S5P COBRA Sulphur Dioxide Product Format Specification

Document number	S5P-BIRA-PRF-SO2CBR	
issue	1.0	
date	14/09/2022	
product version	01.00.00	
status	development	
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Version History

Revision	Date	Author(s)	Description
1.0	14/09/2022	Jonas Vlietinck, Nicolas Theys	First release.

Contents

1 Introduction.

This document serves as a guide to understand the layout and format specifications of the Level-2 (L2) SO2CBR product. For an interpretation and explanation of the data in the SO2CBR product, see [2]. An explanation of the filename structure of the product is given in section 2. From [2] it follows that the retrieval results are subdivided into three fitting windows, which is reflected in the variables, as we will see later. The retrieval results obtained with the COBRA algorithm in the SO2CBR product are currently limited to fitting window 1. For completeness the DOAS retrieval results for fitting window 2 and 3 were added from the TROPOMI SO2 operational algorithm. For all details about the results in those windows, we refer to the documentation on [1].

- **fiting window 1 (310.5-326 nm)** : results from COBRA algorithm.
- **fiting window 2 (325-335 nm)** : results from DOAS algorithm.
- **fiting window 3 (360-390 nm)** : results from DOAS algorithm.

An overview of the variables that contain the main retrieval results and errors is given in section 4.1. The product is stored in a NetCDF4 binary format, following the CF-convention. Furthermore, the file format should be compliant with the guidelines provided in [3]. A description of the global attributes is provided in section 3. A full list of all variables that can be found in the L2 SO2CBR together with all the metadata is provided in section 4.

2 filename construction

S5P_<fileclass>_L2__SO2CBR_<start>_<end>_<orbit>_<coll>_<proc>_<mod>.nc

- **fileclass [4 characters** :] File class of the product. (example: PAL_)
- **start [YYYYMMDDThhmmss** :] start time of the orbit
- **end [YYYYMMDDThhmmss** :] end time of the orbit
- **orbit [5 digits** :] orbit number
- **coll [2 digits** :] collection id
- **proc [6 digits** :] processor version
- **mod [YYYYMMDDThhmmss** :] modification or creation time

3 global attributes

In this section the global attributes in a product file are listed. The name of the attribute is provided together with the datatype. The static or dynamic nature of the attributes is also given. Static means that the attribute has the same values across all product files, dynamic means that the attributes values depends on the orbit of the product file.

Conventions [int32] (*static*)

CF-1.7 (Version of CF convtions that is followed.)

comments [string] (*dynamic*)

(Version of the python packages from which the processor is composed off).

- template-cobra : x.y.z
- cobra-amf : x.y.z
- cobra-so2 : x.y.z

file_class [string] (*dynamic*)

File class of the product.

footprint [string] (*dynamic*)

GeoJSON format. Footprint of the product as a single GeoJSON string value.

history [string] (*dynamic*)

YYY-MM-DDThh:mm:ssZ cobra_so2 <name of the orbit file>, with the time string the time of creation of the file.

id [string] (*dynamic*)

Product name (filename without extension)

input_files [string] (*dynamic*)

List that contains the filenames of all inputs to the processor.

institution [string] (*static*)

BIRA-IASB

orbit [int32] (*dynamic*)

orbit number. (matches the orbit number in the filename)

processing_center [string] (*static*)

S5P-PAL

processor_version [string] (*dynamic*)

xx.yy.zz (version number of the processor)

source [string] (*static*)

Sentinel 5 precursor, TROPOMI, space-borne remote sensing, L2

summary [string] (*static*)

TROPOMI/S5P SO2CBR L2 data Swath 5.5x3.5km2

time_coverage_end [string] (*dynamic*)

YYYY-MM-DDThh:mm:ss.fffZ (Start time of last measurement in the product)

time_coverage_resolution [string] (*dynamic*)

PT<duration>S (duration in seconds of the scanline)

time_coverage_start [string] (*dynamic*)

YYYY-MM-DDThh:mm:ss.fffZ (Start time of first measurement in the product)

time_reference [string] (*static*)

YYYY-MM-DDThh:mm:ss.fffZ (Start of the day of the sensing time)

tracking_id [string] (*dynamic*)

UUID

4 variables

4.1 SO2 main retrieval results

The following variables contain cobra results from fitting window 1 and DOAS results for fitting window 2 and 3.

VCD and SCD	Errors
• sulfurdioxide_total_vertical_column • sulfurdioxide_slant_column_corrected • sulfurdioxide_total_vertical_column_1km • sulfurdioxide_total_vertical_column_7km • sulfurdioxide_total_vertical_column_15km	• sulfurdioxide_total_vertical_column_precision • sulfurdioxide_total_vertical_column_trueness • sulfurdioxide_slant_column_corrected_trueness • sulfurdioxide_total_vertical_column_1km_precision • sulfurdioxide_total_vertical_column_1km_trueness • sulfurdioxide_total_vertical_column_7km_precision • sulfurdioxide_total_vertical_column_7km_trueness • sulfurdioxide_total_vertical_column_15km_precision • sulfurdioxide_total_vertical_column_15km_trueness

The above variables can be found in sections 4.2 and 4.6

Note that a flag *selected_fitting_window_flag*(see section 4) describes the selected fitting window for SO2 retrieval results. For each pixel the flag value indicates whether the used fitting window is 1,2 or 3.

The following variables contain only results for fit window 2 and 3 (and are not relevant for cobra so2 in fit window 1):

- fitted_radiance_shift
- fitted_radiance_squeeze
- number_of_spectral_points_in_retrieval
- number_of_iterations_in_retrieval
- fitted_root_mean_square

4.2 /PRODUCT

corner [int32] (*corner*)

- **units :** 1
- **long_name :** pixel corner index
- **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).

delta_time [int32] (*time, scanline*)

- **long_name :** offset from reference start time of measurement
- **units :** milliseconds since yyyy-mm-dd 00:00:00 (yyyy-mm-dd equals the global attribute *time_reference*)

ground_pixel [int32] (*ground_pixel*)

- **units :** 1
- **axis :** X
- **long_name :** across-track dimension index
- **comment :** This coordinate variable defines the indices across track, from west to east; index starts at 0

latitude [float32] (*time, scanline, ground_pixel*)

- **long_name :** pixel center latitude
- **units :** degrees_north
- **standard_name :** latitude
- **valid_min :** -90.0
- **valid_max :** 90.0
- **bounds :** /PRODUCT/SUPPORT_DATA/GEOLOCATIONS/latitude_bounds

layer [int32] (*layer*)

- **units :** 1
- **long_name :** layer dimension index

longitude [float32] (*time, scanline, ground_pixel*)

- **long_name :** pixel center longitude
- **units :** degrees_east
- **standard_name :** longitude
- **valid_min :** -180.0
- **valid_max :** 180.0
- **bounds :** /PRODUCT/SUPPORT_DATA/GEOLOCATIONS/longitude_bounds

qa_value [uint8] (*time, scanline, ground_pixel*)

- **units :** 1
- **scale_factor :** 0.01
- **add_offset :** 0.0
- **valid_min :** 0
- **valid_max :** 100
- **long_name :** data quality value
- **comment :** A continuous quality descriptor, varying between 0 (no data) and 1 (full quality data). Recommend to ignore data with qa_value < 0.5
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

scanline [int32] (*scanline*)

- **units :** 1
- **axis :** Y
- **long_name :** along-track dimension index
- **comment :** This coordinate variable defines the indices along track; index starts at 0

sulfurdioxide_total_vertical_column [float32] (*time, scanline, ground_pixel*)

- **units :** mol m-2
- **standard_name :** atmosphere_mole_content_of_sulfur_dioxide
- **long_name :** total vertical column of sulfur dioxide for the polluted scenario derived from the total slant column
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude
- **multiplication_factor_to_convert_to_DU :** 2241.15
- **multiplication_factor_to_convert_to_molecules_percm2 :** 6.02214e+19

sulfurdioxide_total_vertical_column_precision [float32] (*time, scanline, ground_pixel*)

- **units :** mol m-2
- **standard_name :** atmosphere_mole_content_of_sulfur_dioxide_standard_error
- **long_name :** precision of the total vertical column of sulfur dioxide for the polluted scenario derived from the total slant column
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude
- **multiplication_factor_to_convert_to_DU :** 2241.15
- **multiplication_factor_to_convert_to_molecules_percm2 :** 6.02214e+19

time [int32] (*time*)

- **units :** seconds since 2010-01-01 00:00:00
- **standard_name :** time
- **axis :** T
- **long_name :** reference time for the measurements
- **comment :** The time in this variable corresponds to the time in the time_reference global attribute

4.3 /PRODUCT/SUPPORT_DATA/GEOLOCATIONS

geolocation_flags [uint8] (*time, scanline, ground_pixel*)

- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude
- **flag_masks :** [0 1 2 4 8 16 128]
- **flag_meanings :** no_error solar_eclipse sun_glint_possible descending night geo_boundary_crossing geolocation_error
- **flag_values :** [0 1 2 4 8 16 128]
- **long_name :** ground pixel quality flag
- **max_val :** 254
- **min_val :** 0
- **units :** 1

latitude_bounds [float32] (*time, scanline, ground_pixel, corner*)

- **units :** degrees_north

longitude_bounds [float32] (*time, scanline, ground_pixel, corner*)

- **units :** degrees_east

satellite_altitude [float32] (*time, scanline*)

- **long_name :** satellite altitude
- **units :** m
- **comment :** The altitude of the satellite with respect to the geodetic sub satellite point on the WGS84 reference ellipsoid
- **valid_min :** 700000.0
- **valid_max :** 900000.0

satellite_latitude [float32] (*time, scanline*)

- **long_name :** sub satellite latitude
- **units :** degrees_north
- **comment :** Latitude of the geodetic sub satellite point on the WGS84 reference ellipsoid
- **valid_min :** -90.0
- **valid_max :** 90.0

satellite_longitude [float32] (*time, scanline*)

- **long_name :** satellite_longitude
- **units :** degrees_east
- **comment :** Longitude of the geodetic sub satellite point on the WGS84 reference ellipsoid
- **valid_min :** -180.0
- **valid_max :** 180.0

satellite_orbit_phase [float32] (*time, scanline*)

- **long_name :** fractional satellite orbit phase
- **units :** 1
- **comment :** Relative offset [0.0, ..., 1.0] of the measurement in the orbit
- **valid_min :** -0.02
- **valid_max :** 1.02

solar_azimuth_angle [float32] (*time, scanline, ground_pixel*)

- **long_name :** solar azimuth angle
- **standard_name :** solar_azimuth_angle
- **units :** degree
- **valid_min :** -180.0
- **valid_max :** 180.0
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude
- **comment :** Solar azimuth angle at the ground pixel location on the reference ellipsoid. Angle is measured clockwise from the North (East = 90, South = 180, West = 270)

solar_zenith_angle [float32] (*time, scanline, ground_pixel*)

- **long_name :** solar zenith angle
- **standard_name :** solar_zenith_angle
- **units :** degree
- **valid_min :** 0.0
- **valid_max :** 180.0
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude
- **comment :** Solar zenith angle at the ground pixel location on the reference ellipsoid. Angle is measured away from the vertical

viewing_azimuth_angle [float32] (*time, scanline, ground_pixel*)

- **long_name :** viewing azimuth angle
- **standard_name :** viewing_azimuth_angle
- **units :** degree
- **valid_min :** -180.0
- **valid_max :** 180.0
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude
- **comment :** Satellite azimuth angle at the ground pixel location on the reference ellipsoid. Angle is measured clockwise from the North (East = 90, South = 180, West = 270)

viewing_zenith_angle [float32] (*time, scanline, ground_pixel*)

- **long_name :** viewing zenith angle
- **standard_name :** viewing_zenith_angle
- **units :** degree
- **valid_min :** 0.0
- **valid_max :** 180.0
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude
- **comment :** Zenith angle of the satellite at the ground pixel location on the reference ellipsoid. Angle is measured away from the vertical

4.4 /PRODUCT/SUPPORT_DATA/INPUT_DATA

aerosol_index_340_380 [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **standard_name :** ultraviolet_aerosol_index
- **comment :** Aerosol index from 380 and 340 nm
- **long_name :** aerosol index from 380 and 340 nm
- **radiation_wavelength :** [340. 380.]
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

cloud_albedo_crb [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **standard_name :** cloud_albedo
- **long_name :** cloud albedo from the CRB model
- **source :** crb
- **comment :** Coregistered cloud albedo based on the OCRA/ROCINN CRB model.
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

cloud_albedo_crb_precision [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **standard_name :** cloud_albedo_standard_error
- **long_name :** cloud albedo precision from the CRB model
- **source :** crb
- **comment :** Error of the coregistered cloud albedo based on the OCRA/ROCINN CRB model.
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

cloud_fraction_crb [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **standard_name :** TBD
- **long_name :** effective radiometric cloud fraction from the CRB model
- **source :** crb
- **comment :** Coregistered effective radiometric cloud fraction using the OCRA/ROCINN CRB model.
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

cloud_fraction_crb_precision [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **standard_name :** TBD
- **long_name :** effective radiometric cloud fraction precision from the CRB model
- **source :** crb
- **comment :** Error of the coregistered effective radiometric cloud fraction using the OCRA/ROCINN CRB model.
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

cloud_height_crb [float32] (*time, scanline, ground_pixel*)

- **units :** m
- **standard_name :** TBD
- **long_name :** cloud radiometric optical centroid height from the CRB model
- **source :** crb
- **comment :** Coregistered height at the level of cloud w.r.t. the geoid/MSL using the OCRA/ROCINN CRB model.
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

cloud_height_crb_precision [float32] (*time, scanline, ground_pixel*)

- **units :** m
- **standard_name :** TBD
- **long_name :** cloud radiometric optical centroid height precision from the CRB model
- **source :** crb
- **comment :** Error of the coregistered height at the level of cloud w.r.t. the geoid/MSL using the OCRA/ROCINN CRB model.
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

cloud_pressure_crb [float32] (*time, scanline, ground_pixel*)

- **units :** Pa
- **standard_name :** TBD
- **long_name :** cloud radiometric optical centroid pressure from the CRB model
- **source :** crb
- **comment :** Coregistered and converted atmospheric pressure at the level of cloud using the OCRA/ROCINN CRB model.
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

cloud_pressure_crb_precision [float32] (*time, scanline, ground_pixel*)

- **units :** Pa
- **standard_name :** TBD
- **long_name :** cloud radiometric optical centroid pressure precision from the CRB model
- **source :** crb
- **comment :** Error of the coregistered and converted atmospheric pressure at the level of cloud using the OCRA/ROCINN CRB model.
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

eastward_wind [float32] (*time, scanline, ground_pixel*)

- **units :** m s-1
- **standard_name :** eastward_wind
- **long_name :** Eastward wind from ECMWF at 10 meter height level
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

instrument_configuration_identifier [int32] (*time, scanline*)

- **long_name :** IcID
- **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

instrument_configuration_version [int16] (*time, scanline*)

- **long_name :** IcVersion
- **comment :** Version of the instrument_configuration_identifier

northward_wind [float32] (*time, scanline, ground_pixel*)

- **units :** m s-1
- **standard_name :** northward_wind
- **long_name :** Northward wind from ECMWF at 10 meter height level
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

ozone_total_vertical_column [float32] (*time, scanline, ground_pixel*)

- **units :** mol m-2
- **standard_name :** atmosphere_mole_content_of_ozone
- **long_name :** total ozone column
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude
- **multiplication_factor_to_convert_to_DU :** 2241.15
- **multiplication_factor_to_convert_to_molecules_percm2 :** 6.02214e+19

ozone_total_vertical_column_precision [float32] (*time, scanline, ground_pixel*)

- **units :** mol m-2
- **standard_name :** atmosphere_mole_content_of_ozone error
- **long_name :** total ozone column random error
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude
- **multiplication_factor_to_convert_to_DU :** 2241.15
- **multiplication_factor_to_convert_to_molecules_percm2 :** 6.02214e+19

scaled_small_pixel_variance [float32] (*time, scanline, ground_pixel*)

- **long_name :** scaled small pixel variance
- **units :** 1
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude
- **comment :** The scaled variance of the reflectances of the small pixels
- **radiation_wavelength :**

sea_ice_cover [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** sea-ice-cover
- **source :** ECMWF
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

snow_cover [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** snow-cover
- **source :** ECMWF
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

snow_ice_flag [uint8] (*time, scanline, ground_pixel*)

- **units :** 1
- **threshold :** 0.3
- **long_name :** snow-ice mask
- **comment :** flag indicating snow/ice at center of ground pixel
- **source :**
- **flag_meanings :** snow_free snow_ice
- **flag_values :** [0 1]
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

snow_ice_flag_nise [uint8] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** snow-ice mask
- **comment :** flag indicating snow/ice at center of ground pixel
- **source :** NSIDC/NISE
- **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_8_percent sea_ice_9_percent sea_ice_10_percent sea_ice_11_percent sea_ice_12_percent sea_ice_13_percent sea_ice_14_percent sea_ice_15_percent sea_ice_16_percent sea_ice_17_percent sea_ice_18_percent sea_ice_19_percent sea_ice_20_percent sea_ice_21_percent sea_ice_22_percent sea_ice_23_percent sea_ice_24_percent sea_ice_25_percent sea_ice_26_percent sea_ice_27_percent sea_ice_28_percent sea_ice_29_percent sea_ice_30_percent sea_ice_31_percent sea_ice_32_percent sea_ice_33_percent sea_ice_34_percent sea_ice_35_percent sea_ice_36_percent sea_ice_37_percent sea_ice_38_percent sea_ice_39_percent sea_ice_40_percent sea_ice_41_percent sea_ice_42_percent sea_ice_43_percent sea_ice_44_percent sea_ice_45_percent sea_ice_46_percent sea_ice_47_percent sea_ice_48_percent sea_ice_49_percent sea_ice_50_percent sea_ice_51_percent sea_ice_52_percent sea_ice_53_percent sea_ice_54_percent sea_ice_55_percent sea_ice_56_percent sea_ice_57_percent sea_ice_58_percent sea_ice_59_percent sea_ice_60_percent sea_ice_61_percent sea_ice_62_percent sea_ice_63_percent sea_ice_64_percent sea_ice_65_percent sea_ice_66_percent sea_ice_67_percent sea_ice_68_percent sea_ice_69_percent sea_ice_70_percent sea_ice_71_percent sea_ice_72_percent sea_ice_73_percent sea_ice_74_percent sea_ice_75_percent sea_ice_76_percent sea_ice_77_percent sea_ice_78_percent sea_ice_79_percent sea_ice_80_percent sea_ice_81_percent sea_ice_82_percent sea_ice_83_percent sea_ice_84_percent sea_ice_85_percent sea_ice_86_percent sea_ice_87_percent sea_ice_88_percent sea_ice_89_percent sea_ice_90_percent sea_ice_91_percent sea_ice_92_percent sea_ice_93_percent sea_ice_94_percent sea_ice_95_percent sea_ice_96_percent sea_ice_97_percent sea_ice_98_percent sea_ice_99_percent sea_ice_100_percent permanent_ice snow mixed_pixels_at_coastlines suspect_ice_value corners ocean
- **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 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]
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

surface_albedo_328nm [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **standard_name :** surface_albedo
- **long_name :** surface albdeo at 328nm
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

surface_albedo_376nm [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **standard_name :** surface_albedo
- **long_name :** surface albdeo at 376nm
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

surface_altitude [float32] (*time, scanline, ground_pixel*)

- **long_name :** surface altitude
- **standard_name :** surface_altitude
- **units :** m
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude
- **source :** http://topotools.cr.usgs.gov/gmted_viewer/
- **comment :** The mean of the sub-pixels of the surface altitude above the reference geoid (WGS84) within the approximate field of view, based on the GMTED2010 surface elevation database

surface_altitude_precision [float32] (*time, scanline, ground_pixel*)

- **long_name :** surface altitude precision
- **standard_name :** surface_altitude standard_error
- **units :** m
- **standard_error_multiplier :** 1.0
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude
- **source :** http://topotools.cr.usgs.gov/gmted_viewer/
- **comment :** The standard deviation of sub-pixels used in calculating the mean surface altitude above the reference geoid (WGS84) within the approximate field of view, based on the GMTED2010 surface elevation database

surface_classification [uint8] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** land-water mask
- **comment :** flag indicating land/water and further surface classifications for the ground pixel
- **source :** USGS (http://edc2.usgs.gov/glcc/globdoc2_0.php) and NASA SDP toolkit (http://newsroom.gsfc.nasa.gov/sdptoolkit/toolkit.html)
- **flag_meanings :** land, water, some_water, coast, value_covers_majority_of_pixel, water+shallow_ocean, water+shallow_inland_water, water+ocean_coastline-lake_shoreline, water+intermittent_water, water+deep_inland_water, water+continental_shelf_ocean, water+deep_ocean, land+urban_and_built-up_land, land+dryland_cropland_and_pasture, land+irrigated_cropland_and_pasture, land+mixed_dryland-irrigated_cropland_and_pasture, land+cropland-grassland_mosaic, land+cropland-woodland_mosaic, land+grassland, land+shrubland, land+mixed_shrubland-grassland, land+savanna, land+deciduous_broadleaf_forest, land+deciduous_needleleaf_forest, land+evergreen_broadleaf_forest, land+evergreen_needleleaf_forest, land+mixed_forest, land+herbaceous_wetland, land+wooded_wetland, land+barren_or_sparsely_vegetated, land+herbaceous_tundra, land+wooded_tundra, land+mixed_tundra, land+bare_ground_tundra, land+snow_or_ice
- **flag_values :** [0 1 2 3 4 9 17 25 33 41 49 57 8 16 24 32 40 48 56 64 72 80 88 96 104 112 120 128 136 144 152 160 168 176 184]
- **flag_masks :** [3 3 3 3 4 249 249 249 249 249 249 249 249 249 249 249 249 249 249 249 249 249 249 249 249 249 249 249 249 249 249 249 249]
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

surface_pressure [float32] (*time, scanline, ground_pixel*)

- **units :** Pa
- **standard_name :** surface_air_pressure
- **long_name :** surface_air_pressure
- **source :**
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

surface_temperature [float32] (*time, scanline, ground_pixel*)

- **units :** K
- **standard_name :** surface_air_temperature
- **long_name :** surface_air_temperature
- **source :**
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

tm5_constant_a [float32] (*time, layer*)

- **units :** Pa

tm5_constant_b [float32] (*time, layer*)

- **units :** 1

tm5_tropopause_layer_index [int32] (*time, scanline, ground_pixel*)

- **units :** 1

4.5 /PRODUCT/SUPPORT_DATA/INPUT_DATA/BACKGROUND_CORRECTION

detector_rows [int32] (*detector_rows*)

- **units :** 1
- **long_name :** detector_rows dimension index

earthshine_reference_radiance [float32] (*detector_rows, wavelengths*)

- **units :** mol.m-2.nm-1.sr-1.s-1

earthshine_reference_wavelength [float32] (*wavelengths*)

- **units :** nm

lat_grid [float32] (*lat_grid*)

- **units :** degrees_north

wavelengths [int32] (*wavelengths*)

- **units :** 1
- **long_name :** wavelengths dimension index

window2 [float32] (*lat_grid, detector_rows*)

- **units :** mol m-2

window3 [float32] (*lat_grid, detector_rows*)

- **units :** mol m-2

4.6 /PRODUCT/SUPPORT_DATA/DETAILED_RESULTS

averaging_kernel [float32] (*time, scanline, ground_pixel, layer*)

- **units :** 1
- **long_name :** averaging kernel

cloud_fraction_intensity_weighted [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** cloud fraction intensity weighted
- **valid_min :** 0.0
- **valid_max :** 1.0
- **comment :** VCD clear sky vs. cloudy weighting factor.
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

cloud_fraction_intensity_weighted_precision [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** random error of the cloud fraction intensity weighted
- **valid_min :** 0.0
- **valid_max :** 1.0
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

doas_polynomial_coefficients_win2 [float32] (*time, scanline, ground_pixel, number_of_doas_polynomial_coefficients_win2*)

- **units :** 1
- **long_name :** DOAS polynomial coefficients
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude
- **comment :** Values of the DOAS polynomial coefficients

doas_polynomial_coefficients_win3 [float32] (*time, scanline, ground_pixel, number_of_doas_polynomial_coefficients_win3*)

- **units :** 1
- **long_name :** DOAS polynomial coefficients
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude
- **comment :** Values of the DOAS polynomial coefficients

fitted_radiance_shift [float32] (*time, scanline, ground_pixel*)

- **units :** nm
- **long_name :** radiance wavelength shift from the doas fit

fitted_radiance_shift_win2 [float32] (*time, scanline, ground_pixel*)

- **units :** nm
- **long_name :** radiance wavelength shift from the doas fit in fitting window 2

fitted_radiance_shift_win3 [float32] (*time, scanline, ground_pixel*)

- **units :** nm
- **long_name :** radiance wavelength shift from the doas fit in fitting window 3

fitted_radiance_squeeze [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** radiance wavelength squeeze from the doas fit

fitted_radiance_squeeze_win2 [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** radiance wavelength shift from the doas fit in fitting window 2

fitted_radiance_squeeze_win3 [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** radiance wavelength shift from the doas fit in fitting window 3

fitted_root_mean_square [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** root mean square of the sulfur dioxide slant column
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

fitted_root_mean_square_win2 [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** root mean square residual of the fit in fitting window 2

fitted_root_mean_square_win3 [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** root mean square residual of the fit in fitting window 3

fitted_slant_columns_win1 [float64] (*time, scanline, ground_pixel, number_of_slant_columns_win1*)

- **units :** mol m-2
- **long_name :** slant columns of all absorbers in fitting window 1
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude
- **index_meaning :** SO2_203K_Bogumil_deconv_resampled_301_364_NOMOPS_BF2bd2-6_band_3.xs

fitted_slant_columns_win1_precision [float32] (*time, scanline, ground_pixel, number_of_slant_columns_win1*)

- **units :** mol m-2
- **long_name :** slant column random errors of all absorbers in fitting window 1
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude
- **index_meaning :** SO2_203K_Bogumil_deconv_resampled_301_364_NOMOPS_BF2bd2-6_band_3.xs

fitted_slant_columns_win2 [float64] (*time, scanline, ground_pixel, number_of_slant_columns_win2*)

- **units :** mol m-2
- **long_name :** slant columns of all absorbers in fitting window 2
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude
- **index_meaning :** SO2_203K_Bogumil_deconv_resampled_301_364_NOMOPS_BF2bd2-6_band_3.xs#1#float64#2#451x1080.bis O3_228K_Brion_vac_NOMOPS_BF2bd2-6_band_3.xs#1#float64#2#451x2010.bis O3_243K_Brion_vac_NOMOPS_BF2bd2-6_band_3.xs#1#float64#2#451x2010.bis o3lambda_Io_S5P_OPT_SFP.xs#1#float64#2#451x2002.bis o3squared_Io_S5P_OPT_SFP.xs#1#float64#2#451x2002.bis Ringev1_HR_200_NOMOPS_BF2bd2-6_band_3.xs#1#float64#2#451x1100.bis Ringev2_HR_870_NOMOPS_BF2bd2-6_band_3.xs#1#float64#2#451x1100.bis

fitted_slant_columns_win2_precision [float32] (*time, scanline, ground_pixel, number_of_slant_columns_win2*)

- **units :** mol m-2
- **long_name :** slant column random all absorbers in fitting window 2
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude
- **index_meaning :** SO2_203K_Bogumil_deconv_resampled_301_364_NOMOPS_BF2bd2-6_band_3.xs#1#float64#2#451x1080.bis O3_228K_Brion_vac_NOMOPS_BF2bd2-6_band_3.xs#1#float64#2#451x2010.bis O3_243K_Brion_vac_NOMOPS_BF2bd2-6_band_3.xs#1#float64#2#451x2010.bis o3lambda_Io_S5P_OPT_SFP.xs#1#float64#2#451x2002.bis o3squared_Io_S5P_OPT_SFP.xs#1#float64#2#451x2002.bis Ringev1_HR_200_NOMOPS_BF2bd2-6_band_3.xs#1#float64#2#451x1100.bis Ringev2_HR_870_NOMOPS_BF2bd2-6_band_3.xs#1#float64#2#451x1100.bis

fitted_slant_columns_win3 [float64] (*time, scanline, ground_pixel, number_of_slant_columns_win3*)

- **units :** mol m-2
- **long_name :** slant columns of all absorbers in fitting window 3
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude
- **index_meaning :** SO2_203K_vandaele_extrapol_NOMOPS_BF2bd2-6_band_3.xs#1#float64#2#451x2010.bis no2_cb_vac_NOMOPS_BF2bd2-6_band_3.xs#1#float64#2#451x2010.bis ring_sao2010_combined_NOMOPS_BF2bd2-6_band_3.xs#1#float64#2#451x2010.bis o4_hand_vac_NOMOPS_BF2bd2-6_band_3.xs#1#float64#2#451x2001.bis

fitted_slant_columns_win3_precision [float32] (*time, scanline, ground_pixel, number_of_slant_columns_win3*)

- **units :** mol m-2
- **long_name :** slant column random errors of all absorbers in fitting window 3
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude
- **index_meaning :** SO2_203K_vandaele_extrapol_NOMOPS_BF2bd2-6_band_3.xs#1#float64#2#451x2010.bis no2_cb_vac_NOMOPS_BF2bd2-6_band_3.xs#1#float64#2#451x2010.bis ring_sao2010_combined_NOMOPS_BF2bd2-6_band_3.xs#1#float64#2#451x2010.bis o4_hand_vac_NOMOPS_BF2bd2-6_band_3.xs#1#float64#2#451x2001.bis

number_of_doas_polynomial_coefficients_win2 [int32] (*number_of_doas_polynomial_coefficients_win2*)

- **units :** 1
- **long_name :** number_of_doas_polynomial_coefficients_win2 dimension index

number_of_doas_polynomial_coefficients_win3 [int32] (*number_of_doas_polynomial_coefficients_win3*)

- **units :** 1
- **long_name :** number_of_doas_polynomial_coefficients_win3 dimension index

number_of_iterations_in_retrieval [uint16] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** number of iterations used in the retrieval
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

number_of_iterations_in_retrieval_win2 [uint16] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** number of iterations used in the retrieval for window 2
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

number_of_iterations_in_retrieval_win3 [uint16] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** number of iterations used in the retrieval for window 3
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

number_of_slant_columns_win1 [int32] (*number_of_slant_columns_win1*)

- **units :** 1
- **long_name :** number_of_slant_columns_win1 dimension index

number_of_slant_columns_win2 [int32] (*number_of_slant_columns_win2*)

- **units :** 1
- **long_name :** number_of_slant_columns_win2 dimension index

number_of_slant_columns_win3 [int32] (*number_of_slant_columns_win3*)

- **units :** 1
- **long_name :** number_of_slant_columns_win3 dimension index

number_of_spectral_points_in_retrieval [uint16] (*time, scanline, ground_pixel*)

- **long_name :** Number of spectral points used in the DOAS retrieval
- **units :** 1
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

number_of_spectral_points_in_retrieval_win2 [uint16] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** Number of spectral points used in the DOAS retrieval for window 2
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

number_of_spectral_points_in_retrieval_win3 [uint16] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** Number of spectral points used in the DOAS retrieval for window 3
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

processing_quality_flags [uint32] (*time, scanline, ground_pixel*)

- **long_name :** Processing quality flags
- **units :** 1
- **comment :** Flags indicating conditions that affect quality of the retrieval.
- **flag_meanings :** success radiance_missing irradiance_missing input_spectrum_missing reflectance_range_error 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 numerical_error lut_error ISRF_error convergence_error cloud_filter_convergence_error max_iteration_convergence_error aot_lower_boundary_convergence_error other_boundary_convergence_error geolocation_error ch4_noscat_zero_error h2o_noscat_zero_error max_optical_thickness_error aerosol_boundary_error boundary_hit_error chi2_error svd_error dfs_error radiative_transfer_error optimal_estimation_error profile_error cloud_error model_error number_of_input_data_points_too_low_error cloud_pressure_spread_too_low_error cloud_too_low_level_error generic_range_error generic_exception input_spectrum_alignment_error abort_error wrong_input_type_error wavelength_calibration_error coregistration_error slant_column_density_error airmass_factor_error vertical_column_density_error signal_to_noise_ratio_error configuration_error key_error saturation_error solar_eclipse_filter cloud_filter altitude_consistency_filter altitude_roughness_filter sun_glint_filter mixed_surface_type_filter snow_ice_filter aai_filter cloud_fraction_fresco_filter aai_scene_albedo_filter small_pixel_radiance_std_filter cloud_fraction_viirs_filter cirrus_reflectance_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_warning altitude_consistency_warning signal_to_noise_ratio_warning deconvolution_warning so2_volcanic_origin_likely_warning so2_volcanic_origin_certain_warning interpolation_warning saturation_warning high_sza_warning cloud_retrieval_warning cloud_inhomogeneity_warning
- **flag_masks :** [255 256 512 1024 2048 4096 8192 16384 32768 65536 131072 262144 524288 1048576 2097152 4194304 8388608 16777216 33554432 67108864 134217728 268435456 536870912]
- **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]
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

qa_value_box_profile [uint8] (*time, scanline, ground_pixel*)

- **units :** 1
- **scale_factor :** 0.01
- **add_offset :** 0.0
- **valid_min :** 0
- **valid_max :** 100
- **long_name :** data quality value
- **comment :** A continuous quality descriptor, varying between 0 (no data) and 1 (full quality data). Recommend to ignore data with qa_value < 0.5
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

selected_fitting_window_flag [int32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** flag describing the selected fitting window for sulfur dioxide retrieval
- **flag_values :** [1 2 3]

sulfurdioxide_averaging_kernel_scaling_box_15km [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** scaling box of the total air mass factor for a sulfur dioxide plume at 15km altitude w.r.t. the sea level
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

sulfurdioxide_averaging_kernel_scaling_box_1km [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** scaling box of the total air mass factor for a sulfur dioxide plume at 1km altitude w.r.t. the topography
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

sulfurdioxide_averaging_kernel_scaling_box_7km [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** scaling box of the total air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

sulfurdioxide_clear_air_mass_factor_15km [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** clear sky air mass factor for a sulfur dioxide plume at 15km altitude w.r.t. the sea level
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

sulfurdioxide_clear_air_mass_factor_1km [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** clear sky air mass factor for a sulfur dioxide plume at 1km altitude w.r.t. the topography
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

sulfurdioxide_clear_air_mass_factor_7km [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** clear sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

sulfurdioxide_clear_air_mass_factor_polluted [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** clear sky air mass factor for the boundary layer polluted scenario
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

sulfurdioxide_cloudy_air_mass_factor_15km [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** cloudy sky air mass factor for a sulfur dioxide plume at 15km altitude w.r.t. the sea level
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

sulfurdioxide_cloudy_air_mass_factor_1km [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** cloudy sky air mass factor for a sulfur dioxide plume at 1km altitude w.r.t. the topography
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

sulfurdioxide_cloudy_air_mass_factor_7km [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** cloudy sky air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

sulfurdioxide_cloudy_air_mass_factor_polluted [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** cloudy sky air mass factor for the boundary layer polluted scenario
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

sulfurdioxide_detection_flag [int32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** sulfur dioxide volcano activity flag
- **flag_meanings :** no detection,detection,clear detection close to known volcano,clear detection close to known anthropogenic source,detection at high SZA
- **flag_values :** [0 1 2 3 4]
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

sulfurdioxide_profile_apriori [float32] (*time, scanline, ground_pixel, layer*)

- **units :** 1
- **long_name :** volume mixing ratio profile of sulfur dioxide
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

sulfurdioxide_slant_column_corrected [float32] (*time, scanline, ground_pixel*)

- **units :** mol m-2
- **long_name :** background corrected sulfur dioxide slant column density for final selected fitting window
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude
- **multiplication_factor_to_convert_to_DU :** 2241.15
- **multiplication_factor_to_convert_to_molecules_percm2 :** 6.02214e+19

sulfurdioxide_slant_column_corrected_trueness [float32] (*time, scanline, ground_pixel*)

- **units :** mol m-2
- **long_name :** systematic error of the corrected sulfur dioxide slant column
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

sulfurdioxide_slant_column_corrected_win1 [float32] (*time, scanline, ground_pixel*)

- **units :** mol m-2
- **long_name :** background corrected sulfur dioxide slant column density for fitting window 1
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude
- **multiplication_factor_to_convert_to_DU :** 2241.15
- **multiplication_factor_to_convert_to_molecules_percm2 :** 6.02214e+19

sulfurdioxide_slant_column_corrected_win2 [float32] (*time, scanline, ground_pixel*)

- **units :** mol m-2
- **long_name :** background corrected sulfur dioxide slant column density for fitting window 2
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude
- **multiplication_factor_to_convert_to_DU :** 2241.15
- **multiplication_factor_to_convert_to_molecules_percm2 :** 6.02214e+19

sulfurdioxide_slant_column_corrected_win3 [float32] (*time, scanline, ground_pixel*)

- **units :** mol m-2
- **long_name :** background corrected sulfur dioxide slant column density for fitting window 3
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude
- **multiplication_factor_to_convert_to_DU :** 2241.15
- **multiplication_factor_to_convert_to_molecules_percm2 :** 6.02214e+19

sulfurdioxide_slant_column_correction_flag [uint8] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** sulfur dioxide slant column density background correction flag
- **flag_meanings :** not-corrected,corrected
- **flag_values :** [0 1]
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

sulfurdioxide_total_air_mass_factor_15km [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** total air mass factor for a sulfur dioxide plume at 15km altitude w.r.t. the sea level
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

sulfurdioxide_total_air_mass_factor_15km_kernel_trueness [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** systematic error of the total air mass factor using kernels for a sulfur dioxide plume at 15km altitude w.r.t. the sea level
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

sulfurdioxide_total_air_mass_factor_15km_precision [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** random error of the total air mass factor for a sulfur dioxide plume at 15km altitude w.r.t. the sea level
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

sulfurdioxide_total_air_mass_factor_15km_trueness [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** systematic error of the total air mass factor for a sulfur dioxide plume at 15km altitude w.r.t. the sea level
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

sulfurdioxide_total_air_mass_factor_1km [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** total air mass factor for a sulfur dioxide plume at 1km altitude w.r.t. the topography
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

sulfurdioxide_total_air_mass_factor_1km_kernel_trueness [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **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
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

sulfurdioxide_total_air_mass_factor_1km_precision [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** random error of the total air mass factor for a sulfur dioxide plume at 1km altitude w.r.t. the topography
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

sulfurdioxide_total_air_mass_factor_1km_trueness [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** systematic error of the total air mass factor for a sulfur dioxide plume at 1km altitude w.r.t. the topography
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

sulfurdioxide_total_air_mass_factor_7km [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** total air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

sulfurdioxide_total_air_mass_factor_7km_kernel_trueness [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **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
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

sulfurdioxide_total_air_mass_factor_7km_precision [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** random error of the total air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

sulfurdioxide_total_air_mass_factor_7km_trueness [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** systematic error of the total air mass factor for a sulfur dioxide plume at 7km altitude w.r.t. the sea level
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

sulfurdioxide_total_air_mass_factor_polluted [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** total air mass factor for boundary layer polluted scenario
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

sulfurdioxide_total_air_mass_factor_polluted_kernel_trueness [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** systematic error of the total air mass factor for the kernel polluted scenario
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

sulfurdioxide_total_air_mass_factor_polluted_precision [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** random error of the total air mass factor for the boundary layer polluted scenario
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

sulfurdioxide_total_air_mass_factor_polluted_trueness [float32] (*time, scanline, ground_pixel*)

- **units :** 1
- **long_name :** systematic error of the total air mass factor for the boundary layer polluted scenario
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude

sulfurdioxide_total_vertical_column_15km [float32] (*time, scanline, ground_pixel*)

- **units :** mol m-2
- **standard_name :** atmosphere_mole_content_of_sulfur_dioxide
- **long_name :** total vertical column density of sulfur dioxide for a sulfur dioxide plume at 15km altitude w.r.t. the sea level
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude
- **multiplication_factor_to_convert_to_DU :** 2241.15
- **multiplication_factor_to_convert_to_molecules_percm2 :** 6.02214e+19

sulfurdioxide_total_vertical_column_15km_precision [float32] (*time, scanline, ground_pixel*)

- **units :** mol m-2
- **standard_name :** atmosphere_mole_content_of_sulfur_dioxide_standard_error
- **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
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude
- **multiplication_factor_to_convert_to_DU :** 2241.15
- **multiplication_factor_to_convert_to_molecules_percm2 :** 6.02214e+19

sulfurdioxide_total_vertical_column_15km_trueness [float32] (*time, scanline, ground_pixel*)

- **units :** mol m-2
- **long_name :** systematic error of the total vertical column density of sulfur dioxide for a sulfur dioxide plume at 15km altitude w.r.t. the sea level
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude
- **multiplication_factor_to_convert_to_DU :** 2241.15
- **multiplication_factor_to_convert_to_molecules_percm2 :** 6.02214e+19

sulfurdioxide_total_vertical_column_1km [float32] (*time, scanline, ground_pixel*)

- **units :** mol m-2
- **standard_name :** atmosphere_mole_content_of_sulfur_dioxide
- **long_name :** total vertical column density of sulfur dioxide for a sulfur dioxide plume at 1km altitude w.r.t. the topography
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude
- **multiplication_factor_to_convert_to_DU :** 2241.15
- **multiplication_factor_to_convert_to_molecules_percm2 :** 6.02214e+19

sulfurdioxide_total_vertical_column_1km_precision [float32] (*time, scanline, ground_pixel*)

- **units :** mol m-2
- **standard_name :** atmosphere_mole_content_of_sulfur_dioxide standard_error
- **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
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude
- **multiplication_factor_to_convert_to_DU :** 2241.15
- **multiplication_factor_to_convert_to_molecules_percm2 :** 6.02214e+19

sulfurdioxide_total_vertical_column_1km_trueness [float32] (*time, scanline, ground_pixel*)

- **units :** mol m-2
- **long_name :** systematic error of the total vertical column density of sulfur dioxide for a sulfur dioxide plume at 1km altitude w.r.t. the topography
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude
- **multiplication_factor_to_convert_to_DU :** 2241.15
- **multiplication_factor_to_convert_to_molecules_percm2 :** 6.02214e+19

sulfurdioxide_total_vertical_column_7km [float32] (*time, scanline, ground_pixel*)

- **units :** mol m-2
- **standard_name :** atmosphere_mole_content_of_sulfur_dioxide
- **long_name :** total vertical column density of sulfur dioxide for a sulfur dioxide plume at 7km altitude w.r.t. the sea level
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude
- **multiplication_factor_to_convert_to_DU :** 2241.15
- **multiplication_factor_to_convert_to_molecules_percm2 :** 6.02214e+19

sulfurdioxide_total_vertical_column_7km_precision [float32] (*time, scanline, ground_pixel*)

- **units :** mol m-2
- **standard_name :** atmosphere_mole_content_of_sulfur_dioxide_standard_error
- **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
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude
- **multiplication_factor_to_convert_to_DU :** 2241.15
- **multiplication_factor_to_convert_to_molecules_percm2 :** 6.02214e+19

sulfurdioxide_total_vertical_column_7km_trueness [float32] (*time, scanline, ground_pixel*)

- **units :** mol m-2
- **long_name :** systematic error of the total vertical column of sulfur dioxide for a sulfur dioxide plume at 7km altitude w.r.t. the sea level
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude
- **multiplication_factor_to_convert_to_DU :** 2241.15
- **multiplication_factor_to_convert_to_molecules_percm2 :** 6.02214e+19

sulfurdioxide_total_vertical_column_trueness [float32] (*time, scanline, ground_pixel*)

- **units :** mol m-2
- **long_name :** systematic error of the total vertical column density of sulfur dioxide for the polluted scenario
- **coordinates :** /PRODUCT/longitude /PRODUCT/latitude
- **multiplication_factor_to_convert_to_DU :** 2241.15
- **multiplication_factor_to_convert_to_molecules_percm2 :** 6.02214e+19

4.7 /PRODUCT/SUPPORT_DATA

4.8 /PRODUCT/SUPPORT_DATA/DETAILED_RESULTS/WAVELENGTH_CALIBRATION

calibration_polynomial_coefficients_win1 [float32] (*number_of_calibrations, degrees_of_polynomial_shift_win1*)

- **units :** 1
- **long_name :** computed coefficients of the polynomial function in fitting window 1

calibration_polynomial_coefficients_win2 [float32] (*number_of_calibrations, degrees_of_polynomial_shift_win2*)

- **units :** 1
- **long_name :** computed coefficients of the polynomial function in fitting window 2

calibration_polynomial_coefficients_win3 [float32] (*number_of_calibrations, degrees_of_polynomial_shift_win3*)

- **units :** 1
- **long_name :** computed coefficients of the polynomial function in fitting window 3

calibration_subwindows_root_mean_square_win1 [float32] (*number_of_calibrations, number_of_subwindows_win1*)

- **units :** 1
- **long_name :** calibration rms per subwindow in fitting window 1

calibration_subwindows_root_mean_square_win2 [float32] (*number_of_calibrations, number_of_subwindows_win2*)

- **units :** 1
- **long_name :** calibration rms per subwindow in fitting window 2

calibration_subwindows_root_mean_square_win3 [float32] (*number_of_calibrations, number_of_subwindows_win3*)

- **units :** 1
- **long_name :** calibration rms per subwindow in fitting window 3

calibration_subwindows_shift_win1 [float32] (*number_of_calibrations, number_of_subwindows_win1*)

- **units :** nm
- **long_name :** irradiance wavelengths shift values per subwindow in fitting window 1

calibration_subwindows_shift_win2 [float32] (*number_of_calibrations, number_of_subwindows_win2*)

- **units :** nm
- **long_name :** irradiance wavelengths shift fitted values per subwindow in fitting window 2

calibration_subwindows_shift_win3 [float32] (*number_of_calibrations, number_of_subwindows_win3*)

- **units :** nm
- **long_name :** irradiance wavelengths shift values per subwindow in fitting window 3

calibration_subwindows_squeeze_win1 [float32] (*number_of_calibrations, number_of_subwindows_win1*)

- **units :** 1
- **long_name :** irradiance wavelengths squeeze fitted values per subwindow in fitting window 1

calibration_subwindows_squeeze_win2 [float32] (*number_of_calibrations, number_of_subwindows_win2*)

- **units :** 1
- **long_name :** irradiance wavelengths squeeze fitted values per subwindow in fitting window 1

calibration_subwindows_squeeze_win3 [float32] (*number_of_calibrations, number_of_subwindows_win3*)

- **units :** 1
- **long_name :** irradiance wavelengths squeeze fitted values per subwindow in fitting window 3

calibration_subwindows_wavelength_win1 [float32] (*number_of_subwindows_win1*)

- **units :** nm
- **long_name :** calibration wavelength center in each subwindow in fitting window 1

calibration_subwindows_wavelength_win2 [float32] (*number_of_subwindows_win2*)

- **units :** nm
- **long_name :** calibration wavelength center in each subwindow in fitting window 2

calibration_subwindows_wavelength_win3 [float32] (*number_of_subwindows_win3*)

- **units :** nm
- **long_name :** calibration wavelength center in each subwindow of the wavelength calibration in window 3

degrees_of_polynomial_shift_win1 [int32] (*degrees_of_polynomial_shift_win1*)

- **units :** 1
- **long_name :** degrees_of_polynomial_shift_win1 dimension index

degrees_of_polynomial_shift_win2 [int32] (*degrees_of_polynomial_shift_win2*)

- **units :** 1
- **long_name :** degrees_of_polynomial_shift_win2 dimension index

degrees_of_polynomial_shift_win3 [int32] (*degrees_of_polynomial_shift_win3*)

- **units :** 1
- **long_name :** degrees_of_polynomial_shift_win3 dimension index

number_of_calibrations [int32] (*number_of_calibrations*)

- **units :** 1
- **long_name :** number_of_calibrations dimension index

number_of_subwindows_win1 [int32] (*number_of_subwindows_win1*)

- **units :** 1
- **long_name :** number_of_subwindows_win1 dimension index

number_of_subwindows_win2 [int32] (*number_of_subwindows_win2*)

- **units :** 1
- **long_name :** number_of_subwindows_win2 dimension index

number_of_subwindows_win3 [int32] (*number_of_subwindows_win3*)

- **units :** 1
- **long_name :** number_of_subwindows_win3 dimension index

References

[1] URL: http://www.tropomi.eu/data-products/sulphur-dioxide.

[2] *S5P COBRA Sulphur Dioxide [L2__SO2CBR_] Readme.* **source**: BIRA; **ref**: S5P-BIRA-PRF-SO2CBR; **issue**: 1.0; **date**: 2022-09-14.

[3] *S5P-PAL: Sentinel 5P Product Algorithm Laboratory L2 Processor File Format Guidelines.* **source**: S&T; **ref**: ST-ESA-S5P_PAL-L2FFG-001; **issue**: 1.3; **date**: 2022-05-11.