are intended to provide a g uld attempt to uniquely identify the dataset. combination of the two should be globally u ite. This attribute originates from the CCI s	The naming authority allows a furthe unique for all time. We use the logica
time_reference	'YYYY-MM-DDT00:00:00Z' (dynam	ic) NC_STRING

time_reference_days since_19500 (dynamic)NC_INTsince_1950NC_OUPLEThe reference time expressed as the number of days since 1950-01-01. This is the reference time unit used by both TM5 and ECMWF.NC_OUPLEThe reference_ulian_day0.0 (dynamic)NC_INT64The reference_seconds reference_seconds0 (dynamic)NC_INT64since_1970The 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.NC_STRINGtime_coverage_start'YYYY-MM-DDTHH:MM:SS.mmmmmZ' (dynamic)NC_STRINGStart of the data granule in UTC as an ISO 8601 [RD35] string. See the discussion of the time_delta variable on page ?? for details.NC_STRINGtime_coverage_end'YYYY-MM-DDTHH:MM:SS.mmmmmZ' (dynamic)NC_STRINGDuration of the data granule as an ISO 8601 [RD35] duration string ("PT%(duration_seconds)sS"). This attribute originates from the CCI standard.NC_STRINGInterval between measurements in the data granule as an ISO 8601 [RD35] duration string ("PT%(duration_seconds)sS"). This attribute originates from the CCI standard.NC_STRINGorbit0 (dynamic)NC_STRINGInterval between measurements in the data granule as an ISO 8601 [RD35] duration string ("PT%(interval- seconds)[S'). For most products this is 1080 ms in nominal operation, except for "1.2_03_FF", which uses 3240 ms due to coaddition. This attribute originates from the CCI standard.NC_STRINGorbit0 (dynamic)NC_STRINGPre-launch testing this value should be set to "-1".NC_STRINGreferences'%(references)s' (static)	
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The reference time expressed as a Julian day number.       NC_INT64         time_reference_seconds 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.       NC_STRING         time_coverage_start       'YYYY-MM-DDTHH:MM:SS.mmmmmmZ' (dynamic)       NC_STRING         Start of the data granule in UTC as an ISO 8601 [RD35] string. See the discussion of the time_delta variable on page ?? for details.       NC_STRING         End of the data granule in UTC as an ISO 8601 [RD35] string. See the discussion of the time_delta variable on page ?? for details.       NC_STRING         Ume_coverage_duration       NC_STRING       NC_STRING         Duration of the data granule as an ISO 8601 [RD35] duration string ("PT%(duration_seconds)SS"). This attribute originates from the CCI standard.       NC_STRING         Itme_coverage_resolution       NC_STRING       NC_STRING         Interval between measurements in the data granule as an ISO 8601 [RD35] duration string ("PT%(duration_seconds)IS"). For most products this is 1080 ms in nominal operation, except for "t.2O3PR", which uses 3240 ms due to coaddition. This attribute originates from the CCI standard.       NC_STRING         orbit       0 (dynamic)       NC_INT       NC_STRING         References that describe the data or methods used to produce it. This attribute originates from the CF standard.       NC_STRING         Precessor_version       '%(version)s' (dynamic)       NC_STRING         Ref	
time_reference_seconds       0 (dynamic)       NC_INT64         since_1970       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.         time_coverage_start       'YYYY-MM-DDTHH:MM:SS.mmmmmZ' (dynamic)       NC_STRING         Start of the data granule in UTC as an ISO 8601 [RD35] string. See the discussion of the time_delta variable on page ?? for details.       NC_STRING         End of the data granule in UTC as an ISO 8601 [RD35] string. See the discussion of the time_delta variable on page ?? for details.       NC_STRING         Ume_coverage_duration       NC_STRING         Duration of the data granule as an ISO 8601 [RD35] duration string ("PT%(duration_seconds)SS"). This attribute originates from the CCI standard.       NC_STRING         Interval between measurements in the data granule as an ISO 8601 [RD35] duration string ("PT%(interval_seconds)IS"). For most products this is 1080 ms in nominal operation, except for "L2_03_FR", which uses 3240 ms due to coaddition. This attribute originates from the CCI standard.       NC_INT         The absolute orbit number, starting at 1 – first ascending node crossing after spacecraft separation. For pre-launch testing this value should be set to "-1".       NC_STRING         References that describe the data or wetendos used to produce it. This attribute originates from the CF standard.       NC_STRING         Processor_version       '%(version)s' (dynamic)       NC_STRING         References that describe the data processor, as string of th	
since_1970         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.         time_coverage_start       'YYYY-MM-DDTHH:MM:SS.mmmmmZ' (dynamic)       NC_STRING         Start of the data granule in UTC as an ISO 8601 [RD35] string. See the discussion of the time_delta variable on page ?? for details.       NC_STRING         End of the data granule in UTC as an ISO 8601 [RD35] string. See the discussion of the time_delta variable on page ?? for details.       NC_STRING         Duration of the data granule as an ISO 8601 [RD35] duration string ("PT%(duration_seconds)sS"). This attribute originates from the CCI standard.       NC_STRING         Duration of the data granule as an ISO 8601 [RD35] duration string ("PT%(duration_seconds)sS"). This attribute originates from the CCI standard.       NC_STRING         Interval between measurements in the data granule as an ISO 8601 [RD35] duration string ("PT%(interval_seconds)fS"). For most products this is 1080 ms in nominal operation, except for "L2_O3_PR", which uses 3240 ms due to coaddition. This attribute originates from the CCI standard.       NC_INT         The absolute orbit number, starting at 1 – first ascending node crossing after spacecraft separation. For pre-launch testing this value should be set to "-1".       NC_STRING         References       "%(version)s" (dynamic)       NC_STRING         The version of the data processor, as string of the form "major.minor.patch".       NC_STRING         References that describe the data or methods used to produce it. This a	
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Start of the data granule in UTC as an ISO 8601 [RD35] string. See the discussion of the time_delta         variable on page ?? for details.         time_coverage_end       'YYYY-MM-DDTHH:MM:SS.mmmmmZ' (dynamic)       NC_STRING         End of the data granule in UTC as an ISO 8601 [RD35] string. See the discussion of the time_delta       variable on page ?? for details.         time_coverage_duration       NC_STRING         Duration of the data granule as an ISO 8601 [RD35] duration string ("PT%(duration_seconds)SS"). This attribute originates from the CCI standard.       NC_STRING         time_coverage_resolution       NC_STRING         Interval between measurements in the data granule as an ISO 8601 [RD35] duration string ("PT%(interval_seconds)fS"). For most products this is 1080 ms in nominal operation, except for "L2_O3_PR", which uses 3240 ms due to coaddition. This attribute originates from the CCI standard.         orbit       0 (dynamic)       NC_INT         The absolute orbit number, starting at 1 – first ascending node crossing after spacecraft separation. For pre-launch testing this value should be set to "-1".       NC_STRING         references       '%(references)s' (static)       NC_STRING         Processor_version       '%(version)s' (dynamic)       NC_STRING         resource-center/index-terms/ (static)       NC_STRING         The version of the data processor, as string of the form "major.minor.patch".       NC_STRING         keywords_vocabulary       'AGU index te	
variable on page ?? for details.         time_coverage_end       'YYYY-MM-DDTHH:MM:SS.mmmmmZ' (dynamic)       NC_STRING         End of the data granule in UTC as an ISO 8601 [RD35] string. See the discussion of the time_delta       variable on page ?? for details.       NC_STRING         time_coverage_duration       NC_STRING       NC_STRING         Duration of the data granule as an ISO 8601 [RD35] duration string ("PT%(duration_seconds)S"). This attribute originates from the CCI standard.       NC_STRING         time_coverage_resolution       NC_STRING       NC_STRING         Interval between measurements in the data granule as an ISO 8601 [RD35] duration string ("PT%(interval_seconds)fS"). For most products this is 1080 ms in nominal operation, except for "L2_03_PR", which uses 3240 ms due to coaddition. This attribute originates from the CCI standard.         orbit       0 (dynamic)       NC_INT         The absolute orbit number, starting at 1 – first ascending node crossing after spacecraft separation. For pre-launch testing this value should be set to "-1".       NC_STRING         References       '%(references)s' (static)       NC_STRING         The version of the data processor, as string of the form "major.minor.patch".       NC_STRING         Keywords_vocabulary       'AGU index terms, http://publications.agu.org/author- resource-center/index-terms/' (static)       NC_STRING         The version of the data processor, as string of the form "major.minor.patch".       NC_STRING       NC_STRING	
End of the data granule in UTC as an ISO 8601 [RD35] string. See the discussion of the time_delta         variable on page ?? for details.         time_coverage_duration       NC_STRING         Duration of the data granule as an ISO 8601 [RD35] duration string ("PT%(duration_seconds)sS"). This attribute originates from the CCI standard.       NC_STRING         time_coverage_resolution       NC_STRING         Interval between measurements in the data granule as an ISO 8601 [RD35] duration string ("PT%(interval_seconds)fS"). For most products this is 1080 ms in nominal operation, except for "L2_O3_PR", which uses 3240 ms due to coaddition. This attribute originates from the CCI standard.         orbit       0 (dynamic)       NC_INT         The absolute orbit number, starting at 1 – first ascending node crossing after spacecraft separation. For pre-launch testing this value should be set to "-1".       NC_STRING         References       "%(references)s' (static)       NC_STRING         References that describe the data or methods used to produce it. This attribute originates from the CF standard.       NC_STRING         processor_version       "%(version)s' (dynamic)       NC_STRING         The version of the data processor, as string of the form "major.minor.patch".       NC_STRING         keywords_vocabulary       'AGU index terms, http://publications.agu.org/author- resource-center/index-terms/' (static)       NC_STRING         The guidelines followed for the keywords_vocabulary" describing the contents of the file. To be pro	
variable on page ?? for details.       NC_STRING         time_coverage_duration       NC_STRING         Duration of the data granule as an ISO 8601 [RD35] duration string ("PT%(duration_seconds)sS"). This attribute originates from the CCI standard.       NC_STRING         Interval between measurements in the data granule as an ISO 8601 [RD35] duration string ("PT%(intervalseconds)fS"). For most products this is 1080 ms in nominal operation, except for "L2_O3_PR", which uses 3240 ms due to coaddition. This attribute originates from the CCI standard.         orbit       0 (dynamic)       NC_INT         The absolute orbit number, starting at 1 – first ascending node crossing after spacecraft separation. For pre-launch testing this value should be set to "-1".       NC_STRING         references       '% (references)s' (static)       NC_STRING         Processor_version       '% (version)s' (dynamic)       NC_STRING         The version of the data processor, as string of the form "major.minor.patch".       NC_STRING         keywords_vocabulary       'AGU index terms, http://publications.agu.org/author-resource-center/index-terms/' (static)       NC_STRING         The guidelines followed for the keywords attribute. We use the index terms published by the AGU.       Keywords from the "keywords_vocabulary" describing the contents of the file. To be provided by the ATBD authors.         standard_name_vocabulary       'NetCDF Climate and Forecast Metadata Conventions Atandata Conventions Standard Name Table (v29, 08 July 2015), http://       NC_STRING	
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attribute originates from the CCI standard.       NC_STRING         time_coverage_resolution       NC_STRING         Interval between measurements in the data granule as an ISO 8601 [RD35] duration string ("PT%(interval_seconds)fS"). For most products this is 1080 ms in nominal operation, except for "L2O3PR", which uses 3240 ms due to coaddition. This attribute originates from the CCI standard.         orbit       0 (dynamic)       NC_INT         The absolute orbit number, starting at 1 – first ascending node crossing after spacecraft separation. For pre-launch testing this value should be set to "-1".       NC_STRING         references       '%(references)s' (static)       NC_STRING         References that describe the data or methods used to produce it. This attribute originates from the CF standard.       NC_STRING         processor_version       '%(version)s' (dynamic)       NC_STRING         The version of the data processor, as string of the form "major.minor.patch".       NC_STRING         keywords_vocabulary       'AGU index terms, http://publications.agu.org/author-resource-center/index-terms/' (static)       NC_STRING         The guidelines followed for the keywords attribute. We use the index terms published by the AGU.       Keywords from the "keywords_vocabulary" describing the contents of the file. To be provided by the ATBD authors.         standard_name_vocabulary       'NetCDF Climate and Forecast Metadata Conventions Attribute, Ne_STRING       NC_STRING	
Interval between measurements in the data granule as an ISO 8601 [RD35] duration string ("PT%(intervalseconds)fS"). For most products this is 1080 ms in nominal operation, except for "L203PR", which uses 3240 ms due to coaddition. This attribute originates from the CCI standard. orbit 0 (dynamic) NC_INT The absolute orbit number, starting at 1 – first ascending node crossing after spacecraft separation. For pre-launch testing this value should be set to "–1". references '%(references)s' (static) NC_STRING References that describe the data or methods used to produce it. This attribute originates from the CF standard. processor_version '%(version)s' (dynamic) NC_STRING The version of the data processor, as string of the form "major.minor.patch". keywords_vocabulary 'AGU index terms, http://publications.agu.org/author- resource-center/index-terms/' (static) NC_STRING The guidelines followed for the keywords attribute. We use the index terms published by the AGU. keywords from the "keywords_vocabulary" describing the contents of the file. To be provided by the ATBD authors. standard_name_vocabulary 'NetCDF Climate and Forecast Metadata Conventions Standard Name Table (v29, 08 July 2015), http://	
seconds)fS"). For most products this is 1080 ms in nominal operation, except for "L2O3PR", which uses 3240 ms due to coaddition. This attribute originates from the CCI standard.       NC_INT         orbit       0 (dynamic)       NC_INT         The absolute orbit number, starting at 1 – first ascending node crossing after spacecraft separation. For pre-launch testing this value should be set to "-1".       NC_STRING         references       '%(references)s' (static)       NC_STRING         References that describe the data or methods used to produce it. This attribute originates from the CF standard.       NC_STRING         processor_version       '%(version)s' (dynamic)       NC_STRING         The version of the data processor, as string of the form "major.minor.patch".       NC_STRING         keywords_vocabulary       'AGU index terms, http://publications.agu.org/author-resource-center/index-terms/' (static)       NC_STRING         The guidelines followed for the keywords attribute. We use the index terms published by the AGU.       Keywords from the "keywords_vocabulary" describing the contents of the file. To be provided by the ATBD authors.         standard_name_vocabulary       'NetCDF Climate and Forecast Metadata Conventions Standard Name Table (v29, 08 July 2015), http://       NC_STRING	
The absolute orbit number, starting at 1 – first ascending node crossing after spacecraft separation. For pre-launch testing this value should be set to "–1".         references       '%(references)s' (static)       NC_STRING         References that describe the data or methods used to produce it. This attribute originates from the CF standard.       NC_STRING         processor_version       '%(version)s' (dynamic)       NC_STRING         The version of the data processor, as string of the form "major.minor.patch".       NC_STRING         keywords_vocabulary       'AGU index terms, http://publications.agu.org/author-resource-center/index-terms/' (static)       NC_STRING         The guidelines followed for the keywords attribute. We use the index terms published by the AGU.       Keywords       NC_STRING         Keywords from the "keywords_vocabulary" describing the contents of the file. To be provided by the ATBD authors.       NC_STRING       NC_STRING         standard_name_vocabulary       'NetCDF Climate and Forecast Metadata Conventions Standard Name Table (v29, 08 July 2015), http://       NC_STRING	
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References that describe the data or methods used to produce it. This attribute originates from the CF standard.         processor_version       '%(version)s' (dynamic)       NC_STRING         The version of the data processor, as string of the form "major.minor.patch".       NC_STRING         keywords_vocabulary       'AGU index terms, http://publications.agu.org/author-resource-center/index-terms/' (static)       NC_STRING         The guidelines followed for the keywords attribute. We use the index terms published by the AGU.       NC_STRING         keywords       '%(keywords_agu)s' (dynamic)       NC_STRING         Keywords from the "keywords_vocabulary" describing the contents of the file. To be provided by the ATBD authors.       NteCDF Climate and Forecast Metadata Conventions Standard Name Table (v29, 08 July 2015), http://	
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The version of the data processor, as string of the form "major.minor.patch".       Keywords_vocabulary       'AGU index terms, http://publications.agu.org/author-resource-center/index-terms/' (static)       NC_STRING         The guidelines followed for the keywords attribute. We use the index terms published by the AGU.       NC_STRING         keywords       '%(keywords_agu)s' (dynamic)       NC_STRING         Keywords from the "keywords_vocabulary" describing the contents of the file. To be provided by the ATBD authors.       NteCDF Climate and Forecast Metadata Conventions Standard Name Table (v29, 08 July 2015), http://	
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resource-center/index-terms/' (static)         The guidelines followed for the keywords attribute. We use the index terms published by the AGU.         keywords         '%(keywords_agu)s' (dynamic)       NC_STRING         Keywords from the "keywords_vocabulary" describing the contents of the file. To be provided by the ATBD authors.       NC_STRING         standard_name_vocabulary       'NetCDF Climate and Forecast Metadata Conventions Standard Name Table (v29, 08 July 2015), http://       NC_STRING	
keywords       '%(keywords_agu)s' (dynamic)       NC_STRING         Keywords from the "keywords_vocabulary" describing the contents of the file. To be provided by the ATBD authors.       Standard_name_vocabulary       NC_STRING         standard_name_vocabulary       'NetCDF Climate and Forecast Metadata Conventions Standard Name Table (v29, 08 July 2015), http://       NC_STRING	
Keywords from the "keywords_vocabulary" describing the contents of the file. To be provided by the ATBD authors.         standard_name_vocabulary       'NetCDF Climate and Forecast Metadata Conventions Standard Name Table (v29, 08 July 2015), http://	
ATBD authors.         standard_name_vocabulary         'NetCDF Climate and Forecast Metadata Conventions Standard Name Table (v29, 08 July 2015), http://	
Standard Name Table (v29, 08 July 2015), http://	
The table followed for the standard_name attributes.	
naming_authority'%(naming_authority)s' (dynamic)NC_STRING	
Specify who is giving out the id attribute. This attribute originates from the CCI standard.	
cdm_data_type     'Swath' (static)     NC_STRING	
The THREDDS data type appropriate for this dataset, fixed to "Swath" for S5P level 2 products. This attribute originates from the CCI standard.	
date_created 'YYYY-mm-ddTHH:MM:SS.ffffffZ' (dynamic) NC_STRING	
date_created       'YYYY-mm-ddTHH:MM:SS.ffffffZ' (dynamic)       NC_STRING         The date on which this file was created. This attribute originates from the CCI standard.          creator_name       '%(credit)s' (dynamic)       NC_STRING	

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.

creator_url '%(creator_url)s' (dynamic)	NC_STRING
Hyperlink to a location where more information on the product can be found. Set to $\tt http=eu/.$ This attribute originates from the CCI standard.	://www.tropomi.
creator_email 'EOSupport@Copernicus.esa.int' (dynamic)	NC_STRING
Point of contact for more information and support for this produ "mailto:EOSupport@Copernicus.esa.int". This attribute originates from the CCI standa	
project 'Sentinel 5 precursor/TROPOMI' (dynamic)	NC_STRING
The name of the scientific project that created the data. This attribute originates from t	he CCI standard.
geospatial_lat_min	NC_FLOAT
Lowest latitude present in the file in decimal degrees. This attribute originates from the	CCI standard.
geospatial_lat_max	NC_FLOAT
Highest latitude present in the file in decimal degrees. This attribute originates from the	e CCI standard.
geospatial_lon_min	NC_FLOAT
Lowest longitude present in the file in decimal degrees. This attribute originates from the	he CCI standard.
geospatial_lon_max	NC_FLOAT
Highest longitude present in the file in decimal degrees. This attribute originates from t	the CCI standard.
license 'No conditions apply' (static)	NC_STRING
describe the restrictions to data access and distribution. For S5P "No conditions ap originates from the CCI standard.	ply". This attribute
platform 'S5P' (static)	NC_STRING
Name of the satellite, set to "S5P". This attribute originates from the CCI standard.	
sensor 'TROPOMI' (static)	NC_STRING
Name of the sensor, set to "TROPOMI". This attribute originates from the CCI standard	d.
spatial_resolution	NC_STRING
Spatial resolution at nadir. For most products this is " $3.5 \times 7 \text{ km}^2$ ", except for "L203 " $28 \times 21 \text{ km}^2$ " and "L2C0" and "L2CH4", which both use" $7 \times 7 \text{ km}^2$ ". This from the CCI standard.	
cpp_compiler_version	NC_STRING
The version of the compiler used for the C++ code. The value of this attribute is set via	the Makefile.
cpp_compiler_flags	NC_STRING
The compiler flags passed to the C++ compiler. The value of this attribute is set via the	
f90_compiler_version	NC_STRING
The version of the compiler version used for the Fortran code. The value of this attr Makefile. Note that not all processors make use of Fortran code.	ribute is set via the
f90_compiler_flags	NC_STRING
The compiler flags passed to the Fortran compiler. The value of this attribute is set via that not all processors make use of Fortran code.	the Makefile. Note
exe_linker_flags	NC_STRING
The flags will be used by the linker when creating an executable. The value of this att Makefile.	ribute is set via the
build_date	NC_STRING
The date on which the processor was built.	
revision_control_identifier '%(revision_control_source_identifier)s' (dynamic)	NC_STRING
revision_control_identifier       '%(revision_control_source_identifier)s' (dynamic)         Revision control system identifier for the source used to build this processor.	NC_STRING

The band from which the geolocation was taken, useful for colocating the level 2 output with other products.			
identifier_product_doi	'%(product_doi)s' (dynamic)	NC_STRING	
	t Identifier") of the current product. It allows to easi t that location is moved after the file has been created		
identifier_product_doi_au- thority	'http://dx.doi.org/' (static)	NC_STRING	
This attribute defines the autho	ritative service for use with DOI values in resolving to	the URL location.	
algorithm_version '%(algorithm_version)s' (dynamic) NC_STRING			
The algorithm version, separate from the processor (framework) version, to accomodate different release schedules for different products.			
product_version	'0.0.0' (dynamic)	NC_STRING	
The product version, separate f	rom the processor (framework) and algorithm versior	۱.	
processing_status 'Nominal' (dynamic) NC_STRING			
Description the processing statu input data.	is of the granule on a global level, mainly based on the	availability of auxiliary	
Possible values: Nominal, Degr	raded		

## 12.2 Common file-level attributes for DLR

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

Name	Value	Туре
cloud_mode		NC_STRING
The attribute aims	at identifying the source of the cloud parameter	r, either "cal" or "crb".
Possible values: cr	b, 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.

Name	Value	Туре
Status_MET	_2D	NC_STRING
The status of	f ECMWF input, either "Nominal" or "Fallback". Note that th	e "MET_2D" auxiliary input is used
as an achor p	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.

Name	Value	Туре
Status_NISE		NC_STRING
The status of NISE input, either "Nominal" or "Fallback".		
Possible values: Nominal, Fallback		

## 12.5 Status dynamic TM5 auxiliary data for NO2, SO2 and HCHO processing

If the TM5 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\_CTMFCT\_CTMANA" global attribute.

Name	Value	Туре
Status CTMFCT CTMANA		NC STRING

#### Status\_CTMFCT\_CTMANA

The status of TM5 Temperature profiles, NO<sub>2</sub>, SO<sub>2</sub> and HCHO profiles, either "Nominal" or "Fallback". Possible types of TM5 data are "AUX\_CTMFCT" for forecast or "AUX\_CTMANA" for analysis. Possible values: Nominal, Fallback

#### Status background correction auxiliary data 12.6

In case of unavailability of background correction auxiliary data, the correction will be not applied and the L2 output file will be flag accordingly.

Name	Value	Туре
Status_BG		NC_STRING
The status of backo	round correction input, either "Nominal" or "Fallt	pack".

Possible values: Nominal, Fallback

#### Status dynamic L2 aerosol index (AER\_AI) auxiliary data 12.7

In case of unavailability of Aerosol Index auxiliary data, fallback solution will be used and the L2 output file will be flagged accordingly.

Name	Value	Туре
Status_AER_AI		NC_STRING
The status of Aerosol Index input, either "Nominal", "Fallback" or "Unneeded".		
Possible values: N	Jominal, Fallback, Unneeded	

## 12.8 Status of the L2 Cloud product as input data

If the L2 Cloud auxiliary data is not available or not valid it will be automatically internally computed. In this case the Level 2 output file will be flagged using the "Status\_L2\_\_CLOUD\_" global attribute as "Internal".

Name	Value	Туре
Status_L2CLOUD_		NC_STRING
The status of L2 cloud input, either "External" or "Internal".		
Possible values: External, Internal		

## 12.9 Status of the reference spectrum used for the retrieval

The information tracks if the earthshine spectrum was used instead of the solar spectrum. In this case the Level 2 output file will be flagged using the "Status\_reference\_spectrum" global attribute.

#### Attributes in referencespectrum

Group attributes attached to referencespectrum			
Name	Value	Туре	
Status_reference_spectrum         'solar earth' (dynamic)         NC_STRING			
The status of reference spectrum, either "earth" or "solar". Note that the earthshine spectrum is calculated from the auxiliary BG processor and it is read in the L2 processor from this intermediate file as input.			
Possible values: earth, solar			

## 12.10 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 ?? for details.

**size** 1 (fixed) **mode** Present in all modes.

## 12.11 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 scanlines are than "later" measu indicating a pixel in	riable scanline refers to the along-track dimension of time-ordered, meaning that "earlier" measurements h urements. This variable merely contains an index to n a file the same index is used. This avoids the off-by-o d in OMI discussions.	nave a lower index ensure that when
Dimensions:	scanline (coordina	te variable).	
Туре:	NC_INT.		
Source:	Processor.		
Mode:	Present in all mod	es.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	Dimensionless, no	physical quantity. This attribute originates from the C	F standard.
	axis	'Y' (static)	NC_STRING
	long_name	'along-track dimension index' (static)	NC_STRING
	comment	'This coordinate variable defines the indices along track; index starts at 0' (static)	NC_STRING
ground_pixe	I		
Description:	urement. The gro For the Sentinel 5 part of the orbit, i.e contains an index	riable ground_pixel refers to the across-track dime und_pixel ordering is from left to right with respect to precursor orbit this corresponds to west to east dur e. a higher index corresponds to a higher longitude. The to ensure that when indicating a pixel in a file the sate by-one confusion that frequently occurred in OMI disc	the flight direction. ing the ascending his variable merely ame index is used.
Dimensions:	ground_pixel (coo	rdinate variable).	
Туре:	NC_INT.		
Source:	Processor.		
Mode:	Present in all mod	es.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	Dimensionless, no	physical quantity. This attribute originates from the C	F standard.
	axis	'X' (static)	NC_STRING

	long_name	'across-track dimension index' (static)	NC_STRING
	comment	'This coordinate variable defines the indices across track, from west to east; index starts at 0' (static)	NC_STRING
time			
Description:	time is set to YYYY formal start of the of difference of the of of time(time) ar scanline as UTC ti	(time) is the reference time of the measurements -MM-DDT00:00:00 UTC, midnight UTC before space surrent orbit. The delta_time(scanline) variable bservations with the reference time. Thus combinin nd delta_time(scanline) yields the measurement ime. The reference time(time) corresponds to the which is specified as a UTC time specified as an ISO 8	craft midnight, the indicates the time g the information ent time for each e global attribute
Dimensions:	time (coordinate va	riable).	
Туре:	NC_INT.		
Source:	Processor.		
Mode:	Present in all mode	S.	
Attributes:	Name	Value	Туре
	units	'seconds since 2010-01-01 00:00:00' (dynamic)	NC_STRING
	standard_name	'time' (static)	NC_STRING
	axis	'T' (static)	NC_STRING
	long_name	'reference time for the measurements' (static)	NC_STRING
	comment	'The time in this variable corresponds to the time in the time_reference global attribute' (static)	NC_STRING

## 12.12 Corner Dimension

All dimensions have an associated variable. Corner dimension is included in a separated file.

corner			
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 counter- clockwise, 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 20 for a graphical depiction of the corners.		
Dimensions:	corner (coordinat	te variable).	
Туре:	NC_INT.		
Source:	Processor.		
Mode:	Present in all mo	des.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	Dimensionless, n	o physical quanity. This attribute originates from the CF	standard.
	long_name	'pixel corner index' (static)	NC_STRING
	comment	'This coordinate variable defines the indices for the pixel corners; index starts a 0 (counter-clockwise, starting from south-western corner of the pixel in ascending part of the orbit).' (static)	NC_STRING

# 12.13 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.		
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all mode	2S.	
Attributes:	Name	Value	Туре
	long_name	'pixel center latitude' (static)	NC_STRING
	units	'degrees_north' (static)	NC_STRING
	standard_name	'latitude' (static)	NC_STRING
	valid_min	-90.0 (static)	NC_FLOAT
	valid_max	90.0 (static)	NC_FLOAT
	bounds	<pre>'/PRODUCT/SUPPORT_DATA/GEOLOCATIONS/ latitude bounds' (static)</pre>	NC_STRING
		ary coordinates, i.e. the pixel corners. Note that the us n extension of the climate and forecasting metadata c	- ·
<b>longitude</b> Description:		ne pixel centers of the ground pixels in the data. La ground pixel center and the ground pixel corners are	
Dimensions:	time, scanline, grou	ind pixel.	
Type:	NC FLOAT.		
Source:	Processor.		
Mode:	Present in all mode	2S.	
Attributes:	Name	Value	Туре
	long_name	'pixel center longitude' (static)	NC_STRING
	units	'degrees_east' (static)	NC_STRING
	standard_name	'longitude' (static)	NC_STRING
	valid_min	-180.0 (static)	NC_FLOAT
	valid_max	180.0 (static)	NC_FLOAT
	bounds	<pre>'/PRODUCT/SUPPORT_DATA/GEOLOCATIONS/ longitude_bounds' (static)</pre>	NC_STRING
		ary coordinates, i.e. the pixel corners. Note that the us n extension of the climate and forecasting metadata c	

# 12.14 Common product fields

delta\_time

Description:			
	time time (time) ( delta_time (scan TAI2010 time. Com delta_time (scan time derived for the start. However, t global attribute time independent measu given the measurem time of the last sam time_coverage_e		time (time) and each scanline as reference with TC time. The UTC me_coverage ot correspond to e result of adding measurement is the measurement
	This variable gives the	ne time offset in ms accuracy.	
Dimensions:	time, scanline, grour	ıd_pixel.	
Туре:	NC_INT.		
Source:	Processor.		
Mode:	Present in all modes		
Attributes:	Name	Value	Туре
	long_name	'offset from reference start time of measurement' (static)	NC_STRING
	units	'milliseconds' (static)	NC_STRING
time_utc			
Description:	The time of observat	tion expressed as ISO 8601 [RD35] date-time string.	
Dimensions:	time, scanline.		
Туре:	NC STRING.		
Source:	Processor.		
Mode:	Present in all modes		
		Value	Туре
Attributes:	Name		
Attributes:	Name long_name	'Time of observation as ISO 8601 date-time string' (static)	NC_STRING
		'Time of observation as ISO 8601 date-time string'	
Attributes: <b>qa_value</b> Description: Dimensions: Type:	A continuous quality value will change bas are provided in the p time, scanline, groun NC_UBYTE.	'Time of observation as ISO 8601 date-time string' (static) descriptor, varying between 0 (no data) and 1 (full of sed on observation conditions and retrieval flags. Def processing_quality_flags elsewhere in the pro-	NC_STRING quality data). The tailed quality flags
<b>qa_value</b> Description: Dimensions: Type: Source:	A continuous quality value will change bas are provided in the p time, scanline, groun NC_UBYTE. Processor.	'Time of observation as ISO 8601 date-time string' (static) descriptor, varying between 0 (no data) and 1 (full of sed on observation conditions and retrieval flags. Det processing_quality_flags elsewhere in the pro- nd_pixel.	NC_STRING quality data). The tailed quality flags
<b>qa_value</b> Description: Dimensions: Type:	A continuous quality value will change bas are provided in the p time, scanline, groun NC_UBYTE.	'Time of observation as ISO 8601 date-time string' (static) descriptor, varying between 0 (no data) and 1 (full of sed on observation conditions and retrieval flags. Det processing_quality_flags elsewhere in the pro- nd_pixel.	NC_STRING quality data). The tailed quality flags
<b>qa_value</b> Description: Dimensions: Type: Source:	A continuous quality value will change bas are provided in the p time, scanline, groun NC_UBYTE. Processor.	'Time of observation as ISO 8601 date-time string' (static) descriptor, varying between 0 (no data) and 1 (full of sed on observation conditions and retrieval flags. Def processing_quality_flags elsewhere in the pro- nd_pixel.	NC_STRING quality data). The tailed quality flags oduct.
<b>qa_value</b> Description: Dimensions: Type: Source: Mode:	A continuous quality value will change bas are provided in the p time, scanline, groun NC_UBYTE. Processor. Present in all modes	'Time of observation as ISO 8601 date-time string' (static) descriptor, varying between 0 (no data) and 1 (full of sed on observation conditions and retrieval flags. Det processing_quality_flags elsewhere in the pro- nd_pixel.	NC_STRING quality data). The tailed quality flags oduct.
<b>qa_value</b> Description: Dimensions: Type: Source: Mode:	A continuous quality value will change bas are provided in the p time, scanline, groun NC_UBYTE. Processor. Present in all modes <i>Name</i>	'Time of observation as ISO 8601 date-time string' (static) descriptor, varying between 0 (no data) and 1 (full of sed on observation conditions and retrieval flags. Def processing_quality_flags elsewhere in the pro- nd_pixel.	NC_STRING quality data). The tailed quality flags oduct.
<b>qa_value</b> Description: Dimensions: Type: Source: Mode:	long_name A continuous quality value will change bas are provided in the p time, scanline, groun NC_UBYTE. Processor. Present in all modes Name units	'Time of observation as ISO 8601 date-time string' (static) descriptor, varying between 0 (no data) and 1 (full d sed on observation conditions and retrieval flags. Det processing_quality_flags elsewhere in the pro- nd_pixel.	NC_STRING quality data). The tailed quality flags oduct. <i>Type</i> NC_STRING
<b>qa_value</b> Description: Dimensions: Type: Source: Mode:	long_name         A continuous quality         value will change bas         are provided in the p         time, scanline, ground         NC_UBYTE.         Processor.         Present in all modes         Name         units         scale_factor	'Time of observation as ISO 8601 date-time string' (static) descriptor, varying between 0 (no data) and 1 (full of sed on observation conditions and retrieval flags. Det processing_quality_flags elsewhere in the pro- nd_pixel. Value '1' (static) 0.01 (static)	NC_STRING quality data). The tailed quality flags oduct. <i>Type</i> NC_STRING NC_FLOAT
<b>qa_value</b> Description: Dimensions: Type: Source: Mode:	long_name         A continuous quality         value will change bas         are provided in the p         time, scanline, ground         NC_UBYTE.         Processor.         Present in all modes         Name         units         scale_factor         add_offset	'Time of observation as ISO 8601 date-time string' (static) r descriptor, varying between 0 (no data) and 1 (full of sed on observation conditions and retrieval flags. Det processing_quality_flags elsewhere in the pro- nd_pixel. Value '1' (static) 0.01 (static) 0 (static)	NC_STRING quality data). The tailed quality flags oduct. <u>Type</u> NC_STRING NC_FLOAT NC_FLOAT
<b>qa_value</b> Description: Dimensions: Type: Source: Mode:	long_name         A continuous quality         value will change bas         are provided in the p         time, scanline, ground         NC_UBYTE.         Processor.         Present in all modes         Name         units         scale_factor         add_offset         valid_min	<pre>'Time of observation as ISO 8601 date-time string' (static) ' descriptor, varying between 0 (no data) and 1 (full of sed on observation conditions and retrieval flags. Def processing_quality_flags elsewhere in the pro nd_pixel Value '1' (static) 0.01 (static) 0 (static) 0 (static)</pre>	NC_STRING quality data). The tailed quality flags oduct. <u>Type</u> NC_STRING NC_FLOAT NC_FLOAT NC_UBYTE
<b>qa_value</b> Description: Dimensions: Type: Source: Mode:	long_name         A continuous quality         value will change bas         are provided in the p         time, scanline, ground         NC_UBYTE.         Processor.         Present in all modes         Name         units         scale_factor         add_offset         valid_min         valid_max	'Time of observation as ISO 8601 date-time string' (static) r descriptor, varying between 0 (no data) and 1 (full of sed on observation conditions and retrieval flags. Def processing_quality_flags elsewhere in the pro- nd_pixel. Value '1' (static) 0.01 (static) 0 (static) 0 (static) 100 (static)	NC_STRING quality data). The tailed quality flags oduct. <i>Type</i> NC_STRING NC_FLOAT NC_FLOAT NC_UBYTE NC_UBYTE

satellite_latit	ude		
Description:	Latitude of the geod	etic sub satellite point on the WGS84 reference ellips	oid.
Dimensions:	time, scanline.		
Туре:	NC_FLOAT.		
Source:	L1B.		
Mode:	Present in all modes	3.	
Attributes:	Name	Value	Туре
	long_name	'sub satellite latitude' (static)	NC_STRING
	units	'degrees_north' (static)	NC_STRING
	comment	'Latitude of the geodetic sub satellite point on the WGS84 reference ellipsoid' (static)	NC_STRING
-	valid_min	-90.0 (static)	NC_FLOAT
-	valid_max	90.0 (static)	NC_FLOAT
satellite_long	jitude		
Description:	Longitude of the geo	odetic sub satellite point on the WGS84 reference elli	psoid.
Dimensions:	time, scanline.		
Туре:	NC_FLOAT.		
Source:	L1B.		
Mode:	Present in all modes	S.	
Attributes:	Name	Value	Туре
-	long_name	'satellite_longitude' (static)	NC_STRING
-	units	'degrees_east' (static)	NC_STRING
-	comment	'Longitude of the geodetic sub satellite point on the WGS84 reference ellipsoid' (static)	NC_STRING
-	valid_min	-180.0 (static)	NC_FLOAT
-	valid_max	180.0 (static)	NC_FLOAT
satellite_altitu	ude		
Description:	The altitude of the s reference ellipsoid.	atellite with respect to the geodetic sub satellite point	nt on the WGS84
Dimensions:	time, scanline.		
Туре:	NC_FLOAT.		
Source:	L 1 D		
Mode:	L1B.		
Attributes:	Present in all modes	5.	
Autoutes.		s. Value	Туре
	Present in all modes		<i>Type</i> NC_STRING
	Present in all modes Name	Value	••
	Present in all modes Name Iong_name	Value 'satellite altitude' (static)	NC_STRING
	Present in all modes Name Iong_name units	Value 'satellite altitude' (static) 'm' (static) 'The altitude of the satellite with respect to the geo- detic sub satellite point on the WGS84 reference	NC_STRING NC_STRING
, itti jutes.	Present in all modes Name Iong_name units comment	Value 'satellite altitude' (static) 'm' (static) 'The altitude of the satellite with respect to the geo- detic sub satellite point on the WGS84 reference ellipsoid' (static)	NC_STRING NC_STRING NC_STRING
satellite_orbi	Present in all modes Name Iong_name units comment valid_min valid_max	Value 'satellite altitude' (static) 'm' (static) 'The altitude of the satellite with respect to the geo- detic sub satellite point on the WGS84 reference ellipsoid' (static) 700000.0 (static)	NC_STRING NC_STRING NC_STRING NC_FLOAT
-	Present in all modes Name Iong_name units comment valid_min valid_max t_phase	Value 'satellite altitude' (static) 'm' (static) 'The altitude of the satellite with respect to the geo- detic sub satellite point on the WGS84 reference ellipsoid' (static) 700000.0 (static)	NC_STRING NC_STRING NC_STRING NC_FLOAT
satellite_orbi	Present in all modes Name Iong_name units comment valid_min valid_max t_phase	Value'satellite altitude' (static)'m' (static)'The altitude of the satellite with respect to the geo- detic sub satellite point on the WGS84 reference ellipsoid' (static)700000.0 (static)900000.0 (static)	NC_STRING NC_STRING NC_STRING NC_FLOAT
satellite_orbit Description:	Present in all modes Name Iong_name units comment valid_min valid_max t_phase Relative offset [0.0,.	Value'satellite altitude' (static)'m' (static)'The altitude of the satellite with respect to the geo- detic sub satellite point on the WGS84 reference ellipsoid' (static)700000.0 (static)900000.0 (static)	NC_STRING NC_STRING NC_STRING NC_FLOAT

# 12.15 Additional geolocation support fields

Mode:	Present in all mode	25.	
Attributes:	Name	Value	Туре
	long_name	'fractional satellite orbit phase' (static)	NC_STRING
	units	'1' (static)	NC_STRING
	comment	'Relative offset [0.0,, 1.0] of the measurement in the orbit' (static)	NC_STRING
	valid_min	-0.02 (static)	NC_FLOAT
	valid_max	1.02 (static)	NC_FLOAT
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, grou	Ind_pixel.	
Туре:	NC_FLOAT.		
Source:	L1B.		
Mode:	Present in all mode	PS.	
Attributes:	Name	Value	Туре
	long_name	'solar zenith angle' (static)	NC_STRING
	standard_name	<pre>'solar_zenith_angle' (static)</pre>	NC_STRING
	units	'degree' (static)	NC_STRING
	valid_min	0.0 (static)	NC_FLOAT
	valid_max	180.0 (static)	NC_FLOAT
	coordinates	<pre>'/PRODUCT/longitude /PRODUCT/latitude' (static)</pre>	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 [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_azimut	h_angle		
Description:	measured clockwis This is the same de	angle at the ground pixel location on the reference ellipse from the North (North = $0^\circ$ , East = $90^\circ$ , South = 18 efinition that is use in both OMI and GOME-2 level 1B	$30^{\circ}$ , West = $270^{\circ}$ ; files.
		e viewing_azimuth_angle on the calculation of th diative transfer calculations.	e relative azimuh
Dimensions:	time, scanline, grou		
Type:	NC FLOAT.		
Source:	L1B.		
Mode:	Present in all mode		
Attributes:	Name	Value	Туре
	long_name	'solar azimuth angle' (static)	<i>Type</i> NC STRING
		'solar_azimuth_angle' (static)	NC_STRING
	standard_name units	'degree' (static)	NC_STRING
			NC_FLOAT
	valid_min valid max	-180.0 (static) 180.0 (static)	NC_FLOAT
	coordinates	<pre>'/PRODUCT/longitude /PRODUCT/latitude' (static)</pre>	NC_STRING

		ngitude are in a different group. How to specify the case is not specified in the climate and forecast	
	comment	'Solar azimuth angle at the ground pixel location on the reference ellipsoid. Angle is measured clock- wise from the North (East = 90, South = 180, West = 270)' (static)	NC_STRING
viewing_zeni	th_angle		
Description:	Zenith angle of the is measured away	satellite $\vartheta$ at the ground pixel location on the referen from the vertical.	ce ellipsoid. Angle
Dimensions:	time, scanline, grou	ind_pixel.	
Туре:	NC_FLOAT.		
Source:	L1B.		
Mode:	Present in all mode	S.	
Attributes:	Name	Value	Туре
	long_name	'viewing zenith angle' (static)	NC_STRING
	standard_name	<pre>'viewing_zenith_angle' (static)</pre>	NC_STRING
	units	'degree' (static)	NC_STRING
	valid_min	0.0 (static)	NC_FLOAT
	valid_max	180.0 (static)	NC_FLOAT
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
	tions [ER5]. comment	'Zenith angle of the satellite at the ground pixel loc- ation on the reference ellipsoid. Angle is measured away from the vertical' (static)	NC_STRING
viewing_azin	nuth_angle		
Description:	The satellite azimuth angle at the ground pixel location on the reference ellipsoid. The angle is measured clockwise from the North (North = $0^{\circ}$ , East = $90^{\circ}$ , South = $180^{\circ}$ , West = $270^{\circ}$ ). This is the same definition that is use in both OMI and GOME-2 level 1B files.		
	azimuth_angle ${\sf f}$	zimuth difference $\varphi - \varphi_0$ it is not sufficient to just rom viewing_azimuth_angle. The angle needed $180^\circ - (\varphi - \varphi_0)) \mod 360^\circ$ .	
Dimensions:	time, scanline, grou	ind_pixel.	
Туре:	NC_FLOAT.		
Source:	L1B.		
Mode:	Present in all mode	s.	
Attributes:	Name	Value	Туре
	long_name	'viewing azimuth angle' (static)	NC_STRING
	standard_name	<pre>'viewing_azimuth_angle' (static)</pre>	NC_STRING
	units	'degree' (static)	NC_STRING
	valid_min	-180.0 (static)	NC_FLOAT
	valid_max	180.0 (static)	NC_FLOAT
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
		ngitude are in a different group. How to specify the case is not specified in the climate and forecast	

	comment	'Satellite azimuth angle at the ground pixel loca- tion on the reference ellipsoid. Angle is measured clockwise from the North (East = 90, South = 180, West = 270)' (static)	NC_STRING
latitude_bou	nds		
Description:		pixel corners of the ground pixels in the data. La ground pixel center and the ground pixel corners are	
	-	el corners follows the CF-metadata conventions [ER8 ter-clockwise when viewed from above. A graphical	-
Dimensions:	time, scanline, grour	nd_pixel, corner.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all modes	5.	
Attributes:	Name	Value	Туре
	units	'degrees_north' (static)	NC_STRING
longitude_bo	ounds		
Description:	The longitude of the	e pixel corners of the ground pixels in the data. La ground pixel center and the ground pixel corners are	-
		el corners follows the CF-metadata conventions [ER5 ter-clockwise when viewed from above. A graphical	-
	given in ligure o.		
Dimensions:	time, scanline, grour	nd_pixel, corner.	
Dimensions: Type:		nd_pixel, corner.	
	time, scanline, grour	nd_pixel, corner.	
Туре:	time, scanline, grour NC_FLOAT.		
Type: Source:	time, scanline, grour NC_FLOAT. Processor.		Туре
Type: Source: Mode:	time, scanline, grour NC_FLOAT. Processor. Present in all modes	S.	<i>Type</i> NC_STRING
Type: Source: Mode: Attributes:	time, scanline, grour NC_FLOAT. Processor. Present in all modes Name units	s. Value	
Type: Source: Mode:	time, scanline, grour NC_FLOAT. Processor. Present in all modes Name units flags Additional flags des possibility of sun glin	<i>Value</i> 'degrees_east' (static) cribing the ground pixel, including the influence of a nt, whether we are in the descending part of the orbi he orbit, whether the pixel crosses the dateline (usefu	NC_STRING solar eclipse, the t, whether we are
Type: Source: Mode: Attributes: geolocation_ Description:	time, scanline, grour NC_FLOAT. Processor. Present in all modes Name units flags Additional flags des possibility of sun glin on the night side of t	<i>Value</i> 'degrees_east' (static) cribing the ground pixel, including the influence of a nt, whether we are in the descending part of the orbi he orbit, whether the pixel crosses the dateline (usefu	NC_STRING solar eclipse, the t, whether we are
Type: Source: Mode: Attributes: geolocation_ Description: Dimensions:	time, scanline, grour NC_FLOAT. Processor. Present in all modes Name units flags Additional flags des possibility of sun glin on the night side of t there was some geo	<i>Value</i> 'degrees_east' (static) cribing the ground pixel, including the influence of a nt, whether we are in the descending part of the orbi he orbit, whether the pixel crosses the dateline (usefu	NC_STRING solar eclipse, the t, whether we are
Type: Source: Mode: Attributes: geolocation_	time, scanline, grour NC_FLOAT. Processor. Present in all modes Name units flags Additional flags des possibility of sun glin on the night side of t there was some geo time, scanline, grour	<i>Value</i> 'degrees_east' (static) cribing the ground pixel, including the influence of a nt, whether we are in the descending part of the orbi he orbit, whether the pixel crosses the dateline (usefu	NC_STRING solar eclipse, the t, whether we are
Type: Source: Mode: Attributes: <b>geolocation_</b> Description: Dimensions: Type:	time, scanline, grour NC_FLOAT. Processor. Present in all modes Name units flags Additional flags des possibility of sun glin on the night side of t there was some geo time, scanline, grour NC_UBYTE.	<i>Value</i> 'degrees_east' (static) cribing the ground pixel, including the influence of a nt, whether we are in the descending part of the orbi he orbit, whether the pixel crosses the dateline (usefu location error. nd_pixel.	NC_STRING solar eclipse, the t, whether we are
Type: Source: Mode: Attributes: geolocation_ Description: Dimensions: Type: Source:	time, scanline, grour NC_FLOAT. Processor. Present in all modes Name units flags Additional flags des possibility of sun glin on the night side of t there was some geo time, scanline, grour NC_UBYTE. Processor.	<i>Value</i> 'degrees_east' (static) cribing the ground pixel, including the influence of a nt, whether we are in the descending part of the orbi he orbit, whether the pixel crosses the dateline (usefu location error. nd_pixel.	NC_STRING solar eclipse, the t, whether we are il for plotting), or if
Type: Source: Mode: Attributes: geolocation_ Description: Dimensions: Type: Source: Mode:	time, scanline, grour NC_FLOAT. Processor. Present in all modes Name units flags Additional flags des possibility of sun glin on the night side of t there was some geo time, scanline, grour NC_UBYTE. Processor. Present in all modes	<i>Value</i> 'degrees_east' (static) cribing the ground pixel, including the influence of a nt, whether we are in the descending part of the orbi he orbit, whether the pixel crosses the dateline (usefu plocation error. nd_pixel.	NC_STRING solar eclipse, the t, whether we are
Type: Source: Mode: Attributes: <b>geolocation_</b> Description: Dimensions: Type: Source: Mode:	time, scanline, grour NC_FLOAT. Processor. Present in all modes Name units flags Additional flags des possibility of sun glin on the night side of t there was some geo time, scanline, grour NC_UBYTE. Processor. Present in all modes Name	Value 'degrees_east' (static) cribing the ground pixel, including the influence of a nt, whether we are in the descending part of the orbi he orbit, whether the pixel crosses the dateline (usefu location error. nd_pixel. <u>Value</u> 255 (static)	NC_STRING solar eclipse, the t, whether we are il for plotting), or if <i>Type</i> NC_UBYTE
Type: Source: Mode: Attributes: <b>geolocation_</b> Description: Dimensions: Type: Source: Mode:	time, scanline, grour NC_FLOAT. Processor. Present in all modes <i>Name</i> <b>units</b> <b>flags</b> Additional flags des possibility of sun glin on the night side of t there was some geo time, scanline, grour NC_UBYTE. Processor. Present in all modes <i>Name</i> <b>_FillValue</b> <b>coordinates</b>	S. Value 'degrees_east' (static) cribing the ground pixel, including the influence of a nt, whether we are in the descending part of the orbi he orbit, whether the pixel crosses the dateline (usefu location error. nd_pixel. S. Value 255 (static) '/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING solar eclipse, the t, whether we are il for plotting), or if
Type: Source: Mode: Attributes: <b>geolocation_</b> Description: Dimensions: Type: Source: Mode:	time, scanline, grour NC_FLOAT. Processor. Present in all modes Name units flags Additional flags des possibility of sun glin on the night side of t there was some geo time, scanline, grour NC_UBYTE. Processor. Present in all modes Name _FillValue	Value 'degrees_east' (static) cribing the ground pixel, including the influence of a nt, whether we are in the descending part of the orbi he orbit, whether the pixel crosses the dateline (usefu location error. nd_pixel. <u>Value</u> 255 (static)	NC_STRING solar eclipse, the t, whether we are il for plotting), or if <i>Type</i> NC_UBYTE NC_STRING
Type: Source: Mode: Attributes: <b>geolocation_</b> Description: Dimensions: Type: Source: Mode:	time, scanline, grour NC_FLOAT. Processor. Present in all modes <i>Name</i> units flags Additional flags des possibility of sun glin on the night side of t there was some geo time, scanline, grour NC_UBYTE. Processor. Present in all modes <i>Name</i> _FillValue coordinates flag_masks	S.         Value         'degrees_east' (static)         cribing the ground pixel, including the influence of a ant, whether we are in the descending part of the orbin he orbit, whether the pixel crosses the dateline (useful clocation error.         he orbit, whether the pixel crosses the dateline (useful clocation error.         hd_pixel.         s.         Value         255 (static)         '/PRODUCT/longitude /PRODUCT/latitude' (static)         0, 1, 2, 4, 8, 16, 128 (static)         'no_error solar_eclipse sun_glint_possible descending night geo_boundary_crossing geolocation_error' (static)	NC_STRING solar eclipse, the t, whether we are il for plotting), or if <i>Type</i> NC_UBYTE NC_STRING NC_UBYTE
Type: Source: Mode: Attributes: <b>geolocation_</b> Description: Dimensions: Type: Source: Mode:	time, scanline, grour NC_FLOAT. Processor. Present in all modes <i>Name</i> units flags Additional flags des possibility of sun glin on the night side of t there was some geo time, scanline, grour NC_UBYTE. Processor. Present in all modes <i>Name</i> _FillValue coordinates flag_masks flag_meanings	S.         Value         'degrees_east' (static)         cribing the ground pixel, including the influence of a nt, whether we are in the descending part of the orbin he orbit, whether the pixel crosses the dateline (useful location error.         nd_pixel.         s.         Value         255 (static)         '/PRODUCT/longitude /PRODUCT/latitude' (static)         0, 1, 2, 4, 8, 16, 128 (static)         'no_error' (static)         0, 1, 2, 4, 8, 16, 128 (static)	NC_STRING solar eclipse, the t, whether we are il for plotting), or if NC_UBYTE NC_UBYTE NC_STRING NC_UBYTE NC_STRING
Type: Source: Mode: Attributes: <b>geolocation_</b> Description: Dimensions: Type: Source: Mode:	time, scanline, grour NC_FLOAT. Processor. Present in all modes <i>Name</i> units flags Additional flags des possibility of sun glin on the night side of t there was some geo time, scanline, grour NC_UBYTE. Processor. Present in all modes <i>Name</i> _FillValue coordinates flag_masks flag_meanings	S.         Value         'degrees_east' (static)         cribing the ground pixel, including the influence of a ant, whether we are in the descending part of the orbin he orbit, whether the pixel crosses the dateline (useful clocation error.         he orbit, whether the pixel crosses the dateline (useful clocation error.         hd_pixel.         s.         Value         255 (static)         '/PRODUCT/longitude /PRODUCT/latitude' (static)         0, 1, 2, 4, 8, 16, 128 (static)         'no_error solar_eclipse sun_glint_possible descending night geo_boundary_crossing geolocation_error' (static)	NC_STRING solar eclipse, the t, whether we are il for plotting), or if <i>Type</i> NC_UBYTE NC_STRING NC_UBYTE NC_STRING

units

'1' (static)

NC\_STRING

# 12.16 Detailed Results related to CAL Cloud Product concerning the Cloud Fraction Intensity Weighted

Variables in detailed\_results\_cloud\_fraction\_intensity\_weighted\_cal

cloud_fractio	on_intensity_weight	ed	
Description:	VCD clear sky vs. c	loudy weighting factor using the CAL model.	
Dimensions:	time, scanline, grou	nd_pixel.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all mode	S.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	Dimensionless unit.	This attribute originates from the NUG, CF standards	S.
	long_name	'cloud fraction intensity weighted' (static)	NC_STRING
	valid_min	0.0 (static)	NC_FLOAT
	valid_max	1.0 (static)	NC_FLOAT
	comment	'VCD clear sky vs. cloudy weighting factor using the CAL model.' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
		gitude coordinates of the TROPOMI swath is not defin and longitude axes. This attribute originates from the 0	
cloud_fractio	on_intensity_weight	ed_precision	
Description:	Error of the VCD cle	ear sky vs. cloudy weighting factor using the CAL mod	del.
Dimensions:	time, scanline, grou	nd_pixel.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all mode	S.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	Dimensionless unit.	This attribute originates from the NUG, CF standards	S.
	long_name	'random error of the cloud fraction intensity weighted' (static)	NC_STRING
	valid_min	0.0 (static)	NC_FLOAT
	valid_max	1.0 (static)	NC_FLOAT
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
		gitude coordinates of the TROPOMI swath is not defin and longitude axes. This attribute originates from the (	

## 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 occured 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, gr	round_pixel.			
Туре:	NC_UINT.				
Source:	Processor.	Processor.			
Mode:	Present in all mo	des.			
Attributes:	Name	Value	Туре		
	long_name	'Processing quality flags' (static)	NC_STRING		
	units	'1' (static)	NC_STRING		
	comment	'Flags indicating conditions that affect quality of the retrieval.' (static)	NC_STRING		

flag_meanings	'success radiance_missing irradiance_missing input_spectrum_missing reflectance_range_error	NC_STRINC
	ler_range_error snr_range_error sza_range_error	
	vza_range_error lut_range_error ozone_range	
	error wavelength_offset_error initialization_error	
	memory_error assertion_error io_error numer-	
	ical_error lut_error ISRF_error convergence_error	
	cloud filter convergence error max iteration -	
	convergence_error aot_lower_boundary_conver-	
	gence_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_er-	
	ror generic_exception input_spectrum_align-	
	ment_error abort_error wrong_input_type_error	
	wavelength calibration error coregistration error	
	slant_column_density_error airmass_factor_er-	
	ror vertical_column_density_error signal_to	
	noise_ratio_error configuration_error key_error	
	saturation_error solar_eclipse_filter cloud_filter alti-	
	tude_consistency_filter altitude_roughness_filter	
	sun_glint_filter mixed_surface_type_filter snow	
	ice_filter aai_filter cloud_fraction_fresco_filter	
	aai_scene_albedo_filter small_pixel_radiance	
	std_filter cloud_fraction_viirs_filter cirrus_re-	
	flectance_viirs_filter cf_viirs_swir_ifov_filter	
	cf_viirs_swir_ofova_filter cf_viirs_swir_ofovb_filter	
	cf_viirs_swir_ofovc_filter cf_viirs_nir_ifov_filter	
	cf_viirs_nir_ofova_filter cf_viirs_nir_ofovb_filter	
	cf_viirs_nir_ofovc_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_warn-	
	ing 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_re-	
	trieval_warning cloud_inhomogeneity_warning	
	(static)	

	flag_masks	255, 255, 255, 255, 255, 255, 255, 255,	NC_UINT
	flag_values	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, 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, 256, 512, 1024, 2048, 4096, 8192, 16384, 32768, 65536, 131072, 262144, 524288, 1048576, 2097152, 4194304, 8388608, 16777216, 33554432, 67108864, 134217728, 268435456, 536870912 (static)	NC_UINT
		'/PRODUCT/longitude /PRODUCT/latitude' (static) ngitude are in a different group. How to specify the case is not specified in the climate and forecast	
	tions [ER5].		
	spectral_points_in_r		
Description:	•	ts in the spectrum that were used in the retrieval.	
Dimensions:	time, scanline, grou	nd_pixel.	
Туре:	NC_USHORT.		
Source:	Processor.	_	
Mode:	Present in all mode		
Attributes:	Name	Value	
	long_name	'Number of spectral points used in the retrieval' (static)	NC_STRING
	units	'1' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
		ngitude are in a different group. How to specify the case is not specified in the climate and forecast i	• •

# 12.18 Debug fields for UPAS

debug_upas2_float1D			
Description:	Debug field, not available in operational environment.		
Dimensions:	time, scanline.		
Туре:	NC_FLOAT.		
Source:	Processor.		

Mode:	Present in all mode	es.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC STRING
debug_upas	2_double1D		
Description:	—	ailable in operational environment.	
Dimensions:	time, scanline.		
Туре:	NC_DOUBLE.		
Source:	Processor.		
Mode:	Present in all mode	es.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
debug_upas	2_int1D		
Description:	Debug field, not av	ailable in operational environment.	
Dimensions:	time, scanline.		
Туре:	NC_INT.		
Source:	Processor.		
Mode:	Present in all mode	es.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
debug_upas	2_ubyte1D		
Description:	Debug field, not av	ailable in operational environment.	
Dimensions:	time, scanline.		
Туре:	NC_UBYTE.		
Source:	Processor.		
Mode:	Present in all mode	es.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
debug_upas	2_byte1D		
Description:	Debug field, not av	ailable in operational environment.	
Dimensions:	time, scanline.		
Туре:	NC_BYTE.		
Source:	Processor.		
Mode:	Present in all mode	es.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
debug_upas	—		
Description:	Debug field, not av	ailable in operational environment.	
Dimensions:	time, scanline.		
Туре:	NC_USHORT.		
Source:	Processor.		
Mode:	Present in all mode	es.	
		Value	Туре

	units	'1' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
debug_upas2	2_float2D_1		
Description:	Debug field, not ava	ailable in operational environment.	
Dimensions:	time, scanline, grou	nd_pixel.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all modes	S.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
debug_upas2	2_float2D_2		
Description:	Debug field, not ava	ailable in operational environment.	
Dimensions:	time, scanline, grou	nd_pixel.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all modes	S.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
debug_upas2	2_float2D_3		
Description:	Debug field, not ava	ailable in operational environment.	
Dimensions:	time, scanline, grou	nd_pixel.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all modes	6	
	i lesent in an moue.	5.	
Attributes:	Name	Value	Туре
Attributes:			
Attributes:	Name	Value	NC_STRING
	Name units	Value '1' (static)	
debug_upas2	Name units coordinates 2_double2D_1	Value '1' (static)	NC_STRING
debug_upas2	Name units coordinates 2_double2D_1	Value '1' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment.	NC_STRING
debug_upas2	Name units coordinates 2_double2D_1 Debug field, not ava	Value '1' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment.	NC_STRING
<b>debug_upas2</b> Description: Dimensions:	Name units coordinates 2_double2D_1 Debug field, not ava time, scanline, grou	Value '1' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment.	NC_STRING
<b>debug_upas2</b> Description: Dimensions: Type:	Name units coordinates 2_double2D_1 Debug field, not ava time, scanline, grou NC_DOUBLE.	Value '1' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment. nd_pixel.	NC_STRING
<b>debug_upas2</b> Description: Dimensions: Type: Source:	Name units coordinates 2_double2D_1 Debug field, not ava time, scanline, grou NC_DOUBLE. Processor.	Value '1' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment. nd_pixel.	NC_STRING
<b>debug_upas2</b> Description: Dimensions: Type: Source: Mode:	Name units coordinates 2_double2D_1 Debug field, not ava time, scanline, grou NC_DOUBLE. Processor. Present in all modes	Value         '1' (static)         '/PRODUCT/longitude /PRODUCT/latitude' (static)         ailable in operational environment.         nd_pixel.         s.         Value         '1' (static)	NC_STRING NC_STRING
<b>debug_upas2</b> Description: Dimensions: Type: Source: Mode:	Name units coordinates 2_double2D_1 Debug field, not ava time, scanline, grou NC_DOUBLE. Processor. Present in all modes Name	Value '1' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment. nd_pixel. s. Value	NC_STRING NC_STRING <i>Type</i> NC_STRING
debug_upas2 Description: Dimensions: Type: Source: Mode: Attributes:	Name units coordinates 2_double2D_1 Debug field, not ava time, scanline, grou NC_DOUBLE. Processor. Present in all modes Name units	Value         '1' (static)         '/PRODUCT/longitude /PRODUCT/latitude' (static)         ailable in operational environment.         nd_pixel.         s.         Value         '1' (static)	NC_STRING NC_STRING <i>Type</i> NC_STRING
debug_upas2 Description: Dimensions: Type: Source: Mode: Attributes:	Name         units         coordinates         2_double2D_1         Debug field, not ava         time, scanline, grou         NC_DOUBLE.         Processor.         Present in all modes         Name         units         coordinates         2_double2D_2	Value         '1' (static)         '/PRODUCT/longitude /PRODUCT/latitude' (static)         ailable in operational environment.         nd_pixel.         s.         Value         '1' (static)	NC_STRING NC_STRING <i>Type</i> NC_STRING
debug_upas2 Description: Dimensions: Type: Source: Mode: Attributes: debug_upas2	Name         units         coordinates         2_double2D_1         Debug field, not ava         time, scanline, grou         NC_DOUBLE.         Processor.         Present in all modes         Name         units         coordinates         2_double2D_2	Value         '1' (static)         '/PRODUCT/longitude /PRODUCT/latitude' (static)         ailable in operational environment.         nd_pixel.         s.         Value         '1' (static)         '/PRODUCT/longitude /PRODUCT/latitude' (static)         ailable in operational environment.	NC_STRING NC_STRING <i>Type</i> NC_STRING
debug_upas2 Description: Dimensions: Type: Source: Mode: Attributes: debug_upas2 Description:	Name         units         coordinates         2_double2D_1         Debug field, not ava         time, scanline, grou         NC_DOUBLE.         Processor.         Present in all modes         Name         units         coordinates         2_double2D_2         Debug field, not ava	Value         '1' (static)         '/PRODUCT/longitude /PRODUCT/latitude' (static)         ailable in operational environment.         nd_pixel.         s.         Value         '1' (static)         '/PRODUCT/longitude /PRODUCT/latitude' (static)         ailable in operational environment.	NC_STRING NC_STRING <i>Type</i> NC_STRING
debug_upas2 Description: Dimensions: Type: Source: Mode: Attributes: debug_upas2 Description: Dimensions:	Name         units         coordinates         2_double2D_1         Debug field, not ava         time, scanline, grou         NC_DOUBLE.         Processor.         Present in all modes         Name         units         coordinates         2_double2D_2         Debug field, not ava         time, scanline, grou	Value         '1' (static)         '/PRODUCT/longitude /PRODUCT/latitude' (static)         ailable in operational environment.         nd_pixel.         s.         Value         '1' (static)         '/PRODUCT/longitude /PRODUCT/latitude' (static)         ailable in operational environment.	NC_STRING NC_STRING <i>Type</i> NC_STRING
debug_upas2 Description: Dimensions: Type: Source: Mode: Attributes: debug_upas2 Description: Dimensions: Type:	Name         units         coordinates         2_double2D_1         Debug field, not ava         time, scanline, grou         NC_DOUBLE.         Processor.         Present in all modes         Name         units         coordinates         2_double2D_2         Debug field, not ava         time, scanline, grou         NC_DOUBLE.	Value         '1' (static)         '/PRODUCT/longitude /PRODUCT/latitude' (static)         allable in operational environment.         nd_pixel.         s.         Value         '1' (static)         '/PRODUCT/longitude /PRODUCT/latitude' (static)         allable in operational environment.         nd_pixel.	NC_STRING NC_STRING <i>Type</i> NC_STRING
debug_upas2 Description: Dimensions: Type: Source: Mode: Attributes: debug_upas2 Description: Dimensions: Type: Source:	Name         units         coordinates         2_double2D_1         Debug field, not ava         time, scanline, grou         NC_DOUBLE.         Processor.         Present in all modes         Name         units         coordinates         2_double2D_2         Debug field, not ava         time, scanline, grou         NC_DOUBLE.         Processor.	Value         '1' (static)         '/PRODUCT/longitude /PRODUCT/latitude' (static)         allable in operational environment.         nd_pixel.         s.         Value         '1' (static)         '/PRODUCT/longitude /PRODUCT/latitude' (static)         allable in operational environment.         nd_pixel.	NC_STRING NC_STRING
debug_upas2 Description: Dimensions: Type: Source: Mode: Attributes: debug_upas2 Description: Dimensions: Type: Source: Mode:	Name         units         coordinates         2_double2D_1         Debug field, not ava         time, scanline, grou         NC_DOUBLE.         Processor.         Present in all modes         Name         units         coordinates         2_double2D_2         Debug field, not ava         time, scanline, grou         NC_DOUBLE.         Processor.         Processor.         Processor.         Processor.         Processor.         Processor.         Processor.         Present in all modes	Value         '1' (static)         '/PRODUCT/longitude /PRODUCT/latitude' (static)         ailable in operational environment.         nd_pixel.         s.         Value         '1' (static)         '/PRODUCT/longitude /PRODUCT/latitude' (static)         ailable in operational environment.         nd_pixel.         s.         s.	NC_STRING NC_STRING Type NC_STRING NC_STRING

Description:	Debug field, not available in operational environment.			
Dimensions:	time, scanline, ground_pixel.			
Туре:	NC_DOUBLE.			
Source:	Processor.			
Mode:	Present in all modes	5.		
Attributes:	Name	Value	Туре	
	units	'1' (static)	NC_STRING	
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING	
debug_upas2	2_int2D_1			
Description:	Debug field, not ava	ilable in operational environment.		
Dimensions:	time, scanline, ground_pixel.			
Туре:	NC_INT.			
Source:	Processor.			
Mode:	Present in all modes	3.		
Attributes:	Name	Value	Туре	
-	units	'1' (static)	NC_STRING	
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING	
debug_upas2	_int2D_2			
Description:	Debug field, not ava	ilable in operational environment.		
Dimensions:	time, scanline, grour	nd_pixel.		
Туре:	NC_INT.			
Source:	Processor.			
Mode:	Present in all modes	5.		
Attributes:	Name	Value	Туре	
	units	'1' (static)	NC_STRING	
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING	
debug_upas2	2_int2D_3			
Description:	Debug field, not ava	ilable in operational environment.		
Dimensions:	time, scanline, grour	nd_pixel.		
Туре:	NC_INT.			
	_			
Source:	Processor.			
	Processor. Present in all modes	S.		
Mode:		s. Value	Туре	
Mode:	Present in all modes			
Mode:	Present in all modes	Value	NC_STRING	
Mode: Attributes:	Present in all modes Name units coordinates	Value '1' (static)	NC_STRING	
Mode: Attributes: debug_upas2	Present in all modes Name units coordinates 2_ubyte2D_1	Value '1' (static)	NC_STRING	
Mode: Attributes: debug_upas2 Description:	Present in all modes Name units coordinates 2_ubyte2D_1	Value '1' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) ilable in operational environment.	NC_STRING	
Mode: Attributes: debug_upas2 Description: Dimensions:	Present in all modes Name units coordinates 2_ubyte2D_1 Debug field, not ava	Value '1' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) ilable in operational environment.	NC_STRING	
Mode: Attributes: debug_upas2 Description: Dimensions: Type:	Present in all modes Name units coordinates 2_ubyte2D_1 Debug field, not ava time, scanline, grour	Value '1' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) ilable in operational environment.	NC_STRING	
Mode: Attributes: debug_upas2 Description: Dimensions: Type: Source:	Present in all modes Name units coordinates 2_ubyte2D_1 Debug field, not ava time, scanline, groun NC_UBYTE.	Value '1' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) ilable in operational environment. nd_pixel.	NC_STRING	
<b>debug_upas2</b> Description: Dimensions:	Present in all modes Name units coordinates 2_ubyte2D_1 Debug field, not ava time, scanline, grour NC_UBYTE. Processor.	Value '1' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) ilable in operational environment. nd_pixel.	NC_STRING	
Mode: Attributes: debug_upas2 Description: Dimensions: Type: Source: Mode:	Present in all modes Name units coordinates 2_ubyte2D_1 Debug field, not ava time, scanline, grour NC_UBYTE. Processor. Present in all modes	Value '1' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) ilable in operational environment. nd_pixel.	NC_STRING NC_STRING	
Mode: Attributes: debug_upas2 Description: Dimensions: Type: Source: Mode:	Present in all modes Name units coordinates 2_ubyte2D_1 Debug field, not ava time, scanline, grour NC_UBYTE. Processor. Present in all modes Name	Value '1' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) ilable in operational environment. nd_pixel. S. Value	NC_STRING NC_STRING	
Mode: Attributes: debug_upas2 Description: Dimensions: Type: Source: Mode:	Present in all modes Name units coordinates 2_ubyte2D_1 Debug field, not ava time, scanline, grour NC_UBYTE. Processor. Present in all modes Name units coordinates	Value '1' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) ilable in operational environment. nd_pixel. S. Value '1' (static)	NC_STRING NC_STRING <i>Type</i> NC_STRING	

Discus 1			
Dimensions:	time, scanline, grou	und_pixel.	
Туре:	NC_UBYTE.		
Source:	Processor.		
Mode:	Present in all mode	es.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
debug_upas2	2_ubyte2D_3		
Description:	Debug field, not ava	ailable in operational environment.	
Dimensions:	time, scanline, grou	und_pixel.	
Туре:	NC_UBYTE.		
Source:	Processor.		
Mode:	Present in all mode	9S.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
debug_upas2	2_byte2D_1		
Description:	Debug field, not ava	ailable in operational environment.	
Dimensions:	time, scanline, grou	und_pixel.	
Туре:	NC_BYTE.		
Source:	Processor.		
Mode:	Present in all mode	9S.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	units		
	coordinates	<pre>'/PRODUCT/longitude /PRODUCT/latitude' (static)</pre>	
debug_upas2	coordinates		
	coordinates 2_byte2D_2		
<b>debug_upas2</b> Description: Dimensions:	coordinates 2_byte2D_2	'/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment.	
Description:	<b>coordinates</b> 2_byte2D_2 Debug field, not ava	'/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment.	
Description: Dimensions: Type:	<b>coordinates</b> 2_byte2D_2 Debug field, not ava time, scanline, grou	'/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment.	
Description: Dimensions: Type: Source:	coordinates 2_byte2D_2 Debug field, not ava time, scanline, grou NC_BYTE.	'/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment. und_pixel.	
Description: Dimensions: Type: Source: Mode:	coordinates 2_byte2D_2 Debug field, not ava time, scanline, grou NC_BYTE. Processor.	'/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment. und_pixel.	
Description: Dimensions: Type: Source: Mode:	<b>coordinates</b> 2_byte2D_2 Debug field, not ava time, scanline, grou NC_BYTE. Processor. Present in all mode	'/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment. und_pixel.	NC_STRING
Description: Dimensions: Type: Source: Mode:	coordinates 2_byte2D_2 Debug field, not ava time, scanline, grou NC_BYTE. Processor. Present in all mode Name	<pre>'/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment. und_pixel. es. Value</pre>	NC_STRING
Description: Dimensions: Type: Source: Mode: Attributes:	coordinates 2_byte2D_2 Debug field, not avaitime, scanline, grou NC_BYTE. Processor. Present in all mode Name units coordinates	<pre>'/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment. und_pixel. es. Value '1' (static)</pre>	NC_STRING
Description: Dimensions: Type: Source: Mode: Attributes: debug_upas2	coordinates2_byte2D_2Debug field, not availatine, scanline, grouNC_BYTE.Processor.Present in all modeNameunitscoordinates2_byte2D_3	<pre>'/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment. und_pixel. es. Value '1' (static)</pre>	NC_STRING
Description: Dimensions: Type: Source: Mode: Attributes: debug_upas2 Description:	coordinates2_byte2D_2Debug field, not availatine, scanline, grouNC_BYTE.Processor.Present in all modeNameunitscoordinates2_byte2D_3	'/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment. und_pixel. es. Value '1' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment.	NC_STRING
Description: Dimensions: Type: Source: Mode: Attributes: debug_upas2 Description: Dimensions:	coordinates         2_byte2D_2         Debug field, not availation, scanline, ground         NC_BYTE.         Processor.         Present in all mode         Name         units         coordinates         2_byte2D_3         Debug field, not availation	'/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment. und_pixel. es. Value '1' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment.	NC_STRING
Description: Dimensions: Type: Source: Mode: Attributes: <b>debug_upas</b> Description: Dimensions: Type:	coordinates2_byte2D_2Debug field, not availatine, scanline, groupNC_BYTE.Processor.Present in all modeNameunitscoordinates2_byte2D_3Debug field, not availatine, scanline, group	'/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment. und_pixel. es. Value '1' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment.	NC_STRING
Description: Dimensions: Type: Source: Mode: Attributes: debug_upas2 Description: Dimensions: Type: Source:	coordinates         2_byte2D_2         Debug field, not availation, scanline, ground field, not availation         NC_BYTE.         Processor.         Present in all model         Name         units         coordinates         2_byte2D_3         Debug field, not availation, group         NC_BYTE.	<pre>'/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment. und_pixel. es. <u>Value '1' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment. und_pixel.</u></pre>	NC_STRING
Description: Dimensions: Type: Source: Mode: Attributes: <b>debug_upas2</b> Description: Dimensions: Type: Source: Mode:	coordinates2_byte2D_2Debug field, not availatine, scanline, grouNC_BYTE.Processor.Present in all modeNameunitscoordinates2_byte2D_3Debug field, not availatine, scanline, grouNC_BYTE.Processor.	<pre>'/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment. und_pixel. es. <u>Value '1' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment. und_pixel.</u></pre>	NC_STRING
Description: Dimensions: Type: Source: Mode: Attributes:	coordinates         2_byte2D_2         Debug field, not availation, scanline, ground field, not availation         NC_BYTE.         Processor.         Present in all model         Name         units         coordinates         2_byte2D_3         Debug field, not availation, ground field, not availation         NC_BYTE.         Processor.         Processor.         Processor.         Processor.         Processor.         Present in all model	<pre>'/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment. und_pixel. es. Value '1' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment. und_pixel. es.</pre>	NC_STRING <i>Type</i> NC_STRING NC_STRING
Description: Dimensions: Type: Source: Mode: Attributes: <b>debug_upas2</b> Description: Dimensions: Type: Source: Mode:	coordinates         2_byte2D_2         Debug field, not avaination of the second of the	<pre>'/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment. und_pixel. es. Value '1' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment. und_pixel. es. Value</pre>	NC_STRING <i>Type</i> NC_STRING NC_STRING <i>Type</i>
Description: Dimensions: Type: Source: Mode: Attributes: <b>debug_upas2</b> Description: Dimensions: Type: Source: Mode: Attributes:	coordinates         2_byte2D_2         Debug field, not availation, scanline, ground iteration of the second of the	<pre>'/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment. und_pixel. es. Value '1' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment. und_pixel. es. Value '1' (static) '1' (static)</pre>	NC_STRING <i>Type</i> NC_STRING NC_STRING <i>Type</i> NC_STRING
Description: Dimensions: Type: Source: Mode: Attributes: <b>debug_upas2</b> Description: Dimensions: Type: Source: Mode: Attributes:	coordinates         2_byte2D_2         Debug field, not availation, scanline, group         NC_BYTE.         Processor.         Present in all mode         Name         units         coordinates         2_byte2D_3         Debug field, not availation, scanline, group         NC_BYTE.         Processor.         Present in all mode         NC_BYTE.         Processor.         Present in all mode         Name         units         coordinates         2_units         coordinates         2_units         coordinates         2_ushort2D_1	<pre>'/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment. und_pixel. es. Value '1' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment. und_pixel. es. Value '1' (static) '1' (static)</pre>	NC_STRING <i>Type</i> NC_STRING NC_STRING <i>Type</i> NC_STRING
Dimensions: Type: Source: Mode: Attributes: debug_upas2 Description: Dimensions: Type: Source: Mode: Attributes: debug_upas2	coordinates         2_byte2D_2         Debug field, not availation, scanline, group         NC_BYTE.         Processor.         Present in all mode         Name         units         coordinates         2_byte2D_3         Debug field, not availation, scanline, group         NC_BYTE.         Processor.         Present in all mode         NC_BYTE.         Processor.         Present in all mode         Name         units         coordinates         2_units         coordinates         2_units         coordinates         2_ushort2D_1	'/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment. und_pixel. Ss. Value '1' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment. und_pixel. Ss. Value '1' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment. und_pixel. Ss. Value '1' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) ailable in operational environment. ailable in operational environment.	NC_STRING <i>Type</i> NC_STRING NC_STRING <i>Type</i> NC_STRING

Source:	Processor.		
Mode:	Present in all mode	9S.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
debug_upas	2_ushort2D_2		
Description:	Debug field, not ava	ailable in operational environment.	
Dimensions:	time, scanline, grou	und_pixel.	
Туре:	NC_USHORT.		
Source:	Processor.		
Mode:	Present in all mode	9S.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
debug_upas	2_ushort2D_3		
Description:	Debug field, not ava	ailable in operational environment.	
Dimensions:	time, scanline, grou	und_pixel.	
Туре:	NC_USHORT.		
Source:	Processor.		
Mode:	Present in all mode	PS	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING

## 12.19 background correction information of SO2

This is the main group containing the background correction SO2.

lat\_grid Number of latitude bins used.

size 36 (fixed) mode Present in all modes.

o3\_grid Number of ozone bins used.

size 52 (fixed) mode Present in all modes.

detector\_rows Cross-pixel dimension.

size 450 (fixed) source L1B. mode Present in all modes.

wavelengths Wavelength dimension for the calculation of the earthshine spectra.

size 9000 (dynamic) source Processor. mode Present in all modes.

#### o3\_grid

Description:Values of ozone bins.Dimensions:o3\_grid (coordinate variable).Type:NC\_FLOAT.Source:Processor.

Attributes:		nodes.	
lat grid	Name	Value	Туре
lat arid	units	'DU' (static)	NC_STRING
<b>5</b>			
Description:	Values of the l	atitude bins.	
Dimensions:	lat_grid (coord	linate variable).	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all r	nodes.	
Attributes:	Name	Value	Туре
	units	'degrees_north' (static)	NC_STRING
window1_nor	th		
Description:	Values of the S hemisphere.	SO2 Background Correction of the first fitting	window of SO2 for the norther
Dimensions:	o3_grid, detec	tor_rows.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all r	nodes.	
Attributes:	Name	Value	Туре
	units	'mol m-2' (static)	NC_STRING
window1_sou	th		
Description:	Values of the S hemisphere.	SO2 Background Correction of the first fitting	window of SO2 for the souther
Dimensions:	o3_grid, detec	tor_rows.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all r	nodes.	
Attributes:	Name	Value	Туре
	units	'mol m-2' (static)	NC_STRING
window2			
Description:	Values of the S	SO2 Background Correction of the second fit	ting window of SO2.
Dimensions:	lat_grid, detec	tor_rows.	
Туре:	NC_FLOAT.		
	Processor.		
Source:	Present in all r	nodes.	
		Value	
Mode:	Name	Value	Туре
Mode:	Name units	'mol m-2' (static)	<i>Type</i> NC_STRING
Source: Mode: Attributes: window3			
Mode: Attributes: - window3	units		NC_STRING
Mode: Attributes: - window3	units	'mol m-2' (static) SO2 Background Correction of the third fitting	NC_STRING
Mode: Attributes: window3 Description:	units Values of the S	'mol m-2' (static) SO2 Background Correction of the third fitting	NC_STRING
Mode: Attributes: window3 Description: Dimensions:	units Values of the S lat_grid, detec	'mol m-2' (static) SO2 Background Correction of the third fitting	NC_STRING
Mode: Attributes: window3 Description: Dimensions: Type: Source:	Units Values of the S lat_grid, detect NC_FLOAT.	'mol m-2' (static) SO2 Background Correction of the third fitting tor_rows.	NC_STRING
Mode: Attributes: window3 Description: Dimensions: Type:	units Values of the S lat_grid, detec NC_FLOAT. Processor.	'mol m-2' (static) SO2 Background Correction of the third fitting tor_rows.	NC_STRING

Dimensions:	wavelengths.		
Type:	NC FLOAT.		
51	_		
Source:	Processor.		
Mode:	Present in all n	nodes.	
Attributes:	Name	Value	Туре
	units	'nm' (static)	NC_STRING
earthshine_r	eference_radia	nce	
Description:	Calculated ear	thshine spectra.	
Dimensions:	detector_rows,	wavelengths.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all n	nodes.	
Attributes:	Name	Value	Туре
	units	'mol.m-2.nm-1.sr-1.s-1' (static)	NC_STRING
•			•

# 12.20 Original and computed snow-ice flag

## Variables in snow\_ice\_flag\_var

snow_ice_fla	ng_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.				
Туре:	NC_UBYTE.	NC_UBYTE.			
Source:	Processor.	Processor.			
Mode:	Present in all mo	des.			
Attributes:	Name	Value	Туре		
	units	'1' (static)	NC_STRING		
	long_name	'snow-ice mask' (static)	NC_STRING		
	_FillValue	'254UB' (static)	NC_STRING		
	comment	'flag indicating snow/ice at center of ground pixel'	NC_STRING		
		(static)			
	source	'NSIDC/NISE' (static)	NC_STRING		

flag_meanings	'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_13_percent sea_ice_14_ percent sea_ice_15_percent sea_ice_14_ percent sea_ice_15_percent sea_ice_14_ percent sea_ice_20_percent sea_ice_21_ percent sea_ice_22_percent sea_ice_23_percent sea_ice_24_percent sea_ice_30_percent sea_ice_31_percent sea_ice_30_percent sea_ice_31_percent sea_ice_30_percent sea_ice_31_percent sea_ice_30_percent sea_ice_31_percent sea_ice_30_percent sea_ice_33_percent sea_ice_30_percent sea_ice_33_percent sea_ice_30_percent sea_ice_33_percent sea_ice_30_percent sea_ice_34_percent sea_ice_37_percent sea_ice_38_percent sea_ice_39_percent sea_ ice_40_percent sea_ice_44_percent sea_ice_42_ percent sea_ice_50_percent sea_ice_42_ percent sea_ice_50_percent sea_ice_51_percent sea_ice_52_percent sea_ice_53_percent sea_ ice_54_percent sea_ice_53_percent sea_ ice_54_percent sea_ice_53_percent sea_ ice_54_percent sea_ice_60_percent sea_ ice_61_percent sea_ice_60_percent sea_ ice_61_percent sea_ice_61_percent sea_ ice_64_percent sea_ice_62_percent sea_ ice_65_percent sea_ice_63_percent sea_ice_65_percent sea_ice_63_percent sea_ice_65_percent sea_ice_63_percent sea_ice_66_percent sea_ice_71_percent sea_ice_70_percent sea_ice_73_percent sea_ice_74_percent sea_ ice_68_percent sea_ice_74_percent sea_ice_75_percent sea_ice_76_percent sea_ice_76_percent sea_ice_80_percent sea_ice_80_percent sea_ice_81_percent sea_ ice_80_percent sea_ice_81_percent sea_ice_84_percent sea_ice_81_percent sea_ice_91_percent sea_ice_80_percent sea_ice_81_percent sea_ice_81_percent sea_ice_80_percent sea_ice_95_percent sea_ice_91_percent sea_ice_91_percent sea_ice_92_percent sea_ice_93_percent sea_ice_80_percent sea_ice_95_percent sea_ice_98_percent sea_ice_95_percent sea_ice_98_percent sea_ice_95_percent sea_ice_98_percent sea_ice_95_percent sea_ice_98_percent sea_ice_95_percent sea_ice_98_percent sea_ice_95_percent sea_ice_98_percent sea_ice_90_percent sea_ice_98_percent sea_ic	NC_UBYTE
flag_values	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,	NC_UBYTE
coordinates	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) '/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
	<b>o - - - - - - - - - -</b>	

	coordinates in this case is not specified in the climate and forecast metadata conven- tions [ER5].			
snow_ice_fla	g			
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.			
Туре:	NC_UBYTE.			
Source:	Processor.			
Mode:	Present in all mode	PS.		
Attributes:	Name	Value	Туре	
	units	'1' (static)	NC_STRING	
	threshold	'0.3' (static)	NC_STRING	
	The threshold in percentage to identify the pixel as snow/ice or snow free.			
	long_name	'snow-ice mask' (static)	NC_STRING	
	_FillValue	'254UB' (static)	NC_STRING	
	comment	'flag indicating snow/ice at center of ground pixel' (static)	NC_STRING	
	source		NC_STRING	
	Possible values: NSIDC/NISE, Fallback_climatology			
	flag_meanings	'snow-free_land snow_ice' (static)	NC_STRING	
	flag_values	0, 1 (static)	NC_UBYTE	
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING	
		ngitude are in a different group. How to specify the r case is not specified in the climate and forecast r		

The latitude and longitude are in a different group. How to specify the related geospatial

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

Variables in main_cloud	l_product_crb
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cloud fractio	on crb			
Description:	Retrieved effective radiometric cloud fraction using the OCRA/ROCINN CRB model.			
, Dimensions:	time, scanline, grou	-		
Туре:	NC_FLOAT.	—		
Source:	Processor.			
Mode:	Present in all mode	S.		
Attributes:	Name	Value	Туре	
	units	'1' (static)	NC_STRING	
	Dimensionless unit.	This attribute originates from the NUG, CF standard	S.	
	standard_name	'TBD' (static)	NC_STRING	
	long_name	'effective radiometric cloud fraction from the CRB model' (static)	NC_STRING	
	source	'crb' (static)	NC_STRING	
	comment	'Retrieved effective radiometric cloud fraction using the OCRA/ROCINN CRB model.' (static)	NC_STRING	

	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
		gitude coordinates of the TROPOMI swath is not definent and longitude axes. This attribute originates from the C	
cloud_fractio	on_crb_precision		
Description:	Error of the retrieve model.	ed effective radiometric cloud fraction using the OCF	A/ROCINN CRE
Dimensions:	time, scanline, grou	nd_pixel.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all modes	S.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	Dimensionless unit.	This attribute originates from the NUG, CF standards	6.
	standard_name	'TBD' (static)	NC_STRING
	long_name	'effective radiometric cloud fraction precision from the CRB model' (static)	NC_STRING
	source	'crb' (static)	NC_STRING
	comment	'Error of the retrieved effective radiometric cloud fraction 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 press	•	nd longitude axes. This attribute originates from the 0	CF standard.
-	ure_crb		
Description:	ure_crb Retrieved atmosphe	ric pressure at the level of cloud using the OCRA/ROC	
Description: Dimensions:	ure_crb Retrieved atmosphe time, scanline, grou	ric pressure at the level of cloud using the OCRA/ROC	
Description: Dimensions: Type:	ure_crb Retrieved atmosphe time, scanline, grout NC_FLOAT.	ric pressure at the level of cloud using the OCRA/ROC	
Description: Dimensions: Type: Source:	Retrieved atmosphe time, scanline, groun NC_FLOAT. Processor.	ric pressure at the level of cloud using the OCRA/ROC nd_pixel.	
Description: Dimensions: Type: Source: Mode:	ure_crb Retrieved atmosphe time, scanline, groun NC_FLOAT. Processor. Present in all modes	ric pressure at the level of cloud using the OCRA/ROC nd_pixel.	CINN CRB model
Description: Dimensions: Type: Source: Mode:	ure_crb Retrieved atmosphe time, scanline, groun NC_FLOAT. Processor. Present in all modes Name	ric pressure at the level of cloud using the OCRA/ROC nd_pixel. s. <i>Value</i>	CINN CRB model
Description: Dimensions: Type: Source: Mode:	ure_crb Retrieved atmosphe time, scanline, groun NC_FLOAT. Processor. Present in all modes Name units	ric pressure at the level of cloud using the OCRA/ROC nd_pixel. s. <u>Value</u> 'Pa' (static)	CINN CRB model <i>Type</i> NC_STRING
Description: Dimensions: Type: Source: Mode:	ure_crb Retrieved atmosphe time, scanline, groun NC_FLOAT. Processor. Present in all modes Name	ric pressure at the level of cloud using the OCRA/ROC nd_pixel. s. <u>Value</u> 'Pa' (static) 'TBD' (static) 'cloud radiometric optical centroid pressure from	CINN CRB model
cloud_press Description: Dimensions: Type: Source: Mode: Attributes:	ure_crb Retrieved atmosphe time, scanline, groun NC_FLOAT. Processor. Present in all modes Name units standard_name long_name	ric pressure at the level of cloud using the OCRA/ROC nd_pixel. s. <u>Value</u> 'Pa' (static) 'TBD' (static) 'cloud radiometric optical centroid pressure from the CRB model' (static)	Type NC_STRING NC_STRING NC_STRING
Description: Dimensions: Type: Source: Mode:	ure_crb Retrieved atmosphe time, scanline, grout NC_FLOAT. Processor. Present in all modes Name units standard_name	ric pressure at the level of cloud using the OCRA/ROC nd_pixel. s. <u>Value</u> 'Pa' (static) 'TBD' (static) 'cloud radiometric optical centroid pressure from	CINN CRB model <i>Type</i> NC_STRING NC_STRING
Description: Dimensions: Type: Source: Mode:	ure_crb Retrieved atmosphe time, scanline, groun NC_FLOAT. Processor. Present in all modes Name units standard_name long_name source	ric pressure at the level of cloud using the OCRA/ROC nd_pixel. s. Value 'Pa' (static) 'TBD' (static) 'cloud radiometric optical centroid pressure from the CRB model' (static) 'crb' (static) 'Retrieved atmospheric pressure at the level of cloud using the OCRA/ROCINN CRB model.'	Type NC_STRING NC_STRING NC_STRING NC_STRING
Description: Dimensions: Type: Source: Mode:	ure_crb         Retrieved atmosphe         time, scanline, grout         NC_FLOAT.         Processor.         Present in all modes         Name         units         standard_name         long_name         source         comment         coordinates         The latitude and long	ric pressure at the level of cloud using the OCRA/ROC nd_pixel. s. <u>Value</u> 'Pa' (static) 'TBD' (static) 'cloud radiometric optical centroid pressure from the CRB model' (static) 'crb' (static) 'Retrieved atmospheric pressure at the level of cloud using the OCRA/ROCINN CRB model.' (static)	Type NC_STRING NC_STRING NC_STRING NC_STRING NC_STRING NC_STRING NC_STRING ed as a Cartesian
Description: Dimensions: Type: Source: Mode: Attributes:	ure_crb         Retrieved atmosphe         time, scanline, grout         NC_FLOAT.         Processor.         Present in all modes         Name         units         standard_name         long_name         source         comment         coordinates         The latitude and long	ric pressure at the level of cloud using the OCRA/ROC nd_pixel. s. Value 'Pa' (static) 'TBD' (static) 'Cloud radiometric optical centroid pressure from the CRB model' (static) 'crb' (static) 'Retrieved atmospheric pressure at the level of cloud using the OCRA/ROCINN CRB model.' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) gitude coordinates of the TROPOMI swath is not define	Type NC_STRING NC_STRING NC_STRING NC_STRING NC_STRING NC_STRING NC_STRING ed as a Cartesiar
Description: Dimensions: Type: Source: Mode: Attributes: Attributes:	ure_crb         Retrieved atmosphe         time, scanline, grout         NC_FLOAT.         Processor.         Present in all modes         Name         units         standard_name         long_name         source         comment         coordinates         The latitude and long         product of latitude a         ure_crb_precision	ric pressure at the level of cloud using the OCRA/ROC nd_pixel. s. Value 'Pa' (static) 'TBD' (static) 'Cloud radiometric optical centroid pressure from the CRB model' (static) 'crb' (static) 'Retrieved atmospheric pressure at the level of cloud using the OCRA/ROCINN CRB model.' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) gitude coordinates of the TROPOMI swath is not define	Type NC_STRING NC_STRING NC_STRING NC_STRING NC_STRING NC_STRING NC_STRING NC_STRING ed as a Cartesiar CF standard.
Description: Dimensions: Type: Source: Mode: Attributes: Attributes: cloud_press Description:	ure_crb         Retrieved atmosphe         time, scanline, grout         NC_FLOAT.         Processor.         Present in all modes         Name         units         standard_name         long_name         source         comment         recordinates         The latitude and long         product of latitude a         ure_crb_precision         Error of the retrieved	ric pressure at the level of cloud using the OCRA/ROC nd_pixel. s. Value 'Pa' (static) 'TBD' (static) 'cloud radiometric optical centroid pressure from the CRB model' (static) 'crb' (static) 'Retrieved atmospheric pressure at the level of cloud using the OCRA/ROCINN CRB model.' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) gitude coordinates of the TROPOMI swath is not define and longitude axes. This attribute originates from the C	Type NC_STRING NC_STRING NC_STRING NC_STRING NC_STRING NC_STRING NC_STRING NC_STRING ed as a Cartesiar CF standard.
Description: Dimensions: Type: Source: Mode: Attributes: Attributes: cloud_press Description: Dimensions:	ure_crb         Retrieved atmosphe         time, scanline, ground         NC_FLOAT.         Processor.         Present in all modes         Name         units         standard_name         long_name         source         comment         reduct of latitude and long         product of latitude a         ure_crb_precision         Error of the retrieved         CRB model.	ric pressure at the level of cloud using the OCRA/ROC nd_pixel. s. Value 'Pa' (static) 'TBD' (static) 'cloud radiometric optical centroid pressure from the CRB model' (static) 'crb' (static) 'Retrieved atmospheric pressure at the level of cloud using the OCRA/ROCINN CRB model.' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) gitude coordinates of the TROPOMI swath is not define and longitude axes. This attribute originates from the C	Type NC_STRING NC_STRING NC_STRING NC_STRING NC_STRING NC_STRING NC_STRING NC_STRING ed as a Cartesiar CF standard.
Description: Dimensions: Type: Source: Mode: Attributes:	ure_crb         Retrieved atmosphe         time, scanline, grout         NC_FLOAT.         Processor.         Present in all modes         Name         units         standard_name         long_name         source         comment         recordinates         The latitude and long         product of latitude a         ure_crb_precision         Error of the retrieved         CRB model.         time, scanline, grout	ric pressure at the level of cloud using the OCRA/ROC nd_pixel. s. Value 'Pa' (static) 'TBD' (static) 'cloud radiometric optical centroid pressure from the CRB model' (static) 'crb' (static) 'Retrieved atmospheric pressure at the level of cloud using the OCRA/ROCINN CRB model.' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) gitude coordinates of the TROPOMI swath is not define and longitude axes. This attribute originates from the C	Type NC_STRING NC_STRING NC_STRING NC_STRING NC_STRING NC_STRING NC_STRING NC_STRING ed as a Cartesiar CF standard.
Description: Dimensions: Type: Source: Mode: Attributes: Attributes: Cloud_press Description: Dimensions: Type:	ure_crb         Retrieved atmosphe         time, scanline, ground         NC_FLOAT.         Processor.         Present in all modes         Name         units         standard_name         long_name         source         comment         coordinates         The latitude and long         product of latitude and long         product of latitude and long         product of latitude and long         Lerror of the retrieved         CRB model.         time, scanline, ground         NC_FLOAT.	ric pressure at the level of cloud using the OCRA/ROC nd_pixel. s. <u>Value</u> 'Pa' (static) 'TBD' (static) 'cloud radiometric optical centroid pressure from the CRB model' (static) 'crb' (static) 'Retrieved atmospheric pressure at the level of cloud using the OCRA/ROCINN CRB model.' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) gitude coordinates of the TROPOMI swath is not define nd longitude axes. This attribute originates from the C	Type NC_STRING NC_STRING NC_STRING NC_STRING NC_STRING NC_STRING NC_STRING NC_STRING ed as a Cartesiar CF standard.

	units	'Pa' (static)	NC_STRING
	standard_name	'TBD' (static)	NC_STRING
	long_name	'cloud radiometric optical centroid pressure preci- sion from the CRB model' (static)	NC_STRING
	source	'crb' (static)	NC_STRING
	comment	'Error of the retrieved atmospheric pressure at the level of cloud using the OCRA/ROCINN CRB model.' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
		gitude coordinates of the TROPOMI swath is not defin and longitude axes. This attribute originates from the (	
cloud_height	_		
Description:	Retrieved height at model.	the level of cloud w.r.t. the geoid/MSL using the OCF	RA/ROCINN CR
Dimensions:	time, scanline, grou	nd_pixel.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all mode	S.	
Attributes:	Name	Value	Туре
	units	'm' (static)	NC_STRING
	standard_name	'TBD' (static)	NC_STRING
	long_name	'cloud radiometric optical centroid height from the CRB model' (static)	NC_STRING
	source	'crb' (static)	NC_STRING
	comment	'Retrieved 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
		gitude coordinates of the TROPOMI swath is not defin and longitude axes. This attribute originates from the (	
cloud_height	_crb_precision		
Description:	Error of the retrie OCRA/ROCINN CF		d/MSL using th
Dimensions:	time, scanline, grou	nd_pixel.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all mode	S.	
Attributes:	Name	Value	Туре
	units	'm' (static)	NC_STRING
	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 retrieved 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
		gitude coordinates of the TROPOMI swath is not defin	ed as a Cartesia
	product of latitude a	and longitude axes. This attribute originates from the (	JF standard.

Description:	Albedo of cloud using the OCRA/ROCINN CRB model.			
Dimensions:	time, scanline, ground_pixel.			
Туре:	NC_FLOAT.			
Source:	Processor.			
Mode:	Present in all mode	S.		
Attributes:	Name	Value	Туре	
	units	'1' (static)	NC_STRING	
	Dimensionless unit.	This attribute originates from the NUG, CF standard	S.	
	standard_name	'cloud_albedo' (static)	NC_STRING	
	long_name	'cloud albedo from the CRB model' (static)	NC_STRING	
	source	'crb' (static)	NC_STRING	
	comment	'Albedo of cloud using the OCRA/ROCINN CRB model.' (static)	NC_STRING	
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING	
		gitude coordinates of the TROPOMI swath is not defin and longitude axes. This attribute originates from the 0		
cloud_albed	o_crb_precision			
Description:	Error of the albedo	of cloud using the OCRA/ROCINN CRB model.		
Dimensions:	time, scanline, grou	nd_pixel.		
Туре:	NC_FLOAT.			
Source:	Processor.			
Mode:	Present in all mode	S.		
Attributes:	Name	Value	Туре	
	units	'1' (static)	NC_STRING	
	Dimensionless unit. This attribute originates from the NUG, CF standards.			
	standard_name	'cloud_albedo_standard_error' (static)	NC_STRING	
	long_name	'cloud albedo precision from the CRB model' (static)	NC_STRING	
	source	'crb' (static)	NC_STRING	
	comment	'Error of the albedo of cloud using the OCRA/ ROCINN CRB model.' (static)	NC_STRING	
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING	
		gitude coordinates of the TROPOMI swath is not defin and longitude axes. This attribute originates from the 0		

# 12.22 Common input data for O3\_\_\_\_ and O3\_TCL products

ozone_total_	vertical_colu	Imn	
Description:	Main output data of $O_3$ Total column product calculated with DOAS algorithm for near real time processing, while for offline and reprocessing the $O_3$ is calculated with GODfit algorithm		
	< <b>TBA #4</b> > 7	he units and other attrib	utes still have to be added.
Dimensions:	time, scanlir	ne, ground_pixel.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all modes.		
Attributes:	Name	Value	Туре

	units	'mol m-2' (static)	NC_STRING
	standard_name	'atmosphere_mole_content_of_ozone' (static)	NC_STRING
	long_name	'total ozone column' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
		gitude coordinates of the TROPOMI swath is not definent not definent and longitude axes. This attribute originates from the	
	multiplication factor_to_con- vert_to_DU	2241.15 (static)	NC_FLOAT
	value this means th "DU" or Dobson Uni	entinel 5 precursor files are given in SI units. For an i at the unit is $mol m^{-2}$ . Traditionally the unit for an interts. This attribute provides the multiplication factor to the value in $mol m^{-2}$ . This is provided as a convenient in DU.	egrated column is calculate the tota
	multiplication factor_to_con- vert_to_mo- lecules_percm2	6.02214e+19 (static)	NC_FLOAT
	value this means th is "molecules cm <sup>-2</sup> ". column in molecules	entinel 5 precursor files are given in SI units. For an i hat the unit is $mol m^{-2}$ . Traditionally the unit for an i This attribute provides the multiplication factor to $ccm^{-2}$ from the value in $mol m^{-2}$ . This is provided as is that work in molecules cm <sup>-2</sup> .	ntegrated columr calculate the tota
ozone total	vertical_column_pro	ecision	
Description:	processing, while fo	Total column product calculated with DOAS algorithm r offline and reprocessing the $O_3$ is calculated with G and other attributes still have to be added.	
Dimensions:	time, scanline, grou	nd pixel.	
Туре:	NC FLOAT.	—	
Source:	Processor.		
Mode:	Present in all modes	5.	
Attributes:	Name	Value	Туре
	units	'mol m-2' (static)	NC_STRING
	standard name	'atmosphere_mole_content_of_ozone error' (static)	NC STRING
	long_name	'total ozone column random error' (static)	NC STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC STRING
		gitude coordinates of the TROPOMI swath is not defin	_
		nd longitude axes. This attribute originates from the	
	multiplication	2241.15 (static)	NC_FLOAT
	factor_to_con- vert_to_DU		
	value this means th "DU" or Dobson Uni	entinel 5 precursor files are given in SI units. For an i at the unit is $mol m^{-2}$ . Traditionally the unit for an inter- ts. This attribute provides the multiplication factor to the value in $mol m^{-2}$ . This is provided as a convenie is in DU.	egrated column is calculate the tota
	multiplication	6.02214e+19 (static)	NC_FLOAT

The quantities in Sentinel 5 precursor files are given in SI units. For an integrated column value this means that the unit is  $mol m^{-2}$ . Traditionally the unit for an integrated column is "molecules cm<sup>-2</sup>". This attribute provides the multiplication factor to calculate the total column in molecules cm<sup>-2</sup> from the value in  $mol m^{-2}$ . This is provided as a convenience to users who have tools that work in molecules cm<sup>-2</sup>.

## 12.23 Additional data support fields

surface_altit	ude		
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.		
Туре:	NC_FLOAT.		
Source:	surface elevation da	atabase.	
Mode:	Present in all mode	S.	
Attributes:	Name	Value	Туре
	long_name	'surface altitude' (static)	NC_STRING
	standard_name	'surface_altitude' (static)	NC_STRING
	units	'm' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
		ngitude are in a different group. How to specify the r case is not specified in the climate and forecast r	
	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 ap-	NC_STRING
		proximate field of view, based on the GMTED2010 surface elevation database' (static)	
surface_altit	ude_precision	•	
surface_altite Description:	The standard deviat	surface elevation database' (static) ion of sub-pixels used in calculating the mean surface GS84) within the approximate field of view, based on	
Description:	The standard deviat reference geoid (W	surface elevation database' (static) tion of sub-pixels used in calculating the mean surface GS84) within the approximate field of view, based on atabase.	
Description: Dimensions:	The standard deviat reference geoid (W surface elevation da	surface elevation database' (static) tion of sub-pixels used in calculating the mean surface GS84) within the approximate field of view, based on atabase.	
Description: Dimensions: Type:	The standard deviat reference geoid (W surface elevation da time, scanline, grou	surface elevation database' (static) ion of sub-pixels used in calculating the mean surface GS84) within the approximate field of view, based on atabase. Ind_pixel.	
Description: Dimensions: Type: Source:	The standard deviat reference geoid (W surface elevation da time, scanline, grou NC_FLOAT.	surface elevation database' (static) tion of sub-pixels used in calculating the mean surface GS84) within the approximate field of view, based on atabase. nd_pixel.	
Description: Dimensions: Type: Source: Mode:	The standard deviat reference geoid (W surface elevation da time, scanline, grou NC_FLOAT. surface elevation da	surface elevation database' (static) tion of sub-pixels used in calculating the mean surface GS84) within the approximate field of view, based on atabase. nd_pixel.	
Description: Dimensions: Type: Source: Mode:	The standard deviat reference geoid (W surface elevation da time, scanline, grou NC_FLOAT. surface elevation da Present in all mode	surface elevation database' (static) ion of sub-pixels used in calculating the mean surface GS84) within the approximate field of view, based on atabase. Ind_pixel. atabase. s.	the GMTED2010
_	The standard deviat reference geoid (W surface elevation da time, scanline, grou NC_FLOAT. surface elevation da Present in all mode Name	surface elevation database' (static) tion of sub-pixels used in calculating the mean surface GS84) within the approximate field of view, based on atabase. nd_pixel. atabase. s. Value	the GMTED2010
Description: Dimensions: Type: Source: Mode:	The standard deviat reference geoid (W surface elevation da time, scanline, grou NC_FLOAT. surface elevation da Present in all mode Name long_name	surface elevation database' (static) ion of sub-pixels used in calculating the mean surface GS84) within the approximate field of view, based on atabase. nd_pixel. atabase. s. Value 'surface altitude precision' (static)	the GMTED2010 <i>Type</i> NC_STRING
Description: Dimensions: Type: Source: Mode:	The standard deviat reference geoid (W surface elevation da time, scanline, grou NC_FLOAT. surface elevation da Present in all mode <i>Name</i> long_name standard_name	surface elevation database' (static) tion of sub-pixels used in calculating the mean surface GS84) within the approximate field of view, based on atabase. Ind_pixel. atabase. s. Value 'surface altitude precision' (static) 'surface_altitude standard_error' (static)	the GMTED2010 <i>Type</i> NC_STRING NC_STRING
Description: Dimensions: Type: Source: Mode:	The standard deviat reference geoid (W surface elevation da time, scanline, grou NC_FLOAT. surface elevation da Present in all mode Name long_name standard_name units standard_error	surface elevation database' (static) tion of sub-pixels used in calculating the mean surface GS84) within the approximate field of view, based on atabase. nd_pixel. atabase. s. <u>Value</u> 'surface altitude precision' (static) 'surface_altitude standard_error' (static) 'm' (static)	the GMTED2010 Type NC_STRING NC_STRING NC_STRING
Description: Dimensions: Type: Source: Mode:	The standard deviat reference geoid (W surface elevation da time, scanline, grou NC_FLOAT. surface elevation da Present in all mode Name long_name standard_name units standard_error multiplier coordinates The latitude and lo	surface elevation database' (static) tion of sub-pixels used in calculating the mean surface GS84) within the approximate field of view, based on atabase. Ind_pixel. atabase. s. Value 'surface altitude precision' (static) 'surface_altitude standard_error' (static) 'm' (static) 1.0 (static)	the GMTED2010 <i>Type</i> NC_STRING NC_STRING NC_STRING NC_FLOAT NC_STRING related geospatia

	comment	'The standard deviation of sub-pixels used in cal- culating the mean surface altitude above the refer- ence geoid (WGS84) within the approximate field of view, based on the GMTED2010 surface elevation database' (static)	NC_STRING
surface_class	sification		
Description: Dimensions: Type: Source:	time, scanline, grou NC_UBYTE.	land/water mask and surface classification data field. ind_pixel. atabase (including flag attributes).	
Mode:	Present in all mode	S.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	long_name	'land-water mask' (static)	NC_STRING
	comment	'flag indicating land/water and further surface clas- sifications for the ground pixel' (static)	NC_STRING
	source	'USGS (http://edc2.usgs.gov/glcc/globdoc2 0.php) and NASA SDP toolkit (http:// newsroom.gsfc.nasa.gov/sdptoolkit/toolkit.html)' (static)	NC_STRING
	flag_meanings	'land, water, some_water, coast, value_cov- ers_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)	NC_STRING
	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 (static)	NC_UBYTE
	flag_masks	3, 3, 3, 3, 4, 249, 249, 249, 249, 249, 249, 249,	NC_UBYTE
·	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
		ngitude are in a different group. How to specify the r case is not specified in the climate and forecast r	

Description: Dimensions:	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-DEMs) 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. time, scanline.		
Туре:	NC_INT.		
Source:	L1B.		
Mode:	Present in all mode	9S.	
Attributes:	Name	Value	Туре
	long_name	'IcID' (static)	NC_STRING
	comment	'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)	NC_STRING
instrument_c	configuration_version	on	
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 using with a new IcVersion.		
Dimensions:	time, scanline.		
Туре:	NC_SHORT.		
Source:	L1B.		
Mode:	Present in all mode	9S.	
Attributes:	Name	Value	Туре
	long_name	'IcVersion' (static)	NC_STRING
	comment	'Version of the instrument_configuration_identifier' (static)	NC_STRING

#### scaled\_small\_pixel\_variance

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

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

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

$$V_{\text{scaled}}(t,r,c) = \frac{V(t,r,c)}{\langle R(t,r,c) \rangle^2}$$
(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  $R = (\pi I)/(\mu_0 E_0)$ , with I the radiance,  $E_0$  the irradiance and  $\mu_0 = \cos(\vartheta_0)$ , where  $\vartheta_0$  is the solar zenith angle.

Dimensions:	time, scanline, grou	nd_pixel.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all mode	S.	
Attributes:	Name	Value	Туре
	long_name	'scaled small pixel variance' (static)	NC_STRING
	units	'1' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
		ngitude are in a different group. How to specify the r case is not specified in the climate and forecast r	• •
	comment	'The scaled variance of the reflectances of the small pixels' (static)	NC_STRING
	radiation_wavelen	gth	NC_FLOAT
		avelength of the small pixel column in nm. Note that c that the start of the ground_pixel index.	lue to the spectral

## 12.24 Input data common to all the L2 DLR products

#### Variables in input\_data

The variables described in section 12.23 "Additional data support fields" on page 66 are included in the output at this location.

surface_pres	sure		
Description:	Surface pressure from ECMWF model data.		
Dimensions:	time, scanline, grou	nd_pixel.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all mode	S.	
Attributes:	Name	Value	Туре
	units	'Pa' (static)	NC_STRING
	standard_name	'surface_air_pressure' (static)	NC_STRING
	long_name	'surface_air_pressure' (static)	NC_STRING
	source		NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
		ngitude are in a different group. How to specify the r case is not specified in the climate and forecast r	<b>v</b> 1

### 12.24.1 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

Group attributes attached to PROCESSOR		
Name	Value	Туре

processing_configuration	'Processing configuration used to generate the current	NC_STRING
	product' (static)	

## 12.25 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.

Name	Value	Туре
number_of_groundpixels	0 (static)	NC_INT
Number of ground pixels in the	file.	
number_of_processed pixels	0 (static)	NC_INT
÷ .	a retrieval was attempted. This is the number_of ed on time or configuration (range and step-size in	
number_of_successfully processed_pixels	0 (static)	NC_INT
Number of ground pixels where	a retrieval was successful.	
number_of_rejected_pixels not_enough_spectrum	0 (static)	NC_INT
	ng was not attempted because after filtering for bad left in either the radiance, irradiance or after calcu	•
number_of_failed_retrievals	0 (static)	NC_INT
Number of pixels where process	sing failed for whatever reason.	
number_of_ground_pixels with_warnings	0 (static)	NC_INT
Number of pixels with one or mo	pre warnings.	
number_of_radiance_miss- ing_occurrences	0 (static)	NC_INT
÷ .	e processing error "the number of spectral pixels n the fitting" occurred, i.e. where the lower 8 bits e "1".	
number_of_irradiance_miss- ing_occurrences	0 (static)	NC_INT
	e processing error "the number of spectral pixels n the fitting" occurred, i.e. where the lower 8 bits e "2".	
number_of_input_spec- trum_missing_occurrences	0 (static)	NC_INT
to perform the retrieval. This is	processing error "the reflectance spectrum does no different from (ir)radiance_missing in that the mis e lower 8 bits of the processing_quality_fla	ssing points may not be
number_of_reflectance range_error_occurrences	0 (static)	NC_INT
number_of_ler_range_er- ror_occurrences	0 (static)	NC_INT
÷	processing error "lambert-equivalent reflectivity out processing_quality_flags have the value	-

number_of_snr_range_er- ror_occurrences	0 (static)	NC_INT
	processing error "too low signal to noise to per ocessing_quality_flags have the value "	
number_of_sza_range_er- ror_occurrences	0 (static)	NC_INT
	e processing error "solar zenith angle out of ra ere the lower 8 bits of the processing_qual.	
number_of_vza_range_er-	0 (static)	NC_INT
ror_occurrences		
	processing error "viewing zenith angle out of r ere the lower 8 bits of the processing_qual.	
number_of_lut_range_er- ror_occurrences	0 (static)	NC_INT
÷ .	e processing error "extrapolation in lookup ta the lower 8 bits of the processing_quality	
number_of_ozone_range_er- ror_occurrences	0 (static)	NC_INT
÷ .	e processing error "ozone column significantly the lower 8 bits of the processing_quali	
number_of_wavelength_off- set_error_occurrences	0 (static)	NC_INT
Number of ground pixels where	processing error "wavelength offset exceeds m bits of the processing_quality_flags ha	
number_of_initialization_er- ror_occurrences	0 (static)	NC_INT
output was generated. The foll wavelengths; The on-ground dis the configuration. Derived a-pri	processing error "an error occurred during the owing errors raise this flag: Mismatch betwee tance between band 1 and band 2 ground pixels ori information does not validate, no processin occessing_quality_flags have the value "	en irradiance and radiance s exceeds a threshold set in ng is possible" occurred, i.e
	0 (static)	NC_INT
÷ .	e processing error "memory allocation or deall ocessing_quality_flags have the value "	
number_of_assertion_er- ror_occurrences	0 (static)	NC_INT
÷ .	processing error "error in algorithm detected du ocessing_quality_flags have the value "	-
number_of_io_error_occur-	0 (static)	NC_INT
	processing error "error detected during transfe nere the lower 8 bits of the processing_qual	
number_of_numerical_er- ror_occurrences	0 (static)	NC_INT
—	processing error "general fatal numerical error	r accurred during inversion

number_of_lut_error_occur- rences	0 (static)	NC_INT
÷ .	processing error "error in accessing the lookup ta ing_quality_flags have the value "17".	able" occurred, i.e. where
number_of_ISRF_error_oc- currences	0 (static)	NC_INT
	processing error "error detected in the input instr e. where the lower 8 bits of the processing_qu	
number_of_convergence_er- ror_occurrences	0 (static)	NC_INT
	processing error "the main algorithm did not conve ing_quality_flags have the value "19".	erge" occurred, i.e. where
number_of_cloud_filter convergence_error_occur- rences	0 (static)	NC_INT
<b>v</b> .	processing error "the cloud filter did not converge _quality_flags have the value "20".	" occurred, i.e. where the
number_of_max_iteration convergence_error_occur- rences	0 (static)	NC_INT
	processing error "no convergence because retuin value from configuration" occurred, i.e. where have the value "21"	
number_of_aot_lower	0 (static)	NC_INT
boundary_convergence_er-		
ror_occurrences		
÷ .	processing error "no convergence because the n succession" occurred, i.e. where the lower 8 b e "22".	•
number_of_other_bound- ary_convergence_error_oc- currences	0 (static)	NC_INT
Number of ground pixels where	processing error "no convergence because a stat Note that a separate failure flag is defined for	
crossing of lower AOT boundar flags have the value "23".	y" occurred, i.e. where the lower 8 bits of the ${\tt p}$	rocessing_quality_
number_of_geolocation_er-	0 (static)	NC_INT
<pre>ror_occurrences Number of ground pixels where p bits of the processing_quali</pre>	processing error "geolocation out of range" occurr	ed, i.e. where the lower
number_of_ch4_noscat	0 (static)	NC_INT
zero_error_occurrences	- ()	
	e processing error "the $CH_4$ column retrieved b strong band is 0" occurred, i.e. where the lower 8 b e "25".	
number_of_h2o_noscat zero_error_occurrences	0 (static)	NC_INT
Number of ground pixels where	e processing error "the $H_2O$ column retrieved b strong band is 0" occurred, i.e. where the lower 8 b	

quality\_flags have the value "26".

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number_of_max_optical thickness_error_occur- rences	0 (static)	NC_INT
Number of ground pixels where	processing error "maximum optical thicknes bits of the processing_quality_flags	÷
number_of_aerosol_bound- ary_error_occurrences	0 (static)	NC_INT
÷ .	e processing error "boundary hit of aerosol bits of the processing_quality_flags	•
number_of_boundary_hit error_occurrences	0 (static)	NC_INT
÷ .	processing error "fatal boundary hit during ite ing_quality_flags have the value "29".	erations" occurred, i.e. where
number_of_chi2_error_oc-	0 (static)	NC_INT
	e processing error " $\chi^2$ is not-a-number or la <code>ocessing_quality_flags</code> have the value	
number_of_svd_error_oc- currences	0 (static)	NC_INT
Number of ground pixels where	processing error "singular value decompositio ing_quality_flags have the value "31".	n failure" occurred, i.e. where
number_of_dfs_error_occur- rences	0 (static)	NC_INT
	processing error "degree of freedom is not-a- ing_quality_flags have the value "32".	number" occurred, i.e. where
number_of_radiative_trans- fer_error_occurrences	0 (static)	NC_INT
• • •	processing error "errors occurred during the random i.e. where the lower 8 bits of the process	•
number_of_optimal_estima- tion_error_occurrences	0 (static)	NC_INT
<b>°</b> 1	processing error "errors occurred during the c i.e. where the lower 8 bits of the processing	
number_of_profile_error_oc- currences	0 (static)	NC_INT
Number of ground pixels where	e processing error "flag that indicates if ther e" occurred, i.e. where the lower 8 bits of th	
number_of_cloud_error_oc- currences	0 (static)	NC_INT
Number of ground pixels where processing_quality_flags	processing error "no cloud data" occurred, i.e	. where the lower 8 bits of the
number_of_model_error_oc- currences	0 (static)	NC_INT
Number of ground pixels where	processing error "forward model failure" occ ty_flags have the value "37".	curred, i.e. where the lower 8
number_of_number_of_in- put_data_points_too_low error_occurrences	0 (static)	NC_INT

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".

	0 (static)	NC_INT
sure_spread_too_low_er-		
ror_occurrences		
	processing error "cloud pressure variability to low to the lower 8 bits of the processing_quality_fla	
number_of_cloud_too_low	0 (static)	NC_INT
level_error_occurrences		
	processing error "clouds are too low in the atmosphered bits of the processing_quality_fl	
number_of_generic_range error_occurrences	0 (static)	NC_INT
Number of ground pixels where of the processing_quality.	processing error "generic range error" occurred, i.	e. where the lower 8 bits
number_of_generic_excep-	0 (static)	NC_INT
tion_occurrences		
Number of ground pixels where	e processing error "catch all generic error" occurre	d, i.e. where the lower 8
	ity_flags have the value "42".	
number_of_input_spec- trum_alignment_error_oc-	0 (static)	NC_INT
currences		
	e processing error "input radiance and irradiance he lower 8 bits of the processing_quality_fl	
number_of_abort_error_oc- currences	0 (static)	NC_INT
÷ .	e processing error "not processed because proces ed, i.e. where the lower 8 bits of the processing.	
number_of_wrong_input type_error_occurrences	0 (static)	NC_INT
number_of_wrong_input type_error_occurrences Number of ground pixels where	0 (static) e processing error "wrong input type error, mismat e. where the lower 8 bits of the processing_qu	ch between expectation
number_of_wrong_input type_error_occurrences Number of ground pixels where and received data" occurred, i.	e processing error "wrong input type error, mismat	ch between expectation
number_of_wrong_input type_error_occurrences Number of ground pixels where and received data" occurred, i. value "45". number_of_wavelength_cal- ibration_error_occurrences Number of ground pixels where	e processing error "wrong input type error, mismat e. where the lower 8 bits of the processing_qu	cch between expectation ality_flags have the NC_INT length calibration of this
number_of_wrong_input type_error_occurrences Number of ground pixels where and received data" occurred, i. value "45". number_of_wavelength_cal- ibration_error_occurrences Number of ground pixels where	e processing error "wrong input type error, mismat e. where the lower 8 bits of the processing_qu 0 (static) e processing error "an error occurred in the wave	cch between expectation ality_flags have the NC_INT length calibration of this
number_of_wrong_input type_error_occurrences Number of ground pixels where and received data" occurred, it value "45". number_of_wavelength_cal- ibration_error_occurrences Number of ground pixels where pixe" occurred, i.e. where the lo number_of_coregistration error_occurrences Number of ground pixels where	e processing error "wrong input type error, mismat e. where the lower 8 bits of the processing_qu 0 (static) e processing error "an error occurred in the wave ower 8 bits of the processing_quality_flags 0 (static) e processing error "no colocated pixels found in a s	the between expectation ality_flags have the NC_INT length calibration of this have the value "46". NC_INT upporting ban" occurred,
number_of_wrong_input type_error_occurrences Number of ground pixels where and received data" occurred, it value "45". number_of_wavelength_cal- ibration_error_occurrences Number of ground pixels where pixe" occurred, i.e. where the lo number_of_coregistration error_occurrences Number of ground pixels where	e processing error "wrong input type error, mismate. e. where the lower 8 bits of the processing_qu 0 (static) e processing error "an error occurred in the wave ower 8 bits of the processing_quality_flags 0 (static)	the between expectation ality_flags have the NC_INT length calibration of this have the value "46". NC_INT upporting ban" occurred,
number_of_wrong_input type_error_occurrences Number of ground pixels where and received data" occurred, it value "45". number_of_wavelength_cal- ibration_error_occurrences Number of ground pixels where pixe" occurred, i.e. where the lo number_of_coregistration error_occurrences Number of ground pixels where i.e. where the lower 8 bits of th number_of_slant_column density_error_occurrences Number of ground pixels where	e processing error "wrong input type error, mismat e. where the lower 8 bits of the processing_qu 0 (static) e processing error "an error occurred in the wave ower 8 bits of the processing_quality_flags 0 (static) e processing error "no colocated pixels found in a s e processing_quality_flags have the value	Ach between expectation ality_flags have the NC_INT length calibration of this have the value "46". NC_INT upporting ban" occurred, "47". NC_INT
number_of_wrong_input type_error_occurrences Number of ground pixels where and received data" occurred, i. value "45". number_of_wavelength_cal- ibration_error_occurrences Number of ground pixels where pixe" occurred, i.e. where the low number_of_coregistration error_occurrences Number of ground pixels where i.e. where the lower 8 bits of th number_of_slant_column density_error_occurrences Number of ground pixels where occurred, i.e. where the lower 8 number_of_slant_column	e processing error "wrong input type error, mismalle. where the lower 8 bits of the processing_qu 0 (static) e processing error "an error occurred in the wave ower 8 bits of the processing_quality_flags 0 (static) e processing error "no colocated pixels found in a s e processing_quality_flags have the value 0 (static) processing error "slant column fit returned error, no 8 bits of the processing_quality_flags have	Ach between expectation ality_flags have the NC_INT length calibration of this have the value "46". NC_INT upporting ban" occurred, "47". NC_INT
number_of_wrong_input type_error_occurrences Number of ground pixels where and received data" occurred, i. value "45". number_of_wavelength_cal- ibration_error_occurrences Number of ground pixels where pixe" occurred, i.e. where the lo number_of_coregistration error_occurrences Number of ground pixels where i.e. where the lower 8 bits of th number_of_slant_column density_error_occurrences Number of ground pixels where occurred, i.e. where the lower 8 number_of_airmass_factor error_occurrences Number of ground pixels where	e processing error "wrong input type error, mismalle. where the lower 8 bits of the processing_qu 0 (static) e processing error "an error occurred in the wave ower 8 bits of the processing_quality_flags 0 (static) e processing error "no colocated pixels found in a s e processing_quality_flags have the value 0 (static) processing error "slant column fit returned error, no 8 bits of the processing_quality_flags have	Ach between expectation ality_flags have the NC_INT length calibration of this have the value "46". NC_INT upporting ban" occurred, "47". NC_INT o values can be compute" the value "48". NC_INT

number_of_vertical column_density_error occurrences	0 (static)	NC_INT
- · · ·	processing error "vertical column density could processing_quality_flags have the value of the	•
number_of_signal_to noise_ratio_error_occur- rences	0 (static)	NC_INT
÷ .	processing error "the signal to noise ratio for t ne lower 8 bits of the processing_quality_:	-
number_of_configuration	0 (static)	NC_INT
- · · ·	processing error "error while parsing the configuing_ng_quality_flags have the value "52".	uratio" occurred, i.e. where
number_of_key_error_oc-	0 (static)	NC_INT
currences Number of ground pixels where p the processing_quality_fl	processing error "key does not exis" occurred, i.a ags have the value "53".	e. where the lower 8 bits c
number_of_saturation_er- ror_occurrences	0 (static)	NC_INT
Number of ground pixels where p	processing error "saturation in input spectru" occ ity_flags have the value "54".	curred, i.e. where the lowe
number_of_solar_eclipse_fil- ter_occurrences	0 (static)	NC_INT
—	e input filter "solar eclipse" occurred, i.e. whe have the value "64".	ere the lower 8 bits of the
number_of_cloud_filter_oc- currences	0 (static)	NC_INT
÷ ,	put filter "the cloud filter triggered causing the piprocessing_quality_flags have the value	
number_of_altitude_consist- ency_filter_occurrences	0 (static)	NC_INT
	nput filter "too large difference between ECMWI wer 8 bits of the processing_quality_fla	
number_of_altitude_rough- ness_filter_occurrences	0 (static)	NC_INT
<b>e</b> .	input filter "too large standard deviation of altit ccessing_quality_flags have the value "6	
number_of_sun_glint_filter		NC_INT
Definition of sun glint angle and	input filter "for pixels over water, viewing direct threshold value from ATBD" occurred, i.e. wh	<b>č</b>
processing_quality_flags number_of_mixed_surface	0 (static)	NC_INT
type_filter_occurrences		
Number of ground pixels where in	nput filter "pixel contains land and water areas (e processing_quality_flags have the valu	,

Number of ground pixels where input filter "pixel contains snow/ice: Snow/ice flag according to dynamic input OR climatological surface albedo at VIS wavelength is larger than 0.5" occurred, i.e. where the lower 8 bits of the processing\_quality\_flags have the value "70".

1 5—1	ity_ilags have the value 70.	
number_of_aai_filter_occur- rences	0 (static)	NC_INT
Number of ground pixels where ir processing_quality_flags	nput filter "aAI smaller than 2.0" occurred, i.e. whe have the value "71".	ere the lower 8 bits of the
number_of_cloud_fraction fresco_filter_occurrences	0 (static)	NC_INT
	e input filter "pixel contains clouds: The FRES preshold value from ATBD" occurred, i.e. where have the value "72".	
number_of_aai_scene_al- bedo_filter_occurrences	0 (static)	NC_INT
380 nm from AAI calculation and	nput filter "pixel contains clouds: The difference to the climatologcal surface albedo exceeds thresho s" occurred, i.e. where the lower 8 bits of the parts	old. Threshold value from
number_of_small_pixel_radi-	0 (static)	NC_INT
ance_std_filter_occurrences		
• •	e input filter "pixel contains clouds: Standard d hold. Threshold value from ATBD" occurred, i.e. ags have the value "74".	
number_of_cloud_fraction	0 (static)	NC_INT
viirs_filter_occurrences	incent filters weisel contained alouder. The aloud fur	
÷ .	input filter "pixel contains clouds: The cloud fra ue from ATBD" occurred, i.e. where the lower 8 bi "75".	
number_of_cirrus_reflect-	0 (static)	NC_INT
ance_viirs_filter_occur-		
	input filter "pixel contains clouds: Cirrus reflec ue from ATBD" occurred, i.e. where the lower 8 b "76".	
number_of_cf_viirs_swir	0 (static)	NC_INT
ifov_filter_occurrences	innut filter "fraction of cloudy MIDC pivels within	CED CIVID around rivel
÷ .	input filter "fraction of cloudy VIIRS pixels wihtin configuration" occurred, i.e. where the lower 8 bi "77".	• .
number_of_cf_viirs_swir ofova_filter_occurrences	0 (static)	NC_INT
Number of ground pixels where in	put filter "fraction of cloudy VIIRS pixels wihtin S5 on" occurred, i.e. where the lower 8 bits of the part $$	
number_of_cf_viirs_swir ofovb_filter_occurrences	0 (static)	NC_INT
÷ .	put filter "fraction of cloudy VIIRS pixels wihtin S5 on" occurred, i.e. where the lower 8 bits of the particular the provided the the lower 8 bits of the particular the second	
number_of_cf_viirs_swir ofovc_filter_occurrences	0 (static)	NC_INT

Number of ground pixels where input filter "fraction of cloudy VIIRS pixels wihtin 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".

<pre>number_of_cf_viirs_nir 0 (static) ifov_filter_occurrences</pre>	NC_INT
Number of ground pixels where input filter "fraction of cloudy VIIRS pixels wihtin exceeds a priori threshold from configuration" occurred, i.e. where the lower 8 bits <code>quality_flags</code> have the value "81".	<b>•</b> ·
number_of_cf_viirs_nir     0 (static)       ofova_filter_occurrences	NC_INT
Number of ground pixels where input filter "fraction of cloudy VIIRS pixels wihtin S5 a priori threshold from configuration" occurred, i.e. where the lower 8 bits of the profilags have the value "82".	
number_of_cf_viirs_nir     0 (static)       ofovb_filter_occurrences	NC_INT
Number of ground pixels where input filter "fraction of cloudy VIIRS pixels wihtin S5 a priori threshold from configuration" occurred, i.e. where the lower 8 bits of the profilags have the value "83".	
number_of_cf_viirs_nir 0 (static) ofovc filter occurrences	NC_INT
Number of ground pixels where input filter "fraction of cloudy VIIRS pixels wihtin S5 a priori threshold from configuration" occurred, i.e. where the lower 8 bits of the profilags have the value "84".	
number_of_refl_cirrus       0 (static)         viirs_swir_filter_occur-       rences	NC_INT
Number of ground pixels where input filter "average VIIRS cirrus reflectance with exceeds a priori threshold from configuration" occurred, i.e. where the lower 8 bits quality_flags have the value "85".	<b>u</b> 1
number_of_refl_cirrus     0 (static)       viirs_nir_filter_occurrences	NC_INT
Number of ground pixels where input filter "average VIIRS cirrus reflectance within NI a priori threshold from configuration" occurred, i.e. where the lower 8 bits of the profilags have the value "86".	
<pre>number_of_diff_refl_cirrus 0 (static) viirs_filter_occurrences</pre>	NC_INT
Number of ground pixels where input filter "difference in VIIRS average cirrus refle and NIR ground pixel exceeds a priori threshold from configuration" occurred, i.e. w the processing_quality_flags have the value "87".	
number_of_ch4_noscat_ra- 0 (static) tio_filter_occurrences	NC_INT
Number of ground pixels where input filter "the ratio between [CH <sub>4</sub> ] <sub>weak</sub> and [CH <sub>4</sub> ] <sub>str</sub>	is below or exceeds
a priori thresholds from configuration" occurred, i.e. where the lower 8 bits of the profilags have the value "88".	0
a priori thresholds from configuration" occurred, i.e. where the lower 8 bits of the profilags have the value "88". number_of_ch4_noscat_ra- 0 (static)	0
a priori thresholds from configuration" occurred, i.e. where the lower 8 bits of the profilags have the value "88".	NC_INT

Number of ground pixels where input filter "the ratio between  $[H_2O]_{weak}$  and  $[H_2O]_{strong}$  is below or exceeds a priori thresholds from configuration" occurred, i.e. where the lower 8 bits of the <code>processing\_quality\_flags</code> have the value "90".

number_of_h2o_noscat_ra-         0 (static)         NC_INT           tio_std_filter_occurrences         Number of ground pixels where input filter "the standard deviation of [H <sub>2</sub> O] <sub>weak</sub> /[H <sub>2</sub> O] <sub>strong</sub> within the SN pixel and the 8 neigbouring pixels exceeds a priori threshold from configuration" occurred, i.e. where lower 8 bits of the processing_quality_flags have the value "91".           number_of_diff_psurf         0 (static)         NC_INT           rences         Number of ground pixels where input filter "difference between the FRESCO apparent surface pressure the ECMWF surface pressure exceeds a priori threshold from configuration" occurred, i.e. where the lo           8 bits of the processing_quality_flags have the value "92".         NC_INT           number_of_psurf_fresco         0 (static)         NC_INT           stdv_filter_occurrences         Number of ground pixels where input filter "the standard deviation of the FRESCO apparent surface press in the NIR pixel and the 8 surrounding pixels exceeds a priori threshold from configuration" occurred where the lower 8 bits of the processing_quality_flags have the value "93".           number_of_ocean_filter_oc-         0 (static)         NC_INT           rumeres         Number of ground pixels where input filter "the ground pixel is over ocean (and ocean glint retrievals are switched on)" occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value "95".           number_of_time_range_fil-         0 (static)         NC_INT           ter_occurrences         Number of ground pixels where input filter "tim
pixel and the 8 neigbouring pixels exceeds a priori threshold from configuration" occurred, i.e. where lower 8 bits of the processing_quality_flags have the value "91". number_of_dlff_psurf 0 (static) NC_INT fresco_ecmwf_filter_occur- rences Number of ground pixels where input filter "difference between the FRESCO apparent surface pressure the ECMWF surface pressure exceeds a priori threshold from configuration" occurred, i.e. where the lo 8 bits of the processing_quality_flags have the value "92". number_of_psurf_fresco 0 (static) NC_INT stdfilter_occurrences Number of ground pixels where input filter "the standard deviation of the FRESCO apparent surface press in the NIR pixel and the 8 surrounding pixels exceeds a priori threshold from configuration" occurred where the lower 8 bits of the processing_quality_flags have the value "93". number_of_occan_filter_oc- 0 (static) NC_INT currences Number of ground pixels where input filter "the ground pixel is over ocean (and ocean glint retrievals are switched on)" occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value "93". number_of_time_range_fil- 0 (static) NC_INT ter_occurrences Number of ground pixels where input filter "time is out of the range that is to be processed" occurred where the lower 8 bits of the processing_quality_flags have the value "95". number_of_pixel_or_scan- 0 (static) NC_INT line_index_filter_occur- rences Number of ground pixels where input filter "to processed because pixel index does not match gen selection criteria" occurred, i.e. where the lower 8 bits of the processing_quality_flags have value "96". number_of_geographic_re- 0 (static) NC_INT
fresco_ecmwf_filter_occur- rences         Number of ground pixels where input filter "difference between the FRESCO apparent surface pressure the ECMWF surface pressure exceeds a priori threshold from configuration" occurred, i.e. where the lot 8 bits of the processing_quality_flags have the value "92".         number_of_psurf_fresco       0 (static)       NC_INT         stdv_filter_occurrences       Number of ground pixels where input filter "the standard deviation of the FRESCO apparent surface press in the NIR pixel and the 8 surrounding pixels exceeds a priori threshold from configuration" occurred where the lower 8 bits of the processing_quality_flags have the value "93".         number_of_ocean_filter_oc-       0 (static)       NC_INT         currences       Number of ground pixels where input filter "the ground pixel is over ocean (and ocean glint retrievals are switched on)" occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value "94".         number_of_time_range_fil-       0 (static)       NC_INT         ter_occurrences       Number of ground pixels where input filter "time is out of the range that is to be processed" occurred where the lower 8 bits of the processing_quality_flags have the value "95".         number_of_pixel_or_scan-       0 (static)       NC_INT         line_index_filter_occur- rences       0 (static)       NC_INT         Number of ground pixels where input filter "not processed because pixel index does not match gen selection criteria" occurred, i.e. where the lower 8 bits of the processing_quality_flags have value "96".       NC_INT
the ECMWF surface pressure exceeds a priori threshold from configuration" occurred, i.e. where the lot 8 bits of the processing_quality_flags have the value "92". number_of_psurf_fresco 0 (static) NC_INT stdv_filter_occurrences Number of ground pixels where input filter "the standard deviation of the FRESCO apparent surface press in the NIR pixel and the 8 surrounding pixels exceeds a priori threshold from configuration" occurred where the lower 8 bits of the processing_quality_flags have the value "93". number_of_ocean_filter_oc- 0 (static) NC_INT currences Number of ground pixels where input filter "the ground pixel is over ocean (and ocean glint retrievals are switched on)" occurred, i.e. where the lower 8 bits of the processing_quality_flags have the va- "94". number_of_time_range_fil- 0 (static) NC_INT ter_occurrences Number of ground pixels where input filter "time is out of the range that is to be processed" occurred where the lower 8 bits of the processing_quality_flags have the value "95". number_of_pixel_or_scan- 0 (static) NC_INT line_index_filter_occur- rences Number of ground pixels where input filter "not processed because pixel index does not match gen selection criteria" occurred, i.e. where the lower 8 bits of the processing_quality_flags have value "96". number_of_geographic_re- 0 (static) NC_INT
number_of_psurf_fresco       0 (static)       NC_INT         stdv_filter_occurrences       Number of ground pixels where input filter "the standard deviation of the FRESCO apparent surface press in the NIR pixel and the 8 surrounding pixels exceeds a priori threshold from configuration" occurred where the lower 8 bits of the processing_quality_flags have the value "93".         number_of_ocean_filter_oc-       0 (static)       NC_INT         currences       Number of ground pixels where input filter "the ground pixel is over ocean (and ocean glint retrievals are switched on)" occurred, i.e. where the lower 8 bits of the processing_quality_flags have the value "94".         number_of_time_range_fil-       0 (static)       NC_INT         ter_occurrences       Number of ground pixels where input filter "time is out of the range that is to be processed" occurred where the lower 8 bits of the processing_quality_flags have the value "95".         number_of_pixel_or_scan-       0 (static)       NC_INT         line_index_filter_occur- rences       0 (static)       NC_INT         Number of ground pixels where input filter "not processed because pixel index does not match gen selection criteria" occurred, i.e. where the lower 8 bits of the processing_quality_flags have value "96".       NC_INT
in the NIR pixel and the 8 surrounding pixels exceeds a priori threshold from configuration" occurred where the lower 8 bits of the processing_quality_flags have the value "93". <b>number_of_ocean_filter_oc-</b> 0 (static) NC_INT <b>currences</b> Number of ground pixels where input filter "the ground pixel is over ocean (and ocean glint retrievals are switched on)" occurred, i.e. where the lower 8 bits of the processing_quality_flags have the va "94". <b>number_of_time_range_fil-</b> 0 (static) NC_INT <b>ter_occurrences</b> Number of ground pixels where input filter "time is out of the range that is to be processed" occurred where the lower 8 bits of the processing_quality_flags have the value "95". <b>number_of_pixel_or_scan-</b> 0 (static) NC_INT <b>line_index_filter_occur-</b> <b>rences</b> Number of ground pixels where input filter "not processed because pixel index does not match gen selection criteria" occurred, i.e. where the lower 8 bits of the processing_quality_flags have value "96". <b>number_of_geographic_re-</b> 0 (static) NC_INT
currences         Number of ground pixels where input filter "the ground pixel is over ocean (and ocean glint retrievals are switched on)" occurred, i.e. where the lower 8 bits of the processing_quality_flags have the va "94".         number_of_time_range_fil-       0 (static)       NC_INT         ter_occurrences       Number of ground pixels where input filter "time is out of the range that is to be processed" occurred where the lower 8 bits of the processing_quality_flags have the value "95".         number_of_pixel_or_scan-       0 (static)       NC_INT         line_index_filter_occur-       rences         Number of ground pixels where input filter "not processed because pixel index does not match gen selection criteria" occurred, i.e. where the lower 8 bits of the processing_quality_flags have value "96".         number_of_geographic_re-       0 (static)       NC_INT
switched on)" occurred, i.e. where the lower 8 bits of the processing_quality_flags have the vare "94".         number_of_time_range_fil-       0 (static)       NC_INT         ter_occurrences       Number of ground pixels where input filter "time is out of the range that is to be processed" occurred where the lower 8 bits of the processing_quality_flags have the value "95".       NC_INT         number_of_pixel_or_scan-       0 (static)       NC_INT         line_index_filter_occur-       0 (static)       NC_INT         selection criteria" occurred, i.e. where the lower 8 bits of the processing_quality_flags have yalue "96".       NC_INT         number_of_geographic_re-       0 (static)       NC_INT
ter_occurrences         Number of ground pixels where input filter "time is out of the range that is to be processed" occurred where the lower 8 bits of the processing_quality_flags have the value "95".         number_of_pixel_or_scan-       0 (static)       NC_INT         line_index_filter_occur-       rences         Number of ground pixels where input filter "not processed because pixel index does not match gen selection criteria" occurred, i.e. where the lower 8 bits of the processing_quality_flags have value "96".         number_of_geographic_re-       0 (static)       NC_INT
Number of ground pixels where input filter "time is out of the range that is to be processed" occurred where the lower 8 bits of the processing_quality_flags have the value "95".         number_of_pixel_or_scan-       0 (static)       NC_INT         line_index_filter_occur-       0 (static)       NC_INT         value "96".       0 (static)       NC_INT         number_of_geographic_re-       0 (static)       NC_INT
line_index_filter_occur- rences         Number of ground pixels where input filter "not processed because pixel index does not match gen selection criteria" occurred, i.e. where the lower 8 bits of the processing_quality_flags have value "96".         number_of_geographic_re-       0 (static)       NC_INT
selection criteria" occurred, i.e. where the lower 8 bits of the processing_quality_flags have value "96".         number_of_geographic_re-       0 (static)
-
Number of ground pixels where input filter "pixel falls outside the specified regions of interest" occurred where the lower 8 bits of the processing_quality_flags have the value "97".
number_of_input_spec-0 (static)NC_INTtrum_warning_occurrences00
Number of ground pixels where processing warning "number of good pixels in radiance, irradiance calculated reflectance below threshold from configuration" occurred, i.e. where bit 8 in the processing quality_flags is set to "1".
number_of_wavelength       0 (static)       NC_INT         calibration_warning_occur-       rences       NC_INT
Number of ground pixels where processing warning "offset from wavelength fit is larger than limit se configuration" occurred, i.e. where bit 9 in the processing_quality_flags is set to "1".
number_of_extrapolation       0 (static)       NC_INT         warning_occurrences       NC_INT
Number of ground pixels where processing warning "pressure or temperature outside cross section I range, other lookup table extrapolation" occurred, i.e. where bit 10 in the processing_quality_fle is set to "1".

number_of_sun_glint_warn- ing_occurrences	0 (static)	NC_INT
Number of ground pixels where p in the processing_quality_s	rocessing warning "sun glint posibility warn Elags is set to "1".	ing" occurred, i.e. where bit 1
number_of_south_atlantic anomaly_warning_occur- rences	0 (static)	NC_INT
- · · ·	processing warning "tROPOMI is inside the irred, i.e. where bit 12 in the processing_	-
number_of_sun_glint_cor- rection_occurrences	0 (static)	NC_INT
Number of ground pixels where p where bit 13 in the processing	processing warning "a sun glint correction h _quality_flags is set to "1".	nas been applied" occurred, i.e
number_of_snow_ice_warn- ing_occurrences	0 (static)	NC_INT
cloud support product" occurred,	processing warning "snow/ice flag is set, i.e. where bit 14 in the processing_qua	lity_flags is set to "1".
number_of_cloud_warning occurrences	0 (static)	NC_INT
Number of ground pixels where pressure (VIIRS not available), of	processing warning "cloud filter based of cloud fraction above threshold or cloud pro- ere bit 15 in the processing_quality_s	essure adjusted to force cloud
number_of_AAI_warning occurrences	0 (static)	NC_INT
÷ .	processing warning "possible aerosol con n the processing_quality_flags is s	-
number_of_pixel_level_in- put_data_missing_occur- rences	0 (static)	NC_INT
	rocessing warning "dynamic auxiliary input on is used" occurred, i.e. where bit 17 in	
number_of_data_range warning occurrences	0 (static)	NC_INT
Water column tends to negative	processing warning "carbon monoxide col values; Heavy water (HDO) column ten processing_quality_flags is set to	ds to negative values; others
number_of_low_cloud_frac-	0 (static)	NC_INT
÷	ocessing warning "low cloud fraction, theref processing_quality_flags is set to	•
number_of_altitude_consist- ency_warning_occurrences	0 (static)	NC_INT
Number of ground pixels where	processing warning "difference between E exceeds threshold from configuration" oc is set to "1".	
number_of_signal_to noise_ratio_warning_occur- rences	0 (static)	NC_INT
Number of ground pixels where p	processing warning "signal to noise ratio in curred, i.e. where bit 21 in the processi	

number_of_deconvolution warning_occurrences	0 (static)	NC_INT
Number of ground pixels where	processing warning "failed deconvolutio urred, i.e. where bit 22 in the process	
number_of_so2_volcanic origin_likely_warning_occur- rences	0 (static)	NC_INT
	processing warning "warning for SO <sub>2</sub> BL p sites" occurred, i.e. where bit 23 in the $pr$	
number_of_so2_volcanic origin_certain_warning_oc- currences	0 (static)	NC_INT
÷	processing warning "warning for SO <sub>2</sub> BL   ere bit 24 in the processing_quality_	•
number_of_interpolation warning_occurrences	0 (static)	NC_INT
Number of ground pixels where	processing warning "warning for interpola a is used, potentially leading to a bias" o s is set to "1".	
number_of_saturation_warn-	0 (static)	NC_INT
ing_occurrences		
• • •	processing warning "saturation occurred s ere bit 26 in the processing_quality.	
	0 (static)	NC_INT
ing_occurrences Number of ground pixels where the processing can be performe	0 (static) e processing warning "warning for high d with less final quality" occurred, i.e. wh	solar zenith angle. In this case
ing_occurrences Number of ground pixels where the processing can be performe quality_flags is set to "1".	e processing warning "warning for high	solar zenith angle. In this case
the processing can be performe quality_flags is set to "1". number_of_cloud_retrieval warning_occurrences	e processing warning "warning for high d with less final quality" occurred, i.e. wh 0 (static)	solar zenith angle. In this case nere bit 27 in the processing_ NC_INT
ing_occurrences Number of ground pixels where the processing can be performe quality_flags is set to "1". number_of_cloud_retrieval warning_occurrences Number of ground pixels where indicates a degraded quality of	e processing warning "warning for high ed with less final quality" occurred, i.e. wh	solar zenith angle. In this case nere bit 27 in the processing NC_INT ng when the retrieval diagnosti
ing_occurrences Number of ground pixels where the processing can be performe quality_flags is set to "1". number_of_cloud_retrieval warning_occurrences Number of ground pixels where	e processing warning "warning for high ed with less final quality" occurred, i.e. wh 0 (static) e processing warning "warning occurrir	solar zenith angle. In this case nere bit 27 in the processing NC_INT ng when the retrieval diagnosti
ing_occurrences Number of ground pixels where the processing can be performe quality_flags is set to "1". number_of_cloud_retrieval warning_occurrences Number of ground pixels where indicates a degraded quality of quality_flags is set to "1". number_of_cloud_inhomo- geneity_warning_occur- rences Number of ground pixels where	e processing warning "warning for high d with less final quality" occurred, i.e. wh 0 (static) e processing warning "warning occurrir f the cloud retrieval" occurred, i.e. whe	solar zenith angle. In this case here bit 27 in the processing NC_INT ang when the retrieval diagnostic ere bit 28 in the processing NC_INT
ing_occurrences Number of ground pixels where the processing can be performe quality_flags is set to "1". number_of_cloud_retrieval warning_occurrences Number of ground pixels where indicates a degraded quality of quality_flags is set to "1". number_of_cloud_inhomo- geneity_warning_occur- rences Number of ground pixels where above a given threshol" occurred global_processing_warn- ings	e processing warning "warning for high ed with less final quality" occurred, i.e. wh 0 (static) e processing warning "warning occurrin f the cloud retrieval" occurred, i.e. whe 0 (static) processing warning "the cloud coregistra d, i.e. where bit 29 in the processing_c 'None' (static)	solar zenith angle. In this case here bit 27 in the processing NC_INT ang when the retrieval diagnostic ere bit 28 in the processing NC_INT
ing_occurrences Number of ground pixels where the processing can be performe quality_flags is set to "1". number_of_cloud_retrieval warning_occurrences Number of ground pixels where indicates a degraded quality of quality_flags is set to "1". number_of_cloud_inhomo- geneity_warning_occur- rences Number of ground pixels where above a given threshol" occurred global_processing_warn- ings All warning messages, separate	e processing warning "warning for high ed with less final quality" occurred, i.e. wh 0 (static) e processing warning "warning occurrin f the cloud retrieval" occurred, i.e. whe 0 (static) processing warning "the cloud coregistra d, i.e. where bit 29 in the processing_c 'None' (static) ed by newlines, with duplicates removed.	solar zenith angle. In this case here bit 27 in the processing
ing_occurrences Number of ground pixels where the processing can be performe quality_flags is set to "1". number_of_cloud_retrieval warning_occurrences Number of ground pixels where indicates a degraded quality of quality_flags is set to "1". number_of_cloud_inhomo- geneity_warning_occur- rences Number of ground pixels where above a given threshol" occurred global_processing_warn- ings All warning messages, separate time_for_algorithm_initializ- ation	e processing warning "warning for high ed with less final quality" occurred, i.e. wh 0 (static) e processing warning "warning occurrin f the cloud retrieval" occurred, i.e. whe 0 (static) processing warning "the cloud coregistra d, i.e. where bit 29 in the processing_d 'None' (static) d by newlines, with duplicates removed. -1.0 (static)	solar zenith angle. In this case here bit 27 in the processing NC_INT ang when the retrieval diagnostic pre bit 28 in the processing NC_INT NC_INT
ing_occurrences Number of ground pixels where the processing can be performe quality_flags is set to "1". number_of_cloud_retrieval warning_occurrences Number of ground pixels where indicates a degraded quality of quality_flags is set to "1". number_of_cloud_inhomo- geneity_warning_occur- rences Number of ground pixels where above a given threshol" occurred global_processing_warn- ings All warning messages, separate time_for_algorithm_initializ- ation Time in seconds needed for initi	e processing warning "warning for high ed with less final quality" occurred, i.e. wh 0 (static) e processing warning "warning occurrin f the cloud retrieval" occurred, i.e. whe 0 (static) processing warning "the cloud coregistra d, i.e. where bit 29 in the processing_c 'None' (static) d by newlines, with duplicates removed. -1.0 (static) alization.	solar zenith angle. In this case here bit 27 in the processing
ing_occurrences Number of ground pixels where the processing can be performe quality_flags is set to "1". number_of_cloud_retrieval warning_occurrences Number of ground pixels where indicates a degraded quality of quality_flags is set to "1". number_of_cloud_inhomo- geneity_warning_occur- rences Number of ground pixels where above a given threshol" occurred global_processing_warn- ings All warning messages, separate time_for_algorithm_initializ- ation Time in seconds needed for initi time_for_processing	e processing warning "warning for high ed with less final quality" occurred, i.e. when 0 (static) e processing warning "warning occurring f the cloud retrieval" occurred, i.e. when 0 (static) processing warning "the cloud coregistra d, i.e. where bit 29 in the processing_d 'None' (static) ed by newlines, with duplicates removed. -1.0 (static) alization. -1.0 (static)	solar zenith angle. In this case here bit 27 in the processing
ing_occurrences Number of ground pixels where the processing can be performe quality_flags is set to "1". number_of_cloud_retrieval warning_occurrences Number of ground pixels where indicates a degraded quality of quality_flags is set to "1". number_of_cloud_inhomo- geneity_warning_occur- rences Number of ground pixels where above a given threshol" occurred global_processing_warn- ings All warning messages, separate time_for_algorithm_initializ- ation Time in seconds needed for initi time_for_processing	e processing warning "warning for high ed with less final quality" occurred, i.e. wh 0 (static) e processing warning "warning occurrin f the cloud retrieval" occurred, i.e. whe 0 (static) processing warning "the cloud coregistra d, i.e. where bit 29 in the processing_c 'None' (static) ed by newlines, with duplicates removed. -1.0 (static) alization. -1.0 (static) cessing.	solar zenith angle. In this case here bit 27 in the processing
ing_occurrences Number of ground pixels where the processing can be performe quality_flags is set to "1". number_of_cloud_retrieval warning_occurrences Number of ground pixels where indicates a degraded quality of quality_flags is set to "1". number_of_cloud_inhomo- geneity_warning_occur- rences Number of ground pixels where above a given threshol" occurred global_processing_warn- ings All warning messages, separate time_for_algorithm_initializ- ation Time in seconds needed for initi time_for_processing	e processing warning "warning for high ed with less final quality" occurred, i.e. when 0 (static) e processing warning "warning occurring f the cloud retrieval" occurred, i.e. when 0 (static) processing warning "the cloud coregistra d, i.e. where bit 29 in the processing_d 'None' (static) d by newlines, with duplicates removed. -1.0 (static) alization. -1.0 (static) cessing. -1.0 (static)	solar zenith angle. In this case here bit 27 in the processing

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

**vertices** For the histogram boundaries.

size 2 (fixed) mode Present in all modes.

histogram\_axis Histogram axis.

size 100 (fixed) mode Present in all modes.

pdf\_axis Probability density function axis.

size 400 (fixed) mode Present in all modes.

histogram a	xis		
Description:		for the histograms of the main parameter.	
Dimensions:		(coordinate variable).	
Type:	NC_FLOAT.	. ,	
Source:	Processor.		
Mode:	Present in all m	odes.	
Attributes:	Name	Value	Туре
	units	'1' (dynamic)	NC_STRING
		ne main parameter. Other attributes – standa m the main parameter as well. This attribute ori	
	bounds	'histogram_bounds' (static)	NC_STRING
pdf_axis			
Description:	Horizontal axis	for the probability distribution functions of the	main parameter.
Dimensions:	pdf_axis (coord	inate variable).	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all m	odes.	
Attributes:	Name	Value	Туре
	units	'1' (dynamic)	NC_STRING
		ne main parameter. Other attributes – <code>standa</code> m the main parameter as well. This attribute ori	
	bounds	'pdf_bounds' (static)	NC_STRING

## 12.26 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.

## 12.27 Granule metadata

Common granule level metadata.

## Attributes in GRANULE\_METADATA

Group attributes attached to GRANULE_METADATA		
Name	Value	Туре
GranuleStart		NC_STRING

Start of the granule as ISO date/time string in UTC: *YYYY-MM-DDTHH:MM:SS.mmmmmmZ*. The formal definition of ISO date/time strings is given in [RD35].

GranuleEnd		NC_STRING
End of the granule as ISO of definition of ISO date/time s	date/time string in UTC: YYYY-MM-DDTHH:MM:S strings is given in [RD35].	SS.mmmmmm <b>Z</b> . The formal
InstrumentName	'TROPOMI' (static)	NC_STRING
The name of the instrument	t, fixed to "TROPOMI".	
MissionName	'Sentinel-5 precursor' (static)	NC_STRING
The name of the mission, fi	xed to "Sentinel-5 precursor".	
MissionShortName	'S5P' (static)	NC_STRING
The short name of the miss	ion, fixed to "S5P".	
ProcessLevel	'2' (static)	NC_STRING
This is a level 2 product.		
ProcessingCenter	'%(processingcenter)s' (dynamic)	NC_STRING
Where was the processor ruuse is "DLR/Oberpfaffenhof	In? The source is the probably the joborder, the mo en".	st likely value for operational
ProcessingNode		NC_STRING
The name of the machine th	nat processed the data. This may aid in diagnosing	g failures in the processing.
ProcessorVersion	'%(version)s' (dynamic)	NC_STRING
The version number of th jor.minor.bugfix".	e processor used to produce the file. This is	a string formatted as "ma-
ProductFormatVersion	1 (static)	NC_INT
The version of the format of the files.	the product file. This should be incremented when	never a datafield is added to
ProcessingMode		NC_STRING
This attribute indicates the	mode of the processor.	
Possible values: Near-realti	me, Offline, Reprocessing, Test, SyntheticTest	

## 12.28 ESA metadata

### 12.28.1 Group "ESA\_METADATA"

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

## 12.28.1.1 Group "earth\_explorer\_header" in "ESA\_METADATA"

#### Attributes in ESA\_METADATA/earth\_explorer\_header

Group attributes attached to earth_explorer_header		
Name	Value	Туре
objectType	'Earth_Explorer_Header' (static)	NC_STRING

### 12.28.1.2 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

Group attributes attached to fixed_header		
Name	Value	Туре

objectType	'Fixed_Header' (static)	NC_STRING
File_Name	'%(logical_filename)s' (dynamic)	NC_STRING
The <i>logical</i> file name, i	.e. the file name without extension.	
File_Description		NC_STRING
This is a copy of the gl	obal "title" attribute.	
Notes		NC_STRING
This is a copy of the gl	obal "comment" attribute.	
Mission	'S5P' (static)	NC_STRING
The mission identifier f	or the Sentinel 5-precursor mission is "S5P".	
File_Class	'%(mode)s' (dynamic)	NC_STRING
The file class of the output. Values are taken from the tailoring of the EO file format tailoring for S5P [RD25, section 4.1.2].		
File_Type	'%(shortname)s' (dynamic)	NC_STRING
Following the EO file format tailoring for S5P [RD25, sections 4.1.3.1 and 4.1.3.2].		
File_Version	0 (dynamic)	NC_INT
The file version information is not part of the file name conventions for S5P. If a file version number is to be recorded in this attribute, then it has to be provided by the PDGS via the job order. If provided, then the		

value is  $\geq 1$ . If not provided the fill value is 0.

## 12.28.1.3 Group "validity\_period" in "fixed\_header"

## Attributes in ESA\_METADATA/earth\_explorer\_header/fixed\_header/validity\_period

Name	Value	Туре
objectType	'Validity_Period' (static)	NC_STRING
Validity_Start		NC_STRING
	g "UTC=" concatenated with the time_coverage_ o the "Validity_Start" element in the "Validity_Period" X	-
Validity_Stop		NC_STRING
The value is the string "UTC=" 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.		

## 12.28.1.4 Group "source" in "fixed\_header"

## Attributes in ESA\_METADATA/earth\_explorer\_header/fixed\_header/source

Group attributes attached	d to source	
Name	Value	Туре
objectType	'Source' (static)	NC_STRING
System	'%(processingcenter)s' (dynamic)	NC_STRING
-	ment element creating the file. For Level 2 files, this used. This attribute corresponds to the "System" e e.	÷
Creator	'%(processor_name)s' (dynamic)	NC_STRING
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.		
Creator_Version	'%(version)s' (dynamic)	NC_STRING

NC STRING

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.

#### Creation\_Date

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.

#### 12.28.1.5 Group "variable\_header" in "earth\_explorer\_header"

### Attributes in ESA\_METADATA/earth\_explorer\_header/variable\_header

Group attributes attac	ched to variable_header	
Name	Value	Туре
objectType	'Variable_Header' (static)	NC_STRING

## 12.28.1.6 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	I to gmd:lineage	
Name	Value	Туре
objectType	'gmd:LI_Lineage' (static)	NC_STRING
gmd:statement	'L2 %(product)s dataset produced by %(processingcen- ter)s from the S5P/TROPOMI L1B product' (dynamic)	NC_STRING

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).

## 12.28.1.7 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		
Name	Value	Туре
objectType	'gmi:LE_ProcessStep' (static)	NC_STRING
gmd:description	'Processing of L1b to L2 %(product)s data for orbit %(orbit)d using the %(institute)s processor version %(version)s' (dynamic)	NC_STRING

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 institude responsible for the CFI and the software version in this string (at the respective %(...)s and %(...)d).

#### 12.28.1.8 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

Group attributes attached to gmi:output			
Name	Value	Туре	
gmd:description		NC_STRING	
Short description of	the output, a copy of the global 'title' attribute.		

objectType	'gmi:LE Source' (static)	NC STRING
	g(	

### 12.28.1.9 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

Group attributes attach	ed to gmd:sourceCitation	
Name	Value	Туре
gmd:title	'%(logical_filename)s' (dynamic)	NC_STRING
Output file name witho	ut extension.	
objectType	'gmd:CI_Citation' (static)	NC_STRING

#### 12.28.1.10 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

Group attributes at	tached to gmd:date	
Name	Value	Туре
gmd:date		NC_STRING
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".		
objectType	'gmd:CI_DateTime' (static)	NC_STRING

## 12.28.1.11 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

Group attributes attached to gmd:dateType		
Name	Value	Туре
codeList	<pre>'http://www.isotc211.org/2005/resources/Codelist/ gmxCodelists.xml#CI_DateTypeCode' (static)</pre>	NC_STRING
codeListValue	'creation' (static)	NC_STRING
objectType	'gmd:CI_DateTypeCode' (static)	NC_STRING

## 12.28.1.12 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

Group attributes attached to gmd:identifier			
Name	Value	Туре	
gmd:code	'%(shortname)s' (dynamic)	NC_STRING	
The product short name, a copy of the 'ProductShortName' attribute in '/METADATA/GRANULE_DESCRIP- TION'.			
objectType	'gmd:MD_Identifier' (static)	NC_STRING	

## 12.28.1.13 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

Group attributes attach	ed to gmi:processedLevel	
Name	Value	Туре
gmd:code	'L2' (static)	NC_STRING
objectType	'gmd:MD_Identifier' (static)	NC_STRING

## 12.28.1.14 Group "gmi:processingInformation" in "gmd:processStep"

Description of the processor in more detail.

Attributes in ESA\_METADATA/earth\_explorer\_header/variable\_header/gmd:lineage/gmd:processStep/gmi:processingInformation

Group attributes attac	hed to gmi:processingInformation	
Name	Value	Туре
objectType	'gmi:LE_Processing' (static)	NC_STRING

#### 12.28.1.15 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

Group attributes attached to gmi:identifier			
Name	Value	Туре	
gmd:code	<pre>'%(institute)s L2 %(product)s processor, version %(ver- sion)s' (dynamic)</pre>	NC_STRING	
Descriptive name of the processor, with the $%()$ s placeholders replaced with the responsible institute's name, product name and software release version.			
objectType	'gmd:MD_Identifier' (static)	NC_STRING	

#### 12.28.1.16 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		
Name	Value	Туре
gmd:title	'L2 %(product)s processor description' (dynamic)	NC_STRING
Title of processor description.		
objectType	'gmd:CI_Citation' (static)	NC_STRING

#### 12.28.1.17 Group "gmd:date" in "gmi:softwareReference"

Release date (compile date) of the processor.

## Attributes in ESA\_METADATA/earth\_explorer\_header/variable\_header/gmd:lineage/gmd:processStep/gmi:processingInformation/gmi:softwareReference/gmd:date

Group attributes att	ached to gmd:date	
Name	Value	Туре
gmd:date		NC_STRING
Release date of the processor expressed as an ISO 8601 date string [RD35].		
objectType	'gmd:CI_DateTime' (static)	NC_STRING

## 12.28.1.18 Group "gmd:dateType" in "gmd:date"

Confirm that this is the release date of the processor.

# Attributes in ESA\_METADATA/earth\_explorer\_header/variable\_header/gmd:lineage/gmd:processStep/gmi:processingInformation/gmi:softwareReference/gmd:date/gmd:dateType

Group attributes attached to gmd:dateType		
Name	Value	Туре
codeList	<pre>'http://www.isotc211.org/2005/resources/Codelist/ gmxCodelists.xml#CI_DateTypeCode' (static)</pre>	NC_STRING
codeListValue	'creation' (static)	NC_STRING
objectType	'gmd:CI_DateTypeCode' (static)	NC_STRING

### 12.28.1.19 Group "gmi:documentation#1" in "gmi:processingInformation"

Reference to the ATBD of the product.

## Attributes in ESA\_METADATA/earth\_explorer\_header/variable\_header/gmd:lineage/gmd:processStep/gmi:processingInformation/gmi:documentation#1

Group attributes attach	ned to gmi:documentation#1	
Name	Value	Туре
objectType	'gmd:CI_Citation' (static)	NC_STRING
gmd:title	'%(title_atbd)s' (dynamic)	NC_STRING
The filename of the cu	rrent release of the ATBD of the current product.	

## 12.28.1.20 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		
Name	Value	Туре
gmd:date	'%(date_atbd)s' (dynamic)	NC_STRING
Release date of the ATBD expressed as an ISO 8601 date string [RD35].		
objectType	'gmd:Cl_Date' (static)	NC_STRING

## 12.28.1.21 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

Group attributes attac	hed to gmd:dateType	
Name	Value	Туре
codeList	<pre>'http://www.isotc211.org/2005/resources/Codelist/ gmxCodelists.xml#CI_DateTypeCode' (static)</pre>	NC_STRING

codeListValue	'publication' (static)	NC_STRING
objectType	<pre>'gmd:CI_DateTypeCode' (static)</pre>	NC_STRING

#### 12.28.1.22 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

Group attributes attach	ed to gmi:documentation#2	
Name	Value	Туре
objectType	'gmd:CI_Citation' (static)	NC_STRING
gmd:title	'%(title_pum)s' (dynamic)	NC_STRING
The filename of the cu	rrent release of the PUM of the current product.	

#### 12.28.1.23 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

Group attributes attached to gmd:date		
Name	Value	Туре
gmd:date	'%(date_pum)s' (dynamic)	NC_STRING
Release date of the PUM expressed as an ISO 8601 date string [RD35].		
objectType	'gmd:CI_Date' (static)	NC_STRING

## 12.28.1.24 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

Group attributes attached to gmd:dateType		
Name	Value	Туре
codeList	<pre>'http://www.isotc211.org/2005/resources/Codelist/ gmxCodelists.xml#CI_DateTypeCode' (static)</pre>	NC_STRING
codeListValue	'publication' (static)	NC_STRING
objectType	'gmd:CI_DateTypeCode' (static)	NC_STRING

#### 12.28.1.25 Group "gmi:report" in "gmd:processStep"

Short report of what occurred during the process step.

## Attributes in ESA\_METADATA/earth\_explorer\_header/variable\_header/gmd:lineage/gmd:processStep/gmi:report

Group attributes attached	I to gmi:report	
Name	Value	Туре
gmi:description	'Sentinel 5-precursor TROPOMI L1b processed to L2 data using the %(institute)s L2 %(product)s processor' (dynamic)	NC_STRING
Textual description of what occurred during the process step. Replace $\%()$ s as indicated.		
gmi:fileType	'netCDF-4' (static)	NC_STRING

Type of file that contains the processing report, in our case the processing report is contained in the main output file.

gmi:name	'%(logical_filename)s.nc' (dynamic)	NC_STRING
objectType	'gmi:LE_ProcessStepReport' (dynamic)	NC_STRING

#### 12.28.1.26 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

Group attributes attach	ned to gmd:source#1	
Name	Value	Туре
objectType	'gmi:LE_Source' (static)	NC_STRING
gmd:description		NC STRING

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.

## 12.28.1.27 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

Group attributes attach	ed to gmi:processedLevel	
Name	Value	Туре
gmd:code	Empty!	NC_STRING
objectType	'gmd:MD_Identifier' (static)	NC_STRING

#### 12.28.1.28 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 attac	hed to gmd:sourceCitation	
Name	Value	Туре
objectType	'gmd:CI_Citation' (static)	NC_STRING

#### 12.28.1.29 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

Group attributes attached to gmd:date		
Name	Value	Туре
gmd:date		NC_STRING

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".

objectType	'gmd:CI Date' (static)	NC STRING
00,000,000	gina.or_bate (blatte)	

## 12.28.1.30 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

Group attributes attached	d to gmd:dateType	
Name	Value	Туре
codeList	<pre>'http://www.isotc211.org/2005/resources/Codelist/ gmxCodelists.xml#CI_DateTypeCode' (static)</pre>	NC_STRING
codeListValue	'creation' (static)	NC_STRING
objectType	'gmd:CI_DateTypeCode' (static)	NC_STRING

### 12.28.1.31 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

Group attributes atta	ached to gmd:title	
Name	Value	Туре
gco:characterStrin	g	NC_STRING
<b>Textual description</b> Source" <b>object</b> ).	of the input file group (same as the "gmd:	description" attribute in the "gmi:LE

#### 12.28.1.32 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

Group attributes attached	to gmd:alternateTitle#1	
Name	Value	Туре
gmx:FileName	Empty!	NC_STRING
The basename of the inp	ut file.	

## 12.29 EOP metadata

#### 12.29.1 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

Group attributes atta	ched to EOP_METADATA	
Name	Value	Туре
gml:id	'%(logical_filename)s.ID' (dynamic)	NC_STRING
Unique ID for this "atm:EarthObservation" object. Constructed from the logical output filename and the extension "ID" separated by a dot.		
objectType	'atm:EarthObservation' (static)	NC_STRING

## 12.29.1.1 Group "om:phenomenonTime" in "EOP\_METADATA"

Time coverage of the granule.

### Attributes in EOP\_METADATA/om:phenomenonTime

Group attributes att	ached to om:phenomenonTime	
Name	Value	Туре
gml:beginPosition	1	NC_STRING
Start of time coverage of the data in the granule expressed as an ISO 8601 date-time string [RD35].		
gml:endPosition		NC_STRING
End of time coverage of the data in the granule expressed as an ISO 8601 date-time string [RD35].		
objectType	'gml:TimePeriod' (static)	NC_STRING

## 12.29.1.2 Group "om:procedure" in "EOP\_METADATA"

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

## Attributes in EOP\_METADATA/om:procedure

Group attributes attached to om:procedure			
Name	Value	Туре	
gml:id	'%(logical_filename)s.EOE' (dynamic)	NC_STRING	
Unique ID for this "eop:EarthObservationEquipment" object. Constructed from the logical output filename and the extension "EOE" separated by a dot.			
objectType	'eop:EarthObservationEquipment' (static)	NC_STRING	

#### 12.29.1.3 Group "eop:platform" in "om:procedure"

Platform name and orbit type.

### Attributes in EOP\_METADATA/om:procedure/eop:platform

Group attributes attached to eop:platform		
Name	Value	Туре
eop:shortName	'Sentinel-5p' (static)	NC_STRING
objectType	'eop:Platform' (static)	NC_STRING

### 12.29.1.4 Group "eop:instrument" in "om:procedure"

Instrument descriptor.

## Attributes in EOP\_METADATA/om:procedure/eop:instrument

Group attributes attached	to eop:instrument	
Name	Value	Туре
eop:shortName	'TROPOMI' (static)	NC_STRING
objectType	'eop:Instrument' (static)	NC_STRING

## 12.29.1.5 Group "eop:sensor" in "om:procedure"

Sensor description.

#### Attributes in EOP\_METADATA/om:procedure/eop:sensor

Group attributes attache	d to eop:sensor	
Name	Value	Туре
eop:sensorType	'ATMOSPHERIC' (static)	NC_STRING
objectType	'eop:Sensor' (static)	NC_STRING

#### 12.29.1.6 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

Group attributes attached	to eop:acquisitionParameters	
Name	Value	Туре
eop:orbitNumber	%(orbit)d (dynamic)	NC_INT
objectType	'eop:Acquisition' (static)	NC_STRING

#### 12.29.1.7 Group "om:observedProperty" in "EOP\_METADATA"

An xlink to the observed property definition.

#### Attributes in EOP\_METADATA/om:observedProperty

Group attributes attack	ned to om:observedProperty	
Name	Value	Туре
nilReason	'inapplicable' (dynamic)	NC_STRING
This element should u	se the attribute 'nilReason="inapplicable".	

### 12.29.1.8 Group "om:featureOfInterest" in "EOP\_METADATA"

#### Attributes in EOP\_METADATA/om:featureOfInterest

Group attributes attach	ed to om:featureOfInterest	
Name	Value	Туре
objectType	'eop:FootPrint' (static)	NC_STRING
gml:id	'%(logical_filename)s.FP' (dynamic)	NC_STRING
Unique ID for this "eop "FP" separated by a do	:FootPrint" object. Constructed from the logical output file t.	ename and the extension

#### 12.29.1.9 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

Group attributes attac	ched to eop:multiExtentOf	
Name	Value	Туре
objectType	'gml:MultiSurface' (static)	NC_STRING

### 12.29.1.10 Group "gml:surfaceMembers" in "eop:multiExtentOf"

#### Attributes in EOP\_METADATA/om:featureOfInterest/eop:multiExtentOf/gml:surfaceMembers

Group attributes attac	ched to gml:surfaceMembers	
Name	Value	Туре
objectType	'gml:Polygon' (static)	NC_STRING

#### 12.29.1.11 Group "gml:exterior" in "gml:surfaceMembers"

### Attributes in EOP\_METADATA/om:featureOfInterest/eop:multiExtentOf/gml:surfaceMembers/gml:exterior

Group attributes at	tached to gml:exterior	
Name	Value	Туре
gml:posList		NC_STRING
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

#### 12.29.1.12 Group "eop:metaDataProperty" in "EOP\_METADATA"

This group contains all the metadata relative to the Eath 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

Group attributes attached to	eop:metaDataProperty	
Name	Value	Туре
objectType	'eop:EarthObservationMetaData' (static)	NC_STRING
eop:acquisitionType	'NOMINAL' (dynamic)	NC_STRING
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 <i>always</i> be 'NOMINAL'.		
eop:identifier	'%(logical_filename)s' (dynamic)	NC_STRING
Logical file name.		
eop:doi	'%(product_doi)s' (dynamic)	NC_STRING
Digital Object Identifier identi	fying the product (see <a href="http://www.datacite.org">http://www.datacite.org</a> for	DOIs for datasets).
eop:parentIdentifier	<pre>'urn:ogc:def:EOP:ESA:SENTINEL.S5P_TROP %(shortname)s' (dynamic)</pre>	NC_STRING
Unique collection identifier for discussion of the value.	r metadata file, see the Level 1B metadata specification [	RD32, table 5] for a
This is a copy of the "gmd:file	eldentifier" attribute in the "/METADATA/ISO_METADATA"	group.
eop:productType	'S5P_%(mode)s_%(product)s' (dynamic)	NC_STRING
•••	ace %(mode)s with the operational mode the processor is RD25]) and %(product)s with the 10 character output 13, RD44, RD45].	
eop:status	'ACQUIRED' (dynamic)	NC_STRING
		· · · · · · · · · · · · · · · · · · ·

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

eop:productQualityStatus	'NOMINAL' (dynamic)	NC_STRING
Indicator that specifies whether	the product quality is degraded or not.	Allowed values: 'DEGRADED',
'NOMINAL'.		

#### eop:productQualityDegradationTkgT APPLICABLE' (dynamic) NC\_STRING

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 out 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.

#### 12.29.1.13 Group "eop:processing" in "eop:metaDataProperty"

Processing information.

### Attributes in EOP\_METADATA/eop:metaDataProperty/eop:processing

Group attributes attached to ed	p:processing	
Name	Value	Туре
objectType	'eop:ProcessingInformation' (static)	NC_STRING
eop:processingCenter	'%(processingcenter)s' (dynamic)	NC_STRING
The processing center, taken fr	om the "Processing_Station" key in the joborder.	
eop:processingDate	'YYYY-mm-ddTHH:MM:SSZ' (dynamic)	NC_STRING
The processing date, as an ISC	0 8601 date-time string [RD35].	
eop:processingLevel	'L2' (static)	NC_STRING
These are all Level 2 products.		
eop:processorName	'%(processor_name)s' (static)	NC_STRING
The name of the processor, "ta	copnll2dp.exe" for KNMI and "upas-12" for DLR.	
eop:processorVersion	'%(version)s' (dynamic)	NC_STRING
Version of the processor, as "m	ajor.minor.bugfix".	
eop:nativeProductFormat	'netCDF-4' (static)	NC_STRING
Native product format.		
eop:processingMode	'%(mode)s' (dynamic)	NC_STRING
	nission specific code list. For S5P we use the <i>File Class</i> 'GSOV', 'OPER', 'NRTI', 'OFFL', 'RPRO'.	identifiers [RD25

## 12.30 ISO metadata

#### 12.30.1 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 "object  ${\tt Type}$  " 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

Group attributes attached to ISO	_METADATA	
Name	Value	Туре
gmd:dateStamp	'2015-10-16' (static)	NC_STRING
Date of creation of the metadata	, as ISO 8601 [RD35] string specifying year, month and c	day.
gmd:fileldentifier	<pre>'urn:ogc:def:EOP:ESA:SENTINEL.S5P_TROP %(shortname)s' (dynamic)</pre>	NC_STRING
Unique identifier for metadata file of the value.	, see the Level 1B metadata specification [RD32, table 5]	for a discussion
<b>Replace %()s with the</b> "Pro DESCRIPTION" <b>metadata group</b> .	oductShortName" value from the Level 2 "/METADA	ATA/GRANULE
gmd:hierarchyLevelName	'EO Product Collection' (static)	NC_STRING
Name of the hierarchy levels for	which the metadata is provided.	
gmd:metadataStandardName	'ISO 19115-2 Geographic Information - Metadata Part 2 Extensions for imagery and gridded data' (static)	NC_STRING
	(ISO 1011E 2:2000(E) SED profile' (statio)	
gmd:metadataStandardVersion (ISO 19115-2:2009(E), S5P profile' (static) NC_STRING		
Version (profile) of the metadata		
objectType	'gmi:MI_Metadata' (static)	NC_STRING
Name of the metadata class [RD	32, table 5].	

## 12.30.1.1 Group "gmd:language" in "ISO\_METADATA"

Language used for the metadata, fixed to English.

## Attributes in ISO\_METADATA/gmd:language

Group attributes attached to gmd:language		
Name	Value	Туре
codeList	'http://www.loc.gov/standards/iso639-2/' (static)	NC_STRING
codeListValue	'eng' (static)	NC_STRING
objectType	'gmd:LanguageCode' (static)	NC_STRING

### 12.30.1.2 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

Group attributes attached to gmd:characterSet			
Name	Value	Туре	
codeList	<pre>'http://www.isotc211.org/2005/resources/Codelist/ gmxCodelists.xml#MD_CharacterSetCode' (static)</pre>	NC_STRING	
codeListValue	'utf8' (static)	NC_STRING	
objectType	'gmd:MD_CharacterSetCode' (static)	NC_STRING	

### 12.30.1.3 Group "gmd:hierarchyLevel" in "ISO\_METADATA"

Scope to wich metadata applies.

#### Attributes in ISO\_METADATA/gmd:hierarchyLevel

Group attributes attached to gmd:hierarchyLevel			
Name	Value	Туре	
codeList	<pre>'http://www.isotc211.org/2005/resources/Codelist/ gmxCodelists.xml#MD_ScopeCode' (static)</pre>	NC_STRING	
codeListValue	'series' (static)	NC_STRING	
objectType	'gmd:MD_ScopeCode' (static)	NC_STRING	

## 12.30.1.4 Group "gmd:contact" in "ISO\_METADATA"

Contact information for the product.

#### Attributes in ISO\_METADATA/gmd:contact

Group attributes attached to gmd:contact			
Name	Value	Туре	
gmd:organisationName	'Copernicus Space Component Data Access System, ESA, Services Coordinated Interface' (static)	NC_STRING	
objectType	'gmd:CI_ResponsibleParty' (static)	NC_STRING	

## 12.30.1.5 Group "gmd:contactInfo" in "gmd:contact"

The detailed contact information.

#### Attributes in ISO\_METADATA/gmd:contact/gmd:contactInfo

Group attributes attached to gmd:contactInfo		
Name	Value	Туре
objectType	'gmd:CI_Contact' (static)	NC_STRING

#### 12.30.1.6 Group "gmd:address" in "gmd:contactInfo"

The actual email address.

#### Attributes in ISO\_METADATA/gmd:contact/gmd:contactInfo/gmd:address

Group attributes attached to gmd:address			
Name	Value	Туре	
gmd:electronicMailAddress	'EOSupport@copernicus.esa.int' (static)	NC_STRING	
objectType	'gmd:CI_Address' (static)	NC_STRING	

### 12.30.1.7 Group "gmd:role" in "gmd:contact"

The role of the adress provided in this group.

## Attributes in ISO\_METADATA/gmd:contact/gmd:role

Group attributes attached to gmd:role			
Name	Value	Туре	
codeList	<pre>'http://www.isotc211.org/2005/resources/Codelist/ gmxCodelists.xml#CI_RoleCode' (static)</pre>	NC_STRING	
codeListValue	'pointOfContact' (static)	NC_STRING	
objectType	'gmd:Cl_RoleCode' (static)	NC_STRING	

#### 12.30.1.8 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 (subclassed) as MD\_DataIdentification because in this case it is used to identify data.

### Attributes in ISO\_METADATA/gmd:identificationInfo

Group attributes at	tached to gmd:identificationInfo	
Name	Value	Туре
gmd:abstract		NC STRING

Brief narrative summary of the content of the resource. This is product specific.

- L2\_AER\_AI (KNMI) Aerosol index with a spatial resolution of 7 × 7 km<sup>2</sup> 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 7 × 7 km<sup>2</sup> 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 7 × 7 km<sup>2</sup> 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  $28 \times 21 \text{ km}^2$  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  $7 \times 7 \text{ km}^2$  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 7 × 7 km<sup>2</sup> 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 7 × 7 km<sup>2</sup> observed at about 13:30 local solar time from spectra measured by TROPOMI
- L2\_\_FRESCO (KNMI) Cloud fraction and cloud pressure with a spatial resolution of  $3.5 \times 7 \text{ km}^2$  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 7 × 7 km<sup>2</sup> observed at about 13:30 local solar time from spectra measured by TROPOMI
- L2\_HCHO\_ (BIRA) Formaldehyde tropospheric column with a spatial resolution of 7 × 7 km<sup>2</sup> 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 7 × 7 km<sup>2</sup> 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 7 × 7 km<sup>2</sup> observed at about 13:30 local solar time from spectra measured by TROPOMI
- L2\_\_SO2\_\_ (BIRA) Sulfur dioxide column with a spatial resolution of 7 × 7 km<sup>2</sup> observed at about 13:30 local solar time from spectra measured by TROPOMI

L2	NP	BDx	TBA

gmd:credit	'%(credit)s' (static)	NC_STRING
Recognition of those who co	ontributed to the resource(s).	
gmd:language	'eng' (static)	NC_STRING
gmd:topicCategory	'climatologyMeteorologyAtmosphere' (static)	NC_STRING
Main theme(s) of the datase	·t.	
objectType	'gmd:MD_DataIdentification' (static)	NC_STRING
Name of the metadata class [RD32, table 10].		

## 12.30.1.9 Group "gmd:citation" in "gmd:identificationInfo"

Citation data for the resource.

#### Attributes in ISO\_METADATA/gmd:identificationInfo/gmd:citation

Group attributes attack	ned to gmd:citation	
Name	Value	Туре
gmd:title		NC_STRING
Name by which the cite	ed resource is known. This is the same as the globa	I "title" attribute.
objectType	'gmd:CI_Citation' (static)	NC_STRING
Name of the metadata	class [RD32, table 11].	

### 12.30.1.10 Group "gmd:date" in "gmd:citation"

## Attributes in ISO\_METADATA/gmd:identificationInfo/gmd:citation/gmd:date

Group attributes attached to gmd:date			
Name	Value	Туре	
gmd:date	'%(processor_release_date)s' (static)	NC_STRING	
objectType	'gmd:CI_Date' (static)	NC_STRING	

#### 12.30.1.11 Group "gmd:dateType" in "gmd:date"

Event used for reference date.

#### Attributes in ISO\_METADATA/gmd:identificationInfo/gmd:citation/gmd:date/gmd:dateType

Group attributes attached to gmd:dateType			
Name	Value	Туре	
codeList	<pre>'http://www.isotc211.org/2005/resources/Codelist/ gmxCodelists.xml#CI_DateTypeCode' (static)</pre>	NC_STRING	
codeListValue	'creation' (static)	NC_STRING	
objectType	'gmd:CI_DateTypeCode' (static)	NC_STRING	

#### 12.30.1.12 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

Group attributes attache	ed to gmd:identifier	
Name	Value	Туре
gmd:code	<pre>'urn:ogc:def:EOP:ESA:SENTINEL.S5P_TF %(shortname)s' (dynamic)</pre>	ROP NC_STRING
Replace "%(shortname)s DESCRIPTION" metada	s" with the "ProductShortName" value from the Level ta group.	2"/METADATA/GRANULE
objectType	'gmd:MD_Identifier' (static)	NC_STRING

### 12.30.1.13 Group "gmd:pointOfContact" in "gmd:identificationInfo"

See description of the "gmd:contact" attribute above.

#### Attributes in ISO\_METADATA/gmd:identificationInfo/gmd:pointOfContact

Group attributes attached to gmd:pointOfContact			
Name	Value	Туре	
gmd:organisationName	'Copernicus Space Component Data Access System, ESA, Services Coordinated Interface' (static)	NC_STRING	
objectType	'gmd:CI_ResponsibleParty' (static)	NC_STRING	

12.30.1.14 Group "gmd:contactInfo" in "gmd:pointOfContact"

### Attributes in ISO\_METADATA/gmd:identificationInfo/gmd:pointOfContact/gmd:contactInfo

Group attributes attac	ched to gmd:contactInfo	
Name	Value	Туре
objectType	'gmd:CI_Contact' (static)	NC_STRING

#### 12.30.1.15 Group "gmd:address" in "gmd:contactInfo"

## Attributes in ISO\_METADATA/gmd:identificationInfo/gmd:pointOfContact/gmd:contactInfo/gmd:address

Group attributes attached to gmd:address			
Name	Value	Туре	
gmd:electronicMailAddress	'EOSupport@copernicus.esa.int' (static)	NC_STRING	
objectType	'gmd:CI_Address' (static)	NC_STRING	

## 12.30.1.16 Group "gmd:role" in "gmd:pointOfContact"

#### Attributes in ISO\_METADATA/gmd:identificationInfo/gmd:pointOfContact/gmd:role

Group attributes attached to gmd:role			
Name	Value	Туре	
codeList	<pre>'http://www.isotc211.org/2005/resources/Codelist/ gmxCodelists.xml#CI_RoleCode' (static)</pre>	NC_STRING	
codeListValue	'distributor' (static)	NC_STRING	
objectType	'gmd:CI_RoleCode' (static)	NC_STRING	

#### 12.30.1.17 Group "gmd:descriptiveKeywords#1" in "gmd:identificationInfo"

Provides category keywords, their type, and reference source. Within the framework of GEMET the choise of keywords is very limited. More meaningful keywords can be derived from the Climate and Forecast metadada conventions' standard name list, see "gmd:descriptiveKeywords#2" below.

#### Attributes in ISO\_METADATA/gmd:identificationInfo/gmd:descriptiveKeywords#1

Group attributes attached to gmd:descriptiveKeywords#1			
Name	Value	Туре	
gmd:keyword#1	'Atmospheric conditions' (static)	NC_STRING	
objectType	'gmd:MD_Keywords' (static)	NC_STRING	

## 12.30.1.18 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

Group attributes attached to gmd:type		
Name	Value	Туре
codeList	<pre>'http://www.isotc211.org/2005/resources/Codelist/ gmxCodelists.xml#MD_KeywordTypeCode' (static)</pre>	NC_STRING
codeListValue	'theme' (static)	NC_STRING
objectType	'gmd:MD_KeywordTypeCode' (static)	NC_STRING

## 12.30.1.19 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

Group attributes attach	ed to gmd:thesaurusName	
Name	Value	Туре
gmd:title	'GEMET - INSPIRE themes, version 1.0' (static)	NC_STRING
objectType	'gmd:CI_Citation' (static)	NC_STRING

#### 12.30.1.20 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

Group attributes attached to gmd:date		
Name	Value	Туре
gmd:date	'2008-06-01' (static)	NC_STRING
objectType	'gmd:CI_Date' (static)	NC_STRING

## 12.30.1.21 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

Group attributes attached	d to gmd:dateType	
Name	Value	Туре
codeList	<pre>'http://www.isotc211.org/2005/resources/Codelist/ gmxCodelists.xml#CI_DateTypeCode' (static)</pre>	NC_STRING
codeListValue	'publication' (static)	NC_STRING
objectType	'gmd:CI_DateTypeCode' (static)	NC_STRING

#### 12.30.1.22 Group "gmd:descriptiveKeywords#2" in "gmd:identificationInfo"

Provides category keywords, their type, and reference source. These keywords are taken from the Climate and Forecast metadada conventions' standard name list [ER5]. 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/BIRA) 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

Group attributes attached to gmd:descriptiveKeywords#2			
Name	Value	Туре	
gmd:keyword#1		NC_STRING	
objectType	'gmd:MD_Keywords' (static)	NC_STRING	

#### 12.30.1.23 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

Group attributes attach	ed to gmd:thesaurusName		
Name	Value		Туре
gmd:title	'CF Standard Name Table v29' (static)		NC_STRING
xlink:href	<pre>'http://cfconventions.org/standard-names.html' namic)</pre>	(dy-	NC_STRING
objectType	'gmd:CI_Citation' (static)		NC_STRING

#### 12.30.1.24 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

Group attributes attached to gmd:date			
Name	Value	Туре	
gmd:date	'2015-07-08' (static)	NC_STRING	
objectType	'gmd:CI_Date' (static)	NC_STRING	

#### 12.30.1.25 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		
Name	Value	Туре

codeList	<pre>'http://www.isotc211.org/2005/resources/Codelist/ gmxCodelists.xml#CI_DateTypeCode' (static)</pre>	NC_STRING
codeListValue	'publication' (static)	NC_STRING
objectType	'gmd:CI_DateTypeCode' (static)	NC_STRING

### 12.30.1.26 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			
Name	Value	Туре	
gmd:useLimitation	'no conditions apply' (static)	NC_STRING	
Limitation affecting the fitness for use of the resource or metadata.			
objectType	'gmd:MD_LegalConstraints' (static)	NC_STRING	

## 12.30.1.27 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			
Name	Value	Туре	
codeList	<pre>'http://www.isotc211.org/2005/resources/Codelist/ gmxCodelists.xml#MD_RestrictionCode' (static)</pre>	NC_STRING	
codeListValue	'copyright' (static)	NC_STRING	
objectType	'gmd:MD_RestrictionCode' (static)	NC_STRING	

#### 12.30.1.28 Group "gmd:spatialRepresentationType" in "gmd:identificationInfo"

Method used to spatially represent geographic information.

## Attributes in ISO\_METADATA/gmd:identificationInfo/gmd:spatialRepresentationType

Group attributes attached	d to gmd:spatialRepresentationType	
Name	Value	Туре
codeList	<pre>'http://www.isotc211.org/2005/resources/Codelist/ gmxCodelists.xml#MD_SpatialRepresentation- TypeCode' (static)</pre>	NC_STRING
codeListValue	'grid' (static)	NC_STRING
objectType	'gmd:MD_SpatialRepresentationTypeCode' (static)	NC_STRING

## 12.30.1.29 Group "gmd:spatialResolution" in "gmd:identificationInfo"

Ground sample distance.

### Attributes in ISO\_METADATA/gmd:identificationInfo/gmd:spatialResolution

Group attributes attache	d to gmd:spatialResolution	
Name	Value	Туре
gmd:distance	7.0 (dynamic)	NC_FLOAT
uom	'km' (static)	NC_STRING
objectType	'gmd:MD_Resolution' (static)	NC_STRING

## 12.30.1.30 Group "gmd:characterSet" in "gmd:identificationInfo"

Group attributes attached to gmd:characterSet		
Name	Value	Туре
codeList	<pre>'http://www.isotc211.org/2005/resources/Codelist/ gmxCodelists.xml#MD_CharacterSetCode' (static)</pre>	NC_STRING
codeListValue	'utf8' (static)	NC_STRING
objectType	'gmd:MD_CharacterSetCode' (static)	NC_STRING

#### Attributes in ISO\_METADATA/gmd:identificationInfo/gmd:characterSet

#### 12.30.1.31 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

Group attributes attacl	ned to gmd:extent	
Name	Value	Туре
objectType	'gmd:EX_Extent' (static)	NC_STRING

#### 12.30.1.32 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:  $-180^{\circ} \le \vartheta \le 180^{\circ}$  and  $-90^{\circ} \le \delta \le 90^{\circ}$ . 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

Group attributes attached to gmd:geographicElement			
Name	Value	Туре	
gmd:eastBoundLongitude	180.0 (dynamic)	NC_FLOAT	
gmd:northBoundLatitude	90.0 (dynamic)	NC_FLOAT	
gmd:southBoundLatitude	-90.0 (dynamic)	NC_FLOAT	
gmd:westBoundLongitude	-180.0 (dynamic)	NC_FLOAT	
gmd:extentTypeCode	'true' (static)	NC_STRING	
Indication of whether the bounding polygon encompasses an area covered by the data or an area where data is not present. The value "true" indicates <i>inclusion</i> .			
objectType	'gmd:EX_GeographicBoundingBox' (static)	NC_STRING	

#### 12.30.1.33 Group "gmd:temporalElement" in "gmd:extent"

## Attributes in ISO\_METADATA/gmd:identificationInfo/gmd:extent/gmd:temporalElement

Group attributes attach	ed to gmd:temporalElement	
Name	Value	Туре
objectType	'gmd:EX_TemporalExtent' (static)	NC_STRING

### 12.30.1.34 Group "gmd:extent" in "gmd:temporalElement"

Time period covered by the content of the dataset.

#### Attributes in ISO\_METADATA/gmd:identificationInfo/gmd:extent/gmd:temporalElement/gmd:extent

Group attributes attach	ned to gmd:extent	
Name	Value	Туре
gml:beginPosition	'2014-11-14T19:58:00' (dynamic)	NC_STRING
Time of the start of the	granule, expressed as ISO 8601 [RD35] date-time string.	
gml:endPosition	'2014-11-14T20:08:00' (dynamic)	NC_STRING
Time of the end of the granule, expressed as ISO 8601 [RD35] date-time string.		
objectType	'gml:TimePeriod' (static)	NC_STRING

## 12.30.1.35 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 12.30.1.43 on page 105) 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

Group attributes attac	hed to gmd:dataQualityInfo	
Name	Value	Туре
objectType	'gmd:DQ_DataQuality' (static)	NC_STRING

#### 12.30.1.36 Group "gmd:scope" in "gmd:dataQualityInfo"

The specific data to which the data quality information applies.

#### Attributes in ISO\_METADATA/gmd:dataQualityInfo/gmd:scope

Group attributes attached to gmd:scope		
Name	Value	Туре
objectType	'gmd:DQ_Scope' (static)	NC_STRING

#### 12.30.1.37 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

Group attributes attache	d to gmd:level	
Name	Value	Туре
codeList	<pre>'http://www.isotc211.org/2005/resources/Codelist/ gmxCodelists.xml#MD_ScopeCode' (static)</pre>	NC_STRING
codeListValue	'dataset' (static)	NC_STRING
objectType	'gmd:MD_ScopeCode' (static)	NC_STRING

#### 12.30.1.38 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

Group attributes attached to gmd:report		
Name	Value	Туре

#### objectType

'gmd:DQ DomainConsistency' (static)

NC STRING

#### 12.30.1.39 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

Group attributes attached	to gmd:result	
Name	Value	Туре
objectType	'gmd:DQ_ConformanceResult' (static)	NC_STRING
gmd:pass	'true' (static)	NC_STRING
Indication of confomance	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	ng of conformance for this result. Within the context of INSPIRE of	conformance can

Explanation of the meaning of conformance for this result. Within the context of INSPIRE conformance ca currently not be determined.

#### 12.30.1.40 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

Group attributes attach	ed to gmd:specification	
Name	Value	Туре
objectType	'gmd:CI_Citation' (static)	NC_STRING
gmd:title	'INSPIRE Data Specification on Orthoimagery	- NC_STRING
	Guidelines, version 3.0rc3' (static)	

## 12.30.1.41 Group "gmd:date" in "gmd:specification"

Reference date for the cited resource.

#### Attributes in ISO\_METADATA/gmd:dataQualityInfo/gmd:report/gmd:result/gmd:specification/gmd:date

Group attributes attached to gmd:date		
Name	Value	Туре
gmd:date	'2013-02-04' (static)	NC_STRING
objectType	'gmd:CI_Date' (static)	NC_STRING

#### 12.30.1.42 Group "gmd:dateType" in "gmd:date"

Meaning of the reference date for the cited resource.

# Attributes in ISO\_METADATA/gmd:dataQualityInfo/gmd:report/gmd:result/gmd:specification/gmd:date/gmd:dateType

Group attributes attached to gmd:dateType		
Name	Value	Туре
codeList	<pre>'http://www.isotc211.org/2005/resources/Codelist/ gmxCodelists.xml#CI_DateTypeCode' (static)</pre>	NC_STRING
codeListValue	'publication' (static)	NC_STRING
objectType	<pre>'gmd:CI_DateTypeCode' (static)</pre>	NC_STRING

## 12.30.1.43 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

Group attributes attached	to gmd:lineage	
Name	Value	Туре
objectType	'gmd:LI_Lineage' (static)	NC_STRING
gmd:statement	'L2 %(product)s dataset produced by %(processingcen- ter)s from the S5P/TROPOMI L1B product' (dynamic)	NC_STRING

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).

## 12.30.1.44 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

Group attributes attached to gmd:processStep		
Name	Value	Туре
objectType	'gmi:LE_ProcessStep' (static)	NC_STRING
gmd:description	'Processing of L1b to L2 %(product)s data for orbit %(orbit)d using the %(institute)s processor version %(version)s' (dynamic)	NC_STRING

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 institude responsible for the CFI and the software version in this string (at the respective %(...)s and %(...)d).

### 12.30.1.45 Group "gmi:output" in "gmd:processStep"

Description of the output.

#### Attributes in ISO\_METADATA/gmd:dataQualityInfo/gmd:lineage/gmd:processStep/gmi:output

Group attributes atta	ached to gmi:output	
Name	Value	Туре
gmd:description		NC_STRING
Short description of	the output, a copy of the global 'title' attribute.	
objectType	'gmi:LE_Source' (static)	NC_STRING

#### 12.30.1.46 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

Group attributes attached to gmd:sourceCitation		
Name	Value	Туре
gmd:title	'%(logical_filename)s' (dynamic)	NC_STRING
Output file name witho	ut extension.	
objectType	'gmd:CI_Citation' (static)	NC_STRING

#### 12.30.1.47 Group "gmd:date" in "gmd:sourceCitation"

Production date and time of the output file.

# Attributes in ISO\_METADATA/gmd:dataQualityInfo/gmd:lineage/gmd:processStep/gmi:output/gmd:sourceCitation/gmd:date

Group attributes attached to gmd:date				
Name	Value	Туре		
gmd:date		NC_STRING		
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".				
objectType	'gmd:CI_DateTime' (static)	NC_STRING		

### 12.30.1.48 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/gmi:output/gmd:sourceCitation/gmd:date/gmd:dateType

Group attributes attached to gmd:dateType			
Name	Value	Туре	
codeList	<pre>'http://www.isotc211.org/2005/resources/Codelist/ gmxCodelists.xml#CI_DateTypeCode' (static)</pre>	NC_STRING	
codeListValue	'creation' (static)	NC_STRING	
objectType	'gmd:Cl_DateTypeCode' (static)	NC_STRING	

## 12.30.1.49 Group "gmd:identifier" in "gmd:sourceCitation"

Identification of the output product.

# Attributes in ISO\_METADATA/gmd:dataQualityInfo/gmd:lineage/gmd:processStep/gmi:output/gmd:sourceCitation/gmd:identifier

Group attributes attached to gmd:identifier			
Name	Value	Туре	
gmd:code	'%(shortname)s' (dynamic)	NC_STRING	
The product short name, a copy of the 'ProductShortName' attribute in '/METADATA/GRANULE_DESCRIP- TION'.			
objectType	'gmd:MD_Identifier' (static)	NC_STRING	

#### 12.30.1.50 Group "gmi:processedLevel" in "gmi:output"

Process level of the output file.

#### Attributes in ISO\_METADATA/gmd:dataQualityInfo/gmd:lineage/gmd:processStep/gmi:output/gmi:processedLevel

Group attributes attach	ned to gmi:processedLevel	
Name	Value	Туре
gmd:code	'L2' (static)	NC_STRING
objectType	'gmd:MD_Identifier' (static)	NC_STRING

#### 12.30.1.51 Group "gmi:processingInformation" in "gmd:processStep"

Description of the processor in more detail.

## Attributes in ISO\_METADATA/gmd:dataQualityInfo/gmd:lineage/gmd:processStep/gmi:processingInformation

Group attributes attached to gmi:processingInformation		
Name	Value	Туре
objectType	'gmi:LE_Processing' (static)	NC_STRING

### 12.30.1.52 Group "gmi:identifier" in "gmi:processingInformation"

Identification of the processor.

# Attributes in ISO\_METADATA/gmd:dataQualityInfo/gmd:lineage/gmd:processStep/gmi:processingInformation/gmi:identifier

Group attributes attac	hed to gmi:identifier	
Name	Value	Туре
gmd:code	<pre>'%(institute)s L2 %(product)s processor, version %(ver- sion)s' (dynamic)</pre>	NC_STRING
B		

Descriptive name of the processor, with the %(...)s placeholders replaced with the responsible institute's name, product name and software release version.

objectType 'gmd:MD_Identifier' (static)	NC_STRING
---	-----------

### 12.30.1.53 Group "gmi:softwareReference" in "gmi:processingInformation"

Reference to document describing processing software.

# Attributes in ISO\_METADATA/gmd:dataQualityInfo/gmd:lineage/gmd:processStep/gmi:processingInformation/gmi:softwareReference

Group attributes attached to gr	ni:softwareReference	
Name	Value	Туре
gmd:title	'L2 %(product)s processor description' (dynamic)	NC_STRING
Title of processor description.		
objectType	'gmd:CI_Citation' (static)	NC_STRING

### 12.30.1.54 Group "gmd:date" in "gmi:softwareReference"

Release date (compile date) of the processor.

# Attributes in ISO\_METADATA/gmd:dataQualityInfo/gmd:lineage/gmd:processStep/gmi:processingInformation/gmi:softwareReference/gmd:date

Group attributes attached to gmd:date			
Name	Value	Туре	
gmd:date		NC_STRING	
Release date of the processor expressed as an ISO 8601 date string [RD35].			
objectType	'gmd:CI_DateTime' (static)	NC_STRING	

# 12.30.1.55 Group "gmd:dateType" in "gmd:date"

Confirm that this is the release date of the processor.

Attributes in ISO\_METADATA/gmd:dataQualityInfo/gmd:lineage/gmd:processStep/gmi:processingInformation/gmi:softwareReference/gmd:date/gmd:dateType

Group attributes attached to gmd:dateType			
Name	Value	Туре	
codeList	<pre>'http://www.isotc211.org/2005/resources/Codelist/ gmxCodelists.xml#CI_DateTypeCode' (static)</pre>	NC_STRING	
codeListValue	'creation' (static)	NC_STRING	
objectType	'gmd:CI_DateTypeCode' (static)	NC_STRING	

# 12.30.1.56 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

Group attributes attach	ed to gmi:documentation#1	
Name	Value	Туре
objectType	'gmd:CI_Citation' (static)	NC_STRING
gmd:title	'%(title_atbd)s' (dynamic)	NC_STRING
The filename of the cur	rent release of the ATBD of the current product.	
doi	'%(atbd_doi)s' (dynamic)	NC_STRING
DOI for the algorithm th	neoretical basis document.	

### 12.30.1.57 Group "gmd:date" in "gmi:documentation#1"

Release date of the ATBD.

# Attributes in ISO\_METADATA/gmd:dataQualityInfo/gmd:lineage/gmd:processStep/gmi:processingInformation/gmi:documentation#1/gmd:date

Group attributes attac	hed to gmd:date	
Name	Value	Туре
gmd:date	'%(date_atbd)s' (dynamic)	NC_STRING
Release date of the A	TBD expressed as an ISO 8601 date string [RD35].	
objectType	'gmd:CI_Date' (static)	NC_STRING
	<b>5</b> <u> </u>	—

### 12.30.1.58 Group "gmd:dateType" in "gmd:date"

Confirm that this is the date of publication.

# Attributes in ISO\_METADATA/gmd:dataQualityInfo/gmd:lineage/gmd:processStep/gmi:processingInformation/gmi:documentation#1/gmd:date/gmd:dateType

Group attributes attached to gmd:dateType			
Name	Value	Туре	
codeList	<pre>'http://www.isotc211.org/2005/resources/Codelist/ gmxCodelists.xml#CI_DateTypeCode' (static)</pre>	NC_STRING	
codeListValue	'publication' (static)	NC_STRING	
objectType	'gmd:CI_DateTypeCode' (static)	NC_STRING	

### 12.30.1.59 Group "gmi:documentation#2" in "gmi:processingInformation"

Reference to the PUM of the product.

# Attributes in ISO\_METADATA/gmd:dataQualityInfo/gmd:lineage/gmd:processStep/gmi:processingInformation/gmi:documentation#2

Group attributes attach	ed to gmi:documentation#2	
Name	Value	Туре
objectType	'gmd:CI_Citation' (static)	NC_STRING
gmd:title	'%(title_pum)s' (dynamic)	NC_STRING
The filename of the cur	rent release of the PUM of the current product.	
doi	'%(pum_doi)s' (dynamic)	NC_STRING
DOI for the product use	er manual.	

# 12.30.1.60 Group "gmd:date" in "gmi:documentation#2"

Release date of the PUM.

# Attributes in ISO\_METADATA/gmd:dataQualityInfo/gmd:lineage/gmd:processStep/gmi:processingInformation/gmi:documentation#2/gmd:date

Group attributes attached to gmd:date			
Name	Value	Туре	
gmd:date	'%(date_pum)s' (dynamic)	NC_STRING	
Release date of the PUM expressed as an ISO 8601 date string [RD35].			
objectType	'gmd:CI_Date' (static)	NC_STRING	

# 12.30.1.61 Group "gmd:dateType" in "gmd:date"

Confirm that this is the date of publication.

# Attributes in ISO\_METADATA/gmd:dataQualityInfo/gmd:lineage/gmd:processStep/gmi:processingInformation/gmi:documentation#2/gmd:date/gmd:dateType

Group attributes attached	d to gmd:dateType	
Name	Value	Туре
codeList	<pre>'http://www.isotc211.org/2005/resources/Codelist/ gmxCodelists.xml#CI_DateTypeCode' (static)</pre>	NC_STRING
codeListValue	'publication' (static)	NC_STRING
objectType	'gmd:CI_DateTypeCode' (static)	NC_STRING

### 12.30.1.62 Group "gmi:report" in "gmd:processStep"

Short report of what occurred during the process step.

### Attributes in ISO\_METADATA/gmd:dataQualityInfo/gmd:lineage/gmd:processStep/gmi:report

Group attributes attached t	o gmi:report		
Name	Value	Туре	
gmi:description	'Sentinel 5-precursor TROPOMI L1b processed to data using the %(institute)s L2 %(product)s process (dynamic)		
Textual description of what occurred during the process step. Replace %()s as indicated.			
gmi:fileType	'netCDF-4' (static)	NC_STRING	
Type of file that contains the processing report, in our case the processing report is contained in the main output file.			
gmi:name	'%(logical_filename)s.nc' (dynamic)	NC_STRING	
objectType	'gmi:LE_ProcessStepReport' (dynamic)	NC_STRING	

### 12.30.1.63 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 attach	ed to gmd:source#1	
Name	Value	Туре
objectType	'gmi:LE_Source' (static)	NC_STRING
gmd:description		NC_STRING

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.

# 12.30.1.64 Group "gmi:processedLevel" in "gmd:source#1"

### Attributes in ISO\_METADATA/gmd:dataQualityInfo/gmd:lineage/gmd:processStep/gmd:source#1/gmi:processedLevel

Group attributes attach	ned to gmi:processedLevel	
Name	Value	Туре
gmd:code	Empty!	NC_STRING
objectType	'gmd:MD_Identifier' (static)	NC_STRING

### 12.30.1.65 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 attack	ned to gmd:sourceCitation	
Name	Value	Туре
objectType	'gmd:CI_Citation' (static)	NC_STRING

### 12.30.1.66 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 att	tached to gmd:date	
Name	Value	Туре
gmd:date		NC_STRING
	d time of the input file(s) in this group expressed as an ition in the XML schema appears to allow the use	<b>.</b>
objectType	'gmd:CI_Date' (static)	NC_STRING

# 12.30.1.67 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	d to gmd:dateType	
Name	Value	Туре
codeList	<pre>'http://www.isotc211.org/2005/resources/Codelist/ gmxCodelists.xml#CI_DateTypeCode' (static)</pre>	NC_STRING
codeListValue	'creation' (static)	NC_STRING
objectType	'gmd:CI_DateTypeCode' (static)	NC_STRING

### 12.30.1.68 Group "gmd:title" in "gmd:sourceCitation"

# Attributes in ISO\_METADATA/gmd:dataQualityInfo/gmd:lineage/gmd:processStep/gmd:source#1/gmd:sourceCitation/gmd:title

Group attributes at	tached to gmd:title	
Name	Value	Туре
gco:characterStri	ng	NC_STRING
Textual description	n of the input file group (same as the "gmd:de	scription" attribute in the "gmi:LE -

Source" object).

### 12.30.1.69 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:dataQualityInfo/gmd:lineage/gmd:processStep/gmd:source#1/gmd:sourceCitation/gmd:alternateTitle#1

Group attributes attache	d to gmd:alternateTitle#1	
Name	Value	Туре
gmx:FileName	Empty!	NC_STRING
The basename of the inp	out file.	

### 12.30.1.70 Group "gmi:acquisitionInformation" in "ISO\_METADATA"

Metadata regarding the acquisition of the original data.

### Attributes in ISO\_METADATA/gmi:acquisitionInformation

Group attributes attach	ned to gmi:acquisitionInformation	
Name	Value	Туре
objectType	'gmi:MI_AcquisitionInformation' (static)	NC_STRING

### 12.30.1.71 Group "gmi:platform" in "gmi:acquisitionInformation"

The platform we are on.

### Attributes in ISO\_METADATA/gmi:acquisitionInformation/gmi:platform

Group attributes attached	to gmi:platform	
Name	Value	Туре
gmi:description	'Sentinel 5 Precursor' (static)	NC_STRING
objectType	'gmi:MI_Platform' (static)	NC_STRING

### 12.30.1.72 Group "gmi:identifier" in "gmi:platform"

Short identifier of the platform.

### Attributes in ISO\_METADATA/gmi:acquisitionInformation/gmi:platform/gmi:identifier

Group attributes attached	to gmi:identifier	
Name	Value	Туре
gmd:code	'S5P' (static)	NC_STRING
gmd:codeSpace	'http://www.esa.int/' (static)	NC_STRING
objectType	'gmd:RS_Identifier' (static)	NC_STRING

# 12.30.1.73 Group "gmi:instrument" in "gmi:platform"

The instrument used for the observations.

### Attributes in ISO\_METADATA/gmi:acquisitionInformation/gmi:platform/gmi:instrument

Group attributes attached to	gmi:instrument	
Name	Value	Туре
objectType	'gmi:MI_Instrument' (static)	NC_STRING
gmi:type	'UV-VIS-NIR-SWIR imaging spectrometer' (static)	NC_STRING
Type of the instrument.		

#### 12.30.1.74 Group "gmi:identifier" in "gmi:instrument"

Unique identifier for the instrument.

#### Attributes in ISO\_METADATA/gmi:acquisitionInformation/gmi:platform/gmi:instrument/gmi:identifier

Group attributes attached	to gmi:identifier	
Name	Value	Туре
gmd:code	'TROPOMI' (static)	NC_STRING
The actual identifier.		
gmd:codeSpace	'http://www.esa.int/' (static)	NC_STRING
Name or identifier of the o	rganization responsible for the namespace.	
objectType	'gmd:RS_Identifier' (static)	NC_STRING

# **13** Description of the SO<sub>2</sub> product

Description of the main output file for the Sulphur dioxide  $SO_2$  product from the TROPOMI instrument on the Sentinel 5-precursor mission.

# Global attributes in SO2\_\_\_\_

The attributes described in section 12.1 "Common file-level attributes" on page 36 are included in the output at this location.

The attributes described in section 12.2 "Common file-level attributes for DLR" on page 39 are included in the output at this location.

The attributes described in section 12.3 "Status dynamic ECMWF auxiliary data" on page 39 are included in the output at this location.

The attributes described in section 12.4 "Status dynamic NISE auxiliary data" on page 39 are included in the output at this location.

The attributes described in section 12.5 "Status dynamic TM5 auxiliary data for NO2, SO2 and HCHO processing" on page 39 are included in the output at this location.

The attributes described in section 12.6 "Status background correction auxiliary data" on page 40 are included in the output at this location.

The attributes described in section 12.7 "Status dynamic L2 aerosol index (AER<sub>A</sub>I)auxiliarydata" on page 40 are included in theo

The attributes described in section 12.8 "Status of the L2 Cloud product as input data" on page 40 are included in the output at this location.

The attributes described in section 12.9 "Status of the reference spectrum used for the retrieval" on page 40 are included in the output at this location.

Group attributes atta	ached to SO2	
Name	Value	Туре
title	'TROPOMI/S5P Sulphur Dioxide SO2' (dynamic)	NC_STRING
	ription of the product. In near-realtime processing the granule materiate title will become dynamic. This attribute originates from the NUC	•

references	'https://atmos.eoc.dlr.de/tropomi' (static)	NC_STRING
	he data or methods used to produce it. A URI to the <i>i</i> This attribute originates from the CF standard.	ATBD seems to be an
Status_L2_O3		NC_STRING
The status of L2 Ozone inp	ut, either "External" or "Internal".	

Possible values: External, Internal

# 13.1 Group "PRODUCT" in "SO2\_\_\_"

This is the main group containing the  $SO_2$  product. At this level the dimensions are defined, the actual data can be found one level deeper.

### Dimensions in SO2\_\_\_/PRODUCT

The dimensions described in section 12.10 "Common dimensions" on page 40 are included in the output at this location.

The dimensions described in section 12.10 "Common dimensions" on page 40 are included in the output at this location.

layer The number of layers in the  $SO_2$  profile data and averaging kernels.

size 1 (dynamic) source Processor. mode Present in all modes.

# Variables in SO2\_\_\_/PRODUCT

The variables described in section 12.11 "Coordinate variables" on page 41 are included in the output at this location.

The variables described in section 12.12 "Corner Dimension" on page 42 are included in the output at this location.

The variables described in section 12.13 "The geolocation fields" on page 42 are included in the output at this location.

The variables described in section 12.14 "Common product fields" on page 43 are included in the output at this location.

sulfurdioxide	_total_vertical_colu	Imn in SO2/PRODUCT		
Description:	Vertical column density of the sulphur dioxide $SO_2$ product for the polluted scenario (anthropogenic $SO_2$ in the PBL).			
Dimensions:	time, scanline, ground_pixel.			
Туре:	NC_FLOAT.			
Source:	Processor.			
Mode:	Present in all mode	S.		
Attributes:	Name	Value	Туре	
	units	'mol m-2' (static)	NC_STRING	
	standard_name	'atmosphere_mole_content_of_sulfur_dioxide' (static)	NC_STRING	
	long_name	'total vertical column of sulfur dioxide for the pol- luted scenario derived from the total slant column' (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 Carl product of latitude and longitude axes. This attribute originates from the CF standard			
	multiplication factor_to_con- vert_to_DU	2241.15 (static)	NC_FLOAT	

		entinel 5 precursor files are given in SI units. For an	
	value this means that the unit is $mol m^{-2}$ . Traditionally the unit for an integrated column is "DU" or Dobson Units. This attribute provides the multiplication factor to calculate the total		
		the value in $mol m^{-2}$ . This is provided as a conveni	
	have tools that work	•	ence to users who
			NC_FLOAT
	multiplication factor_to_con-	6.02214e+19 (static)	NC_FLOAI
	vert to mo-		
	lecules percm2		
	value this means the is "molecules $cm^{-2}$ " column in molecules	entinel 5 precursor files are given in SI units. For an nat the unit is $mol m^{-2}$ . Traditionally the unit for an . This attribute provides the multiplication factor to $s cm^{-2}$ from the value in $mol m^{-2}$ . This is provided as Is that work in molecules $cm^{-2}$ .	integrated column calculate the total
sulfurdioxide	_total_vertical_colu	Imn_precision in SO2/PRODUCT	
Description:		the vertical column density of the sulphur dioxide $S$ anthropogenic $SO_2$ in the PBL).	$O_2$ product for the
Dimensions:	time, scanline, grou	nd_pixel.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all mode	S.	
Attributes:	Name	Value	Туре
	units	'mol m-2' (static)	NC_STRING
	standard_name	'atmosphere_mole_content_of_sulfur_dioxide standard_error' (static)	NC_STRING
	long_name	'precision of the total vertical column of sulfur diox- ide for the polluted scenario derived from the total slant column' (static)	
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
		gitude coordinates of the TROPOMI swath is not defi and longitude axes. This attribute originates from the	
	multiplication factor_to_con- vert to DU	2241.15 (static)	NC_FLOAT
	The quantities in Se value this means th "DU" or Dobson Un	entinel 5 precursor files are given in SI units. For an lat the unit is $mol m^{-2}$ . Traditionally the unit for an in its. This attribute provides the multiplication factor to the value in $mol m^{-2}$ . This is provided as a convenies in DU.	tegrated column is calculate the total
	multiplication factor_to_con- vert_to_mo- lecules percm2	6.02214e+19 (static)	NC_FLOAT
	value this means the second s	entinel 5 precursor files are given in SI units. For an nat the unit is $mol m^{-2}$ . Traditionally the unit for an . This attribute provides the multiplication factor to $s cm^{-2}$ from the value in $mol m^{-2}$ . This is provided as Is that work in molecules $cm^{-2}$ .	integrated column calculate the total

# 13.1.1 Group "SUPPORT\_DATA" in "PRODUCT"

# 13.1.1.1 Group "GEOLOCATIONS" in "SUPPORT\_DATA"

#### Variables in SO2 /PRODUCT/SUPPORT DATA/GEOLOCATIONS

The variables described in section 12.15 "Additional geolocation support fields" on page 45 are included in the output at this location.

#### 13.1.1.2 Group "DETAILED\_RESULTS" in "SUPPORT\_DATA"

### Dimensions in SO2\_\_\_/PRODUCT/SUPPORT\_DATA/DETAILED\_RESULTS

number\_of\_slant\_columns\_win1 Fitted slant column densities of all fitted species in fitting window 1.

size 1 (dynamic) source Processor. mode Present in all modes.

number\_of\_slant\_columns\_win2 Fitted slant column densities of all fitted species in fitting window 2.

size 1 (dynamic) source Processor. mode Present in all modes.

number\_of\_slant\_columns\_win3 Fitted slant column densities of all fitted species in fitting window 3.

size 1 (dynamic) source Processor. mode Present in all modes.

### Variables in SO2\_\_\_/PRODUCT/SUPPORT\_DATA/DETAILED\_RESULTS

The variables described in section 12.16 "Detailed Results related to CAL Cloud Product concerning the Cloud Fraction Intensity Weighted" on page 49 are included in the output at this location.

The variables described in section 12.17 "Additional detailed results fields" on page 49 are included in the output at this location.

The variables described in section 12.18 "Debug fields for UPAS" on page 52 are included in the output at this location.

sulfurdioxide RESULTS	e_total_vertical_colu	Imn_trueness in SO2/PRODUCT/SUPPORT_D	ATA/DETAILED
Description:	Systematic error of the vertical column density of the sulphur dioxide $SO_2$ product for the polluted scenario (anthropogenic $SO_2$ in the PBL).		
Dimensions:	time, scanline, grou	nd_pixel.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all mode	S.	
Attributes:	Name	Value	Туре
	units	'mol m-2' (static)	NC_STRING
	long_name	'systematic error of the total vertical column density of sulfur dioxide for the polluted scenario' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
		gitude coordinates of the TROPOMI swath is not defin and longitude axes. This attribute originates from the 0	
	multiplication	2241.15 (static)	NC_FLOAT
	factor_to_con- vert_to_DU		

	value this means tha "DU" or Dobson Unit	entinel 5 precursor files are given in SI units. For an i at the unit is $mol m^{-2}$ . Traditionally the unit for an interts. This attribute provides the multiplication factor to the value in $mol m^{-2}$ . This is provided as a convenie in DU.	egrated column is calculate the tota
	multiplication factor_to_con- vert_to_mo- lecules_percm2	6.02214e+19 (static)	NC_FLOAT
	value this means th is "molecules $cm^{-2}$ ". column in molecules	entinel 5 precursor files are given in SI units. For an i tat the unit is $molm^{-2}$ . Traditionally the unit for an in This attribute provides the multiplication factor to $cm^{-2}$ from the value in $molm^{-2}$ . This is provided as that work in molecules $cm^{-2}$ .	ntegrated column alculate the total
fitted_slant_c	columns_win1 in SO	2/PRODUCT/SUPPORT_DATA/DETAILED_RES	ULTS
Description:	Fitted slant column of	densities $N^s$ of all fitted species in fitting window 1.	
Dimensions: Type:	time, scanline, grour NC DOUBLE.	nd_pixel, number_of_slant_columns_win1.	
Source:	Processor.		
Mode:	Present in all modes	5.	
Attributes:	Name	Value	Туре
	units	'mol m-2' (static)	NC_STRING
	long_name	'slant columns of all absorbers in fitting window 1' (static)	NC_STRING
	coordinates	<pre>'/PRODUCT/longitude /PRODUCT/latitude' (static)</pre>	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.		
	index_meaning	'1' (dynamic)	NC_STRING
		des the meaning of the indexes for the current varianded by a blank space.	able. Indexes are
fitted slant of	columns_win1_preci	ision in SO2/PRODUCT/SUPPORT_DATA/DETA	ILED_RESULTS
		slant column densities $N^s$ of all fitted species in fitting	
	Random error of the	r signification of the second second second single single second seco	g window 1
		nd_pixel, number_of_slant_columns_win1.	g window 1
Description: Dimensions: Type:	time, scanline, grour		g window 1
Description: Dimensions: Type: Source:	time, scanline, grour NC_FLOAT.	nd_pixel, number_of_slant_columns_win1.	g window 1
Description: Dimensions: Type: Source: Mode:	time, scanline, grour NC_FLOAT. Processor.	nd_pixel, number_of_slant_columns_win1.	g window 1
Description: Dimensions: Type: Source: Mode:	time, scanline, grour NC_FLOAT. Processor. Present in all modes	nd_pixel, number_of_slant_columns_win1.	
Description: Dimensions:	time, scanline, grour NC_FLOAT. Processor. Present in all modes Name	nd_pixel, number_of_slant_columns_win1. s. Value	Туре
Description: Dimensions: Type: Source: Mode:	time, scanline, grour NC_FLOAT. Processor. Present in all modes Name units	nd_pixel, number_of_slant_columns_win1. s. <u>Value</u> 'mol m-2' (static) 'slant column random errors of all absorbers in	<i>Type</i> NC_STRING
Description: Dimensions: Type: Source: Mode:	time, scanline, grour NC_FLOAT. Processor. Present in all modes Name units long_name coordinates The latitude and long	nd_pixel, number_of_slant_columns_win1. s. <u>Value</u> 'mol m-2' (static) 'slant column random errors of all absorbers in fitting window 1' (static)	<i>Type</i> NC_STRING NC_STRING NC_STRING ed as a Cartesian
Description: Dimensions: Type: Source: Mode:	time, scanline, grour NC_FLOAT. Processor. Present in all modes Name units long_name coordinates The latitude and long	nd_pixel, number_of_slant_columns_win1. S. Value 'mol m-2' (static) 'slant column random errors of all absorbers in fitting window 1' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) gitude coordinates of the TROPOMI swath is not defin	<i>Type</i> NC_STRING NC_STRING NC_STRING ed as a Cartesiar
Description: Dimensions: Type: Source: Mode:	time, scanline, grour NC_FLOAT. Processor. Present in all modes <i>Name</i> <b>units</b> <b>long_name</b> <b>coordinates</b> The latitude and long product of latitude and <b>index_meaning</b> This attribute provide	nd_pixel, number_of_slant_columns_win1. s. Value 'mol m-2' (static) 'slant column random errors of all absorbers in fitting window 1' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) gitude coordinates of the TROPOMI swath is not defin nd longitude axes. This attribute originates from the 0	<i>Type</i> NC_STRING NC_STRING NC_STRING ed as a Cartesian CF standard. NC_STRING
Description: Dimensions: Type: Source: Mode: Attributes:	time, scanline, grour NC_FLOAT. Processor. Present in all modes <i>Name</i> <b>units</b> <b>long_name</b> <b>coordinates</b> The latitude and long product of latitude and <b>index_meaning</b> This attribute provice supposed to be divide	nd_pixel, number_of_slant_columns_win1. S. Value 'mol m-2' (static) 'slant column random errors of all absorbers in fitting window 1' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) gitude coordinates of the TROPOMI swath is not defin nd longitude axes. This attribute originates from the 0 '1' (dynamic) des the meaning of the indexes for the current varia	<i>Type</i> NC_STRING NC_STRING NC_STRING ed as a Cartesia CF standard. NC_STRING able. Indexes are
Description: Dimensions: Type: Source: Mode: Attributes:	time, scanline, grour NC_FLOAT. Processor. Present in all modes Name units long_name coordinates The latitude and long product of latitude and index_meaning This attribute provic supposed to be divic columns_win2 in SO	And_pixel, number_of_slant_columns_win1.	<i>Type</i> NC_STRING NC_STRING NC_STRING ed as a Cartesia CF standard. NC_STRING able. Indexes are

Source:	Processor.			
Mode:	Present in all modes			
Attributes:	Name	Value	Туре	
	units	'mol m-2' (static)	NC_STRING	
	long_name	'slant columns of all absorbers in fitting window 2' (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 Cartesia product of latitude and longitude axes. This attribute originates from the CF standard.			
	index_meaning	'1' (dynamic)	NC_STRING	
		les the meaning of the indexes for the current varianded by a blank space.	ble. Indexes ar	
fitted_slant_	columns_win2_preci	sion in SO2/PRODUCT/SUPPORT_DATA/DETA	ILED_RESULTS	
Description:	Random error of the	slant column density $N^s$ of all fitted species in fitting	window 2	
Dimensions:	time, scanline, grour	nd_pixel, number_of_slant_columns_win2.		
Туре:	NC_FLOAT.			
Source:	Processor.			
Mode:	Present in all modes			
Attributes:	Name	Value	Туре	
	units	'mol m-2' (static)	NC_STRING	
	long_name	'slant column random all absorbers in fitting window 2' (static)	NC_STRING	
	coordinates	<pre>'/PRODUCT/longitude /PRODUCT/latitude' (static)</pre>	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.			
	index_meaning '1' (dynamic) NC_STRING			
	•	les the meaning of the indexes for the current varia led by a blank space.	ble. Indexes ar	
fitted_slant_o	columns_win3 in SO2	2/PRODUCT/SUPPORT_DATA/DETAILED_RESI	11 T S	
Description:			SLIG	
Dimensions:	Slant column density	$\gamma N^s$ of all fitted species in fitting window 3	JEI O	
	-	<i>A</i> N <sup>3</sup> of all fitted species in fitting window 3 nd_pixel, number_of_slant_columns_win3.		
Туре:	-			
Type: Source:	time, scanline, grour			
Source:	time, scanline, grour NC_DOUBLE.	nd_pixel, number_of_slant_columns_win3.		
Source: Mode:	time, scanline, grour NC_DOUBLE. Processor.	nd_pixel, number_of_slant_columns_win3.	Туре	
Source: Mode:	time, scanline, grour NC_DOUBLE. Processor. Present in all modes	nd_pixel, number_of_slant_columns_win3.		
Source: Mode:	time, scanline, grour NC_DOUBLE. Processor. Present in all modes Name	nd_pixel, number_of_slant_columns_win3.	Туре	
Source: Mode:	time, scanline, grour NC_DOUBLE. Processor. Present in all modes Name units	nd_pixel, number_of_slant_columns_win3.	<i>Type</i> NC_STRING	
Source: Mode:	time, scanline, grour NC_DOUBLE. Processor. Present in all modes Name units long_name coordinates The latitude and long	nd_pixel, number_of_slant_columns_win3.	<i>Type</i> NC_STRING NC_STRING NC_STRING ed as a Cartesia	
Source: Mode:	time, scanline, grour NC_DOUBLE. Processor. Present in all modes Name units long_name coordinates The latitude and long	nd_pixel, number_of_slant_columns_win3. <i>Value</i> 'mol m-2' (static) 'slant columns of all absorbers in fitting window 3' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) pitude coordinates of the TROPOMI swath is not defin	<i>Type</i> NC_STRING NC_STRING NC_STRING ed as a Cartesia	
Source: Mode:	time, scanline, grour NC_DOUBLE. Processor. Present in all modes Name units long_name coordinates The latitude and long product of latitude and index_meaning This attribute provid	Ad_pixel, number_of_slant_columns_win3. Value 'mol m-2' (static) 'slant columns of all absorbers in fitting window 3' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) pitude coordinates of the TROPOMI swath is not defin and longitude axes. This attribute originates from the 0	<i>Type</i> NC_STRING NC_STRING NC_STRING ed as a Cartesia CF standard. NC_STRING	
Source: Mode: Attributes:	time, scanline, grour NC_DOUBLE. Processor. Present in all modes <i>Name</i> <b>units</b> <b>long_name</b> <b>coordinates</b> The latitude and long product of latitude and <b>index_meaning</b> This attribute provid supposed to be divide	Ad_pixel, number_of_slant_columns_win3. Value 'mol m-2' (static) 'slant columns of all absorbers in fitting window 3' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) pitude coordinates of the TROPOMI swath is not defin- nd longitude axes. This attribute originates from the O '1' (dynamic) les the meaning of the indexes for the current varia	<i>Type</i> NC_STRING NC_STRING NC_STRING ed as a Cartesia CF standard. NC_STRING uble. Indexes at	
Source: Mode: Attributes: <b>fitted_slant_</b>	time, scanline, grour NC_DOUBLE. Processor. Present in all modes Name units long_name coordinates The latitude and long product of latitude and index_meaning This attribute provid supposed to be divid columns_win3_preci	Ad_pixel, number_of_slant_columns_win3. Value 'mol m-2' (static) 'slant columns of all absorbers in fitting window 3' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) gitude coordinates of the TROPOMI swath is not defin- nd longitude axes. This attribute originates from the 0 '1' (dynamic) les the meaning of the indexes for the current varia ded by a blank space.	<i>Type</i> NC_STRING NC_STRING ed as a Cartesia CF standard. NC_STRING able. Indexes a	
Source: Mode: Attributes: <b>fitted_slant_</b> Description:	time, scanline, grour NC_DOUBLE. Processor. Present in all modes Name units long_name coordinates The latitude and long product of latitude and index_meaning This attribute provid supposed to be divid columns_win3_preci Random error of the	Ad_pixel, number_of_slant_columns_win3. Value 'mol m-2' (static) 'slant columns of all absorbers in fitting window 3' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) gitude coordinates of the TROPOMI swath is not defin- nd longitude axes. This attribute originates from the C '1' (dynamic) les the meaning of the indexes for the current varia- ded by a blank space. sion in SO2/PRODUCT/SUPPORT_DATA/DETA	<i>Type</i> NC_STRING NC_STRING ed as a Cartesia CF standard. NC_STRING able. Indexes an	
Source: Mode: Attributes:	time, scanline, grour NC_DOUBLE. Processor. Present in all modes Name units long_name coordinates The latitude and long product of latitude and index_meaning This attribute provid supposed to be divid columns_win3_preci Random error of the	ind_pixel, number_of_slant_columns_win3.         Value         'mol m-2' (static)         'slant columns of all absorbers in fitting window 3' (static)         '/PRODUCT/longitude /PRODUCT/latitude' (static)         gitude coordinates of the TROPOMI swath is not definend longitude axes. This attribute originates from the 0 '1' (dynamic)         les the meaning of the indexes for the current variated by a blank space.         slant column density N <sup>s</sup> of all fitted species in fitting	<i>Type</i> NC_STRING NC_STRING ed as a Cartesia CF standard. NC_STRING uble. Indexes an	

Mode:	Present in all mode	es.	
Attributes:	Name	Value	Туре
	units	'mol m-2' (static)	NC_STRING
	long_name	'slant column random errors of all absorbers in fitting window 3' (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.		
	index_meaning	'1' (dynamic)	NC_STRING
		ides the meaning of the indexes for the current varia rided by a blank space.	able. Indexes are
selected_fitti	ng_window_flag in	SO2/PRODUCT/SUPPORT_DATA/DETAILED_RE	ESULTS
Description:	Flag which gives in density from DOAS	nformation about the selected window while computing S.	the slant column
Dimensions:	time, scanline, grou	und_pixel.	
Туре:	NC_INT.		
Source:	Processor.		
Mode:	Present in all mode	es.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	long_name	'flag describing the selected fitting window for sulfur dioxide retrieval' (static)	NC_STRING
	flag_values	1,2,3 (static)	NC_INT
sulfurdioxide	_slant_column_co	rrected in SO2/PRODUCT/SUPPORT_DATA/DET/	AILED_RESULTS
Description:	correction algorithr has been correcte	ensity <i>N<sup>s</sup></i> for the final selected fitting window, corrected I n. The global attribute "Status_BG" indicates if the sla d ("Nominal") or untouched ("Fallback"). Note that if Fallback", the data will be set entirely as fill value.	nt column density
Dimensions:	time, scanline, grou	-	
Туре:	NC_FLOAT.	_	
Source:	Processor.		
Mode:	Present in all mode	es.	
Attributes:	Name	Value	Туре
	units	'mol m-2' (static)	NC_STRING
	long_name	'background corrected sulfur dioxide slant column density for final selected fitting window' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
		ngitude coordinates of the TROPOMI swath is not defin and longitude axes. This attribute originates from the 0	
	multiplication factor_to_con- vert_to_DU	2241.15 (static)	NC_FLOAT
	value this means the "DU" or Dobson Ur	centinel 5 precursor files are given in SI units. For an i that the unit is $mol m^{-2}$ . Traditionally the unit for an intentiate. This attribute provides the multiplication factor to the value in $mol m^{-2}$ . This is provided as a convenient k in DU.	egrated column is calculate the total

	multiplication	6.02214e+19 (static)	NC_FLOAT
	factor_to_con-		
	vert_to_mo-		
	lecules_percm2	entinel 5 precursor files are given in SI units. For an i	ntograted column
	value this means the is "molecules $cm^{-2}$ " column in molecules	hat the unit is $molm^{-2}$ . Traditionally the unit for an in . This attribute provides the multiplication factor to $cscm^{-2}$ from the value in $molm^{-2}$ . This is provided as ls that work in molecules $cm^{-2}$ .	ntegrated column calculate the total
<b>sulfurdioxide</b> RESULTS	slant_column_cor	rected_trueness in SO2/PRODUCT/SUPPORT_I	DATA/DETAILED_
Description:	by the background slant column density	$SO_2$ slant column density $N^s$ for the final selected fitting correction algorithm. The global attribute "Status_Boy has been corrected ("Nominal") or untouched ("Fallbright ribute is set to "Fallback", the data will be set entirely	G" indicates if the back"). Note that if
Dimensions:	time, scanline, grou	nd_pixel.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all mode	S.	
Attributes:	Name	Value	Туре
	units	'mol m-2' (static)	NC_STRING
	long_name	'systematic error of the corrected sulfur dioxide slant column' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
		gitude coordinates of the TROPOMI swath is not defin and longitude axes. This attribute originates from the 0	
<b>sulfurdioxide</b> RESULTS	_slant_column_cor	rected_win1 in SO2/PRODUCT/SUPPORT_D	ATA/DETAILED_
Description:	<i>SO</i> <sub>2</sub> slant column c correction algorithm	density $N^s$ fitted in fitting window 1 and corrected by n.	y the background
Dimensions:	time, scanline, grou	nd_pixel.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all mode	S.	
Attributes:	Name	Value	Туре
	units	'mol m-2' (static)	NC_STRING
	long_name	'background corrected sulfur dioxide slant column density for fitting window 1' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
		gitude coordinates of the TROPOMI swath is not defin and longitude axes. This attribute originates from the 0	
	multiplication factor_to_con- vert_to_DU	2241.15 (static)	NC_FLOAT
	value this means th "DU" or Dobson Un	entinel 5 precursor files are given in SI units. For an i lat the unit is $mol m^{-2}$ . Traditionally the unit for an interit. This attribute provides the multiplication factor to the value in $mol m^{-2}$ . This is provided as a convenie $\kappa$ in DU.	egrated column is calculate the tota

	multiplication factor_to_con- vert_to_mo- lecules_percm2	6.02214e+19 (static)	NC_FLOAT
	The quantities in Se value this means th is "molecules cm <sup>-2</sup> " column in molecules users who have too	entinel 5 precursor files are given in SI units. For an hat the unit is $mol m^{-2}$ . Traditionally the unit for ar $r$ . This attribute provides the multiplication factor to $s cm^{-2}$ from the value in $mol m^{-2}$ . This is provided a bls that work in molecules cm <sup>-2</sup> .	n integrated column o calculate the total as a convenience to
sulfurdioxide RESULTS	e_slant_column_cor	rrected_win2 in SO2/PRODUCT/SUPPORT_	_DATA/DETAILED
Description:	$SO_2$ slant column density $N^s$ fitted in fitting window 2 and corrected by the background correction algorithm.		
Dimensions:	time, scanline, grou	ind_pixel.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all mode	2S.	
Attributes:	Name	Value	Туре
	units	'mol m-2' (static)	NC_STRING
	long_name	'background corrected sulfur dioxide slant column density for fitting window 2' (static)	n 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.		
	multiplication factor_to_con- vert_to_DU	2241.15 (static)	NC_FLOAT
	The quantities in Sentinel 5 precursor files are given in SI units. For an integrated column value this means that the unit is $mol m^{-2}$ . Traditionally the unit for an integrated column is "DU" or Dobson Units. This attribute provides the multiplication factor to calculate the total column in DU from the value in $mol m^{-2}$ . This is provided as a convenience to users who have tools that work in DU.		
	multiplication factor_to_con- vert_to_mo- lecules_percm2	6.02214e+19 (static)	NC_FLOAT
	value this means the second se	entinel 5 precursor files are given in SI units. For an hat the unit is $mol m^{-2}$ . Traditionally the unit for ar $r$ . This attribute provides the multiplication factor to $s cm^{-2}$ from the value in $mol m^{-2}$ . This is provided a loss that work in molecules $cm^{-2}$ .	n integrated column
<b>sulfurdioxide</b> RESULTS	e_slant_column_cor	rected_win3 in SO2/PRODUCT/SUPPORT_	_DATA/DETAILED_
Description:	SO <sub>2</sub> slant column of correction algorithm	density $N^s$ fitted in fitting window 3 and corrected n.	by the background
Dimensions:	time, scanline, grou	ind_pixel.	
Туре:	NC_FLOAT.		
Source:	Processor.		
	Present in all mode	PS.	
Mode:			
Mode: Attributes:	Name units	Value 'mol m-2' (static)	<i>Type</i> NC STRING

	long_name	'background corrected sulfur dioxide slant column density for fitting window 3' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
		gitude coordinates of the TROPOMI swath is not define nd longitude axes. This attribute originates from the C	
	multiplication factor_to_con- vert_to_DU	2241.15 (static)	NC_FLOAT
	value this means th "DU" or Dobson Uni	entinel 5 precursor files are given in SI units. For an in at the unit is $mol m^{-2}$ . Traditionally the unit for an inter ts. This attribute provides the multiplication factor to o the value in $mol m^{-2}$ . This is provided as a convenien- t in DU.	egrated column i calculate the tota
	multiplication factor_to_con- vert_to_mo- lecules_percm2	6.02214e+19 (static)	NC_FLOAT
	value this means the is "molecules $cm^{-2}$ ". column in molecules	entinel 5 precursor files are given in SI units. For an in the unit is $mol m^{-2}$ . Traditionally the unit for an ir This attribute provides the multiplication factor to c $acm^{-2}$ from the value in $mol m^{-2}$ . This is provided as that work in molecules cm <sup>-2</sup> .	ntegrated colum alculate the tota
fitted_root_m	nean_square_win1 ir	n SO2/PRODUCT/SUPPORT_DATA/DETAILED_F	RESULTS
Description:	Root mean square v	value of doas result for fitting window 1.	
Dimensions:	time, scanline, grou	nd_pixel.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all modes	5.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	long_name	'root mean square residual of the fit in fitting window	NC_STRING
		1' (static)	
fitted_root_m	nean_square_win2 ir		RESULTS
	- · -		RESULTS
Description:	- · -	NO2/PRODUCT/SUPPORT_DATA/DETAILED_F value of doas result for fitting window 2.	RESULTS
Description: Dimensions:	Root mean square	NO2/PRODUCT/SUPPORT_DATA/DETAILED_F value of doas result for fitting window 2.	RESULTS
Description: Dimensions: Type:	Root mean square v time, scanline, grou	NO2/PRODUCT/SUPPORT_DATA/DETAILED_F value of doas result for fitting window 2.	RESULTS
Description: Dimensions: Type: Source:	Root mean square v time, scanline, groun NC_FLOAT.	NO2/PRODUCT/SUPPORT_DATA/DETAILED_F value of doas result for fitting window 2. nd_pixel.	RESULTS
Description: Dimensions: Type: Source: Mode:	Root mean square v time, scanline, groun NC_FLOAT. Processor.	NO2/PRODUCT/SUPPORT_DATA/DETAILED_F value of doas result for fitting window 2. nd_pixel.	RESULTS
Description: Dimensions: Type: Source:	Root mean square v time, scanline, groun NC_FLOAT. Processor. Present in all modes	NO2/PRODUCT/SUPPORT_DATA/DETAILED_F value of doas result for fitting window 2. nd_pixel.	
Description: Dimensions: Type: Source: Mode:	Root mean square v time, scanline, groun NC_FLOAT. Processor. Present in all modes Name	n SO2/PRODUCT/SUPPORT_DATA/DETAILED_F value of doas result for fitting window 2. nd_pixel.	Туре
Description: Dimensions: Type: Source: Mode: Attributes:	Root mean square v time, scanline, groun NC_FLOAT. Processor. Present in all modes Name units long_name	NO2/PRODUCT/SUPPORT_DATA/DETAILED_F value of doas result for fitting window 2. nd_pixel. S. <u>Value</u> '1' (static) 'root mean square residual of the fit in fitting window	<i>Type</i> NC_STRING NC_STRING
Description: Dimensions: Type: Source: Mode: Attributes:	Root mean square v time, scanline, grout NC_FLOAT. Processor. Present in all modes <u>Name</u> units long_name	A SO2/PRODUCT/SUPPORT_DATA/DETAILED_F value of doas result for fitting window 2. nd_pixel. s. Value '1' (static) 'root mean square residual of the fit in fitting window 2' (static)	<i>Type</i> NC_STRING NC_STRING
Description: Dimensions: Type: Source: Mode: Attributes: fitted_root_m Description:	Root mean square v time, scanline, grout NC_FLOAT. Processor. Present in all modes <u>Name</u> units long_name	A SO2/PRODUCT/SUPPORT_DATA/DETAILED_F value of doas result for fitting window 2. nd_pixel. S. Value '1' (static) 'root mean square residual of the fit in fitting window 2' (static) n SO2/PRODUCT/SUPPORT_DATA/DETAILED_F value of doas result for fitting window 3.	<i>Type</i> NC_STRING NC_STRING
Description: Dimensions: Type: Source: Mode: Attributes:	Root mean square v time, scanline, groun NC_FLOAT. Processor. Present in all modes Name units Iong_name mean_square_win3 in Root mean square v	A SO2/PRODUCT/SUPPORT_DATA/DETAILED_F value of doas result for fitting window 2. nd_pixel. S. Value '1' (static) 'root mean square residual of the fit in fitting window 2' (static) n SO2/PRODUCT/SUPPORT_DATA/DETAILED_F value of doas result for fitting window 3.	<i>Type</i> NC_STRING NC_STRING
Description: Dimensions: Type: Source: Mode: Attributes: <b>fitted_root_m</b> Description: Dimensions: Type:	Root mean square v time, scanline, group NC_FLOAT. Processor. Present in all modes Name units long_name hean_square_win3 in Root mean square v time, scanline, group	A SO2/PRODUCT/SUPPORT_DATA/DETAILED_F value of doas result for fitting window 2. nd_pixel. S. Value '1' (static) 'root mean square residual of the fit in fitting window 2' (static) n SO2/PRODUCT/SUPPORT_DATA/DETAILED_F value of doas result for fitting window 3.	<i>Type</i> NC_STRING NC_STRING
Description: Dimensions: Type: Source: Mode: Attributes: fitted_root_m Description: Dimensions: Type: Source:	Root mean square v time, scanline, groun NC_FLOAT. Processor. Present in all modes Name units long_name mean_square_win3 in Root mean square v time, scanline, groun NC_FLOAT. Processor.	A SO2/PRODUCT/SUPPORT_DATA/DETAILED_F value of doas result for fitting window 2. nd_pixel. S. <u>Value</u> '1' (static) 'root mean square residual of the fit in fitting window 2' (static) D SO2/PRODUCT/SUPPORT_DATA/DETAILED_F value of doas result for fitting window 3. nd_pixel.	<i>Type</i> NC_STRING NC_STRING
Description: Dimensions: Type: Source: Mode: Attributes: <b>fitted_root_m</b> Description: Dimensions: Type:	Root mean square v time, scanline, groun NC_FLOAT. Processor. Present in all modes Name units long_name hean_square_win3 in Root mean square v time, scanline, groun NC_FLOAT.	A SO2/PRODUCT/SUPPORT_DATA/DETAILED_F value of doas result for fitting window 2. nd_pixel. S. <u>Value</u> '1' (static) 'root mean square residual of the fit in fitting window 2' (static) D SO2/PRODUCT/SUPPORT_DATA/DETAILED_F value of doas result for fitting window 3. nd_pixel.	<i>Type</i> NC_STRING NC_STRING

	long_name	'root mean square residual of the fit in fitting window 3' (static)	NC_STRING
averaging ke	ernel in SO2 /PRO	DUCT/SUPPORT DATA/DETAILED RESULTS	
Description:	Averaging kernel		
Dimensions:	time, scanline, grour	nd_pixel, layer.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all modes	).	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	long_name	'averaging kernel' (static)	NC STRING
sulfurdioxide		D2/PRODUCT/SUPPORT_DATA/DETAILED_RE	_
Description:	Volume mixing ratio		
Dimensions:	time, scanline, grour	-	
Туре:	NC FLOAT.		
Source:	Processor.		
Mode:	Present in all modes		
Attributes:	Name	 Value	Туре
	units	'1' (static)	NC_STRING
	long_name	'volume mixing ratio profile of sulfur dioxide' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC STRING
fitted radian	connect the data wit	nd longitude axes. Following [ER5, section 5.2] we us h the geolocation. This attribute originates from the ( RODUCT/SUPPORT DATA/DETAILED RESULTS	
Dimensions:	time, scanline, grour		
Type:	NC FLOAT.		
Source:	Processor.		
Mode:	Present in all modes		
Attributes:	Name	 Value	Туре
Allindules.	units	'nm' (static)	NC STRING
	long_name	'radiance wavelength shift from the doas fit' (static)	NC_STRING
fitted radian	-	/PRODUCT/SUPPORT DATA/DETAILED RESUL	
Dimensions:	time, scanline, grour		10
Type:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all modes		
Attributes:	Name	 Value	Tupo
	units	'1' (static)	<i>Type</i> NC_STRING
	long_name	'radiance wavelength squeeze from the doas fit'	NC_STRING
	iony_name	(static)	
fitted radian	ce shift win1 in SO2	2/PRODUCT/SUPPORT_DATA/DETAILED_RESU	
Dimensions:	time, scanline, grour		
Type:	NC FLOAT.	·~_p	
Source:	Processor.		
Mode:	Present in all modes		
Attributes:	Name	 Value	Туре
Autoutes.	units	'nm' (static)	NC STRING
	unita	init (Statio)	

	long_name	'radiance wavelength shift from the doas fit in fitting window 1' (static)	NC_STRING
fitted_radianc	ce_squeeze_win1 in	SO2/PRODUCT/SUPPORT_DATA/DETAILED_R	ESULTS
Dimensions:	time, scanline, grour		
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all modes		
Attributes:	Name	Value	Туре
-	units	'1' (static)	NC_STRING
-	long_name	'radiance wavelength squeeze from the doas fit in fitting window 1' (static)	NC_STRING
number_of_s RESULTS	pectral_points_in_re	etrieval_win1 in SO2/PRODUCT/SUPPORT_D	ATA/DETAILED_
Description:	The number of point	s in the spectrum that were used in the retrieval for fi	tting window 1.
Dimensions:	time, scanline, grour	nd_pixel.	
Туре:	NC_USHORT.		
Source:	Processor.		
Mode:	Present in all modes		
Attributes:	Name	Value	Туре
-	units	'1' (static)	NC_STRING
-	long_name	'number of spectral points used in the retrieval for window 1' (static)	NC_STRING
-	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
		gitude are in a different group. How to specify the recase is not specified in the climate and forecast n	
fitted radianc	e shift win2 in SO2	PRODUCT/SUPPORT DATA/DETAILED RESU	IITS
_		2/PRODUCT/SUPPORT_DATA/DETAILED_RESU	ILTS
Dimensions:	time, scanline, grour		ILTS
Dimensions: Type:	time, scanline, grour NC_FLOAT.		JLTS
Dimensions: Type: Source:	time, scanline, grour NC_FLOAT. Processor.	nd_pixel.	JLTS
Dimensions: Type: Source: Mode:	time, scanline, grour NC_FLOAT. Processor. Present in all modes	nd_pixel.	
Dimensions: Type: Source: Mode:	time, scanline, grour NC_FLOAT. Processor.	nd_pixel. s. Value	Туре
Dimensions: Type: Source:	time, scanline, grour NC_FLOAT. Processor. Present in all modes Name	nd_pixel. <i>Value</i> 'nm' (static) 'radiance wavelength shift from the doas fit in fitting	
Dimensions: Type: Source: Mode: Attributes:	time, scanline, grour NC_FLOAT. Processor. Present in all modes Name units Iong_name	nd_pixel.	<i>Type</i> NC_STRING NC_STRING
Dimensions: Type: Source: Mode: Attributes:	time, scanline, grour NC_FLOAT. Processor. Present in all modes Name units Iong_name ce_squeeze_win2 in	nd_pixel. <i>Value</i> 'nm' (static) 'radiance wavelength shift from the doas fit in fitting window 2' (static) SO2/PRODUCT/SUPPORT_DATA/DETAILED_R	<i>Type</i> NC_STRING NC_STRING
Dimensions: Type: Source: Mode: Attributes: fitted_radiance Dimensions:	time, scanline, grour NC_FLOAT. Processor. Present in all modes Name units Iong_name ce_squeeze_win2 in time, scanline, grour	nd_pixel. <i>Value</i> 'nm' (static) 'radiance wavelength shift from the doas fit in fitting window 2' (static) SO2/PRODUCT/SUPPORT_DATA/DETAILED_R	<i>Type</i> NC_STRING NC_STRING
Dimensions: Type: Source: Mode: Attributes: <b>fitted_radianc</b> Dimensions: Type:	time, scanline, grour NC_FLOAT. Processor. Present in all modes Name units Iong_name ce_squeeze_win2 in	nd_pixel. <i>Value</i> 'nm' (static) 'radiance wavelength shift from the doas fit in fitting window 2' (static) SO2/PRODUCT/SUPPORT_DATA/DETAILED_R	<i>Type</i> NC_STRING NC_STRING
Dimensions: Type: Source: Mode: Attributes: fitted_radianc Dimensions: Type: Source:	time, scanline, grour NC_FLOAT. Processor. Present in all modes Name units long_name ce_squeeze_win2 in time, scanline, grour NC_FLOAT.	nd_pixel. <i>Value</i> 'nm' (static) 'radiance wavelength shift from the doas fit in fitting window 2' (static) SO2/PRODUCT/SUPPORT_DATA/DETAILED_R nd_pixel.	<i>Type</i> NC_STRING NC_STRING
Dimensions: Type: Source: Mode: Attributes: <b>fitted_radianc</b> Dimensions: Type: Source: Mode:	time, scanline, grour NC_FLOAT. Processor. Present in all modes Name units Iong_name ce_squeeze_win2 in time, scanline, grour NC_FLOAT. Processor.	nd_pixel. <i>Value</i> 'nm' (static) 'radiance wavelength shift from the doas fit in fitting window 2' (static) SO2/PRODUCT/SUPPORT_DATA/DETAILED_R nd_pixel.	<i>Type</i> NC_STRING NC_STRING
Dimensions: Type: Source: Mode: Attributes: fitted_radianc Dimensions: Type: Source: Mode:	time, scanline, grour NC_FLOAT. Processor. Present in all modes Name units Iong_name ce_squeeze_win2 in time, scanline, grour NC_FLOAT. Processor. Present in all modes Name	nd_pixel. <i>Value</i> 'nm' (static) 'radiance wavelength shift from the doas fit in fitting window 2' (static) SO2/PRODUCT/SUPPORT_DATA/DETAILED_R nd_pixel. <i>Value</i>	<i>Type</i> NC_STRING NC_STRING ESULTS
Dimensions: Type: Source: Mode: Attributes:	time, scanline, grour NC_FLOAT. Processor. Present in all modes Name units long_name ce_squeeze_win2 in time, scanline, grour NC_FLOAT. Processor. Present in all modes	nd_pixel. <i>Value</i> 'nm' (static) 'radiance wavelength shift from the doas fit in fitting window 2' (static) SO2/PRODUCT/SUPPORT_DATA/DETAILED_R nd_pixel.	<i>Type</i> NC_STRING NC_STRING ESULTS
Dimensions: Type: Source: Mode: Attributes: fitted_radianc Dimensions: Type: Source: Mode: Attributes: 	time, scanline, grour NC_FLOAT. Processor. Present in all modes Name units Iong_name ce_squeeze_win2 in time, scanline, grour NC_FLOAT. Processor. Present in all modes Name units Iong_name	ind_pixel.         Value         'nm' (static)         'radiance wavelength shift from the doas fit in fitting window 2' (static)         SO2/PRODUCT/SUPPORT_DATA/DETAILED_R         ind_pixel.         S.         Value         '1' (static)         'radiance wavelength shift from the doas fit in fitting	<i>Type</i> NC_STRING NC_STRING ESULTS <i>Type</i> NC_STRING NC_STRING
Dimensions: Type: Source: Mode: Attributes: fitted_radianc Dimensions: Type: Source: Mode: Attributes: 	time, scanline, grour NC_FLOAT. Processor. Present in all modes Name units Iong_name ce_squeeze_win2 in time, scanline, grour NC_FLOAT. Processor. Present in all modes Name units Iong_name pectral_points_in_re	ind_pixel.         Value         'nm' (static)         'radiance wavelength shift from the doas fit in fitting window 2' (static)         SO2/PRODUCT/SUPPORT_DATA/DETAILED_R         ind_pixel.         S.         Value         '1' (static)         'radiance wavelength shift from the doas fit in fitting window 2' (static)	<i>Type</i> NC_STRING NC_STRING ESULTS <i>Type</i> NC_STRING NC_STRING ATA/DETAILED
Dimensions: Type: Source: Mode: Attributes: fitted_radianc Dimensions: Type: Source: Mode: Attributes:	time, scanline, grour NC_FLOAT. Processor. Present in all modes Name units Iong_name ce_squeeze_win2 in time, scanline, grour NC_FLOAT. Processor. Present in all modes Name units Iong_name pectral_points_in_re	ind_pixel.         Value         'nm' (static)         'radiance wavelength shift from the doas fit in fitting window 2' (static)         SO2/PRODUCT/SUPPORT_DATA/DETAILED_R         id_pixel.         S.         Value         '1' (static)         'radiance wavelength shift from the doas fit in fitting window 2' (static)         'radiance wavelength shift from the doas fit in fitting window 2' (static)         etrieval_win2 in SO2/PRODUCT/SUPPORT_D         s in the spectrum that were used in the retrieval for w	<i>Type</i> NC_STRING NC_STRING ESULTS <i>Type</i> NC_STRING NC_STRING ATA/DETAILED

Present in all mode	es.	
Name	Value	Туре
units	'1' (static)	NC_STRING
long_name	'number of spectral points used in the retrieval for window 2' (static)	NC_STRING
coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
coordinates in this		
		JLTS
-	und_pixel.	
NC_FLOAT.		
Processor.		
Present in all mode	es.	
Name	Value	Туре
units	'nm' (static)	NC_STRING
long_name	'radiance wavelength shift from the doas fit in fitting window 3' (static)	NC_STRING
e_squeeze_win3 i	n SO2/PRODUCT/SUPPORT_DATA/DETAILED_R	ESULTS
time, scanline, gro	und_pixel.	
NC_FLOAT.		
Processor.		
Present in all mode	es.	
Name	Value	Туре
units	'1' (static)	NC STRING
long_name	<ul> <li>'1' (static)</li> <li>'radiance wavelength shift from the doas fit in fitting window 3' (static)</li> </ul>	NC_STRING NC_STRING
long_name		NC_STRING
long_name pectral_points_in_	<pre>'radiance wavelength shift from the doas fit in fitting window 3' (static) _retrieval_win3 in SO2/PRODUCT/SUPPORT_D</pre>	NC_STRING
long_name pectral_points_in_ The number of poi	<pre>'radiance wavelength shift from the doas fit in fitting window 3' (static) retrieval_win3 in SO2/PRODUCT/SUPPORT_D nts in the spectrum that were used in the retrieval for w</pre>	NC_STRING
long_name pectral_points_in_ The number of poi time, scanline, gro	<pre>'radiance wavelength shift from the doas fit in fitting window 3' (static) retrieval_win3 in SO2/PRODUCT/SUPPORT_D nts in the spectrum that were used in the retrieval for w</pre>	NC_STRING
long_name pectral_points_in_ The number of poi time, scanline, gro NC_USHORT.	<pre>'radiance wavelength shift from the doas fit in fitting window 3' (static) retrieval_win3 in SO2/PRODUCT/SUPPORT_D nts in the spectrum that were used in the retrieval for w</pre>	NC_STRING
long_name pectral_points_in_ The number of poi time, scanline, gro NC_USHORT. Processor.	<pre>'radiance wavelength shift from the doas fit in fitting window 3' (static) _retrieval_win3 in SO2/PRODUCT/SUPPORT_D nts in the spectrum that were used in the retrieval for w und_pixel.</pre>	NC_STRING
long_name pectral_points_in_ The number of poi time, scanline, gro NC_USHORT. Processor. Present in all mode	<pre>'radiance wavelength shift from the doas fit in fitting window 3' (static) _retrieval_win3 in SO2/PRODUCT/SUPPORT_D nts in the spectrum that were used in the retrieval for w und_pixel.</pre>	NC_STRING ATA/DETAILED vindow 3.
long_name pectral_points_in_ The number of poi time, scanline, gro NC_USHORT. Processor. Present in all mode Name	<pre>'radiance wavelength shift from the doas fit in fitting window 3' (static) _retrieval_win3 in SO2/PRODUCT/SUPPORT_D nts in the spectrum that were used in the retrieval for w und_pixel. es. Value</pre>	NC_STRING ATA/DETAILED vindow 3. <i>Type</i>
long_name pectral_points_in_ The number of poi time, scanline, gro NC_USHORT. Processor. Present in all mode	<pre>'radiance wavelength shift from the doas fit in fitting window 3' (static) _retrieval_win3 in SO2/PRODUCT/SUPPORT_D nts in the spectrum that were used in the retrieval for w und_pixel. es. <u>Value</u> '1' (static) 'number of spectral points used in the retrieval for</pre>	NC_STRING ATA/DETAILED vindow 3.
long_name pectral_points_in_ The number of poi time, scanline, gro NC_USHORT. Processor. Present in all mode Name units long_name	<pre>'radiance wavelength shift from the doas fit in fitting window 3' (static) _retrieval_win3 in SO2/PRODUCT/SUPPORT_D nts in the spectrum that were used in the retrieval for w und_pixel. es. <u>Value</u> '1' (static) 'number of spectral points used in the retrieval for window 3' (static)</pre>	NC_STRING ATA/DETAILED vindow 3. <u>Type</u> NC_STRING NC_STRING
Iong_name pectral_points_in_ The number of poi time, scanline, gro NC_USHORT. Processor. Present in all mode Name units Iong_name Coordinates The latitude and lo coordinates in this	<pre>'radiance wavelength shift from the doas fit in fitting window 3' (static) _retrieval_win3 in SO2/PRODUCT/SUPPORT_D nts in the spectrum that were used in the retrieval for w und_pixel. es. <u>Value</u> '1' (static) 'number of spectral points used in the retrieval for</pre>	NC_STRING ATA/DETAILED vindow 3.  Type NC_STRING NC_STRING NC_STRING elated geospat
long_name pectral_points_in_ The number of points_in_ time, scanline, grove NC_USHORT. Processor. Present in all mode Name units long_name Coordinates The latitude and loce coordinates in this tions [ER5].	<pre>'radiance wavelength shift from the doas fit in fitting window 3' (static) _retrieval_win3 in SO2/PRODUCT/SUPPORT_D nts in the spectrum that were used in the retrieval for w und_pixel. es. <u>Value                                     </u></pre>	NC_STRING ATA/DETAILED vindow 3. <u>Type</u> NC_STRING NC_STRING NC_STRING elated geospat netadata conve
long_name pectral_points_in_ The number of poi time, scanline, gro NC_USHORT. Processor. Present in all mode Name units long_name coordinates The latitude and lo coordinates in this tions [ER5]. _total_air_mass_fa	<pre>'radiance wavelength shift from the doas fit in fitting window 3' (static) _retrieval_win3 in SO2/PRODUCT/SUPPORT_D nts in the spectrum that were used in the retrieval for w und_pixel. es. Value '1' (static) 'number of spectral points used in the retrieval for window 3' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) ongitude are in a different group. How to specify the r s case is not specified in the climate and forecast n actor_polluted in SO2/PRODUCT/SUPPORT_D</pre>	NC_STRING ATA/DETAILED vindow 3. <u>Type</u> NC_STRING NC_STRING NC_STRING elated geospati netadata conve
Iong_name pectral_points_in_ The number of poi time, scanline, gro NC_USHORT. Processor. Present in all mode Name units Iong_name Coordinates The latitude and lo coordinates in this tions [ER5]total_air_mass_factory	<pre>'radiance wavelength shift from the doas fit in fitting window 3' (static) _retrieval_win3 in SO2/PRODUCT/SUPPORT_D nts in the spectrum that were used in the retrieval for w und_pixel. es. <u>Value                                     </u></pre>	NC_STRING ATA/DETAILED vindow 3. <u>Type</u> NC_STRING NC_STRING NC_STRING elated geospati netadata conve
long_name pectral_points_in_ The number of poi time, scanline, gro NC_USHORT. Processor. Present in all mode Name units long_name coordinates The latitude and lo coordinates in this tions [ER5]. _total_air_mass_fa	<pre>'radiance wavelength shift from the doas fit in fitting window 3' (static) _retrieval_win3 in SO2/PRODUCT/SUPPORT_D nts in the spectrum that were used in the retrieval for w und_pixel. es. <u>Value                                     </u></pre>	NC_STRING ATA/DETAILED vindow 3. <u>Type</u> NC_STRING NC_STRING NC_STRING elated geospati netadata conve
	units long_name coordinates The latitude and lo coordinates in this tions [ER5]. ce_shift_win3 in SC time, scanline, gro NC_FLOAT. Processor. Present in all mode Name units long_name ce_squeeze_win3 in time, scanline, gro NC_FLOAT. Processor. Present in all mode NC_FLOAT. Processor. Present in all mode NC_FLOAT. Processor. Present in all mode Name	units       '1' (static)         long_name       'number of spectral points used in the retrieval for window 2' (static)         coordinates       '/PRODUCT/longitude /PRODUCT/latitude' (static)         The latitude and longitude are in a different group. How to specify the r coordinates in this case is not specified in the climate and forecast r tions [ER5].         ce_shift_win3 in SO2/PRODUCT/SUPPORT_DATA/DETAILED_RESU time, scanline, ground_pixel.         NC_FLOAT.         Processor.         Present in all modes.         Name       Value         units       'nm' (static)         long_name       'radiance wavelength shift from the doas fit in fitting window 3' (static)         ce_squeeze_win3 in SO2/PRODUCT/SUPPORT_DATA/DETAILED_RESU time, scanline, ground_pixel.         NC_FLOAT.         Processor.         Present in all modes.         Present in all modes.         radiance wavelength shift from the doas fit in fitting window 3' (static)         ce_squeeze_win3 in SO2/PRODUCT/SUPPORT_DATA/DETAILED_R         time, scanline, ground_pixel.         NC_FLOAT.         Processor.         Present in all modes.

Mode:	Present in all mode	S	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	long_name	'total air mass factor for boundary layer polluted scenario' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
	product of latitude a	ngitude coordinates of the TROPOMI swath is not define and longitude axes. Following [ER5, section 5.2] we us ith the geolocation. This attribute originates from the C	se this attribute t
sulfurdioxide DETAILED_R		ctor_polluted_precision in SO2/PRODUCT/S	SUPPORT_DATA
Description:	Random error of the	e total air mass factor $M$ for the polluted case.	
Dimensions:	time, scanline, grou	ind_pixel.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all mode	S.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	long_name	'random error of the total air mass factor for the boundary layer polluted scenario' (static)	NC_STRING
	coordinates	<pre>'/PRODUCT/longitude /PRODUCT/latitude' (static)</pre>	NC_STRING
	The latitude and lon product of latitude a	'/PRODUCT/longitude /PRODUCT/latitude' (static) ngitude coordinates of the TROPOMI swath is not define and longitude axes. Following [ER5, section 5.2] we us ith the geolocation. This attribute originates from the C	ed as a Cartesia se this attribute t
	The latitude and lon product of latitude a connect the data wi _total_air_mass_fa	igitude coordinates of the TROPOMI swath is not define and longitude axes. Following [ER5, section 5.2] we us	ed as a Cartesia se this attribute t CF standard.
DETAILED_R	The latitude and lon product of latitude a connect the data wi <b>_total_air_mass_fa</b> ESULTS	ngitude coordinates of the TROPOMI swath is not define and longitude axes. Following [ER5, section 5.2] we us ith the geolocation. This attribute originates from the C	ed as a Cartesia se this attribute t CF standard.
DETAILED_R Description:	The latitude and lon product of latitude a connect the data wi <b>_total_air_mass_fa</b> ESULTS	ingitude coordinates of the TROPOMI swath is not define and longitude axes. Following [ER5, section 5.2] we us ith the geolocation. This attribute originates from the C ctor_polluted_trueness in SO2/PRODUCT/S the total air mass factor $M$ for the polluted case.	ed as a Cartesia se this attribute t CF standard.
DETAILED_R Description: Dimensions:	The latitude and lon product of latitude a connect the data wi <b>ctotal_air_mass_fa</b> ESULTS Systematic error of	ingitude coordinates of the TROPOMI swath is not define and longitude axes. Following [ER5, section 5.2] we us ith the geolocation. This attribute originates from the C ctor_polluted_trueness in SO2/PRODUCT/S the total air mass factor $M$ for the polluted case.	ed as a Cartesia se this attribute t CF standard.
DETAILED_R Description: Dimensions: Type:	The latitude and lon product of latitude a connect the data wi <b>e_total_air_mass_fa</b> ESULTS Systematic error of time, scanline, grou	ingitude coordinates of the TROPOMI swath is not define and longitude axes. Following [ER5, section 5.2] we us ith the geolocation. This attribute originates from the C ctor_polluted_trueness in SO2/PRODUCT/S the total air mass factor $M$ for the polluted case.	ed as a Cartesia se this attribute t CF standard.
DETAILED_R Description: Dimensions: Type: Source:	The latitude and lon product of latitude a connect the data wi <b>e_total_air_mass_fa</b> ESULTS Systematic error of time, scanline, grou NC_FLOAT.	ingitude coordinates of the TROPOMI swath is not define and longitude axes. Following [ER5, section 5.2] we us ith the geolocation. This attribute originates from the C <b>ctor_polluted_trueness</b> in SO2/PRODUCT/S the total air mass factor $M$ for the polluted case. ind_pixel.	ed as a Cartesia se this attribute t CF standard.
DETAILED_R Description: Dimensions: Type: Source: Mode:	The latitude and lon product of latitude a connect the data wi e_total_air_mass_fa ESULTS Systematic error of time, scanline, grou NC_FLOAT. Processor.	ingitude coordinates of the TROPOMI swath is not define and longitude axes. Following [ER5, section 5.2] we us ith the geolocation. This attribute originates from the C <b>ctor_polluted_trueness</b> in SO2/PRODUCT/S the total air mass factor $M$ for the polluted case. ind_pixel.	ed as a Cartesia se this attribute t CF standard.
DETAILED_R Description: Dimensions: Type: Source: Mode:	The latitude and lon product of latitude a connect the data wi e_total_air_mass_fa ESULTS Systematic error of time, scanline, grou NC_FLOAT. Processor. Present in all mode	regitude coordinates of the TROPOMI swath is not define and longitude axes. Following [ER5, section 5.2] we us ith the geolocation. This attribute originates from the C <b>ctor_polluted_trueness</b> in SO2/PRODUCT/S the total air mass factor $M$ for the polluted case. ind_pixel.	ed as a Cartesia se this attribute t CF standard. GUPPORT_DATA
DETAILED_R Description: Dimensions: Type: Source: Mode:	The latitude and lon product of latitude a connect the data wi e_total_air_mass_fa ESULTS Systematic error of time, scanline, grou NC_FLOAT. Processor. Present in all mode Name	regitude coordinates of the TROPOMI swath is not define and longitude axes. Following [ER5, section 5.2] we us ith the geolocation. This attribute originates from the C ctor_polluted_trueness in SO2/PRODUCT/S the total air mass factor <i>M</i> for the polluted case. ind_pixel.	ed as a Cartesia se this attribute t CF standard. SUPPORT_DATA
DETAILED_R Description: Dimensions: Type: Source: Mode:	The latitude and lon product of latitude a connect the data wi e_total_air_mass_fa ESULTS Systematic error of time, scanline, grou NC_FLOAT. Processor. Present in all mode Name units	regitude coordinates of the TROPOMI swath is not define and longitude axes. Following [ER5, section 5.2] we us ith the geolocation. This attribute originates from the O ctor_polluted_trueness in SO2/PRODUCT/S the total air mass factor <i>M</i> for the polluted case. ind_pixel. s. <u>Value</u> '1' (static) 'systematic error of the total air mass factor for the	ed as a Cartesia se this attribute t CF standard. SUPPORT_DATA SUPPORT_DATA
DETAILED_R Description: Dimensions: Type: Source: Mode:	The latitude and lon product of latitude a connect the data wi e_total_air_mass_fa ESULTS Systematic error of time, scanline, grou NC_FLOAT. Processor. Present in all mode Name units long_name Coordinates The latitude and lon product of latitude a	regitude coordinates of the TROPOMI swath is not define and longitude axes. Following [ER5, section 5.2] we us ith the geolocation. This attribute originates from the C ctor_polluted_trueness in SO2/PRODUCT/S the total air mass factor <i>M</i> for the polluted case. ind_pixel. ss. <u>Value</u> '1' (static) 'systematic error of the total air mass factor for the boundary layer polluted scenario' (static)	ed as a Cartesia se this attribute to CF standard. GUPPORT_DATA GUPPORT_DATA NC_STRING NC_STRING NC_STRING ed as a Cartesia se this attribute to
DETAILED_R Description: Dimensions: Type: Source: Mode: Attributes: sulfurdioxide	The latitude and lon product of latitude a connect the data wi e_total_air_mass_fa ESULTS Systematic error of time, scanline, grou NC_FLOAT. Processor. Present in all mode Name units long_name Coordinates The latitude and lon product of latitude a connect the data wi	Angitude coordinates of the TROPOMI swath is not define and longitude axes. Following [ER5, section 5.2] we us ith the geolocation. This attribute originates from the C ctor_polluted_trueness in SO2/PRODUCT/S the total air mass factor <i>M</i> for the polluted case. and_pixel. ss. <u>Value</u> '1' (static) 'systematic error of the total air mass factor for the boundary layer polluted scenario' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) and longitude axes. Following [ER5, section 5.2] we us ith the geolocation. This attribute originates from the C	ed as a Cartesia se this attribute t CF standard. SUPPORT_DATA SUPPORT_DATA NC_STRING NC_STRING NC_STRING ed as a Cartesia se this attribute t CF standard.
DETAILED_R Description: Dimensions: Type: Source: Mode: Attributes: Attributes: sulfurdioxide DATA/DETAIL	The latitude and lon product of latitude a connect the data wi e_total_air_mass_fa ESULTS Systematic error of time, scanline, grou NC_FLOAT. Processor. Present in all mode Name units long_name Coordinates The latitude and lon product of latitude a connect the data wi e_total_air_mass_fa ED_RESULTS	Angitude coordinates of the TROPOMI swath is not define and longitude axes. Following [ER5, section 5.2] we us ith the geolocation. This attribute originates from the C ctor_polluted_trueness in SO2/PRODUCT/S the total air mass factor <i>M</i> for the polluted case. and_pixel. ss. <u>Value</u> '1' (static) 'systematic error of the total air mass factor for the boundary layer polluted scenario' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) and longitude axes. Following [ER5, section 5.2] we us ith the geolocation. This attribute originates from the C	ed as a Cartesia se this attribute to CF standard. GUPPORT_DATA GUPPORT_DATA NC_STRING NC_STRING NC_STRING ed as a Cartesia se this attribute to CF standard. JCT/SUPPORT_
DETAILED_R Description: Dimensions: Type: Source: Mode: Attributes: <b>Sulfurdioxide</b> DATA/DETAIL Description:	The latitude and lon product of latitude a connect the data wi e_total_air_mass_fa ESULTS Systematic error of time, scanline, grou NC_FLOAT. Processor. Present in all mode Name units long_name Coordinates The latitude and lon product of latitude a connect the data wi e_total_air_mass_fa ED_RESULTS	Angitude coordinates of the TROPOMI swath is not define and longitude axes. Following [ER5, section 5.2] we us ith the geolocation. This attribute originates from the C ctor_polluted_trueness in SO2/PRODUCT/S the total air mass factor <i>M</i> for the polluted case. and_pixel. ss. <u>Value</u> '1' (static) 'systematic error of the total air mass factor for the boundary layer polluted scenario' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) and longitude axes. Following [ER5, section 5.2] we us ith the geolocation. This attribute originates from the C ctor_polluted_kernel_trueness in SO2/PRODUCT the total air mass factor <i>M</i> when kernels are used for the the total air mass factor <i>M</i> when kernels are used for the section of the total air mass factor for the conditional and longitude the product for the polluted originates from the C ctor_polluted_kernel_trueness in SO2/PRODUCT	ed as a Cartesia se this attribute to CF standard. GUPPORT_DATA GUPPORT_DATA NC_STRING NC_STRING NC_STRING ed as a Cartesia se this attribute to CF standard. JCT/SUPPORT_
DETAILED_R Description: Dimensions: Type: Source: Mode: Attributes: <b>sulfurdioxide</b> DATA/DETAIL Description: Dimensions:	The latitude and lon product of latitude a connect the data wi e_total_air_mass_fa ESULTS Systematic error of time, scanline, grou NC_FLOAT. Processor. Present in all mode Name units long_name coordinates The latitude and lon product of latitude a connect the data wi e_total_air_mass_fa ED_RESULTS Systematic error of	Angitude coordinates of the TROPOMI swath is not define and longitude axes. Following [ER5, section 5.2] we us ith the geolocation. This attribute originates from the C ctor_polluted_trueness in SO2/PRODUCT/S the total air mass factor <i>M</i> for the polluted case. and_pixel. ss. <u>Value</u> '1' (static) 'systematic error of the total air mass factor for the boundary layer polluted scenario' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) and longitude axes. Following [ER5, section 5.2] we us ith the geolocation. This attribute originates from the C ctor_polluted_kernel_trueness in SO2/PRODUCT the total air mass factor <i>M</i> when kernels are used for the the total air mass factor <i>M</i> when kernels are used for the section of the total air mass factor for the conditional and longitude the product for the polluted originates from the C ctor_polluted_kernel_trueness in SO2/PRODUCT	ed as a Cartesia se this attribute to CF standard. GUPPORT_DATA GUPPORT_DATA NC_STRING NC_STRING NC_STRING ed as a Cartesia se this attribute to CF standard. JCT/SUPPORT
DETAILED_R Description: Dimensions: Type: Source: Mode: Attributes: <b>sulfurdioxide</b> DATA/DETAIL Description: Dimensions: Type:	The latitude and lon product of latitude a connect the data wi e_total_air_mass_fa ESULTS Systematic error of time, scanline, grou NC_FLOAT. Processor. Present in all mode Name units long_name Coordinates The latitude and lon product of latitude a connect the data wi e_total_air_mass_fa ED_RESULTS Systematic error of time, scanline, grou	Angitude coordinates of the TROPOMI swath is not define and longitude axes. Following [ER5, section 5.2] we us ith the geolocation. This attribute originates from the C ctor_polluted_trueness in SO2/PRODUCT/S the total air mass factor <i>M</i> for the polluted case. and_pixel. ss. <u>Value</u> '1' (static) 'systematic error of the total air mass factor for the boundary layer polluted scenario' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) and longitude axes. Following [ER5, section 5.2] we us ith the geolocation. This attribute originates from the C ctor_polluted_kernel_trueness in SO2/PRODUCT the total air mass factor <i>M</i> when kernels are used for the the total air mass factor <i>M</i> when kernels are used for the section of the total air mass factor for the conditional and longitude the section.	ed as a Cartesia se this attribute to CF standard. GUPPORT_DATA GUPPORT_DATA NC_STRING NC_STRING NC_STRING ed as a Cartesia se this attribute to CF standard. JCT/SUPPORT_
DETAILED_R Description: Dimensions: Type: Source: Mode: Attributes: Attributes: <b>sulfurdioxide</b> DATA/DETAIL Description: Dimensions: Type: Source:	The latitude and lon product of latitude a connect the data wi e_total_air_mass_fa ESULTS Systematic error of time, scanline, grou NC_FLOAT. Processor. Present in all mode Name units long_name coordinates The latitude and lon product of latitude a connect the data wi e_total_air_mass_fa ED_RESULTS Systematic error of time, scanline, grou NC_FLOAT.	ingitude coordinates of the TROPOMI swath is not define and longitude axes. Following [ER5, section 5.2] we us ith the geolocation. This attribute originates from the C ctor_polluted_trueness in SO2/PRODUCT/S the total air mass factor <i>M</i> for the polluted case. and_pixel. ss. <u>Value</u> '1' (static) 'systematic error of the total air mass factor for the boundary layer polluted scenario' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) orgitude coordinates of the TROPOMI swath is not define and longitude axes. Following [ER5, section 5.2] we us ith the geolocation. This attribute originates from the C ctor_polluted_kernel_trueness in SO2/PRODUC the total air mass factor <i>M</i> when kernels are used for the ind_pixel.	ed as a Cartesia se this attribute to CF standard. GUPPORT_DATA GUPPORT_DATA NC_STRING NC_STRING NC_STRING ed as a Cartesia se this attribute to CF standard. JCT/SUPPORT_
DETAILED_R Description: Dimensions: Type: Source: Mode: Attributes: sulfurdioxide	The latitude and lon product of latitude a connect the data wi e_total_air_mass_fa ESULTS Systematic error of time, scanline, grou NC_FLOAT. Processor. Present in all mode Name units long_name coordinates The latitude and lon product of latitude a connect the data wi e_total_air_mass_fa ED_RESULTS Systematic error of time, scanline, grou NC_FLOAT. Processor.	ingitude coordinates of the TROPOMI swath is not define and longitude axes. Following [ER5, section 5.2] we us ith the geolocation. This attribute originates from the C ctor_polluted_trueness in SO2/PRODUCT/S the total air mass factor <i>M</i> for the polluted case. and_pixel. ss. <u>Value</u> '1' (static) 'systematic error of the total air mass factor for the boundary layer polluted scenario' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) orgitude coordinates of the TROPOMI swath is not define and longitude axes. Following [ER5, section 5.2] we us ith the geolocation. This attribute originates from the C ctor_polluted_kernel_trueness in SO2/PRODUC the total air mass factor <i>M</i> when kernels are used for the ind_pixel.	ed as a Cartesia se this attribute t CF standard. GUPPORT_DATA GUPPORT_DATA NC_STRING NC_STRING NC_STRING ed as a Cartesia se this attribute t CF standard. JCT/SUPPORT_

	long_name	'systematic error of the total air mass factor for the kernel polluted scenario' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
	product of latitude a	yitude coordinates of the TROPOMI swath is not defin nd longitude axes. Following [ER5, section 5.2] we u h the geolocation. This attribute originates from the 0	se this attribute to
sulfurdioxide RESULTS		ctor_polluted in SO2/PRODUCT/SUPPORT_D	
Description:	Clear air mass facto	r for the polluted case.	
Dimensions:	time, scanline, grour	nd_pixel.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all modes	).	
Attributes:	Name	Value	Туре
-	units	'1' (static)	NC_STRING
-	long_name	'clear sky air mass factor for the boundary layer polluted scenario' (static)	NC_STRING
-	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
	product of latitude a	gitude coordinates of the TROPOMI swath is not definent of longitude axes. Following [ER5, section 5.2] we under the geolocation. This attribute originates from the formation the section of the section	se this attribute to
RESULTS		factor_polluted in SO2/PRODUCT/SUPPORT_E	DATA/DETAILED_
Description: Dimensions:	time, scanline, grour	tor for the polluted case.	
	NC FLOAT.		
Type: Source:	Processor.		
Mode:	Present in all modes		
Attributes:	Name	 Value	Туре
Allinbules.	units	'1' (static)	NC STRING
-	long_name	'cloudy sky air mass factor for the boundary layer polluted scenario' (static)	NC_STRING
-	coordinates	<pre>'/PRODUCT/longitude /PRODUCT/latitude' (static)</pre>	NC_STRING
		<b>9</b>	
	product of latitude a	yitude coordinates of the TROPOMI swath is not defin nd longitude axes. Following [ER5, section 5.2] we u h the geolocation. This attribute originates from the 0	ed as a Cartesian se this attribute to
sulfurdioxide	product of latitude a	nd longitude axes. Following [ER5, section 5.2] we u h the geolocation. This attribute originates from the (	ed as a Cartesian se this attribute to CF standard.
	product of latitude an connect the data wit _total_vertical_colu	nd longitude axes. Following [ER5, section 5.2] we u h the geolocation. This attribute originates from the ( mn_1km in SO2/PRODUCT/SUPPORT_DATA/ sity of the Sulphur Dioxide <i>SO</i> <sub>2</sub> product for a sulfur diox	ed as a Cartesian se this attribute to CF standard. DETAILED_RES
ULTS	product of latitude and connect the data wit <b>_total_vertical_colu</b> Vertical column dens	nd longitude axes. Following [ER5, section 5.2] we u h the geolocation. This attribute originates from the ( mn_1km in SO2/PRODUCT/SUPPORT_DATA/ sity of the Sulphur Dioxide <i>SO</i> <sub>2</sub> product for a sulfur diox ography.	ed as a Cartesian se this attribute to CF standard. DETAILED_RES
ULTS Description:	product of latitude and connect the data wit <b>_total_vertical_colu</b> Vertical column dens altitude w.r.t. the top	nd longitude axes. Following [ER5, section 5.2] we u h the geolocation. This attribute originates from the ( mn_1km in SO2/PRODUCT/SUPPORT_DATA/ sity of the Sulphur Dioxide <i>SO</i> <sub>2</sub> product for a sulfur diox ography.	ed as a Cartesian se this attribute to CF standard. DETAILED_RES
ULTS Description: Dimensions:	product of latitude an connect the data wit <b>total_vertical_colum</b> Vertical column dens altitude w.r.t. the top time, scanline, grour	nd longitude axes. Following [ER5, section 5.2] we u h the geolocation. This attribute originates from the ( mn_1km in SO2/PRODUCT/SUPPORT_DATA/ sity of the Sulphur Dioxide <i>SO</i> <sub>2</sub> product for a sulfur diox ography.	ed as a Cartesian se this attribute to CF standard. DETAILED_RES
ULTS Description: Dimensions: Type:	product of latitude at connect the data wit <b>_total_vertical_colu</b> Vertical column dens altitude w.r.t. the top time, scanline, grour NC_FLOAT.	nd longitude axes. Following [ER5, section 5.2] we u h the geolocation. This attribute originates from the ( mn_1km in SO2/PRODUCT/SUPPORT_DATA/ sity of the Sulphur Dioxide <i>SO</i> <sub>2</sub> product for a sulfur dio ography. nd_pixel.	ed as a Cartesian se this attribute to CF standard. DETAILED_RES
ULTS Description: Dimensions: Type: Source:	product of latitude an connect the data wit <b>_total_vertical_colum</b> Vertical column dens altitude w.r.t. the top time, scanline, grour NC_FLOAT. Processor.	nd longitude axes. Following [ER5, section 5.2] we u h the geolocation. This attribute originates from the ( mn_1km in SO2/PRODUCT/SUPPORT_DATA/ sity of the Sulphur Dioxide <i>SO</i> <sub>2</sub> product for a sulfur dio ography. nd_pixel.	ed as a Cartesian se this attribute to CF standard. DETAILED_RES-
ULTS Description: Dimensions: Type: Source: Mode:	product of latitude an connect the data wit <b>_total_vertical_colum</b> Vertical column dens altitude w.r.t. the top time, scanline, grour NC_FLOAT. Processor. Present in all modes	nd longitude axes. Following [ER5, section 5.2] we u h the geolocation. This attribute originates from the ( mn_1km in SO2/PRODUCT/SUPPORT_DATA/ sity of the Sulphur Dioxide <i>SO</i> <sub>2</sub> product for a sulfur dio ography. nd_pixel.	ed as a Cartesian se this attribute to CF standard. DETAILED_RES- xide plume at 1km

	long_name	'total vertical column density of sulfur dioxide for a sulfur dioxide plume at 1km altitude w.r.t. the topography' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
		gitude coordinates of the TROPOMI swath is not definent not definent and longitude axes. This attribute originates from the second	
	multiplication factor_to_con- vert_to_DU	2241.15 (static)	NC_FLOAT
	value this means the "DU" or Dobson Uni	entinel 5 precursor files are given in SI units. For an i at the unit is $mol m^{-2}$ . Traditionally the unit for an interts. This attribute provides the multiplication factor to the value in $mol m^{-2}$ . This is provided as a convenient in DU.	egrated column is calculate the total
	multiplication factor_to_con- vert_to_mo- lecules_percm2	6.02214e+19 (static)	NC_FLOAT
	value this means the is "molecules $cm^{-2}$ ".	entinel 5 precursor files are given in SI units. For an i at the unit is $mol m^{-2}$ . Traditionally the unit for an i This attribute provides the multiplication factor to $c cm^{-2}$ from the value in $mol m^{-2}$ . This is provided as s that work in molecules cm <sup>-2</sup> .	ntegrated column calculate the total
sulfurdioxide	_ <b>total_vertical_colu</b> ESULTS	mn_1km_precision in SO2/PRODUCT/S	SUPPORT_DATA/
Description:		e vertical column density of the Sulphur Dioxide $SO_2$ pm altitude w.r.t. the topography.	roduct for a sulfur
Dimensions:	time, scanline, grou	nd_pixel.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all modes	S.	
Attributes:	Name	Value	Туре
	units	'mol m-2' (static)	NC_STRING
	standard_name	'atmosphere_mole_content_of_sulfur_dioxide standard_error' (static)	NC_STRING
	long_name	'random error of the total vertical column density of sulfur dioxide for a sulfur dioxide plume at 1km altitude w.r.t. the topography' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
		gitude coordinates of the TROPOMI swath is not definent not longitude axes. This attribute originates from the	
	multiplication factor_to_con- vert_to_DU	2241.15 (static)	NC_FLOAT
	value this means the "DU" or Dobson Uni	entinel 5 precursor files are given in SI units. For an i at the unit is $mol m^{-2}$ . Traditionally the unit for an inter- ts. This attribute provides the multiplication factor to the value in $mol m^{-2}$ . This is provided as a convenie in DU.	egrated column is calculate the tota
	multiplication factor_to_con- vert_to_mo-	6.02214e+19 (static)	NC_FLOAT

	The quantities in Se	ntinel 5 precursor files are given in SI units. For an i	ntegrated column		
		at the unit is $mol m^{-2}$ . Traditionally the unit for an in			
		This attribute provides the multiplication factor to c			
		$cm^{-2}$ from the value in $molm^{-2}.$ This is provided as	a convenience to		
	users who have tool	s that work in molecules $cm^{-2}$ .			
sulfurdioxide	_total_vertical_colu	mn_1km_trueness in SO2/PRODUCT/S	SUPPORT_DATA		
DETAILED_R	ESULTS				
Description:		the vertical column density of the Sulphur Dioxide at 1km altitude w.r.t. the topography.	SO <sub>2</sub> product for a		
Dimensions:	time, scanline, grour	nd_pixel.			
Туре:	NC_FLOAT.				
Source:	Processor.				
Mode:	Present in all modes	3.			
Attributes:	Name	Value	Туре		
	units	'mol m-2' (static)	NC_STRING		
	long name	'systematic error of the total vertical column density	NC STRING		
	<u>9_</u>	of sulfur dioxide for a sulfur dioxide plume at 1km altitude w.r.t. the topography' (static)			
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING		
	The latitude and long	gitude coordinates of the TROPOMI swath is not defin	ed as a Cartesiar		
	product of latitude a	nd longitude axes. This attribute originates from the (	CF standard.		
	multiplication	2241.15 (static)	NC_FLOAT		
	factor_to_con-				
	vert_to_DU				
	The quantities in Se	entinel 5 precursor files are given in SI units. For an i			
	The quantities in Se value this means tha "DU" or Dobson Unit	at the unit is $mol m^{-2}$ . Traditionally the unit for an interest. This attribute provides the multiplication factor to the value in $mol m^{-2}$ . This is provided as a convenie	egrated column is calculate the tota		
	The quantities in Se value this means tha "DU" or Dobson Unit column in DU from t	at the unit is $mol m^{-2}$ . Traditionally the unit for an interest. This attribute provides the multiplication factor to the value in $mol m^{-2}$ . This is provided as a convenie	egrated column is calculate the tota		
	The quantities in Se value this means tha "DU" or Dobson Unit column in DU from t have tools that work	at the unit is $mol m^{-2}$ . Traditionally the unit for an interact ts. This attribute provides the multiplication factor to a the value in $mol m^{-2}$ . This is provided as a convenie in DU.	egrated column is calculate the tota nce to users who		
	The quantities in Se value this means tha "DU" or Dobson Unit column in DU from t have tools that work multiplication factor_to_con- vert_to_mo-	at the unit is $mol m^{-2}$ . Traditionally the unit for an interact ts. This attribute provides the multiplication factor to a the value in $mol m^{-2}$ . This is provided as a convenie in DU.	egrated column is calculate the tota nce to users who		
	The quantities in Se value this means tha "DU" or Dobson Unit column in DU from t have tools that work multiplication factor_to_con- vert_to_mo- lecules_percm2	at the unit is $mol m^{-2}$ . Traditionally the unit for an interest. This attribute provides the multiplication factor to each the value in $mol m^{-2}$ . This is provided as a convenie in DU. 6.02214e+19 (static)	egrated column is calculate the tota nce to users who NC_FLOAT		
	The quantities in Se value this means tha "DU" or Dobson Unit column in DU from t have tools that work <b>multiplication</b> factor_to_con- vert_to_mo- lecules_percm2 The quantities in Se value this means th is "molecules cm <sup>-2</sup> ". column in molecules	at the unit is $mol m^{-2}$ . Traditionally the unit for an interact ts. This attribute provides the multiplication factor to a the value in $mol m^{-2}$ . This is provided as a convenie in DU.	egrated column is calculate the tota nce to users who NC_FLOAT ntegrated column calculate the tota		
	The quantities in Se value this means tha "DU" or Dobson Unit column in DU from t have tools that work <b>multiplication</b> factor_to_con- vert_to_mo- lecules_percm2 The quantities in Se value this means th is "molecules cm <sup>-2</sup> ". column in molecules users who have tools	at the unit is $mol m^{-2}$ . Traditionally the unit for an interest. This attribute provides the multiplication factor to one the value in $mol m^{-2}$ . This is provided as a convenie in DU. 6.02214e+19 (static) entinel 5 precursor files are given in SI units. For an interest at the unit is $mol m^{-2}$ . Traditionally the unit for an interest the unit is $mol m^{-2}$ . Traditionally the unit for an interest at the unit is $mol m^{-2}$ . Traditionally the unit for an interest at the unit is $mol m^{-2}$ . Traditionally the unit for an interest at the value provides the multiplication factor to c $cm^{-2}$ from the value in $mol m^{-2}$ . This is provided as	NC_FLOAT NC_FLOAT NC_Grated column ntegrated column aconvenience to		
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ULTS Description: Dimensions: Type: Source:	The quantities in Se value this means tha "DU" or Dobson Unit column in DU from t have tools that work multiplication factor_to_con- vert_to_mo- lecules_percm2 The quantities in Se value this means th is "molecules cm <sup>-2</sup> ". column in molecules users who have tools e_total_air_mass_factor time, scanline, grour NC_FLOAT. Processor.	at the unit is $mol m^{-2}$ . Traditionally the unit for an interest. This attribute provides the multiplication factor to one the value in $mol m^{-2}$ . This is provided as a convenie in DU. 6.02214e+19 (static) entinel 5 precursor files are given in SI units. For an interest at the unit is $mol m^{-2}$ . Traditionally the unit for an interest at the unit is $mol m^{-2}$ . Traditionally the unit for an interest at the value provides the multiplication factor to c $cm^{-2}$ from the value in $mol m^{-2}$ . This is provided as a sthat work in molecules $cm^{-2}$ . etor_1km in SO2/PRODUCT/SUPPORT_DATA/ $mod_pixel$ .	egrated column is calculate the tota nce to users who NC_FLOAT ntegrated column calculate the tota a convenience to DETAILED_RES		
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ULTS Description: Dimensions: Type: Source: Mode:	The quantities in Se value this means tha "DU" or Dobson Unit column in DU from t have tools that work multiplication factor_to_con- vert_to_mo- lecules_percm2 The quantities in Se value this means th is "molecules cm <sup>-2</sup> ". column in molecules users who have tools e_total_air_mass_face Total air mass factor time, scanline, grour NC_FLOAT. Processor. Present in all modes <i>Name</i> units	at the unit is $mol m^{-2}$ . Traditionally the unit for an intervalue in $mol m^{-2}$ . This is provided as a convenie the value in $mol m^{-2}$ . This is provided as a convenie in DU. 6.02214e+19 (static) entinel 5 precursor files are given in SI units. For an i at the unit is $mol m^{-2}$ . Traditionally the unit for an in This attribute provides the multiplication factor to c $cm^{-2}$ from the value in $mol m^{-2}$ . This is provided as s that work in molecules $cm^{-2}$ . etor_1km in SO2/PRODUCT/SUPPORT_DATA/ c, <i>M</i> for a sulfur dioxide plume at 1km altitude w.r.t. th $md_pixel$ .	agrated column is         calculate the tota         nce to users who         NC_FLOAT         ntegrated column         ntegrated column         calculate the tota         a convenience to         DETAILED_RES         e topography.         Type         NC_STRING		
ULTS Description: Dimensions: Type: Source: Mode:	The quantities in Se value this means tha "DU" or Dobson Unit column in DU from t have tools that work <b>multiplication</b> factor_to_con- vert_to_mo- lecules_percm2 The quantities in Se value this means th is "molecules cm <sup>-2</sup> ". column in molecules users who have tools e_total_air_mass_factor time, scanline, grour NC_FLOAT. Processor. Present in all modes <i>Name</i>	at the unit is $mol m^{-2}$ . Traditionally the unit for an interest. This attribute provides the multiplication factor to or the value in $mol m^{-2}$ . This is provided as a convenie in DU. 6.02214e+19 (static) entinel 5 precursor files are given in SI units. For an in at the unit is $mol m^{-2}$ . Traditionally the unit for an in This attribute provides the multiplication factor to c $cm^{-2}$ from the value in $mol m^{-2}$ . This is provided as s that work in molecules $cm^{-2}$ . etor_1km in SO2/PRODUCT/SUPPORT_DATA/ r, <i>M</i> for a sulfur dioxide plume at 1km altitude w.r.t. the mol_pixel.	NC_FLOAT NC_FLOAT NC_FLOAT NC_FLOAT NC_FLOAT NC_FLOAT NC_FLOAT DETAILED_RES e topography.		

	The latitude and long	gitude coordinates of the TROPOMI swath is not defin	ed as a Cartesian
	product of latitude a	nd longitude axes. Following [ER5, section 5.2] we us	se this attribute to
		h the geolocation. This attribute originates from the (	
sulfurdioxide	e_total_air_mass_fac ESULTS	tor_1km_precision in SO2/PRODUCT/S	SUPPORT_DATA/
Description:	Random error of the the topography.	total air mass factor $M$ for a sulfur dioxide plume at	1km altitude w.r.t.
Dimensions:	time, scanline, grour	nd_pixel.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all modes	).	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	long_name	'random error of the total air mass factor for a sulfur dioxide plume at 1km altitude w.r.t. the topography' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
	product of latitude a	gitude coordinates of the TROPOMI swath is not defin nd longitude axes. Following [ER5, section 5.2] we us h the geolocation. This attribute originates from the 0	se this attribute to
sulfurdioxide	e_total_air_mass_fac ESULTS	tor_1km_trueness in SO2/PRODUCT/S	SUPPORT_DATA/
Description:	Systematic error of t the topography.	he total air mass factor $M$ for a sulfur dioxide plume at	1km altitude w.r.t.
Dimensions:	time, scanline, grour	nd_pixel.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all modes	5.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	long_name	'systematic error of the total air mass factor for a sulfur dioxide plume at 1km altitude w.r.t. the topography' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
	product of latitude a	gitude coordinates of the TROPOMI swath is not defin nd longitude axes. Following [ER5, section 5.2] we us h the geolocation. This attribute originates from the 0	se this attribute to
sulfurdioxide		tor_1km_kernel_trueness in SO2/PRODUCT/S	SUPPORT_DATA/
Description:	•	the total air mass factor $M$ when kernels are used for e.w.r.t. the topography.	or a sulfur dioxide
Dimensions:	time, scanline, grour		
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all modes	5.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	long_name	'systematic error of the total air mass factor using kernels for a sulfur dioxide plume at 1km altitude w.r.t. the topography' (static)	NC_STRING

	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
	product of latitude	ngitude coordinates of the TROPOMI swath is not defir and longitude axes. Following [ER5, section 5.2] we u vith the geolocation. This attribute originates from the	se this attribute to
sulfurdioxide	e_clear_air_mass_fa	actor_1km in SO2/PRODUCT/SUPPORT_DATA	DETAILED_RES-
Description:	Clear sky air mass	factor for a sulfur dioxide plume at 1km altitude w.r.t.	the topography.
Dimensions:	time, scanline, grou	und_pixel.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all mode	es.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	long_name	'clear sky air mass factor for a sulfur dioxide plume at 1km altitude w.r.t. the topography' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
	product of latitude	ngitude coordinates of the TROPOMI swath is not defir and longitude axes. Following [ER5, section 5.2] we u vith the geolocation. This attribute originates from the	se this attribute to
sulfurdioxide	e_cloudy_air_mass_	_factor_1km in SO2/PRODUCT/SUPPORT_DATA	/DETAILED_RES
Description:	Cloudy sky air mas	ss factor for a sulfur dioxide plume at 1km altitude w.r.t	. the topography.
Dimensions:	time, scanline, grou	und_pixel.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all mode	es.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	long_name	'cloudy sky air mass factor for a sulfur dioxide plume at 1km altitude w.r.t. the topography' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
	product of latitude	ngitude coordinates of the TROPOMI swath is not defir and longitude axes. Following [ER5, section 5.2] we u vith the geolocation. This attribute originates from the	se this attribute to
sulfurdioxide	e_averaging_kernel ESULTS	_scaling_box_1km in SO2_/PRODUCT/S	SUPPORT_DATA
Description:	Scaling box of the t topography.	total air mass factor $M$ for a sulfur dioxide plume at 1 km	n altitude w.r.t. the
Dimensions:	time, scanline, grou	und_pixel.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all mode	es.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	long_name	'scaling box of the total air mass factor for a sulfur dioxide plume at 1km altitude w.r.t. the topography' (static)	NC_STRING
	coordinates	<pre>'/PRODUCT/longitude /PRODUCT/latitude' (static)</pre>	NC_STRING
			—

	The latitude and long product of latitude a	nd longitude axes. Following [ER5, section 5.2] we us	se this attribute to		
	connect the data wit	th the geolocation. This attribute originates from the C	CF standard.		
<b>sulfurdioxide</b> ULTS	_total_vertical_colu	mn_7km in SO2/PRODUCT/SUPPORT_DATA/	DETAILED_RES		
Description:	Vertical column density of the sulphur dioxide $SO_2$ product for a sulfur dioxide plume at 7km altitude w.r.t. the sea level.				
Dimensions:	time, scanline, ground_pixel.				
Туре:	NC_FLOAT.				
Source:	Processor.				
Mode:	Present in all modes	5.			
Attributes:	Name	Value	Туре		
-	units	'mol m-2' (static)	NC_STRING		
-	standard_name	'atmosphere_mole_content_of_sulfur_dioxide' (static)	NC_STRING		
-	long_name	'total vertical column density of sulfur dioxide for a sulfur dioxide plume at 7km altitude w.r.t. the sea level' (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.			
		5 5			
	value this means that	2241.15 (static) entinel 5 precursor files are given in SI units. For an in at the unit is $mol m^{-2}$ . Traditionally the unit for an inter-	egrated column i		
	factor_to_con- vert_to_DU The quantities in Se value this means tha "DU" or Dobson Unit	2241.15 (static) entinel 5 precursor files are given in SI units. For an in at the unit is $mol m^{-2}$ . Traditionally the unit for an inter- ts. This attribute provides the multiplication factor to of the value in $mol m^{-2}$ . This is provided as a convenie	ntegrated column egrated column is calculate the tota		
-	factor_to_con- vert_to_DU The quantities in Se value this means tha "DU" or Dobson Unit column in DU from thave tools that work multiplication factor_to_con- vert_to_mo-	2241.15 (static) entinel 5 precursor files are given in SI units. For an in at the unit is $mol m^{-2}$ . Traditionally the unit for an inter- ts. This attribute provides the multiplication factor to of the value in $mol m^{-2}$ . This is provided as a convenie	ntegrated colum egrated column i calculate the tota		
	factor_to_con- vert_to_DU The quantities in Se value this means tha "DU" or Dobson Unit column in DU from the have tools that work multiplication factor_to_con- vert_to_mo- lecules_percm2 The quantities in Se value this means the is "molecules cm <sup>-2</sup> ". column in molecules	2241.15 (static) entinel 5 precursor files are given in SI units. For an in at the unit is $mol m^{-2}$ . Traditionally the unit for an inter- ts. This attribute provides the multiplication factor to a the value in $mol m^{-2}$ . This is provided as a convenie in DU.	ntegrated column egrated column is calculate the tota nce to users who NC_FLOAT ntegrated column ealculate the tota		
sulfurdioxide	factor_to_con- vert_to_DU The quantities in Se value this means tha "DU" or Dobson Unit column in DU from the have tools that work multiplication factor_to_con- vert_to_mo- lecules_percm2 The quantities in Se value this means the is "molecules cm <sup>-2</sup> ". column in molecules users who have tool _total_vertical_colu	2241.15 (static) entinel 5 precursor files are given in SI units. For an in at the unit is mol m <sup>-2</sup> . Traditionally the unit for an inter ts. This attribute provides the multiplication factor to o the value in mol m <sup>-2</sup> . This is provided as a convenie in DU. 6.02214e+19 (static) entinel 5 precursor files are given in SI units. For an in at the unit is mol m <sup>-2</sup> . Traditionally the unit for an in This attribute provides the multiplication factor to c ccm <sup>-2</sup> from the value in mol m <sup>-2</sup> . This is provided as s that work in molecules cm <sup>-2</sup> .	ntegrated column egrated column is calculate the tota nce to users who NC_FLOAT ntegrated column ealculate the tota		
DETAILED_R	factor_to_con- vert_to_DU The quantities in Se value this means tha "DU" or Dobson Unit column in DU from the have tools that work multiplication factor_to_con- vert_to_mo- lecules_percm2 The quantities in Se value this means th is "molecules cm <sup>-2</sup> ". column in molecules users who have tool total_vertical_colu ESULTS Random error of the	2241.15 (static) entinel 5 precursor files are given in SI units. For an in at the unit is mol m <sup>-2</sup> . Traditionally the unit for an inter ts. This attribute provides the multiplication factor to o the value in mol m <sup>-2</sup> . This is provided as a convenie in DU. 6.02214e+19 (static) entinel 5 precursor files are given in SI units. For an in at the unit is mol m <sup>-2</sup> . Traditionally the unit for an in This attribute provides the multiplication factor to c ccm <sup>-2</sup> from the value in mol m <sup>-2</sup> . This is provided as s that work in molecules cm <sup>-2</sup> .	ntegrated column egrated column is calculate the tota nce to users who NC_FLOAT NC_FLOAT ntegrated column calculate the tota a convenience to		
DETAILED_REDESCRIPTION:	factor_to_con- vert_to_DU The quantities in Se value this means tha "DU" or Dobson Unit column in DU from the have tools that work multiplication factor_to_con- vert_to_mo- lecules_percm2 The quantities in Se value this means th is "molecules cm <sup>-2</sup> ". column in molecules users who have tool total_vertical_colu ESULTS Random error of the	2241.15 (static) entinel 5 precursor files are given in SI units. For an in at the unit is $mol m^{-2}$ . Traditionally the unit for an inter- ts. This attribute provides the multiplication factor to of the value in $mol m^{-2}$ . This is provided as a convenie in DU. 6.02214e+19 (static) entinel 5 precursor files are given in SI units. For an in the unit is $mol m^{-2}$ . Traditionally the unit for an in This attribute provides the multiplication factor to c $cm^{-2}$ from the value in $mol m^{-2}$ . This is provided as s that work in molecules $cm^{-2}$ . <b>mn_7km_precision</b> in SO2/PRODUCT/S e vertical column density of the Sulphur Dioxide $SO_2$ p m altitude w.r.t. the sea level.	ntegrated column egrated column is calculate the tota nce to users who NC_FLOAT NC_FLOAT ntegrated column calculate the tota a convenience to		
DETAILED_RI Description: Dimensions:	factor_to_con- vert_to_DU The quantities in Se value this means tha "DU" or Dobson Unit column in DU from the have tools that work multiplication factor_to_con- vert_to_mo- lecules_percm2 The quantities in Se value this means the is "molecules cm <sup>-2</sup> ". column in molecules users who have tool total_vertical_colue SULTS Random error of the dioxide plume at 7km	2241.15 (static) entinel 5 precursor files are given in SI units. For an in at the unit is $mol m^{-2}$ . Traditionally the unit for an inter- ts. This attribute provides the multiplication factor to of the value in $mol m^{-2}$ . This is provided as a convenie in DU. 6.02214e+19 (static) entinel 5 precursor files are given in SI units. For an in the unit is $mol m^{-2}$ . Traditionally the unit for an in This attribute provides the multiplication factor to c $cm^{-2}$ from the value in $mol m^{-2}$ . This is provided as s that work in molecules $cm^{-2}$ . <b>mn_7km_precision</b> in SO2/PRODUCT/S e vertical column density of the Sulphur Dioxide $SO_2$ p m altitude w.r.t. the sea level.	ntegrated column egrated column is calculate the tota nce to users who NC_FLOAT NC_FLOAT ntegrated column calculate the tota a convenience to		
DETAILED_RE Description: Dimensions: Type:	factor_to_con- vert_to_DU The quantities in Sevalue this means tha "DU" or Dobson Unit column in DU from the have tools that work multiplication factor_to_con- vert_to_mo- lecules_percm2 The quantities in Sevalue this means the is "molecules cm <sup>-2</sup> ". column in molecules users who have tool total_vertical_colue SULTS Random error of the dioxide plume at 7km time, scanline, groun	2241.15 (static) entinel 5 precursor files are given in SI units. For an in at the unit is $mol m^{-2}$ . Traditionally the unit for an inter- ts. This attribute provides the multiplication factor to of the value in $mol m^{-2}$ . This is provided as a convenie in DU. 6.02214e+19 (static) entinel 5 precursor files are given in SI units. For an in the unit is $mol m^{-2}$ . Traditionally the unit for an in This attribute provides the multiplication factor to c $cm^{-2}$ from the value in $mol m^{-2}$ . This is provided as s that work in molecules $cm^{-2}$ . <b>mn_7km_precision</b> in SO2/PRODUCT/S e vertical column density of the Sulphur Dioxide $SO_2$ p m altitude w.r.t. the sea level.	ntegrated column egrated column is calculate the tota nce to users who NC_FLOAT NC_FLOAT ntegrated column calculate the tota a convenience to		
DETAILED_RI Description: Dimensions: Type: Source:	factor_to_con- vert_to_DU The quantities in Sevalue this means tha "DU" or Dobson Unit column in DU from the have tools that work multiplication factor_to_con- vert_to_mo- lecules_percm2 The quantities in Sevalue this means the is "molecules cm <sup>-2</sup> ". column in molecules users who have tool total_vertical_colue SULTS Random error of the dioxide plume at 7km time, scanline, groun NC_FLOAT.	2241.15 (static) entinel 5 precursor files are given in SI units. For an in at the unit is $mol m^{-2}$ . Traditionally the unit for an inter ts. This attribute provides the multiplication factor to of the value in $mol m^{-2}$ . This is provided as a convenie in DU. 6.02214e+19 (static) entinel 5 precursor files are given in SI units. For an in that the unit is $mol m^{-2}$ . Traditionally the unit for an in This attribute provides the multiplication factor to c $cm^{-2}$ from the value in $mol m^{-2}$ . This is provided as s that work in molecules $cm^{-2}$ . <b>mn_7km_precision</b> in SO2/PRODUCT/S e vertical column density of the Sulphur Dioxide $SO_2$ p m altitude w.r.t. the sea level. $md_pixel$ .	ntegrated column egrated column is calculate the tota nce to users who NC_FLOAT NC_FLOAT ntegrated column calculate the tota a convenience to		
DETAILED_RE Description: Dimensions: Type: Source: Mode:	factor_to_con- vert_to_DU The quantities in Sevalue this means tha "DU" or Dobson Unit column in DU from the have tools that work multiplication factor_to_con- vert_to_mo- lecules_percm2 The quantities in Sevalue this means the is "molecules cm <sup>-2</sup> ". column in molecules users who have tool _total_vertical_colue SULTS Random error of the dioxide plume at 7km time, scanline, groun NC_FLOAT. Processor.	2241.15 (static) entinel 5 precursor files are given in SI units. For an in at the unit is $mol m^{-2}$ . Traditionally the unit for an inter ts. This attribute provides the multiplication factor to of the value in $mol m^{-2}$ . This is provided as a convenie in DU. 6.02214e+19 (static) entinel 5 precursor files are given in SI units. For an in that the unit is $mol m^{-2}$ . Traditionally the unit for an in This attribute provides the multiplication factor to c $cm^{-2}$ from the value in $mol m^{-2}$ . This is provided as s that work in molecules $cm^{-2}$ . <b>mn_7km_precision</b> in SO2/PRODUCT/S e vertical column density of the Sulphur Dioxide $SO_2$ p m altitude w.r.t. the sea level. $md_pixel$ .	ntegrated column egrated column i calculate the tota nce to users whe NC_FLOAT ntegrated column calculate the tota a convenience to SUPPORT_DATA		
	factor_to_con- vert_to_DU The quantities in Se value this means tha "DU" or Dobson Unit column in DU from the have tools that work multiplication factor_to_con- vert_to_mo- lecules_percm2 The quantities in Se value this means th is "molecules cm <sup>-2</sup> ". column in molecules users who have tool total_vertical_colue SULTS Random error of the dioxide plume at 7km time, scanline, grour NC_FLOAT. Processor.	2241.15 (static) entinel 5 precursor files are given in SI units. For an interact the unit is $mol m^{-2}$ . Traditionally the unit for an interact the value in $mol m^{-2}$ . This is provided as a convenie the value in $mol m^{-2}$ . This is provided as a convenie in DU. 6.02214e+19 (static) entinel 5 precursor files are given in SI units. For an interact the unit is $mol m^{-2}$ . Traditionally the unit for an interact the unit is $mol m^{-2}$ . Traditionally the unit for an interact the unit is $mol m^{-2}$ . Traditionally the unit for an interact the unit is $mol m^{-2}$ . Traditionally the unit for an interact the unit is $mol m^{-2}$ . Traditionally the unit for an interact the unit is $mol m^{-2}$ . Traditionally the unit for an interact the unit is $mol m^{-2}$ . This is provided as a stat work in molecules $cm^{-2}$ . mn_7km_precision in SO2/PRODUCT/S evertical column density of the Sulphur Dioxide $SO_2$ p m altitude w.r.t. the sea level. nd_pixel.	ntegrated column egrated column i calculate the tota nce to users whe NC_FLOAT ntegrated column calculate the tota a convenience to CUPPORT_DATA roduct for a sulfu		

	long_name	'random error of the total vertical column of sulfur dioxide for a sulfur dioxide plume at 7km altitude w.r.t. the sea level' (static)	NC_STRING
	coordinates	<pre>'/PRODUCT/longitude /PRODUCT/latitude' (static)</pre>	NC_STRING
		gitude coordinates of the TROPOMI swath is not definent not longitude axes. This attribute originates from the C	CF standard.
	multiplication factor_to_con- vert_to_DU	2241.15 (static)	NC_FLOAT
	value this means the "DU" or Dobson Uni	entinel 5 precursor files are given in SI units. For an in at the unit is $mol m^{-2}$ . Traditionally the unit for an inter- ts. This attribute provides the multiplication factor to of the value in $mol m^{-2}$ . This is provided as a convenie in DU.	egrated column i calculate the tota
	multiplication factor_to_con- vert_to_mo- lecules_percm2	6.02214e+19 (static)	NC_FLOAT
	The quantities in Se value this means th is "molecules $cm^{-2}$ ". column in molecules	entinel 5 precursor files are given in SI units. For an in that the unit is $mol m^{-2}$ . Traditionally the unit for an in This attribute provides the multiplication factor to c $ccm^{-2}$ from the value in $mol m^{-2}$ . This is provided as as that work in molecules $cm^{-2}$ .	ntegrated column alculate the tota
sulfurdioxide	_ <b>total_vertical_colu</b> ESULTS	mn_7km_trueness in SO2/PRODUCT/S	SUPPORT_DATA
Description:	-	the vertical column density of the Sulphur Dioxide at 7km altitude w.r.t. the sea level.	$SO_2$ product for a
Dimensions:	time, scanline, grou	nd_pixel.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all modes	5.	
Attributes:	Name	Value	Туре
	units	'mol m-2' (static)	NC_STRING
	long_name	'systematic error of the total vertical column of sul- fur dioxide for a sulfur dioxide plume at 7km altitude w.r.t. the sea level' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
		gitude coordinates of the TROPOMI swath is not definent not definent and longitude axes. This attribute originates from the 0	
	multiplication factor_to_con- vert_to_DU	2241.15 (static)	NC_FLOAT
	value this means the "DU" or Dobson Uni	entinel 5 precursor files are given in SI units. For an in at the unit is $mol m^{-2}$ . Traditionally the unit for an inter- ts. This attribute provides the multiplication factor to of the value in $mol m^{-2}$ . This is provided as a convenie is in DU.	egrated column i calculate the tota
	multiplication factor_to_con- vert_to_mo- lecules_percm2	6.02214e+19 (static)	NC_FLOAT

	value this means th is "molecules $cm^{-2}$ ". column in molecules	ntinel 5 precursor files are given in SI units. For an i at the unit is $mol m^{-2}$ . Traditionally the unit for an in This attribute provides the multiplication factor to $c cm^{-2}$ from the value in $mol m^{-2}$ . This is provided as s that work in molecules $cm^{-2}$ .	ntegrated column alculate the total
sulfurdioxide	e_total_air_mass_fac	tor_7km in SO2/PRODUCT/SUPPORT_DATA/	DETAILED_RES-
Description: Dimensions: Type: Source: Mode:	Total air mass factor time, scanline, grour NC_FLOAT. Processor. Present in all modes		e sea level.
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	long_name	'total air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
	product of latitude a	gitude coordinates of the TROPOMI swath is not defin nd longitude axes. Following [ER5, section 5.2] we us h the geolocation. This attribute originates from the 0	se this attribute to
sulfurdioxide	e_total_air_mass_fac ESULTS	stor_7km_precision in SO2/PRODUCT/S	SUPPORT_DATA/
Description:	Random error of the the sea level.	e total air mass factor <i>M</i> for a sulfur dioxide plume at	7km altitude w.r.t
Dimensions:	time, scanline, grour	nd_pixel.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all modes	S.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	long_name	'random error of the total air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
	product of latitude a	gitude coordinates of the TROPOMI swath is not defin nd longitude axes. Following [ER5, section 5.2] we us h the geolocation. This attribute originates from the 0	se this attribute to
sulfurdioxide	e_total_air_mass_fac ESULTS	stor_7km_trueness in SO2/PRODUCT/S	SUPPORT_DATA/
Description:	Systematic error of t the sea level.	he total air mass factor $M$ for a sulfur dioxide plume at	7km altitude w.r.t
Dimensions:	time, scanline, grour	nd_pixel.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all modes	)	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	long_name	'systematic error of the total air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level' (static)	NC_STRING

plume at 7km altitude w.r.t. the sea level. Dimensions: time, scanline, ground_pixel. Type: NC_FLOAT. Source: Processor. Mode: Present in all modes. Attributes:           Name         Value         Type           Mode:         Present in all modes.         NC_STRING           Iong_name         'systematic error of the total air mass factor using         NC_STRING           Iong_name         'systematic error of the total air mass factor using         NC_STRING           coordinates         '1' (static)         NC_STRING           coordinates         'PRODUCT/Iongitude /PRODUCT/latitude' (static)         NC_STRING           bescription:         Clear sky air mass factor _Tkm in SO2/PRODUCT/SUPPORT_DATA/DETAILED_RES-ULTS           Description:         Clear sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level.           Dimensions:         time, scanline, ground_pixel.           Type:         NC_FLOAT.           Source:         Present in all modes.           Attributes:         Name         Value         Type           Mode:         Present in all modes.         NC_STRING           Iong_name         'clear sky air mass factor for a sulfur dioxide plume NC_STRING           Iong_name         'lear sky air mass factor for a sulfur dioxide plume         NC_STRING           Iong_name         'lear sky air mass factor for a sulfur dioxide plume <td< th=""><th></th><th></th><th></th><th></th></td<>				
product of latitude and longitude axes. Following [ER5, section 5.2] we use this attribute to connect the data with the geolocation. This attribute originates from the CF standard. Description: Systematic error of the total air mass factor <i>T</i> km, kernel_trueness in SO2_/PRODUCT/SUPPORT_DATA/ DETAILED_RESULTS Description: Systematic error of the total air mass factor <i>M</i> when kernels are used for a sulfur dioxide plume at 7km altitude w.r.t. the sea level. Type: NC_FLOAT. Processor. Mode: Processor. Mode: Present in all modes. Attributes: Name Value Type units '1' (static) NC_STRING Iong_name 'systematic error of the total air mass factor using NC_STRING Iong_name 'systematic error of the total air mass factor using NC_STRING The latitude and longitude acces. Following [ER5, section 5.2] we use this attribute to connect the data with the geolocation. This attribute originates from the CF standard. Sulfurdioxide_clear_air_mass_factor_7km in SO2_/PRODUCT/SUPPORT_DATA/DETAILED_RES- ULTS Description: Clear sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level. Dimensions: time, scanline, ground_pixel. NC_FLOAT. Source: Processor. Mode: Present in all modes. Attributes: Name Value Type UITS Noc_FLOAT. NC_FLOAT. NC_FLOAT. NC_FLOAT. NC_STRING Iong_name 'clear sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level. Dimensions: time, scanline, ground_pixel. NC_FLOAT. NC_STRING Iong_name 'clear sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level. Dimensions: The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude acces. Following [ER5, section 5.2] we use this attribute to connect the data with the geolocation. This attribute originates from the CF standard. Sulfurdioxide_clear_structure. NC_FLOAT. Source: Processor. Mode: Present in all modes. Attributes: Name Value Type UTS Description: Cloudy sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. t		coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
connect the data with the geolocation. This attribute originates from the CF standard. sulfurdioxide_total_air_mass_factor_7km_kernel_trueness in SO2/PRODUCT/SUPPORT_DATA/ DETAILED_RESULTS Description: Systematic error of the total air mass factor M when kernels are used for a sulfur dioxide plume at 7km altitude w.r.t. the sea level. Dimensions: time, scanline, ground_pixel. Type: NC_FLOAT. Source: Processor. Mode: Present in all modes. Attributes: Name Value Type units '1' (static) NC_STRING NC_STRING NC_STRING The latitude and longitude axes. Following [ER5, section 5.2] we use this attribute to connect the data with the geolocation. This attribute originates from the CF standard. Sulfurdioxide_clear_air_mass_factor_7km in SO2/PRODUCT/SUPPORT_DATA/DETAILED_RES- ULTS Description: Clear sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level. Dimensions: time, scanline, ground_pixel. Type: NC_FLOAT. Source: Processor. Mode: Present in all modes. Attributes: Name Value Type units '1' (static) NC_STRING The latitude and longitude axes. Following [ER5, section 5.2] we use this attribute to connect the data with the geolocation. This attribute originates from the CF standard. Sulfurdioxide_clear_air_mass_factor_7km in SO2/PRODUCT/SUPPORT_DATA/DETAILED_RES- ULTS Description: Clear sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level. Dimensions: time, scanline, ground_pixel. Type: NC_FLOAT. Source: Processor. Mode: Present in all modes. Attributes: Name Value Type units '1' (static) NC_STRING The latitude and longitude axes. Following [ER5, section 5.2] we use this attribute to connect the data with the geolocation. This attribute originates from the CF standard. Sulfurdioxide_cloudy_air_mass_factor_Tkm in SO2/PRODUCT/SUPPORT_DATA/DETAILED_RES- ULTS Description: Clear sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level. Dimensions: time, scanline, ground_pixel. Type: NC_FLOAT. Source: Processor. Processor. Processor.				
sulfurdioxide_total_air_mass_factor_7km_kernel_trueness in SO2/PRODUCT/SUPPORT_DATA/ DETAILED_RESULTS Description: Systematic error of the total air mass factor <i>M</i> when kernels are used for a sulfur dioxide plume at 7km altitude w.r.t. the sea level. Dimensions: time, scanline, ground_pixel. Type: NC_FLOAT. Source: Processor. Mode: Prosent in all modes. Attributes: Name Value Type units '1' (static) NC_STRING long_name 'systematic error of the total air mass factor using NC_STRING kernels for a sulfur dioxide plume at 7km altitude w.r.t. the sea level (static) coordinates '/PRODUCT/longitude /PRODUCT/attitude' (static) NC_STRING The latitude and longitude accordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude accordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude accordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude accordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude accordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude accordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude accord. PRODUCT/SUPPORT_DATA/DETAILED_RES- ULTS Description: Clear sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level. Dimensions: time, scanline, ground_pixel. Type: NC_FLOAT. Source: Processor. Mode: Present in all modes. Attributes: Name Value Type units '1' (static) NC_STRING The latitude and longitude axes. Following [ERS, section 5.2] we use this attribute of connect the data with the geolocation. This attribute originates from the CF standard. sulfurdioxide_cloudy air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level. Dimensions: time, scanline, ground_pixel. Type: NC_FLOAT. Source: Processor. Processor. Processor. Processor. Processor. Processor. Processor. Processor. Processor. Processor. Processor. Processor. Pro				
DETAILED_RËSULTŠ Description: Systematic error of the total air mass factor <i>M</i> when kernels are used for a sulfur dioxide plume at 7km altitude w.r.t. the sea level. Dimensions: time, scanline, ground_pixel. Type: NC_FLOAT. Source: Processor. Mode: Present in all modes. Attributes:            Name         Value         Type           units         '1' (static)         NC_STRING           Iong_name         'systematic error of the total air mass factor using NC_STRING         NC_STRING           Iong_name         'systematic error of the total air mass factor using NC_STRING         NC_STRING           Iong_name         'systematic error of the total air mass factor using NC_STRING         NC_STRING           coordinates         '/PRODUCT/longitude /PRODUCT/atitude' (static)         NC_STRING           coordinates         '/PRODUCT/longitude /PRODUCT/atitude' (static)         NC_STRING           sulfurdioxide_clear_air_mass_factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level.         NC_STRING           Dimensions:         Clear sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level.           UITS         NC_FLOAT.         NC_STRING           Type:         NC_FLOAT.         NC_STRING           Iong_name         'alue         Type           units         '1' (static)         NC_STRING           Iong_name         'alue         NC_STRING           Iong_name				
Description:         Systematic error of the total air mass factor M when kernels are used for a sulfur dioxide plume at 7km altitude w.r.t. the sea level.           Dimensions:         time, scanline, ground_pixel.           Type:         NC_FLOAT.           Source:         Processor.           Mode:         Present in all modes.           Attributes:         Name         Value           Iong_name         'systematic error of the total air mass factor using kernels for a suffur dioxide plume at 7km altitude w.r.t. the sea level (static)         NC_STRING           Coordinates         '/PRODUCT/longitude /PRODUCT/latitude' (static)         NC_STRING           Description:         Clear_gir_mass_factor_7km in SO2/PRODUCT/SUPPORT_DATA/DETAILED_RES- ULTS         Description:           Description:         Clear sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level.         Dimensions:           time, scanline, ground_pixel.         Type         NC_FLOAT.           Source:         Processor.         NC_STRING           Mode:         Present in all modes.         NC_STRING           Attributes:         Name         Value         Type           UITS         Description:         Clear sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level.           Dimensions:         time, scanline, ground_pixel. <td< td=""><td></td><td></td><td>ctor_7km_kernel_trueness in SO2/PRODUCT/S</td><td>SUPPORI_DAIA/</td></td<>			ctor_7km_kernel_trueness in SO2/PRODUCT/S	SUPPORI_DAIA/
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       'systematic error of the total air mass factor using kernels for a sulfur dioxide plume at 7km altitude w.r.t. the sea level' (static)       NC_STRING         coordinates       '/PRODUCT/longitude /PRODUCT/latitude' (static)       NC_STRING         coordinates       '/PRODUCT/longitude /PRODUCT/SUPPORT_DATA/DETAILED_RES- ULTS         Description:       Clear sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level.         Dimensions:       time, scanline, ground_pixel.         Type:       NC_FLOAT.         Source:       Present in all modes.         Attributes:       Name       Value       Type         Ints       '1' (static)       NC_STRING         Iong_name       '1/PRODUCT/SUPPORT_DATA/DETAILED_RES- ULTS       NC_FLOAT.         Source:       Present in all modes.       NC_STRING         Iong_name       '1/' (static)       NC_STRING         Iong_name       '1/' (static)       NC_STRING         Iong_name	Description:	Systematic error of		or a sulfur dioxide
Type:         NC_FLOAT.           Source:         Processor.           Mode:         Precessor.           Mode:         Precessor.           Attributes:         Name         Value         Type           units         '1' (static)         NC_STRING           long_name         'systematic error of the total air mass factor using         NC_STRING           coordinates         '/PRODUCT/longitude /PRODUCT/latitude' (static)         NC_STRING           coordinates         '/PRODUCT/longitude /PRODUCT/latitude' (static)         NC_STRING           conduct of latitude and longitude axes. Following [ER6, section 5.2] we use this attribute to connect the data with the geolocation. This attribute originates from the CF standard.           sulfurdioxide_clear_air_mass_factor_7km in SO2/PRODUCT/SUPPORT_DATA/DETAILED_RES-ULTS         Description:           Dimensions:         time, scanline, ground_pixel.         Type           Type:         NC_FLOAT.         NC_STRING           Source:         Processor.         MC_STRING           Iong_name         'clear sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level.           Dimensions:         time, scanline, ground_pixel.         NC_STRING           Type         NC_FLOAT.         Name         Value         Type           units	Dimensions:	•		
Source:         Processor.           Mode:         Present in all modes.           Attributes:         Name         Value         Type           units         '1' (static)         NC_STRING           long_name         'systematic error of the total air mass factor using         NC_STRING           coordinates         ''PRODUCT/Individe /PRODUCT/latitude' (static)         NC_STRING           coordinates         ''PRODUCT/Individe /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. Following [ER5, section 5.2] we use this attribute to connect the data with the geolocation. This attribute originates from the CF standard.           sulfurdioxide         Clear sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level.           Dimensions:         Time, ground_pixel.           Type:         NC_FLOAT.           Source:         Present in all modes.           Attributes:         Name         Value         Type           units         '1' (static)         NC_STRING           long_name         'clear sky air mass factor for a sulfur dioxide plume         NC_STRING           long_name         'clear sky air mass factor for a sulfur dioxide plume         NC_STRING           long_name         'cle				
Mode:       Present in all modes.         Attributes:       Name       Value       Type         units       '1' (static)       NC_STRING         long_name       'systematic error of the total air mass factor using kernels for a sulfur dioxide plume at 7km altitude w.r.t. the sea level' (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. Following [ER5, section 5.2] we use this attribute to connect the data with the geolocation. This attribute originates from the CF standard.         sulfurdioxide_clear_air_mass_factor_7km in SO2/PRODUCT/SUPPORT_DATA/DETAILED_RES- ULTS       Description:         Clear sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level.       Dimensions:         time, scanline, ground_pixel.       Type         Type:       NC_FLOAT.         Source:       Processor.         Processor.       Processor.         Mode:       Present in all modes.         Attributes:       Name       Value       Type         units       '1' (static)       NC_STRING         Iong_name       'clear sky air mass factor for a sulfur dioxide plume       NC_STRING         The latitude and longitude coordinates of the TROPOMI swath is not defined				
Attributes:       Name       Value       Type         units       '1' (static)       NC_STRING         long_name       'systematic error of the total air mass factor using kernels for a sulfur dioxide plume at 7km altitude       NC_STRING         coordinates       '/PRODUCT/longitude /PRODUCT/latitude' (static)       NC_STRING         sulfurdioxide_clear_air_mass_factor_7km in SO2_/PRODUCT/SUPPORT_DATA/DETAILED_RES-ULTS       Clear sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level.         Dimensions:       time, scanline, ground_pixel.       Type         Type:       NC_FLOAT.       NC_STRING         Source:       Processor.       NC_STRING         Iong_name       'clear sky air mass factor for a sulfur dioxide plume       NC_STRING         at 7km altitude w.r.t. the sea level' (static)       NC_STRING         imits       '1' (static)       NC_STRING         at 7km altitude w.r.t. the sea level' (static)       NC_STRING         time, scanline, ground_pixel.       Npe       Nme         type:       '1'			9	
Inits         11' (static)         NC_STRING           Iong_name         'systematic error of the total air mass factor using kernels for a sulfur dioxide plume at 7km altitude w.r.t. the sea level' (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. Following [ER5, section 5.2] we use this attribute to connect the data with the geolocation. This attribute originates from the CF standard.           sulfurdioxide_clear_air_mass_factor_7km in SO2/PRODUCT/SUPPORT_DATA/DETAILED_RES- ULTS         Clear sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level.           Dimensions:         time, scanline, ground_pixel.         NC_STRING           Type:         NC_FLOAT.         Source:           Source:         Present in all modes.         NC_STRING           Attributes:         Name         Value         Type           units         '1' (static)         NC_STRING           coordinates         '/PRODUCT/longitude /PRODUCT/latitude' (static)         NC_STRING           at 7km altitude w.r.t. the sea level' (static)         NC_STRING         at 7km altitude w.r.t. the sea level' (static)           coordinates         '/PRODUCT/longitude /PRODUCT/latitude' (static)         NC_STRING           Iong_name <t< td=""><td></td><td></td><td></td><td>Τιπρ</td></t<>				Τιπρ
Iong_name         'systematic error of the total air mass factor using kernels for a sulfur dioxide plume at 7km altitude         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. Following [ER5, section 5.2] we use this attribute to connect the data with the geolocation. This attribute originates from the CF standard.           sulfurdioxide_clear_air_mass_factor_7km in SO2/PRODUCT/SUPPORT_DATA/DETAILED_RES- ULTS         Clear sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level.           Dimensions:         time, scanline, ground_pixel.         Type           Type:         NC_FLOAT.         NC_STRING           Source:         Processor.         NC_STRING           Iong_name         'lear sky air mass factor for a sulfur dioxide plume         NC_STRING           Mare         Value         Type           units         'l' (static)         NC_STRING           Iong_name         'clear sky air mass factor for a sulfur dioxide plume         NC_STRING           Mote:         Present in all modes.         NC_STRING           Attributes:         Name         Value         Type           Iong_name         'lear sky air mass factor for a sulfur dioxide plume at 7km altititude w.r.t. the sea level.         String	Attributes.			
kernels for a sulfur dioxide plume at 7km altitude w.r.t. the sea level (static)           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. Following [ER5, section 5.2] we use this attribute to connect the data with the geolocation. This attribute originates from the CF standard.           sulfurdioxide_clear_air_mass_factor_7km in SO2/PRODUCT/SUPPORT_DATA/DETAILED_RES- ULTS           Description:         Clear sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level.           Dimensions:         time, scanline, ground_pixel.           Type:         NC_FLOAT.           Source:         Processor.           Mode:         Present in all modes.           Attributes:         Name         Value           inits         '1' (static)         NC_STRING           Iong_name         'clear sky air mass factor for a sulfur dioxide plume         NC_STRING           at 7km altitude and longitude axes. Following [ER5, section 5.2] we use this attribute to connect the data with the geolocation. This attribute originates from the CF standard.           sulfurdioxide_cloudy_air_mass_factor_7km in SO2/PRODUCT/SUPPORT_DATA/DETAILED_RES- ULTS         Nc_STRING           Description:         Cloudy sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level.				
The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. Following [ER5, section 5.2] we use this attribute to connect the data with the geolocation. This attribute originates from the CF standard.         sulfurdioxide_clear_air_mass_factor_7km in SO2/PRODUCT/SUPPORT_DATA/DETAILED_RES-ULTS         Description:       Clear sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level.         Dimensions:       time, scanline, ground_pixel.         Type:       NC_FLOAT.         Source:       Processor.         Mode:       Present in all modes.         Attributes:       Name       Value         units       '1' (static)       NC_STRING         The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude acondinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude acondinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude acondinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. Following [ER5, section 5.2] we use this attribute to connect the data with the geolocation. This attribute originates from the CF standard.         sulfurdioxide_cloudy_air_mass_factor_7km in SO2/PRODUCT/SUPPORT_DATA/DETAILED_RES-ULTS         Description:       Cloudy sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level.		long_name	kernels for a sulfur dioxide plume at 7km altitude	NC_STRING
product of latitude and longitude axes. Following [ER5, section 5.2] we use this attribute to connect the data with the geolocation. This attribute originates from the CF standard. sulfurdioxide_clear_air_mass_factor_7km in SO2/PRODUCT/SUPPORT_DATA/DETAILED_RES- ULTS Description: Clear sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level. Dimensions: time, scanline, ground_pixel. Type: NC_FLOAT. Source: Processor. Mode: Present in all modes. Attributes: Name Value Type units '1' (static) NC_STRING The latitude and longitude axes. Following [ER5, section 5.2] we use this attribute to connect the data with the geolocation. This attribute originates from the CF standard. sulfurdioxide_cloady_air_mass_factor_7km in SO2/PRODUCT/latitude (static) NC_STRING The latitude and longitude axes. Following [ER5, section 5.2] we use this attribute to connect the data with the geolocation. This attribute originates from the CF standard. sulfurdioxide_cloudy_air_mass_factor_7km in SO2/PRODUCT/latitude (static) NC_STRING The latitude and longitude axes. Following [ER5, section 5.2] we use this attribute to connect the data with the geolocation. This attribute originates from the CF standard. sulfurdioxide_cloudy_air_mass_factor_7km in SO2/PRODUCT/SUPPORT_DATA/DETAILED_RES- ULTS Description: Cloudy sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level. Dimensions: time, scanline, ground_pixel. Type: NC_FLOAT. Source: Processor. Mode: Present in all modes. Attributes: Name Value Type units '1' (static) NC_STRING NC_STRING Node: Present in all modes.		coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
ULTS Description: Clear sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level. 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 'clear sky air mass factor for a sulfur dioxide plume NC_STRING coordinates '/PRODUCT/longitude /PRODUCT/latitude' (static) NC_STRING The latitude and longitude axes. Following [ER5, section 5.2] we use this attribute to connect the data with the geolocation. This attribute originates from the CF standard. sulfurdioxide_cloudy_air_mass_factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level. Dimensions: time, scanline, ground_pixel. Type: NC_FLOAT. Source: Processor. Mode: Present in all modes. Attributes: Name Value Type units '1' (static) NC_STRING imme_scanline, ground_pixel. Xtributes: Name Value Type units '1' (static) NC_STRING imme_scanline, ground_pixel. Xtributes: Name Value Type units '1' (static) NC_STRING Noc_STRING		product of latitude a	and longitude axes. Following [ER5, section 5.2] we us	se this attribute to
ULTS Description: Clear sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level. 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 'clear sky air mass factor for a sulfur dioxide plume NC_STRING coordinates '/PRODUCT/longitude /PRODUCT/latitude' (static) NC_STRING The latitude and longitude axes. Following [ER5, section 5.2] we use this attribute to connect the data with the geolocation. This attribute originates from the CF standard. sulfurdioxide_cloudy_air_mass_factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level. Dimensions: time, scanline, ground_pixel. Type: NC_FLOAT. Source: Processor. Mode: Present in all modes. Attributes: Name Value Type units '1' (static) NC_STRING imme_scanline, ground_pixel. Xtributes: Name Value Type units '1' (static) NC_STRING imme_scanline, ground_pixel. Xtributes: Name Value Type units '1' (static) NC_STRING Noc_STRING	sulfurdioxide	e clear air mass fa	actor 7km in SO2 /PRODUCT/SUPPORT DATA/	DETAILED RES-
Dimensions:       time, scanline, ground_pixel.         Type:       NC_FLOAT.         Source:       Processor.         Mode:       Present in all modes.         Attributes:       Name       Value         Inits       '1' (static)       NC_STRING         Iong_name       'clear sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level' (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. Following [ER5, section 5.2] we use this attribute to connect the data with the geolocation. This attribute originates from the CF standard.         sulfurdioxide_cloudy_air_mass_factor_7km in SO2/PRODUCT/SUPPORT_DATA/DETAILED_RES- ULTS         Description:       Cloudy sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level.         Dimensions:       time, scanline, ground_pixel.         Type:       NC_FLOAT.         Source:       Processor.         Mode:       Present in all modes.         Attributes:       Name       Value         Mode:       Present in all modes.         Attributes:       Name       Value         Integer tripe       '1' (static)       NC_STRING <td>ULTS</td> <td></td> <td></td> <td>—</td>	ULTS			—
Type: NC_FLOAT. Source: Processor. Mode: Present in all modes. Attributes: Name Value Type units '1' (static) NC_STRING Coordinates '1' (static) NC_STRING (coordinates '1/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. Following [ER5, section 5.2] we use this attribute to connect the data with the geolocation. This attribute originates from the CF standard. sulfurdioxide_cloudy_air_mass_factor_7km in SO2/PRODUCT/SUPPORT_DATA/DETAILED_RES- ULTS Description: Cloudy sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level. Type: NC_FLOAT. Source: Processor. Mode: Present in all modes. Attributes: Name Value Type units '1' (static) NC_STRING long_name 'cloudy sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level'. Source: Name Value Type units '1' (static) NC_STRING NC_STR	Description:	Clear sky air mass	factor for a sulfur dioxide plume at 7km altitude w.r.t. t	he sea level.
Source:       Processor.         Mode:       Present in all modes.         Attributes:       Name       Value       Type         units       '1' (static)       NC_STRING         long_name       'clear sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level' (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. Following [ER5, section 5.2] we use this attribute to connect the data with the geolocation. This attribute originates from the CF standard.         sulfurdioxide_cloudy_air_mass_factor_7km in SO2/PRODUCT/SUPPORT_DATA/DETAILED_RES- ULTS       Cloudy sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level.         Dimensions:       time, scanline, ground_pixel.       Type         Type:       NC_FLOAT.       Source:         Present in all modes.       Mame       Value         Attributes:       Name       Value         Mode:       Present in all modes.       NC_STRING         Iong_name       'cloudy sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level' (static)       NC_STRING	Dimensions:	time, scanline, grou	ind_pixel.	
Mode:       Present in all modes.         Attributes:       Name       Value       Type         units       '1' (static)       NC_STRING         long_name       'clear sky air mass factor for a sulfur dioxide plume       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. Following [ER5, section 5.2] we use this attribute to connect the data with the geolocation. This attribute originates from the CF standard.         sulfurdioxide_cloudy_air_mass_factor_7km in SO2/PRODUCT/SUPPORT_DATA/DETAILED_RES-ULTS       Cloudy sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level.         Dimensions:       time, scanline, ground_pixel.       Type         Type:       NC_FLOAT.       Source:         Present in all modes.       Type         Attributes:       Name       Value         Inits       '1' (static)       NC_STRING         Iong_name       'cloudy sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level.	Туре:	NC_FLOAT.		
Attributes:         Name         Value         Type           units         '1' (static)         NC_STRING           long_name         'clear sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level' (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. Following [ER5, section 5.2] we use this attribute to connect the data with the geolocation. This attribute originates from the CF standard.           sulfurdioxide_cloudy_air_mass_factor_7km in SO2/PRODUCT/SUPPORT_DATA/DETAILED_RES- ULTS         Cloudy sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level.           Dimensions:         time, scanline, ground_pixel.         time, scanline, ground_pixel.           Type:         NC_FLOAT.         Value         Type           Mode:         Present in all modes.         Type           Mtributes:         Name         Value         Type           units         '1' (static)         NC_STRING           long_name         'cloudy sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level' (static)         NC_STRING	Source:	Processor.		
units       '1' (static)       NC_STRING         long_name       'clear sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level' (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. Following [ER5, section 5.2] we use this attribute to connect the data with the geolocation. This attribute originates from the CF standard.         sulfurdioxide_cloudy_air_mass_factor_7km in SO2/PRODUCT/SUPPORT_DATA/DETAILED_RES- ULTS       Cloudy sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level.         Dimensions:       time, scanline, ground_pixel.       time, scanline, ground_pixel.         Type:       NC_FLOAT.       Source:       Processor.         Mode:       Present in all modes.       Type         Attributes:       Name       Value       Type         units       '1' (static)       NC_STRING         long_name       'cloudy sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level' (static)       NC_STRING	Mode:	Present in all mode	S.	
Iong_name       'clear sky air mass factor for a sulfur dioxide plume       NC_STRING         at 7km altitude w.r.t. the sea level' (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. Following [ER5, section 5.2] we use this attribute to connect the data with the geolocation. This attribute originates from the CF standard.         sulfurdioxide_cloudy_air_mass_factor_7km in SO2/PRODUCT/SUPPORT_DATA/DETAILED_RES-ULTS       Occurs factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level.         Dimensions:       time, scanline, ground_pixel.       Type:         NC_FLOAT.       Source:       Processor.         Mode:       Present in all modes.       Type         units       '1' (static)       NC_STRING         Iong_name       'cloudy sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level.	Attributes:	Name	Value	Туре
at 7km altitude w.r.t. the sea level' (static)         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. Following [ER5, section 5.2] we use this attribute to connect the data with the geolocation. This attribute originates from the CF standard.         sulfurdioxide_cloudy_air_mass_factor_7km in SO2/PRODUCT/SUPPORT_DATA/DETAILED_RES-ULTS         Description:       Cloudy sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level.         Dimensions:       time, scanline, ground_pixel.         Type:       NC_FLOAT.         Source:       Present in all modes.         Attributes:       Name       Value       Type         units       '1' (static)       NC_STRING         long_name       'cloudy sky air mass factor for a sulfur dioxide not su		units	'1' (static)	NC_STRING
The latitude and longitude coordinates of the TROPOMI swath is not defined as a Cartesian product of latitude and longitude axes. Following [ER5, section 5.2] we use this attribute to connect the data with the geolocation. This attribute originates from the CF standard.         sulfurdioxide_cloudy_air_mass_factor_7km in SO2/PRODUCT/SUPPORT_DATA/DETAILED_RES-ULTS         Description:       Cloudy sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level.         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       'cloudy sky air mass factor for a sulfur dioxide w.r.t. the sea level' (static)		long_name		NC_STRING
product of latitude and longitude axes. Following [ER5, section 5.2] we use this attribute to connect the data with the geolocation. This attribute originates from the CF standard.         sulfurdioxide_cloudy_air_mass_factor_7km in SO2/PRODUCT/SUPPORT_DATA/DETAILED_RES-ULTS         Description:       Cloudy sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level.         Dimensions:       time, scanline, ground_pixel.         Type:       NC_FLOAT.         Source:       Processor.         Mode:       Present in all modes.         Attributes:       Name       Value         inits       '1' (static)       NC_STRING         Iong_name       'cloudy sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level' (static)		coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
ULTS       Cloudy sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level.         Dimensions:       time, scanline, ground_pixel.         Type:       NC_FLOAT.         Source:       Processor.         Mode:       Present in all modes.         Attributes:       Name       Value         Inits       '1' (static)       NC_STRING         Iong_name       'cloudy sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level' (static)		product of latitude a	and longitude axes. Following [ER5, section 5.2] we us	se this attribute to
Dimensions:       time, scanline, ground_pixel.         Type:       NC_FLOAT.         Source:       Processor.         Mode:       Present in all modes.         Attributes:       Name       Value         units       '1' (static)       NC_STRING         long_name       'cloudy sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level' (static)       NC_STRING	sulfurdioxide	e_cloudy_air_mass_	factor_7km in SO2/PRODUCT/SUPPORT_DATA	/DETAILED_RES-
Dimensions:       time, scanline, ground_pixel.         Type:       NC_FLOAT.         Source:       Processor.         Mode:       Present in all modes.         Attributes:       Name       Value         units       '1' (static)       NC_STRING         long_name       'cloudy sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level' (static)       NC_STRING	Description:	Cloudy sky air mas	s factor for a sulfur dioxide plume at 7km altitude w.r.t	. the sea level.
Source:       Processor.         Mode:       Present in all modes.         Attributes:       Name       Value       Type         units       '1' (static)       NC_STRING         long_name       'cloudy sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level' (static)       NC_STRING	Dimensions:			
Source:       Processor.         Mode:       Present in all modes.         Attributes:       Name       Value       Type         units       '1' (static)       NC_STRING         long_name       'cloudy sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level' (static)       NC_STRING	Туре:	NC_FLOAT.		
Name       Value       Type         units       '1' (static)       NC_STRING         long_name       'cloudy sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level' (static)       NC_STRING	Source:	—		
units       '1' (static)       NC_STRING         long_name       'cloudy sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level' (static)       NC_STRING	Mode:	Present in all mode	S.	
units       '1' (static)       NC_STRING         long_name       'cloudy sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level' (static)       NC_STRING	Attributes:	Name	Value	Туре
long_name'cloudy sky air mass factor for a sulfur dioxideNC_STRINGplume at 7km altitude w.r.t. the sea level' (static)		units	'1' (static)	
			'cloudy sky air mass factor for a sulfur dioxide	
		coordinates	<pre>//PRODUCT/longitude /PRODUCT/latitude' (static)</pre>	NC STRING

	The latitude and long	gitude coordinates of the TROPOMI swath is not defin	ed as a Cartesian		
	•	nd longitude axes. Following [ER5, section 5.2] we us th the geolocation. This attribute originates from the 0			
<b>sulfurdioxide</b> DETAILED_R	e_averaging_kernel_ ESULTS	scaling_box_7km in SO2/PRODUCT/S	SUPPORT_DATA		
Description:	Scaling box of the to sea level.	tal air mass factor $M$ for a sulfur dioxide plume at 7kn	n altitude w.r.t. the		
Dimensions:	time, scanline, grou	nd_pixel.			
Туре:	NC_FLOAT.				
Source:	Processor.				
Mode:	Present in all modes	S.			
Attributes:	Name	Value	Туре		
	units	'1' (static)	NC_STRING		
	long_name	'scaling box of the total air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level' (static)	NC_STRING		
	product of latitude a	'/PRODUCT/longitude /PRODUCT/latitude' (static) gitude coordinates of the TROPOMI swath is not defin nd longitude axes. Following [ER5, section 5.2] we us th the geolocation. This attribute originates from the 0	se this attribute to		
	e_total_vertical_colu	mn_15km in SO2/PRODUCT/SUPPORT_DATA/	DETAILED_RES		
ULTS Description:	Vertical column den altitude w.r.t. the sea	sity of the sulfur dioxide $SO_2$ product for a sulfur dioxida level.	de plume at 15kn		
Dimensions:	time, scanline, grou	nd_pixel.			
Туре:	NC_FLOAT.				
Source:	Processor.				
Mode:	Present in all modes	5.			
Attributes:	Name	Value	Туре		
	units	'mol m-2' (static)	NC_STRING		
	standard_name	'atmosphere_mole_content_of_sulfur_dioxide' (static)	NC_STRING		
	long_name	'total vertical column density of sulfur dioxide for a sulfur dioxide plume at 15km altitude w.r.t. the sea level' (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.				
-	multiplication factor_to_con- vert_to_DU	2241.15 (static)	NC_FLOAT		
	value this means th "DU" or Dobson Uni	entinel 5 precursor files are given in SI units. For an i at the unit is $mol m^{-2}$ . Traditionally the unit for an interest. This attribute provides the multiplication factor to the value in $mol m^{-2}$ . This is provided as a convenient of DU.	egrated column is calculate the tota		
	multiplication factor_to_con- vert_to_mo- lecules_percm2	6.02214e+19 (static)	NC_FLOAT		

	The quantities in Se	entinel 5 precursor files are given in SI units. For an i	ntegrated column
	value this means the	hat the unit is $mol m^{-2}$ . Traditionally the unit for an i	ntegrated column
		. This attribute provides the multiplication factor to	
		s cm <sup>-2</sup> from the value in molm <sup>-2</sup> . This is provided as	a convenience to
		Is that work in molecules $cm^{-2}$ .	
DETAILED_R		umn_15km_precision in SO2/PRODUCT/S	SUPPORT_DATA/
Description:		e vertical column density of the sulfur dioxide $SO_2$ p km altitude w.r.t. the sea level.	roduct for a sulfur
Dimensions:	time, scanline, grou	nd_pixel.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all mode	S.	
Attributes:	Name	Value	Туре
	units	'mol m-2' (static)	NC_STRING
	standard_name	'atmosphere_mole_content_of_sulfur_dioxide standard_error' (static)	NC_STRING
	long_name	'random error of the total vertical column density of sulfur dioxide for a sulfur dioxide plume at 15km altitude w.r.t. the sea level' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
		gitude coordinates of the TROPOMI swath is not defir and longitude axes. This attribute originates from the	
	multiplication2241.15 (static)NC_FLOATfactor_to_con-vert_to_DUThe quantities in Sentinel 5 precursor files are given in SI units. For an integrated column value this means that the unit is mol m <sup>-2</sup> . Traditionally the unit for an integrated column is "DU" or Dobson Units. This attribute provides the multiplication factor to calculate the total		
		the value in $\mathrm{mol}\mathrm{m}^{-2}.$ This is provided as a convenient	
	multiplication factor_to_con- vert_to_mo-	6.02214e+19 (static)	NC_FLOAT
	lecules_percm2		
	The quantities in Se value this means th is "molecules cm <sup>-2</sup> " column in molecules	entinel 5 precursor files are given in SI units. For an interact the unit is $mol m^{-2}$ . Traditionally the unit for an it. This attribute provides the multiplication factor to $s cm^{-2}$ from the value in $mol m^{-2}$ . This is provided as $s cm^{-2}$ from the value in $mol m^{-2}$ .	ntegrated column calculate the total
	The quantities in Se value this means th is "molecules cm <sup>-2</sup> " column in molecules users who have too	hat the unit is $mol m^{-2}$ . Traditionally the unit for an i . This attribute provides the multiplication factor to $s cm^{-2}$ from the value in $mol m^{-2}$ . This is provided as	ntegrated column calculate the total a convenience to
DETAILED_R	The quantities in Se value this means th is "molecules cm <sup>-2</sup> ", column in molecules users who have too e_total_vertical_colu ESULTS Systematic error of	hat the unit is $mol m^{-2}$ . Traditionally the unit for an i. . This attribute provides the multiplication factor to $c s cm^{-2}$ from the value in $mol m^{-2}$ . This is provided as is that work in molecules $cm^{-2}$ .	ntegrated column calculate the total a convenience to SUPPORT_DATA/
DETAILED_R Description:	The quantities in Se value this means th is "molecules cm <sup>-2</sup> ", column in molecules users who have too e_total_vertical_colu ESULTS Systematic error of	hat the unit is $mol m^{-2}$ . Traditionally the unit for an i . This attribute provides the multiplication factor to $contend contend conten$	ntegrated column calculate the total a convenience to SUPPORT_DATA/
DETAILED_R Description: Dimensions:	The quantities in Se value this means th is "molecules cm <sup>-2</sup> " column in molecules users who have too e_total_vertical_colu ESULTS Systematic error of dioxide plume at 15	hat the unit is $mol m^{-2}$ . Traditionally the unit for an i . This attribute provides the multiplication factor to $contend contend conten$	ntegrated column calculate the total a convenience to SUPPORT_DATA/
DETAILED_R Description: Dimensions: Type:	The quantities in Se value this means th is "molecules cm <sup>-2</sup> " column in molecules users who have too e_total_vertical_colu ESULTS Systematic error of dioxide plume at 15 time, scanline, grou	hat the unit is $mol m^{-2}$ . Traditionally the unit for an i . This attribute provides the multiplication factor to $contend contend conten$	ntegrated column calculate the total a convenience to SUPPORT_DATA/
sulfurdioxide DETAILED_R Description: Dimensions: Type: Source: Mode:	The quantities in Se value this means th is "molecules cm <sup>-2</sup> ", column in molecules users who have too e_total_vertical_colu ESULTS Systematic error of dioxide plume at 15 time, scanline, grou NC_FLOAT.	hat the unit is $molm^{-2}$ . Traditionally the unit for an i . This attribute provides the multiplication factor to $contend contend contend$	ntegrated column calculate the total a convenience to SUPPORT_DATA/
DETAILED_R Description: Dimensions: Type: Source:	The quantities in Se value this means th is "molecules cm <sup>-2</sup> " column in molecules users who have too e_total_vertical_colu ESULTS Systematic error of dioxide plume at 15 time, scanline, grou NC_FLOAT. Processor.	hat the unit is $molm^{-2}$ . Traditionally the unit for an i . This attribute provides the multiplication factor to $contend contend contend$	ntegrated column calculate the total a convenience to SUPPORT_DATA/

sulfurdioxide DETAILED_R Description: Dimensions: Type: Source: Mode: Attributes:	product of latitude an connect the data wit contal_air_mass_fac ESULTS	'/PRODUCT/longitude /PRODUCT/latitude' (static) gitude coordinates of the TROPOMI swath is not defin nd longitude axes. Following [ER5, section 5.2] we us h the geolocation. This attribute originates from the C stor_15km_precision in SO2/PRODUCT/S total air mass factor <i>M</i> for a sulfur dioxide plume at 1 nd_pixel.	ed as a Cartesia se this attribute to CF standard. SUPPORT_DATA
DETAILED_R Description: Dimensions: Type: Source: Mode:	The latitude and long product of latitude and connect the data wit e_total_air_mass_fac ESULTS Random error of the the sea level. time, scanline, grour NC_FLOAT. Processor. Present in all modes Name	'/PRODUCT/longitude /PRODUCT/latitude' (static) gitude coordinates of the TROPOMI swath is not defin nd longitude axes. Following [ER5, section 5.2] we us h the geolocation. This attribute originates from the C stor_15km_precision in SO2/PRODUCT/S total air mass factor <i>M</i> for a sulfur dioxide plume at 1 nd_pixel.	ed as a Cartesia se this attribute to CF standard. SUPPORT_DATA 15km altitude w.r.
DETAILED_R Description: Dimensions: Type: Source: Mode:	The latitude and long product of latitude ar connect the data wit e_total_air_mass_fac ESULTS Random error of the the sea level. time, scanline, grour NC_FLOAT. Processor. Present in all modes	'/PRODUCT/longitude /PRODUCT/latitude' (static) gitude coordinates of the TROPOMI swath is not defin nd longitude axes. Following [ER5, section 5.2] we us h the geolocation. This attribute originates from the C stor_15km_precision in SO2/PRODUCT/S total air mass factor <i>M</i> for a sulfur dioxide plume at 1 nd_pixel.	ed as a Cartesia se this attribute to CF standard. SUPPORT_DATA 15km altitude w.r.
DETAILED_R Description: Dimensions: Type: Source:	The latitude and long product of latitude an connect the data wit e_total_air_mass_fac ESULTS Random error of the the sea level. time, scanline, grour NC_FLOAT. Processor.	'/PRODUCT/longitude /PRODUCT/latitude' (static) gitude coordinates of the TROPOMI swath is not defin nd longitude axes. Following [ER5, section 5.2] we us h the geolocation. This attribute originates from the C stor_15km_precision in SO2/PRODUCT/S total air mass factor <i>M</i> for a sulfur dioxide plume at 1 nd_pixel.	ed as a Cartesia se this attribute to CF standard. SUPPORT_DATA
DETAILED_R Description: Dimensions: Type:	The latitude and long product of latitude ar connect the data wit e_total_air_mass_fac ESULTS Random error of the the sea level. time, scanline, grour NC_FLOAT.	'/PRODUCT/longitude /PRODUCT/latitude' (static) gitude coordinates of the TROPOMI swath is not defin nd longitude axes. Following [ER5, section 5.2] we us h the geolocation. This attribute originates from the C stor_15km_precision in SO2/PRODUCT/S total air mass factor <i>M</i> for a sulfur dioxide plume at 1	ed as a Cartesia se this attribute to CF standard. SUPPORT_DATA
DETAILED_R Description: Dimensions:	The latitude and long product of latitude an connect the data wit e_total_air_mass_fac ESULTS Random error of the the sea level. time, scanline, grour	'/PRODUCT/longitude /PRODUCT/latitude' (static) gitude coordinates of the TROPOMI swath is not defin nd longitude axes. Following [ER5, section 5.2] we us h the geolocation. This attribute originates from the C stor_15km_precision in SO2/PRODUCT/S total air mass factor <i>M</i> for a sulfur dioxide plume at 1	ed as a Cartesia se this attribute to CF standard. SUPPORT_DATA
DETAILED_R Description:	The latitude and long product of latitude and connect the data wit e_total_air_mass_fac ESULTS Random error of the the sea level.	'/PRODUCT/longitude /PRODUCT/latitude' (static) gitude coordinates of the TROPOMI swath is not defin nd longitude axes. Following [ER5, section 5.2] we us h the geolocation. This attribute originates from the C stor_15km_precision in SO2/PRODUCT/S total air mass factor <i>M</i> for a sulfur dioxide plume at 1	ed as a Cartesia se this attribute to CF standard. SUPPORT_DATA
DETAILED_R	The latitude and long product of latitude and connect the data wit e_total_air_mass_fac ESULTS	'/PRODUCT/longitude /PRODUCT/latitude' (static) gitude coordinates of the TROPOMI swath is not defin nd longitude axes. Following [ER5, section 5.2] we us h the geolocation. This attribute originates from the C stor_15km_precision in SO2/PRODUCT/S	ed as a Cartesia se this attribute t CF standard. SUPPORT_DATA
	The latitude and long product of latitude an connect the data wit e_total_air_mass_fac	'/PRODUCT/longitude /PRODUCT/latitude' (static) gitude coordinates of the TROPOMI swath is not defin nd longitude axes. Following [ER5, section 5.2] we us h the geolocation. This attribute originates from the 0	ed as a Cartesia se this attribute t CF standard.
	The latitude and long product of latitude and	'/PRODUCT/longitude /PRODUCT/latitude' (static) gitude coordinates of the TROPOMI swath is not defin nd longitude axes. Following [ER5, section 5.2] we us	ed as a Cartesia se this attribute t
	The latitude and long	'/PRODUCT/longitude /PRODUCT/latitude' (static) gitude coordinates of the TROPOMI swath is not defin	ed as a Cartesia
		'/PRODUCT/longitude /PRODUCT/latitude' (static)	
			NO OTRINO
	long_name	15km altitude w.r.t. the sea level' (static)	
	long_name	'total air mass factor for a sulfur dioxide plume at	NC_STRING
Attributes:	Name units	'1' (static)	Type
Mode:	Present in all modes		Tunc
Source:	Processor.		
Туре:	NC_FLOAT.		
Dimensions:	time, scanline, grour	iu_pixei.	
Description:		, $M$ for a sulfur dioxide plume at 15km altitude w.r.t. t	he sea level.
ULTS			
culfurdiovide	is "molecules cm <sup>-2</sup> ". column in molecules users who have tool	at the unit is $mol m^{-2}$ . Traditionally the unit for an in This attribute provides the multiplication factor to $c cm^{-2}$ from the value in $mol m^{-2}$ . This is provided as s that work in molecules $cm^{-2}$ . etor_15km in SO2/PRODUCT/SUPPORT_DATA/	alculate the tota a convenience to
	The quantities in Se	ntinel 5 precursor files are given in SI units. For an i	
	lecules_percm2		
	factor_to_con- vert_to_mo-		
	multiplication	6.02214e+19 (static)	NC_FLOAT
		the value in $\mathrm{mol}\mathrm{m}^{-2}$ . This is provided as a convenie	
	value this means that	at the unit is $mol m^{-2}$ . Traditionally the unit for an interest. This attribute provides the multiplication factor to $\phi$	egrated column i
	factor_to_con- vert_to_DU	ntinel 5 precursor files are given in SI units. For an i	ntograted colum
	product of latitude an multiplication -	nd longitude axes. This attribute originates from the ( 2241.15 (static)	CF standard.
	The latitude and long	gitude coordinates of the TROPOMI swath is not defin	ed as a Cartesia
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC STRING
		of sulfur dioxide for a sulfur dioxide plume at 15km altitude w.r.t. the sea level' (static)	

	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
	product of latitude a	gitude coordinates of the TROPOMI swath is not defin nd longitude axes. Following [ER5, section 5.2] we us th the geolocation. This attribute originates from the 0	se this attribute to
sulfurdioxide		ctor_15km_trueness in SO2/PRODUCT/S	SUPPORT_DATA/
Description:	Systematic error of w.r.t. the sea level.	the total air mass factor $M$ for a sulfur dioxide plume	e at 15km altitude
Dimensions:	time, scanline, grou	nd_pixel.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all modes	S.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	long_name	'systematic error of the total air mass factor for a sulfur dioxide plume at 15km altitude w.r.t. the sea level' (static)	NC_STRING
	coordinates	<pre>'/PRODUCT/longitude /PRODUCT/latitude' (static)</pre>	NC_STRING
	product of latitude a	gitude coordinates of the TROPOMI swath is not defin nd longitude axes. Following [ER5, section 5.2] we us th the geolocation. This attribute originates from the 0	se this attribute to
		ctor_15km_kernel_trueness in SO2/PRODUCT/	SUPPORT_DATA/
DETAILED_R Description:	Systematic error of	the total air mass factor $M$ when kernels are used for	or a sulfur dioxide
Dimensional	•	ide w.r.t. the sea level.	
Dimensions: Type:	time, scanline, ground_pixel.		
Source:	NC_FLOAT. Processor.		
Mode:	Present in all modes		
		-	
Attributes:	Name	Value	Туре
Attributes:	Name units	Value '1' (static)	<i>Type</i> NC_STRING
Attributes:			
Attributes:	units	'1' (static) 'systematic error of the total air mass factor using kernels for a sulfur dioxide plume at 15km altitude	NC_STRING
Attributes:	units long_name coordinates The latitude and long product of latitude a	'1' (static) 'systematic error of the total air mass factor using kernels for a sulfur dioxide plume at 15km altitude w.r.t. the sea level' (static)	NC_STRING NC_STRING NC_STRING ed as a Cartesian se this attribute to
	units long_name coordinates The latitude and long product of latitude a connect the data with	<ul> <li>'1' (static)</li> <li>'systematic error of the total air mass factor using kernels for a sulfur dioxide plume at 15km altitude w.r.t. the sea level' (static)</li> <li>'/PRODUCT/longitude /PRODUCT/latitude' (static) gitude coordinates of the TROPOMI swath is not defin nd longitude axes. Following [ER5, section 5.2] we use</li> </ul>	NC_STRING NC_STRING NC_STRING ed as a Cartesian se this attribute to CF standard.
sulfurdioxide	units long_name coordinates The latitude and long product of latitude a connect the data wite clear_air_mass_fact	<ul> <li>'1' (static)</li> <li>'systematic error of the total air mass factor using kernels for a sulfur dioxide plume at 15km altitude w.r.t. the sea level' (static)</li> <li>'/PRODUCT/longitude /PRODUCT/latitude' (static) gitude coordinates of the TROPOMI swath is not defin nd longitude axes. Following [ER5, section 5.2] we us th the geolocation. This attribute originates from the Comparison of the transmission of transmission of the transmission of transmission of transmission of the transmission of transmission o</li></ul>	NC_STRING NC_STRING ed as a Cartesian se this attribute to CF standard. /DETAILED_RES-
sulfurdioxide ULTS	units long_name coordinates The latitude and long product of latitude a connect the data wite clear_air_mass_fact	<ul> <li>'1' (static)</li> <li>'systematic error of the total air mass factor using kernels for a sulfur dioxide plume at 15km altitude w.r.t. the sea level' (static)</li> <li>'/PRODUCT/longitude /PRODUCT/latitude' (static) gitude coordinates of the TROPOMI swath is not defin nd longitude axes. Following [ER5, section 5.2] we us th the geolocation. This attribute originates from the Cctor_15km in SO2/PRODUCT/SUPPORT_DATA/</li> <li>'actor for a sulfur dioxide plume at 15km altitude w.r.t.</li> </ul>	NC_STRING NC_STRING ed as a Cartesian se this attribute to CF standard. /DETAILED_RES-
<b>sulfurdioxide</b> ULTS Description:	units long_name coordinates The latitude and long product of latitude a connect the data wit e_clear_air_mass_factor Clear sky air mass f	<ul> <li>'1' (static)</li> <li>'systematic error of the total air mass factor using kernels for a sulfur dioxide plume at 15km altitude w.r.t. the sea level' (static)</li> <li>'/PRODUCT/longitude /PRODUCT/latitude' (static) gitude coordinates of the TROPOMI swath is not defin nd longitude axes. Following [ER5, section 5.2] we us th the geolocation. This attribute originates from the Cctor_15km in SO2/PRODUCT/SUPPORT_DATA/</li> <li>'actor for a sulfur dioxide plume at 15km altitude w.r.t.</li> </ul>	NC_STRING NC_STRING ed as a Cartesian se this attribute to CF standard. /DETAILED_RES-
sulfurdioxide ULTS Description: Dimensions:	units long_name coordinates The latitude and long product of latitude a connect the data wit e_clear_air_mass_fact Clear sky air mass f time, scanline, groun NC_FLOAT. Processor.	<ul> <li>'1' (static)</li> <li>'systematic error of the total air mass factor using kernels for a sulfur dioxide plume at 15km altitude w.r.t. the sea level' (static)</li> <li>'/PRODUCT/longitude /PRODUCT/latitude' (static) gitude coordinates of the TROPOMI swath is not defin nd longitude axes. Following [ER5, section 5.2] we us the the geolocation. This attribute originates from the Cctor_15km in SO2/PRODUCT/SUPPORT_DATA/</li> <li>'actor for a sulfur dioxide plume at 15km altitude w.r.t. nd_pixel.</li> </ul>	NC_STRING NC_STRING ed as a Cartesian se this attribute to CF standard. /DETAILED_RES-
<b>sulfurdioxide</b> ULTS Description: Dimensions: Type:	units long_name coordinates The latitude and long product of latitude a connect the data wite clear_air_mass_fact Clear sky air mass f time, scanline, groun NC_FLOAT.	<ul> <li>'1' (static)</li> <li>'systematic error of the total air mass factor using kernels for a sulfur dioxide plume at 15km altitude w.r.t. the sea level' (static)</li> <li>'/PRODUCT/longitude /PRODUCT/latitude' (static) gitude coordinates of the TROPOMI swath is not defin nd longitude axes. Following [ER5, section 5.2] we us the the geolocation. This attribute originates from the Cctor_15km in SO2/PRODUCT/SUPPORT_DATA/</li> <li>'actor for a sulfur dioxide plume at 15km altitude w.r.t. nd_pixel.</li> </ul>	NC_STRING NC_STRING ed as a Cartesian se this attribute to CF standard. /DETAILED_RES-
sulfurdioxide ULTS Description: Dimensions: Type: Source:	units long_name coordinates The latitude and long product of latitude a connect the data wite clear_air_mass_fact Clear sky air mass f time, scanline, grout NC_FLOAT. Processor. Present in all modes Name	<ul> <li>'1' (static)</li> <li>'systematic error of the total air mass factor using kernels for a sulfur dioxide plume at 15km altitude w.r.t. the sea level' (static)</li> <li>'/PRODUCT/longitude /PRODUCT/latitude' (static) gitude coordinates of the TROPOMI swath is not defin nd longitude axes. Following [ER5, section 5.2] we us the the geolocation. This attribute originates from the C ctor_15km in SO2/PRODUCT/SUPPORT_DATA/</li> <li>factor for a sulfur dioxide plume at 15km altitude w.r.t. nd_pixel.</li> </ul>	NC_STRING NC_STRING NC_STRING ed as a Cartesian se this attribute to CF standard. /DETAILED_RES- the sea level.
sulfurdioxide ULTS Description: Dimensions: Type: Source: Mode:	units long_name coordinates The latitude and long product of latitude a connect the data wit e_clear_air_mass_fact Clear sky air mass f time, scanline, grout NC_FLOAT. Processor. Present in all modes Name units	<ul> <li>'1' (static)</li> <li>'systematic error of the total air mass factor using kernels for a sulfur dioxide plume at 15km altitude w.r.t. the sea level' (static)</li> <li>'/PRODUCT/longitude /PRODUCT/latitude' (static) gitude coordinates of the TROPOMI swath is not defin nd longitude axes. Following [ER5, section 5.2] we us the the geolocation. This attribute originates from the Cctor_15km in SO2/PRODUCT/SUPPORT_DATA/</li> <li>factor for a sulfur dioxide plume at 15km altitude w.r.t. nd_pixel.</li> </ul>	NC_STRING NC_STRING ed as a Cartesian se this attribute to CF standard. DETAILED_RES- the sea level.
sulfurdioxide ULTS Description: Dimensions: Type: Source: Mode:	units long_name coordinates The latitude and long product of latitude a connect the data wite clear_air_mass_fact Clear sky air mass f time, scanline, grout NC_FLOAT. Processor. Present in all modes Name	<ul> <li>'1' (static)</li> <li>'systematic error of the total air mass factor using kernels for a sulfur dioxide plume at 15km altitude w.r.t. the sea level' (static)</li> <li>'/PRODUCT/longitude /PRODUCT/latitude' (static) gitude coordinates of the TROPOMI swath is not defin nd longitude axes. Following [ER5, section 5.2] we us the the geolocation. This attribute originates from the C ctor_15km in SO2/PRODUCT/SUPPORT_DATA/</li> <li>factor for a sulfur dioxide plume at 15km altitude w.r.t. nd_pixel.</li> </ul>	NC_STRING NC_STRING NC_STRING ed as a Cartesian se this attribute to CF standard. /DETAILED_RES- the sea level.

· · · · · · · ·	long_name flag_meanings flag_values	<ul> <li>'sulfur dioxide slant column density background correction flag' (static)</li> <li>'not-corrected,corrected' (static)</li> <li>0, 1 (static)</li> </ul>	NC_STRING NC_STRING NC_UBYTE	
	long_name	'sulfur dioxide slant column density background correction flag' (static)	NC_STRING	
			_	
	นาแจ			
	units	'1' (static)	NC STRING	
Attributes:	Name	Value	Туре	
Mode:	Present in all mode	S.		
Source:	Processor.			
Type:	NC UBYTE.			
Dimensions:	flag will be always 0 time, scanline, grou	).		
Description:		ch indicates if the background correction has been ap e that in case that the Status BG global attribute is se	•	
Sulfurdioxide ULTS	_siant_column_cor		DE IAILED_KES	
	product of latitude a connect the data wi	and longitude axes. Following [ER5, section 5.2] we us the geolocation. This attribute originates from the 0 rection flag in SO2 /PRODUCT/SUPPORT DATA	se this attribute to CF standard.	
		gitude coordinates of the TROPOMI swath is not defin		
	coordinates	<pre>'/PRODUCT/longitude /PRODUCT/latitude' (static)</pre>	NC_STRING	
	long_name	dioxide plume at 15km altitude w.r.t. the sea level' (static)		
	units	'1' (static) 'scaling box of the total air mass factor for a sulfur	NC_STRING	
Attributes:	Name	Value	Type	
Mode:				
Source:	Processor.	_		
Туре:	NC_FLOAT.			
Dimensions:	time, scanline, grou	nd_pixel.		
·	the sea level.			
DETAILED_RI Description:		total air mass factor $M$ for a sulfur dioxide plume at 1	5km altitude w.r.t	
	_averaging_kernel_		SUPPORT_DATA	
	product of latitude a	and longitude axes. Following [ER5, section 5.2] we us the the geolocation. This attribute originates from the (	se this attribute to	
		gitude coordinates of the TROPOMI swath is not defin	—	
	coordinates	plume at 15km altitude w.r.t. the sea level' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static)	NC STRING	
	long_name	'cloudy sky air mass factor for a sulfur dioxide	NC_STRING	
	units	'1' (static)	NC_STRING	
Attributes:	Name	Value	Туре	
Mode:	Present in all mode	s		
Type: Source:	Processor.			
	time, scanline, grou NC FLOAT.	inu_pixei.		
Description: Dimensions:		s factor for a sulfur dioxide plume at 15km altitude w.r	.i. the sea level.	
RESULTS		- far share for an an effect of the set of t		
	_cloudy_air_mass_	factor_15km in SO2/PRODUCT/SUPPORT_D	ATA/DETAILED_	
		5		
	•	and longitude axes. Following [ER5, section 5.2] we us th the geolocation. This attribute originates from the 0		

	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
		gitude are in a different group. How to specify the r case is not specified in the climate and forecast n	
sulfurdioxide	_detection_flag in So	02/PRODUCT/SUPPORT_DATA/DETAILED_RE	SULTS
Description:	eruption. The flag is	indicates if enhanced SO2 has been detected from a 0 for no detection, 1 SO2 detection, 2 for clear volc o known anthropogenic source, 4 for detection at hig	anic detection, 3
Dimensions:	time, scanline, grour	nd_pixel.	
Туре:	NC_INT.		
Source:	Processor.		
Mode:	Present in all modes	i.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	long_name	'sulfur dioxide volcano activity flag' (static)	NC_STRING
	flag_meanings	'no detection,detection,clear detection close to known volcano,clear detection close to known an- thropogenic source,detection at high SZA' (static)	NC_STRING
	flag_values	0,1,2,3,4 (static)	NC_INT
-	coordinates	<pre>'/PRODUCT/longitude /PRODUCT/latitude' (static)</pre>	NC_STRING
		gitude are in a different group. How to specify the r case is not specified in the climate and forecast n	
number_of_it	erations_in_retrieva	I in SO2/PRODUCT/SUPPORT_DATA/DETAILEI	D_RESULTS
Dimensions:	time, scanline, grour	nd_pixel.	
Туре:	NC_USHORT.		
Source:	Processor.		
Mode:	Present in all modes	).	
Attributes:			
	Name	Value	Туре
	Name units	'1' (static)	<i>Type</i> NC_STRING
-		<ul><li>'1' (static)</li><li>'number of iterations used in the retrieval' (static)</li></ul>	
	units	'1' (static)	NC_STRING
-	units long_name coordinates	<ul><li>'1' (static)</li><li>'number of iterations used in the retrieval' (static)</li></ul>	NC_STRING NC_STRING NC_STRING
number_of_it	units long_name coordinates	<ul> <li>'1' (static)</li> <li>'number of iterations used in the retrieval' (static)</li> <li>'/PRODUCT/longitude /PRODUCT/latitude' (static)</li> <li>I_win1 in SO2/PRODUCT/SUPPORT_DATA/</li> </ul>	NC_STRING NC_STRING NC_STRING
number_of_it	units long_name coordinates terations_in_retrieva	<ul> <li>'1' (static)</li> <li>'number of iterations used in the retrieval' (static)</li> <li>'/PRODUCT/longitude /PRODUCT/latitude' (static)</li> <li>I_win1 in SO2/PRODUCT/SUPPORT_DATA/</li> </ul>	NC_STRING NC_STRING NC_STRING
number_of_it ULTS Dimensions:	units long_name coordinates terations_in_retrieva time, scanline, grour	<ul> <li>'1' (static)</li> <li>'number of iterations used in the retrieval' (static)</li> <li>'/PRODUCT/longitude /PRODUCT/latitude' (static)</li> <li>I_win1 in SO2/PRODUCT/SUPPORT_DATA/</li> </ul>	NC_STRING NC_STRING NC_STRING
number_of_it ULTS Dimensions: Type:	units long_name coordinates terations_in_retrieva time, scanline, grour NC_USHORT.	'1' (static) 'number of iterations used in the retrieval' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) I_win1 in SO2/PRODUCT/SUPPORT_DATA/ nd_pixel.	NC_STRING NC_STRING NC_STRING
number_of_it ULTS Dimensions: Type: Source:	units long_name coordinates terations_in_retrieva time, scanline, grour NC_USHORT. Processor.	'1' (static) 'number of iterations used in the retrieval' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) I_win1 in SO2/PRODUCT/SUPPORT_DATA/ nd_pixel.	NC_STRING NC_STRING NC_STRING
number_of_it ULTS Dimensions: Type: Source: Mode:	units long_name coordinates terations_in_retrieva time, scanline, grour NC_USHORT. Processor. Present in all modes	'1' (static) 'number of iterations used in the retrieval' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) I_win1 in SO2/PRODUCT/SUPPORT_DATA/ nd_pixel.	NC_STRING NC_STRING NC_STRING DETAILED_RES-
number_of_it ULTS Dimensions: Type: Source: Mode:	units long_name coordinates terations_in_retrieva time, scanline, grour NC_USHORT. Processor. Present in all modes Name	'1' (static) 'number of iterations used in the retrieval' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) Il_win1 in SO2/PRODUCT/SUPPORT_DATA/ nd_pixel. S. Value	NC_STRING NC_STRING NC_STRING DETAILED_RES-
number_of_it ULTS Dimensions: Type: Source: Mode:	units long_name coordinates terations_in_retrieva time, scanline, grour NC_USHORT. Processor. Present in all modes <i>Name</i> units	'1' (static) 'number of iterations used in the retrieval' (static) '/PRODUCT/longitude /PRODUCT/latitude' (static) I_win1 in SO2/PRODUCT/SUPPORT_DATA/ nd_pixel.	NC_STRING NC_STRING NC_STRING DETAILED_RES- <i>Type</i> NC_STRING
number_of_it ULTS Dimensions: Type: Source: Mode: Attributes:	units         long_name         coordinates         terations_in_retrieva         time, scanline, grour         NC_USHORT.         Processor.         Present in all modes         Name         units         long_name         coordinates	<ul> <li>'1' (static)</li> <li>'number of iterations used in the retrieval' (static)</li> <li>'/PRODUCT/longitude /PRODUCT/latitude' (static)</li> <li>I_win1 in SO2/PRODUCT/SUPPORT_DATA/</li> <li>nd_pixel.</li> <li>.</li> <li>Value</li> <li>'1' (static)</li> <li>'number of iterations used in the retrieval for window 1' (static)</li> </ul>	NC_STRING NC_STRING NC_STRING DETAILED_RES- Type NC_STRING NC_STRING NC_STRING
number_of_it ULTS Dimensions: Type: Source: Mode: Attributes:	units         long_name         coordinates         terations_in_retrieva         time, scanline, grour         NC_USHORT.         Processor.         Present in all modes         Name         units         long_name         coordinates	<ul> <li>'1' (static)</li> <li>'number of iterations used in the retrieval' (static)</li> <li>'/PRODUCT/longitude /PRODUCT/latitude' (static)</li> <li>I_win1 in SO2/PRODUCT/SUPPORT_DATA/</li> <li>nd_pixel.</li> <li>.</li> <li>Value</li> <li>'1' (static)</li> <li>'number of iterations used in the retrieval for window</li> <li>1' (static)</li> <li>'/PRODUCT/longitude /PRODUCT/latitude' (static)</li> <li>I_win2 in SO2/PRODUCT/SUPPORT_DATA/</li> </ul>	NC_STRING NC_STRING NC_STRING DETAILED_RES- Type NC_STRING NC_STRING NC_STRING
number_of_it ULTS Dimensions: Type: Source: Mode: Attributes:	units         long_name         coordinates         cerations_in_retrieva         time, scanline, grour         NC_USHORT.         Processor.         Present in all modes         Name         units         long_name         coordinates         cerations_in_retrieva	<ul> <li>'1' (static)</li> <li>'number of iterations used in the retrieval' (static)</li> <li>'/PRODUCT/longitude /PRODUCT/latitude' (static)</li> <li>I_win1 in SO2/PRODUCT/SUPPORT_DATA/</li> <li>nd_pixel.</li> <li>.</li> <li>Value</li> <li>'1' (static)</li> <li>'number of iterations used in the retrieval for window</li> <li>1' (static)</li> <li>'/PRODUCT/longitude /PRODUCT/latitude' (static)</li> <li>I_win2 in SO2/PRODUCT/SUPPORT_DATA/</li> </ul>	NC_STRING NC_STRING NC_STRING DETAILED_RES- Type NC_STRING NC_STRING NC_STRING

Mode:	Present in all mode	8.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	long_name	'number of iterations used in the retrieval for window 2' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
number_of_i ULTS	terations_in_retrieva	al_win3 in SO2/PRODUCT/SUPPORT_DATA/	DETAILED_RES-
Dimensions:	time, scanline, grou	nd_pixel.	
Туре:	NC_USHORT.		
Source:	Processor.		
Mode:	Present in all mode	S.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	long_name	'number of iterations used in the retrieval for window 3' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
fitted_root_n	nean_square in SO2_	/PRODUCT/SUPPORT_DATA/DETAILED_RESU	LTS
Dimensions:	time, scanline, grou	nd_pixel.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all modes	S.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	long_name	'root mean square of the sulfur dioxide slant column' (static)	NC_STRING
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING

### 13.1.1.3 Group "WAVELENGTH\_CALIBRATIONS" in "DETAILED\_RESULTS"

### Dimensions in SO2\_\_\_/PRODUCT/SUPPORT\_DATA/DETAILED\_RESULTS/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\_win1** 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\_win1 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.

**degrees\_of\_polynomial\_shift\_win2** 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\_win2** 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.

**degrees\_of\_polynomial\_shift\_win3** 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\_win3 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 SO2\_\_\_/PRODUCT/SUPPORT\_DATA/DETAILED\_RESULTS/WAVELENGTH\_CALIBRATIONS

	olynomial_coefficie ENGTH CALIBRATIC	nts_win1 in SO2/PRODUCT/SUPPORT_DATA/ DNS	DETAILED_RES-	
Description:	Computed coefficients of the polynomial function. It may have multiple windows.			
Dimensions:	number_of_calibrations, degrees_of_polynomial_shift_win1.			
Type:	NC_FLOAT.			
Source:	Processor.			
Mode:	Present in all modes.			
Attributes:	Name	Value	Туре	
	units	'1' (static)	NC_STRING	
	long_name	'computed coefficients of the polynomial function in fitting window 1' (static)	NC_STRING	
	<b>ubwindows_shift_w</b> H_CALIBRATIONS	in1 in SO2/PRODUCT/SUPPORT_DATA/DETA	ILED_RESULTS/	
Description:	Computed waveleng	ths shift values per subwindow. It may have multiple	windows.	
Dimensions:	number_of_calibrations, number_of_subwindows_win1.			
Туре:	NC_FLOAT.			
Source:	Processor.			
Mode:	Present in all modes	S.		
Attributes:	Name	Value	Туре	
	units	'nm' (static)	NC_STRING	
	long_name	'irradiance wavelengths shift values per subwindow in fitting window 1' (static)	NC_STRING	
calibration_subwindows_squeeze_win1 in SO2/PRODUCT/SUPPORT_DATA/DETAILED_RES-ULTS/WAVELENGTH CALIBRATIONS				
Description:	Computed waveleng	ths squeeze values per subwindow. It may have mul	tiple windows.	
Dimensions:	number_of_calibrati	ons, number_of_subwindows_win1.		
Туре:	NC_FLOAT.			
Source:	Processor.			
Mode:	Present in all modes	S.		

Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	long_name	'irradiance wavelengths squeeze fitted values per subwindow in fitting window 1' (static)	NC_STRING
	<b>subwindows_root_m</b> ESULTS/WAVELENG	nean_square_win1 in SO2/PRODUCT/S GTH_CALIBRATIONS	SUPPORT_DATA
Description:	Computed RMS val	lues per subwindow. It may have multiple windows.	
Dimensions:	number_of_calibrat	ions, number_of_subwindows_win1.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all mode	S.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	long_name	'calibration rms per subwindow in fitting window 1' (static)	NC_STRING
	ubwindows_wavele ENGTH_CALIBRATI	ngth_win1 in SO2/PRODUCT/SUPPORT_DATA/ ONS	DETAILED_RES
Description:	_	gth center in each subwindow. It may have multiple w	indows.
Dimensions:	number_of_subwind	dows_win1.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all mode	S.	
Attributes:	Name	Value	Туре
	units	'nm' (static)	NC_STRING
	long_name	'calibration wavelength center in each subwindow in fitting window 1' (static)	NC_STRING
	olynomial_coefficie ENGTH CALIBRATIO	ents_win2 in SO2/PRODUCT/SUPPORT_DATA/ ONS	DETAILED_RES
Description:	Computed coefficie	nts of the polynomial function. It may have multiple w	ndows.
Dimensions:	number_of_calibrat	ions, degrees_of_polynomial_shift_win2.	
Туре:	NC FLOAT.		
Source:	Processor.		
Mode:	Present in all mode	S.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	long_name	'computed coefficients of the polynomial function in fitting window 2' (static)	NC_STRING
	ubwindows_shift_w H_CALIBRATIONS	<pre>vin2 in SO2/PRODUCT/SUPPORT_DATA/DETA</pre>	ILED_RESULTS
Description:	Computed wavelen	gths shift values per subwindow. It may have multiple	windows.
Dimensions:	number_of_calibrat	ions, number_of_subwindows_win2.	
Туре:	NC_FLOAT.		
Type.	D		
Source:	Processor.		
•••	Processor. Present in all mode	S.	
Source:		s. Value	Туре
Source: Mode:	Present in all mode		<i>Type</i> NC_STRING

calibration s	ubwindows squeez	e_win2 in SO2/PRODUCT/SUPPORT_DATA/	DETAILED RES-
	ENGTH_CALIBRATIC		
Description:	Computed waveleng	gths squeeze values per subwindow. It may have mul	tiple windows.
Dimensions:	number_of_calibrati	ons, number_of_subwindows_win2.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all modes	S.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC STRING
	long_name	'irradiance wavelengths squeeze fitted values per subwindow in fitting window 1' (static)	NC_STRING
calibration s	ubwindows_root_m		UPPORT DATA/
	ESULTS/WAVELENG		_
Description:	Computed RMS val	ues per subwindow. It may have multiple windows.	
Dimensions:	number_of_calibrati	ons, number_of_subwindows_win2.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all modes	S.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC STRING
	long_name	'calibration rms per subwindow in fitting window 2' (static)	NC_STRING
ULTS/WAVEL Description:	ENGTH_CALIBRATIC	ngth_win2 in SO2/PRODUCT/SUPPORT_DATA/ DNS gth center in each subwindow. It may have multiple w	
ULTS/WAVEL Description: Dimensions: Type:	ENGTH_CALIBRATIC Calibration waveleng number_of_subwind NC_FLOAT.	ngth_win2 in SO2/PRODUCT/SUPPORT_DATA/ DNS gth center in each subwindow. It may have multiple w	_
ULTS/WAVEL Description: Dimensions: Type: Source:	ENGTH_CALIBRATIC Calibration wavelen number_of_subwind NC_FLOAT. Processor.	ngth_win2 in SO2/PRODUCT/SUPPORT_DATA/ DNS gth center in each subwindow. It may have multiple w dows_win2.	_
ULTS/WAVEL Description: Dimensions: Type: Source: Mode:	ENGTH_CALIBRATIC Calibration waveleng number_of_subwind NC_FLOAT. Processor. Present in all modes	ngth_win2 in SO2/PRODUCT/SUPPORT_DATA/ DNS gth center in each subwindow. It may have multiple w dows_win2.	vindows.
ULTS/WAVEL Description: Dimensions: Type: Source:	ENGTH_CALIBRATIC Calibration waveleng number_of_subwind NC_FLOAT. Processor. Present in all modes Name	ngth_win2 in SO2/PRODUCT/SUPPORT_DATA/ DNS gth center in each subwindow. It may have multiple w dows_win2.	rindows. <i>Type</i>
ULTS/WAVEL Description: Dimensions: Type: Source: Mode:	ENGTH_CALIBRATIC Calibration waveleng number_of_subwind NC_FLOAT. Processor. Present in all modes Name units	ngth_win2 in SO2/PRODUCT/SUPPORT_DATA/ DNS gth center in each subwindow. It may have multiple w dows_win2. s. <u>Value</u> 'nm' (static)	rindows. <i>Type</i> NC_STRING
ULTS/WAVEL Description: Dimensions: Type: Source: Mode:	ENGTH_CALIBRATIC Calibration waveleng number_of_subwind NC_FLOAT. Processor. Present in all modes Name	ngth_win2 in SO2/PRODUCT/SUPPORT_DATA/ DNS gth center in each subwindow. It may have multiple w dows_win2. s. <u>Value</u> 'nm' (static) 'calibration wavelength center in each subwindow	rindows. <i>Type</i>
ULTS/WAVEL Description: Dimensions: Type: Source: Mode: Attributes: calibration_p	ENGTH_CALIBRATIC Calibration wavelene number_of_subwind NC_FLOAT. Processor. Present in all modes Name units Iong_name	ngth_win2 in SO2/PRODUCT/SUPPORT_DATA/ ONS gth center in each subwindow. It may have multiple w dows_win2. s. <u>Value</u> 'nm' (static) 'calibration wavelength center in each subwindow in fitting window 2' (static) nts_win3 in SO2/PRODUCT/SUPPORT_DATA/	<i>Type</i> NC_STRING NC_STRING
ULTS/WAVEL Description: Dimensions: Type: Source: Mode: Attributes: <b>calibration_p</b> ULTS/WAVEL	ENGTH_CALIBRATIC Calibration waveleng number_of_subwind NC_FLOAT. Processor. Present in all modes Name units Iong_name	ngth_win2 in SO2/PRODUCT/SUPPORT_DATA/ ONS gth center in each subwindow. It may have multiple w dows_win2. s. <u>Value</u> 'nm' (static) 'calibration wavelength center in each subwindow in fitting window 2' (static) nts_win3 in SO2/PRODUCT/SUPPORT_DATA/	<i>Type</i> NC_STRING NC_STRING DETAILED_RES
ULTS/WAVEL Description: Dimensions: Type: Source: Mode: Attributes: calibration_p	ENGTH_CALIBRATIC Calibration wavelene number_of_subwind NC_FLOAT. Processor. Present in all modes Name units long_name polynomial_coefficie ENGTH_CALIBRATIC Computed coefficie	ngth_win2 in SO2/PRODUCT/SUPPORT_DATA/ DNS gth center in each subwindow. It may have multiple w dows_win2. s. <i>Value</i> 'nm' (static) 'calibration wavelength center in each subwindow in fitting window 2' (static) nts_win3 in SO2/PRODUCT/SUPPORT_DATA/ DNS	<i>Type</i> NC_STRING NC_STRING DETAILED_RES
ULTS/WAVEL Description: Dimensions: Type: Source: Mode: Attributes: <b>calibration_p</b> ULTS/WAVEL Description:	ENGTH_CALIBRATIC Calibration wavelene number_of_subwind NC_FLOAT. Processor. Present in all modes Name units long_name polynomial_coefficie ENGTH_CALIBRATIC Computed coefficie	ngth_win2 in SO2/PRODUCT/SUPPORT_DATA/ DNS gth center in each subwindow. It may have multiple w dows_win2. s. <u>Value</u> 'nm' (static) 'calibration wavelength center in each subwindow in fitting window 2' (static) nts_win3 in SO2/PRODUCT/SUPPORT_DATA/ DNS nts of the polynomial function. It may have multiple wi	<i>Type</i> NC_STRING NC_STRING DETAILED_RES
ULTS/WAVEL Description: Dimensions: Type: Source: Mode: Attributes: <b>calibration_p</b> ULTS/WAVEL Description: Dimensions:	ENGTH_CALIBRATIC Calibration wavelend number_of_subwind NC_FLOAT. Processor. Present in all modes Name units Iong_name polynomial_coefficie ENGTH_CALIBRATIC Computed coefficient number_of_calibrati	ngth_win2 in SO2/PRODUCT/SUPPORT_DATA/ DNS gth center in each subwindow. It may have multiple w dows_win2. s. <u>Value</u> 'nm' (static) 'calibration wavelength center in each subwindow in fitting window 2' (static) nts_win3 in SO2/PRODUCT/SUPPORT_DATA/ DNS nts of the polynomial function. It may have multiple wi	<i>Type</i> NC_STRING NC_STRING DETAILED_RES-
ULTS/WAVEL Description: Dimensions: Type: Source: Mode: Attributes: <b>calibration_p</b> ULTS/WAVEL Description: Dimensions: Type:	ENGTH_CALIBRATIC Calibration wavelend number_of_subwind NC_FLOAT. Processor. Present in all modes Name units long_name polynomial_coefficie ENGTH_CALIBRATIC Computed coefficier number_of_calibrati NC_FLOAT.	ngth_win2 in SO2/PRODUCT/SUPPORT_DATA/ DNS gth center in each subwindow. It may have multiple w dows_win2. s. <u>Value</u> 'nm' (static) 'calibration wavelength center in each subwindow in fitting window 2' (static) nts_win3 in SO2/PRODUCT/SUPPORT_DATA/ DNS nts of the polynomial function. It may have multiple withons, degrees_of_polynomial_shift_win3.	<i>Type</i> NC_STRING NC_STRING DETAILED_RES-
ULTS/WAVEL Description: Dimensions: Type: Source: Mode: Attributes: <b>calibration_p</b> ULTS/WAVEL Description: Dimensions: Type: Source:	ENGTH_CALIBRATIC Calibration wavelene number_of_subwind NC_FLOAT. Processor. Present in all modes Name units long_name polynomial_coefficie ENGTH_CALIBRATIC Computed coefficier number_of_calibrati NC_FLOAT. Processor.	ngth_win2 in SO2/PRODUCT/SUPPORT_DATA/ DNS gth center in each subwindow. It may have multiple w dows_win2. s. <u>Value</u> 'nm' (static) 'calibration wavelength center in each subwindow in fitting window 2' (static) nts_win3 in SO2/PRODUCT/SUPPORT_DATA/ DNS nts of the polynomial function. It may have multiple withons, degrees_of_polynomial_shift_win3.	<i>Type</i> NC_STRING NC_STRING DETAILED_RES-
ULTS/WAVEL Description: Dimensions: Type: Source: Mode: Attributes: <b>calibration_p</b> ULTS/WAVEL Description: Dimensions: Type: Source: Mode:	ENGTH_CALIBRATIC Calibration wavelend number_of_subwind NC_FLOAT. Processor. Present in all modes Name units Iong_name Polynomial_coefficie ENGTH_CALIBRATIC Computed coefficien number_of_calibrati NC_FLOAT. Processor. Present in all modes	ngth_win2 in SO2/PRODUCT/SUPPORT_DATA/ DNS gth center in each subwindow. It may have multiple w dows_win2. s. <u>Value</u> 'nm' (static) 'calibration wavelength center in each subwindow in fitting window 2' (static) nts_win3 in SO2/PRODUCT/SUPPORT_DATA/ DNS nts of the polynomial function. It may have multiple wi ons, degrees_of_polynomial_shift_win3. s. <u>Value</u>	<i>Type</i> NC_STRING NC_STRING DETAILED_RES- indows.
ULTS/WAVEL Description: Dimensions: Type: Source: Mode: Attributes: <b>calibration_p</b> ULTS/WAVEL Description: Dimensions: Type: Source: Mode:	ENGTH_CALIBRATIC Calibration wavelene number_of_subwind NC_FLOAT. Processor. Present in all modes Name units long_name oolynomial_coefficie ENGTH_CALIBRATIC Computed coefficie number_of_calibrati NC_FLOAT. Processor. Present in all modes Name	ngth_win2 in SO2/PRODUCT/SUPPORT_DATA/ DNS gth center in each subwindow. It may have multiple w dows_win2. s. <u>Value</u> 'nm' (static) 'calibration wavelength center in each subwindow in fitting window 2' (static) nts_win3 in SO2/PRODUCT/SUPPORT_DATA/ DNS nts of the polynomial function. It may have multiple wi ons, degrees_of_polynomial_shift_win3. S.	<i>Type</i> NC_STRING NC_STRING DETAILED_RES-
ULTS/WAVEL Description: Type: Source: Mode: Attributes: <b>calibration_p</b> ULTS/WAVEL Description: Dimensions: Type: Source: Mode: Attributes: <b>calibration_s</b>	ENGTH_CALIBRATIC Calibration wavelene number_of_subwind NC_FLOAT. Processor. Present in all modes Name units long_name colynomial_coefficie ENGTH_CALIBRATIC Computed coefficier number_of_calibrati NC_FLOAT. Processor. Present in all modes Name units long_name	ngth_win2 in SO2/PRODUCT/SUPPORT_DATA/ DNS gth center in each subwindow. It may have multiple w dows_win2. s. Value 'nm' (static) 'calibration wavelength center in each subwindow in fitting window 2' (static) nts_win3 in SO2/PRODUCT/SUPPORT_DATA/ DNS nts of the polynomial function. It may have multiple wi ons, degrees_of_polynomial_shift_win3. s. Value '1' (static) 'computed coefficients of the polynomial function	<i>Type</i> NC_STRING NC_STRING DETAILED_RES- indows.
ULTS/WAVEL Description: Dimensions: Type: Source: Mode: Attributes: <b>calibration_p</b> ULTS/WAVEL Description: Dimensions: Type: Source: Mode: Attributes: <b>calibration_s</b>	ENGTH_CALIBRATIC Calibration wavelend number_of_subwind NC_FLOAT. Processor. Present in all modes Name units Iong_name oolynomial_coefficie ENGTH_CALIBRATIC Computed coefficien number_of_calibrati NC_FLOAT. Processor. Present in all modes Name units Iong_name subwindows_shift_w H_CALIBRATIONS	ngth_win2 in SO2/PRODUCT/SUPPORT_DATA/ DNS gth center in each subwindow. It may have multiple w dows_win2. s. <u>Value</u> 'nm' (static) 'calibration wavelength center in each subwindow in fitting window 2' (static) nts_win3 in SO2/PRODUCT/SUPPORT_DATA/ DNS nts of the polynomial function. It may have multiple wi ions, degrees_of_polynomial_shift_win3. s. <u>Value</u> '1' (static) 'computed coefficients of the polynomial function in fitting window 3' (static)	<i>Type</i> NC_STRING NC_STRING DETAILED_RES- indows. <i>Type</i> NC_STRING NC_STRING ILED_RESULTS/
ULTS/WAVEL Description: Dimensions: Type: Source: Mode: Attributes: Calibration_p ULTS/WAVEL Description: Dimensions: Type: Source: Mode: Attributes: Calibration_s WAVELENGT	ENGTH_CALIBRATIC Calibration wavelene number_of_subwind NC_FLOAT. Processor. Present in all modes Name units Iong_name oolynomial_coefficie ENGTH_CALIBRATIC Computed coefficier number_of_calibrati NC_FLOAT. Processor. Present in all modes Name units Iong_name units Iong_name	ngth_win2 in SO2/PRODUCT/SUPPORT_DATA/ DNS gth center in each subwindow. It may have multiple w dows_win2. s. Value 'nm' (static) 'calibration wavelength center in each subwindow in fitting window 2' (static) nts_win3 in SO2/PRODUCT/SUPPORT_DATA/ DNS nts of the polynomial function. It may have multiple wi ons, degrees_of_polynomial_shift_win3. s. Value '1' (static) 'computed coefficients of the polynomial function in fitting window 3' (static) 'in3 in SO2/PRODUCT/SUPPORT_DATA/DETA	<i>Type</i> NC_STRING NC_STRING DETAILED_RES- indows. <i>Type</i> NC_STRING NC_STRING ILED_RESULTS/

Source:	Processor.		
Mode:	Present in all mod	les.	
Attributes:	Name	Value	Туре
	units	'nm' (static)	NC_STRING
	long_name	'irradiance wavelengths shift values per subwindow in fitting window 3' (static)	NC_STRING
	<b>ubwindows_sque</b> ENGTH_CALIBRAT	eze_win3 in SO2/PRODUCT/SUPPORT_DATA/ FIONS	DETAILED_RE
Description:	Computed wavele	ngths squeeze values per subwindow. It may have mul	tiple windows.
Dimensions:	number_of_calibra	ations, number_of_subwindows_win3.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all mod	les.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	long_name	'irradiance wavelengths squeeze fitted values per subwindow in fitting window 3' (static)	NC_STRING
DETAILED_R Description:		IGTH_CALIBRATIONS alues per subwindow. It may have multiple windows.	
Dimensions:	number_of_calibra	ations, number_of_subwindows_win3.	
Туре:			
	NC_FLOAT.		
Source:	NC_FLOAI. Processor.		
Source: Mode:	—	les.	
	Processor.	les. Value	Туре
Mode:	Processor. Present in all mod		<i>Type</i> NC_STRING
Mode:	Processor. Present in all mod	Value	
Mode: Attributes: calibration_s	Processor. Present in all mod Name units long_name	Value '1' (static) 'calibration rms per subwindow in fitting window 3' (static) length_win3 in SO2/PRODUCT/SUPPORT_DATA/	NC_STRING NC_STRING
Mode: Attributes: calibration_s	Processor. Present in all mod Name units long_name subwindows_wave ENGTH_CALIBRAT	Value '1' (static) 'calibration rms per subwindow in fitting window 3' (static) length_win3 in SO2/PRODUCT/SUPPORT_DATA/	NC_STRING NC_STRING /DETAILED_RE
Mode: Attributes: calibration_s ULTS/WAVEL	Processor. Present in all mod Name units long_name subwindows_wave ENGTH_CALIBRAT	Value '1' (static) 'calibration rms per subwindow in fitting window 3' (static) length_win3 in SO2/PRODUCT/SUPPORT_DATA/ FIONS ength center in each subwindow. It may have multiple w	NC_STRING NC_STRING /DETAILED_RE
Mode: Attributes: calibration_s ULTS/WAVEL Description:	Processor. Present in all mod Name units long_name subwindows_wave ENGTH_CALIBRAT Calibration wavele	Value '1' (static) 'calibration rms per subwindow in fitting window 3' (static) length_win3 in SO2/PRODUCT/SUPPORT_DATA/ FIONS ength center in each subwindow. It may have multiple w	NC_STRING NC_STRING /DETAILED_RE
Mode: Attributes: calibration_s ULTS/WAVEL Description: Dimensions:	Processor. Present in all mod <u>Name</u> units long_name subwindows_wave ENGTH_CALIBRAT Calibration waveled number_of_subwi	Value '1' (static) 'calibration rms per subwindow in fitting window 3' (static) length_win3 in SO2/PRODUCT/SUPPORT_DATA/ FIONS ength center in each subwindow. It may have multiple w	NC_STRING NC_STRING /DETAILED_RE
Mode: Attributes: calibration_s ULTS/WAVEL Description: Dimensions: Type:	Processor. Present in all mod Name units long_name subwindows_wavel ENGTH_CALIBRAT Calibration wavele number_of_subwi NC_FLOAT.	Value '1' (static) 'calibration rms per subwindow in fitting window 3' (static) length_win3 in SO2/PRODUCT/SUPPORT_DATA/ FIONS ength center in each subwindow. It may have multiple w ndows_win3.	NC_STRING NC_STRING /DETAILED_RE
Mode: Attributes: <b>calibration_s</b> ULTS/WAVEL Description: Dimensions: Type: Source:	Processor. Present in all mod Name units long_name subwindows_wave ENGTH_CALIBRAT Calibration wavele number_of_subwi NC_FLOAT. Processor.	Value '1' (static) 'calibration rms per subwindow in fitting window 3' (static) length_win3 in SO2/PRODUCT/SUPPORT_DATA/ FIONS ength center in each subwindow. It may have multiple w ndows_win3.	NC_STRING NC_STRING /DETAILED_RE
Mode: Attributes: <b>calibration_s</b> ULTS/WAVEL Description: Dimensions: Type: Source: Mode:	Processor. Present in all mod Name units long_name subwindows_wavel ENGTH_CALIBRAT Calibration wavele number_of_subwi NC_FLOAT. Processor. Present in all mod	Value '1' (static) 'calibration rms per subwindow in fitting window 3' (static) length_win3 in SO2/PRODUCT/SUPPORT_DATA/ FIONS ength center in each subwindow. It may have multiple w ndows_win3.	NC_STRING NC_STRING /DETAILED_RE

#### 13.1.1.4 Group "INPUT\_DATA" in "SUPPORT\_DATA"

The groups described in section 12.24 "Input data common to all the L2 DLR products" on page 69 are included in the output at this location.

#### Variables in SO2 /PRODUCT/SUPPORT DATA/INPUT DATA

The variables described in section 12.20 "Original and computed snow-ice flag" on page 59 are included in the output at this location.

The variables described in section 12.21 "Main fields for Cloud Product based on CRB model" on page 61 are included in the output at this location.

The variables described in section 12.22 "Common input data for O3 andO3<sub>T</sub>CLproducts" onpage 64 are included in the output at this location.

tm5_constan	it_a in SO2/PRO	DUCT/SUPPORT_DATA/INPUT_DATA	
Dimensions:	time, layer.		
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all mode	9S.	
Attributes:	Name	Value	Туре
	units	'Pa' (static)	NC_STRING
tm5_constan	it_b in SO2/PRO	DUCT/SUPPORT_DATA/INPUT_DATA	
Dimensions:	time, layer.		
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	Present in all mode	9S.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
aerosol_inde	x_340_380 in SO2_	_/PRODUCT/SUPPORT_DATA/INPUT_DATA	
Description:	Aerosol index from OFFL mode.	L2AER _ AI (at wavelengths 340/380, i.e. the TO	OMS pair). Only ir
Dimensions:	time, scanline, grou	und_pixel.	
Туре:	NC_FLOAT.		
Source:	Processor.		
Mode:	OFFL.		
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	standard_name	'ultraviolet_aerosol_index' (static)	NC_STRING
	comment	'Aerosol index from 380 and 340 nm' (static)	NC_STRING
	long_name	'aerosol index from 380 and 340 nm' (static)	NC_STRING
	radiation wavelength	340.0, 380.0 (static)	NC_FLOAT
	The wavelengths u	sed for the determination of the aerosol index.	
	coordinates	'/PRODUCT/longitude /PRODUCT/latitude' (static)	NC_STRING
surface albe	do_328nm in SO2_	/PRODUCT/SUPPORT DATA/INPUT DATA	
Description:		m OMI database for fit window 1+2 at 328nm	
Dimensions:	time, scanline, grou		
Type:	NC FLOAT.	—	
Source:	Processor.		
Mode:	Present in all mode	9S.	
Attributes:	Name	Value	Туре
	units	'1' (static)	NC_STRING
	standard name	'surface_albedo' (static)	NC STRING
	long_name	'surface albdeo at 328nm' (static)	NC STRING
surface albe	do 376nm in SO2	/PRODUCT/SUPPORT DATA/INPUT DATA	
Description:		m OMI database for fit window 3 at 376nm	
, Dimensions:	time, scanline, grou		
Туре:	NC_FLOAT.	_	
Source:	Processor.		
Mode:	Present in all mode	9S.	
Attributes:	Name	Value	Туре
		·	.,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,

units	'1' (static)	NC_STRING
standard_name	'surface_albedo' (static)	NC_STRING
long_name	'surface albdeo at 376nm' (static)	NC_STRING

#### 13.1.1.5 Group "BACKGROUND\_CORRECTION" in "INPUT\_DATA"

The groups described in section 12.19 "background correction information of SO2" on page 57 are included in the output at this location.

## 13.2 Group "METADATA" in "SO2\_\_\_"

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 12.28 "ESA metadata" on page 82 are included in the output at this location.

The groups described in section 12.29 "EOP metadata" on page 90 are included in the output at this location.

The groups described in section 12.30 "ISO metadata" on page 94 are included in the output at this location.

#### 13.2.1 Group "QA\_STATISTICS" in "METADATA"

The groups described in section 12.25 "Quality assurance statistics" on page 70 are included in the output at this location.

sulfurdioxide	_total_column_hist	ogram in SO2/METADATA/QA_STATISTICS		
Description:	Histogram of the $SO_2$ values in the current granule.			
Dimensions:	histogram_axis.			
Туре:	NC_INT.			
Source:	Processor.			
Mode:	Present in all mode	S.		
Attributes:	Name	Value	Туре	
	units	'1' (static)	NC_STRING	
	comment	'Histogram of the total column O3 in the current granule' (static)	NC_STRING	
sulfurdioxide	_total_column_pdf	in SO2/METADATA/QA_STATISTICS		
Description:		unction of the $SO_2$ values in the current granule. The vaspread out using the error estimate.	lues are weighted	
Dimensions:	pdf_axis.			
Туре:	NC_FLOAT.			
Source:	Processor.			
Mode:	Present in all mode	S.		
Attributes:	Name	Value	Туре	
	units	'1' (static)	NC_STRING	
	comment	'Probability density function of the total column O3 in the current granule' (static)	NC_STRING	

#### Variables in SO2\_\_\_/METADATA/QA\_STATISTICS

13.2.2 Group "ALGORITHM\_SETTINGS" in "METADATA"

### 13.2.3 Group "GRANULE\_DESCRIPTION" in "METADATA"

#### Attributes in SO2\_\_\_/METADATA/GRANULE\_DESCRIPTION

The attributes described in section 12.27 "Granule metadata" on page 81 are included in the output at this location.

Group attributes attached to GRANULE_DESCRIPTION			
Name	Value	Туре	
ProductShortName	'L2SO2' (static)	NC_STRING	
The short product name.	For the $SO_2$ product this is fixed to "L2 SO2".		

# 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.

#	Short name	Description	Algorithm
0	success	No failures, output contains value. Warnings still possible.	All
1	radiance_missing	The number of spectral pixels in the radiance due to flagging is too small to perform the fitting.	All
2	irradiance_missing	The number of spectral pixels in the irradiance due to flagging is too small to perform the fitting.	All
3	input_spectrum_missing	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.	All
4	reflectance_range_error	Any of the reflectances is out of bounds ( $R < 0$ or $R > R_{max}$ ).	FRESCO
5	ler_range_error	Lambert-equivalent reflectivity out of range error.	CO, CH <sub>4</sub>
6	snr_range_error	Too low signal to noise to perform retrieval.	CO
7	sza_range_error	Solar zenith angle out of range, maximum value from configuration.	All
8	vza_range_error	Viewing zenith angle out of range, maximum value from configuration.	Development phase only
9	lut_range_error	Extrapolation in lookup table (airmass factor, cloud radiances).	NO <sub>2</sub>
10	ozone_range_error	Ozone column significantly out of range of profile climatology.	Total O <sub>3</sub> column
11	wavelength_offset_error	Wavelength offset exceeds maximum from configuration.	FRESCO, NO <sub>2</sub>
12	initialization_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.	All
13	memory_error	Memory allocation or deallocation error.	CO, CH <sub>4</sub>
14	assertion_error	Error in algorithm detected during assertion.	CO
15	io_error	Error detected during transfer of data between algorithm and framework.	CO, ALH, CH <sub>4</sub> , O <sub>3</sub> profile
16	numerical_error	General fatal numerical error occurred during inversion.	CO, FRESCO
17	lut_error	Error in accessing the lookup table.	CH <sub>4</sub>
18	ISRF_error	Error detected in the input instrument spectral response function input data.	CH <sub>4</sub>
19	convergence_error	The main algorithm did not converge.	All
20	cloud_filter_convergence_error	The cloud filter did not converge.	CO

 Table 12: Processing quality flags, errors, processing failures and filter conditions for S5P Level 2 (continued).

#	Short name	Description	Algorithm
21	max_iteration_convergence_error	No convergence because retrieval exceeds maximum number of iterations. Max- imum value from configuration.	ALH
22	aot_lower_boundary_convergence_error	No convergence because the aerosol optical thickness crosses lower boundary twice in succession.	ALH
23	other_boundary_convergence_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.	ALH
24	geolocation_error	Geolocation out of range.	
25	ch4_noscat_zero_error	The $CH_4$ column retrieved by the non-scattering CO algorithm from the weak band or strong band is 0.	CH <sub>4</sub>
26	h2o_noscat_zero_error	The $H_2O$ column retrieved by the non-scattering CO algorithm from the weak band or strong band is 0.	CH <sub>4</sub>
27	max_optical_thickness_error	Maximum optical thickness exceeded during iterations.	CH <sub>4</sub>
28	aerosol_boundary_error	Boundary hit of aerosol parameters at last iteration.	CH <sub>4</sub>
29	boundary_hit_error	Fatal boundary hit during iterations.	CH <sub>4</sub>
30	chi2_error	$\chi^2$ is not-a-number or larger than $10^{10}$ .	CH <sub>4</sub>
31	svd_error	Singular value decomposition failure.	CH <sub>4</sub>
32	dfs_error	Degree of freedom is not-a-number.	CH <sub>4</sub>
33	radiative_transfer_error	Errors occurred during the radiative transfer computations, no processing possible.	O <sub>3</sub> profile
34	optimal_estimation_error	Errors occurred during the optimal estimation, processing has been terminated.	O <sub>3</sub> profile
35	profile_error	Flag that indicates if there were any errors during the computation of the ozone profile.	O <sub>3</sub> profile
36	cloud_error	No cloud data.	Cloud
37	model_error	Forward model failure.	Cloud, Total O <sub>3</sub> column
38	number_of_input_data_points_too_low_error	Not enough input ozone columns to calculate a tropospheric column.	Tropospheric O3 column
39	cloud_pressure_spread_too_low_error	Cloud pressure variability to low to estimate a tropospheric column.	Tropospheric O3 column
40	cloud_too_low_level_error	Clouds are too low in the atmosphere to assume sufficient shielding.	Tropospheric O3 column
41	generic_range_error	Generic range error.	All
42	generic_exception	Catch all generic error.	All
43	input_spectrum_alignment_error	Input radiance and irradiance spectra are not aligned correctly.	All

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 Table 12: Processing quality flags, errors, processing failures and filter conditions for S5P Level 2 (continued).

#	Short name	Description	Algorithm
44	abort_error	Not processed because processor aborted prematurely (time out or user abort)	All
45	wrong_input_type_error	Wrong input type error, mismatch between expectation and received data.	All
46	wavelength_calibration_error	An error occurred in the wavelength calibration of this pixel	All
47	coregistration_error	No colocated pixels found in a supporting band	All
48	slant_column_density_error	Slant column fit returned error, no values can be computed	
49	airmass_factor_error	Airmass factor could not be computed	
50	vertical_column_density_error	vertical column density could not be computed	
51	signal_to_noise_ratio_error	The signal to noise ratio for this spectrum is too low for processing	All
52	configuration_error	Error while parsing the configuration	All
53	key_error	Key does not exist	All
54	saturation_error	Saturation in input spectrum	All
64	solar_eclipse_filter	Solar eclipse.	All
65	cloud_filter	The cloud filter triggered causing the pixel to be skipped.	CO, ALH, CH <sub>4</sub>
66	altitude_consistency_filter	Too large difference between ECMWF altitude and DEM altitude value.	CO, CH <sub>4</sub>
67	altitude_roughness_filter	Too large standard deviation of altitude in DEM.	CO, ALH, CH <sub>4</sub>
68	sun_glint_filter	For pixels over water, viewing direction inside sun glint region. Definition of sun glint angle and threshold value from ATBD.	ALH
69	mixed_surface_type_filter	Pixel contains land and water areas (e.g. coastal pixel).	ALH
70	snow_ice_filter	Pixel contains snow/ice: Snow/ice flag according to dynamic input OR climatological surface albedo at VIS wavelength is larger than 0.5.	ALH
71	aai_filter	AAI smaller than 2.0.	ALH
72	cloud_fraction_fresco_filter	Pixel contains clouds: The FRESCO effective cloud fraction is larger than threshold. Threshold value from ATBD.	ALH
73	aai_scene_albedo_filter	Pixel contains clouds: The difference between scene albedo at 380 nm from AAI calculation and the climatologcal surface albedo exceeds threshold. Threshold value from ATBD. This test filters out clouds.	ALH
74	small_pixel_radiance_std_filter	Pixel contains clouds: Standard deviation of radiances in small-pixel column ex- ceeds threshold. Threshold value from ATBD.	ALH, CH <sub>4</sub>
75	cloud_fraction_viirs_filter	Pixel contains clouds: The cloud fraction from VIIRS / NPP exceeds theshold. Threshold value from ATBD.	ALH

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 Table 12: Processing quality flags, errors, processing failures and filter conditions for S5P Level 2 (continued).

#	Short name	Description	Algorithm
76	cirrus_reflectance_viirs_filter	Pixel contains clouds: Cirrus reflectance from VIIRS / NPP exceeds threshold. Threshold value from ATBD.	ALH
77	cf_viirs_swir_ifov_filter	Fraction of cloudy VIIRS pixels wihtin S5P SWIR ground pixel exceeds a priori threshold from configuration.	CH <sub>4</sub>
78	cf_viirs_swir_ofova_filter	Fraction of cloudy VIIRS pixels wihtin S5P SWIR OFOVa exceeds a priori threshold from configuration.	CH <sub>4</sub>
79	cf_viirs_swir_ofovb_filter	Fraction of cloudy VIIRS pixels wihtin S5P SWIR OFOVb exceeds a priori threshold from configuration.	CH <sub>4</sub>
80	cf_viirs_swir_ofovc_filter	Fraction of cloudy VIIRS pixels wihtin S5P SWIR OFOVc exceeds a priori threshold from configuration.	CH <sub>4</sub>
81	cf_viirs_nir_ifov_filter	Fraction of cloudy VIIRS pixels wihtin S5P NIR ground pixel exceeds a priori threshold from configuration.	CH <sub>4</sub>
82	cf_viirs_nir_ofova_filter	Fraction of cloudy VIIRS pixels wihtin S5P NIR OFOVa exceeds a priori threshold from configuration.	CH <sub>4</sub>
83	cf_viirs_nir_ofovb_filter	Fraction of cloudy VIIRS pixels wihtin S5P NIR OFOVb exceeds a priori threshold from configuration.	CH <sub>4</sub>
84	cf_viirs_nir_ofovc_filter	Fraction of cloudy VIIRS pixels wihtin S5P NIR OFOVc exceeds a priori threshold from configuration.	CH <sub>4</sub>
85	refl_cirrus_viirs_swir_filter	Average VIIRS cirrus reflectance within SWIR ground pixel exceeds a priori threshold from configuration.	CH <sub>4</sub>
86	refl_cirrus_viirs_nir_filter	Average VIIRS cirrus reflectance within NIR ground pixel exceeds a priori threshold from configuration.	CH <sub>4</sub>
87	diff_refl_cirrus_viirs_filter	Difference in VIIRS average cirrus reflectance between SWIR and NIR ground pixel exceeds a priori threshold from configuration.	CH <sub>4</sub>
88	ch4_noscat_ratio_filter	The ratio between $[CH_4]_{weak}$ and $[CH_4]_{strong}$ is below or exceeds a priori thresholds from configuration.	CH <sub>4</sub>
89	ch4_noscat_ratio_std_filter	The standard deviation of $[CH_4]_{weak}/[CH_4]_{strong}$ within the SWIR pixel and the 8 neighbouring pixels exceeds a priori threshold from configuration.	CH <sub>4</sub>
90	h2o_noscat_ratio_filter	The ratio between $[H_2O]_{weak}$ and $[H_2O]_{strong}$ is below or exceeds a priori thresholds from configuration.	CH <sub>4</sub>

 Table 12: Processing quality flags, errors, processing failures and filter conditions for S5P Level 2 (continued).

#	Short name	Description	Algorithm
91	h2o_noscat_ratio_std_filter	The standard deviation of $[H_2O]_{weak}/[H_2O]_{strong}$ within the SWIR pixel and the 8 neigbouring pixels exceeds a priori threshold from configuration.	CH <sub>4</sub>
92	diff_psurf_fresco_ecmwf_filter	Difference between the FRESCO apparent surface pressure and the ECMWF surface pressure exceeds a priori threshold from configuration.	CH <sub>4</sub>
93	psurf_fresco_stdv_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.	CH <sub>4</sub>
94	ocean_filter	The ground pixel is over ocean (and ocean glint retrievals are not switched on).	CH <sub>4</sub>
95	time_range_filter	Time is out of the range that is to be processed.	All
96	pixel_or_scanline_index_filter	Not processed because pixel index does not match general selection criteria.	All
97	geographic_region_filter	Pixel falls outside the specified regions of interest.	All

**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.

Bit #	Mask (hex)	Short name	Description	Algorithm
0–7	0x000000FF	error	If non-zero an error has occurred when processing the pixel, see table 12 for details.	All
8	0x00000100	input_spectrum_warning	Number of good pixels in radiance, irradiance or calculated reflectance below threshold from configuration.	All
9	0x00000200	wavelength_calibration_warning	Offset from wavelength fit is larger than limit set in configuration.	Most
10	0x00000400	extrapolation_warning	Pressure or temperature outside cross section LUT range, other lookup table extrapolation.	CO, CH <sub>4</sub>
11	0x0000800	sun_glint_warning	Sun glint posibility warning.	All
12	0x00001000	south_atlantic_anomaly_warning	TROPOMI is inside the south Atlantic anomaly while taking these measure- ments.	All
13	0x00002000	sun_glint_correction	A sun glint correction has been applied.	Cloud
14	0x00004000	snow_ice_warning	Snow/ice flag is set, i.e. using scene data from the cloud support product.	NO <sub>2</sub>
15	0x00008000	cloud_warning	Cloud filter based on FRESCO apparent surface pressure (VIIRS not avail- able), cloud fraction above threshold or cloud pressure adjusted to force cloud above surface.	$CH_4, O_3$ profile

S5P-L2-DLR-PUM-400E Page 155 of 157 Table 13: Processing quality flags, warnings for S5P Level 2 (continued).

Bit #	Mask (hex)	Short name	Description	Algorithm
16	0x00010000	AAI_warning	Possible aerosol contamination as indicated by the AAI.	O <sub>3</sub> profile
17	0x00020000	pixel_level_input_data_missing	Dynamic auxiliary input data (e.g cloud) is missing for this ground pixel. A fallback option is used.	All
18	0x00040000	data_range_warning	Carbon monoxide column tends to negative values; Water column tends to negative values; Heavy water (HDO) column tends to negative values; others.	CO, CH <sub>4</sub>
19	0x00080000	low_cloud_fraction_warning	Low cloud fraction, therefore no cloud pressure retrieved.	Cloud
20	0x00100000	altitude_consistency_warning	Difference between ECMWF surface elevation and high-resolution surface elevation exceeds threshold from configuration.	CH <sub>4</sub>
21	0x00200000	signal_to_noise_ratio_warning	Signal to noise ratio in SWIR and/or NIR band below threshold from configur- ation.	CH <sub>4</sub>
22	0x00400000	deconvolution_warning	Failed deconvolution irradiance spectrum (not pixel-specific, but row-specific).	CO, CH <sub>4</sub>
23	0x00800000	so2_volcanic_origin_likely_warning	Warning for SO <sub>2</sub> BL product, UTLS products: volcanic origin except for heavily polluted sites.	SO <sub>2</sub>
24	0x01000000	so2_volcanic_origin_certain_warning	Warning for SO <sub>2</sub> BL product, UTLS products: volcanic origin certain.	SO <sub>2</sub>
25	0x02000000	interpolation_warning	Warning for interpolation on partially missing data. In this case the valid available data is used, potentially leading to a bias.	All
26	0x04000000	saturation_warning	Saturation occurred spectrum, possibly causing biases in the retrieval	All
27	0x08000000	high_sza_warning	Warning for high solar zenith angle. In this case, the processing can be performed with less final quality.	All
28	0x10000000	cloud_retrieval_warning	Warning occurring when the retrieval diagnostic indicates a degraded quality of the cloud retrieval.	Cloud
29	0x20000000	cloud_inhomogeneity_warning	The cloud coregistration inhomogeneity parameter is above a given threshold	Cloud
30	0x40000000		Reserved for future use	

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 [RD46].

Bit #	Mask (hex)	Short name	Description
0	0x03	Land	The pixel is over land, for more than 50 %

Table 14: Surface classification for S5P Level 2 (continued).

Bit #	Mask (hex)	Short name	Description
1	0x03	Water	The pixel is over water, for more than 50 %
2	0x03	some_water	Pixel contains water (however small the fraction), i.e. at least one of the $15 \times 15$ arcsecond subpixels in the SDP dataset is classified as water
3	0x03	coastline	Pixel is water, but contains land (coastline)
0	0x04	mixed_surface	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
4	0x04	value_covers_majority_of_pixel	Pixel is dominated by surface type, i.e. type covers more than 50 % of pixel surface
9	0xF9	Water+Shallow_Ocean	Water, shallow ocean
17	0xF9	Water+Shallow_Inland_Water	Water, shallow inland water (lake)
25	0xF9	Water+Ocean_Coastline-Lake_Shoreline	Water, mixed with land; coastline
33	0xF9	Water+Intermittent_Water	Intermittent water, for instance the Wadden Sea
41	0xF9	Water+Deep_Inland_Water	Deep inland water
49	0xF9	Water+Continental_Shelf_Ocean	Water, continental shelf ocean
57	0xF9	Water+Deep_Ocean	Water, deep ocean
8	0xF9	Land+Urban_And_Built-up_Land	Land, urban areas
16	0xF9	Land+Dryland_Cropland_And_Pasture	Land, Dryland Cropland and Pasture
24	0xF9	Land+Irrigated_Cropland_And_Pasture	Land, Irrigated Cropland and Pasture
32	0xF9	Land+Mixed_Dryland-irrigated_Cropland_And_Pasture	Land, Mixed Dryland/Irrigated Cropland and Pasture
40	0xF9	Land+Cropland-grassland_Mosaic	Land, Cropland/Grassland Mosaic
48	0xF9	Land+Cropland-woodland_Mosaic	Land, Cropland/Woodland Mosaic
56	0xF9	Land+Grassland	Land, Grassland
64	0xF9	Land+Shrubland	Land, Shrubland
72	0xF9	Land+Mixed_Shrubland-grassland	Land, Mixed Shrubland/Grassland
80	0xF9	Land+Savanna	Land, Savanna
88	0xF9	Land+Deciduous_Broadleaf_Forest	Land, Deciduous Broadleaf Forest
96	0xF9	Land+Deciduous_Needleleaf_Forest	Land, Deciduous Needleleaf Forest
104	0xF9	Land+Evergreen_Broadleaf_Forest	Land, Evergreen Broadleaf Forest
112	0xF9	Land+Evergreen_Needleleaf_Forest	Land, Evergreen Needleleaf Forest

 Table 14:
 Surface classification for S5P Level 2 (continued).

Bit #	Mask (hex)	Short name	Description
120	0xF9	Land+Mixed_Forest	Land, Mixed Forest
128	0xF9	Land+Herbaceous_Wetland	Land, Herbaceous Wetland
136	0xF9	Land+Wooded_Wetland	Land, Wooded Wetland
144	0xF9	Land+Barren_Or_Sparsely_Vegetated	Land, Barren or Sparsely Vegetated
152	0xF9	Land+Herbaceous_Tundra	Land, Herbaceous Tundra
160	0xF9	Land+Wooded_Tundra	Land, Wooded Tundra
168	0xF9	Land+Mixed_Tundra	Land, Mixed Tundra
176	0xF9	Land+Bare_Ground_Tundra	Land, Bare Ground Tundra
184	0xF9	Land+Snow_Or_Ice	Land, Snow or Ice