

Shortname: OMS02e
Longname: OMI/Aura Sulfur Dioxide (SO2) Total Column Daily L3 Best Pixel Global
0.25deg Lat/Lon Grid
PFS Version: 1.1.7
Date: 2015 February 12
Author(s): Nick Krotkov (NASA/GSFC), Peter Leonard (ADNET), Michael Walters (ADNET)

PGE Version: 1.1.7
Lead Algorithm Scientist: Nick Krotkov (NASA/GSFC)
Lead Algorithm Developer: Nick Krotkov (NASA/GSFC)
Other Algorithm Developers:
- Michael Walters (ADNET)
- Er-Woon Chiou (ADNET)
- Can Li (ESSIC)
- Laura Dunlap (ESSIC)
- Peter Leonard (ADNET)
Lead PGE Developer: Peter Leonard (ADNET)

Description: >

This document specifies the format of the Ozone Monitoring Instrument (OMI) OMS02e product, which is the daily Level 3 (L3e) gridded data product that corresponds to the OMS02 product. The latter is the U.S. OMI Science Team's Level 2 (L2) total column Planetary Boundary Layer (PBL) sulfur dioxide orbital swath data product based on Principal Component Analysis (References 1 and 2). The "e" at the end of "OMS02e" represents "expanded", and is based on the selection of a single "best" OMI pixel to represent each L3e grid-cell, and, therefore, includes ancillary information about aerosols, clouds and observational geometry.

The L3e product contains 24 UTC hours of L2 product subsetted onto a longitude-latitude grid. An OMI L3e day is defined to be the 24 hours that lie between UTC times of 0 hours, 0 minutes, 0 seconds and 23 hours, 59 minutes, 59.999999 seconds. The adopted L3e grid is a 0.25-degree by 0.25-degree grid in longitude and latitude. The dimensions of this grid are 1440 by 720. The grid cell at coordinates (1, 1) is centered at (longitude = -179.875, latitude = -89.875), and the grid cell at coordinates (1440, 720) is centered at (longitude = 179.875, latitude = 89.875). The adopted L3e grid is consistent with the document entitled "Definition of OMI Grids for Level 3 and Level 4 Data Products" by J.P. Veefkind et al. (Reference 3).

The L2 data are not averaged or weighted in any way in the L3e product. Each grid cell in the L3e product contains only one "best pixel", selected from all "good" L2 observations that overlap with the L3e grid cell, which has the shortest path length [path length = $1/\cos(\text{solar zenith angle}) + 1/\cos(\text{viewing zenith angle})$]. The overlap is based on a simple model for the OMI ground pixels corners and is consistent with the definition in heritage TOMS L3 products. An L2 observation can be mapped onto more than one L3e grid cell, if the L2 observation overlaps with and has the shortest path length for more than one L3e grid cell. If no "good" overlaps are found (e.g., due to clouds) all fields are set to fill values for the cell.

A "good" OMS02 L2 scene is defined as one that has:

- 1) a solar zenith angle that is less than or equal to 70.0 degrees,
- 2) an SO2 column amount in the Planetary Boundary Layer (PBL) that is not equal to the missing value,
- 3) a cross-track scene number between 3 and 58 (1-based, inclusive),
- 4) a row anomaly flag that is not set (i.e., bit 11 of the L2 PBL SO2 quality flag is not set),

and

- 5) a radiative cloud fraction that is less than or equal to 0.2.

A local monthly climatological air-mass factor correction (Reference 4) is subsequently applied to the data for each selected "best pixel".

The L3e product currently excludes L2 data collected in spatial and spectral zoom modes.

The product is stored as one HDF-EOS 5 grid file, and has a size of 4 to 7 MB. The format of the L3e product file is consistent with the document entitled "HDF-EOS Aura File Format Guidelines" by C. Craig et al. (Reference 5).

Global Metadata:

- Metadata Name: EndUTC
Mandatory: T
Data Type: HE5T_NATIVE_CHAR
Number of Values: 1
Data Source: PGE
Description: >
UTC at the end of the L3e granule in "YYYY-MM-DDT23:59:59.999999Z" format.
- Metadata Name: GranuleDay
Mandatory: T
Data Type: HE5T_NATIVE_INT
Number of Values: 1
Minimum Value: 1
Maximum Value: 31
Data Source: PGE
Description: The day of the month at the start of the L3e granule.
- Metadata Name: GranuleDayOfYear
Mandatory: T
Data Type: HE5T_NATIVE_INT
Number of Values: 1
Minimum Value: 1
Maximum Value: 366
Data Source: PGE
Description: The day of the year at the start of the L3e granule.
- Metadata Name: GranuleMonth
Mandatory: T
Data Type: HE5T_NATIVE_INT
Number of Values: 1
Minimum Value: 1
Maximum Value: 12
Data Source: PGE
Description: The month of the year at the start of the L3e granule.
- Metadata Name: GranuleYear
Mandatory: T
Data Type: HE5T_NATIVE_INT
Number of Values: 1
Minimum Value: 2000
Maximum Value: 2099
Data Source: PGE
Description: The (four-digit) year at the start of the L3e granule.
- Metadata Name: HDFEOSVersion
Mandatory: T
Data Type: HE5T_NATIVE_CHAR
Number of Values: 1
Data Source: HE
Description: >
The version of HDF-EOS 5 used in production. Example is "HDFEOS_5.1.8".
- Metadata Name: InputPointer
Mandatory: T
Data Type: HE5T_NATIVE_CHAR

Number of Values: 1
Data Source: PGE
Description: >
A space-separated list of the L2G input granules.

- Metadata Name: InstrumentName
Mandatory: T
Data Type: HE5T_NATIVE_CHAR
Number of Values: 1
Valid: OMI
Data Source: PGE
Description: Actual is "OMI" (see Section 6.1 of Reference 5).
- Metadata Name: OrbitNumber
Mandatory: T
Data Type: HE5T_NATIVE_INT
Number of Values: 1,60
Minimum Value: 1
Maximum Value: 999999
Data Source: L2G
Description: The OMI orbit number for each L2 input granule.
- Metadata Name: OrbitPeriod
Mandatory: T
Data Type: HE5T_NATIVE_DOUBLE
Number of Values: 1,60
Minimum Value: 5000.0
Maximum Value: 7000.0
Data Source: L2G
Description: >
The Aura orbital period for each L2 input granule (in seconds).
- Metadata Name: Period
Mandatory: T
Data Type: HE5T_NATIVE_CHAR
Number of Values: 1
Valid: Daily,Weekly,Monthly
Data Source: PGE
Description: The duration of the L3e granule. Actual is "Daily".
- Metadata Name: PGEVERSION
Mandatory: T
Data Type: HE5T_NATIVE_CHAR
Number of Values: 1
Data Source: PCF
Description: Example is "0.9.55" (see Appendix K of Reference 6).
- Metadata Name: ProcessLevel
Mandatory: T
Data Type: HE5T_NATIVE_CHAR
Number of Values: 1
Valid: 3e
Data Source: PGE
Description: Actual is "3e".
- Metadata Name: StartUTC
Mandatory: T
Data Type: HE5T_NATIVE_CHAR
Number of Values: 1
Data Source: PGE
Description: >
UTC at the start of the L3e granule in "YYYY-MM-DDT00:00:00.000000Z"
format.
- Metadata Name: TAI93At0z0fGranule
Mandatory: T

Data Type: HE5T_NATIVE_DOUBLE
Number of Values: 1
Minimum Value: 0.0
Maximum Value: 1.0e+30
Data Source: PGE
Description: >
The TAI93 time at 0z of the L3e granule (see Section 6.1 of Reference 5).

Grid Metadata:

- Metadata Name: GCTPProjectionCode
Mandatory: T
Data Type: HE5T_NATIVE_INT
Number of Values: 1
Minimum Value: 0
Maximum Value: 99
Data Source: PGE
Description: >
The GCTP projection code of the L3e grid. Actual is 0, which corresponds to the geographic projection.
- Metadata Name: GridName
Mandatory: T
Data Type: HE5T_NATIVE_CHAR
Number of Values: 1
Valid: OMI Total Column Amount S02
Data Source: PGE
Description: Actual is "OMI Total Column Amount S02".
- Metadata Name: GridOrigin
Mandatory: T
Data Type: HE5T_NATIVE_CHAR
Number of Values: 1
Valid: Center
Data Source: PGE
Description: >
The origin of the L3e grid. Actual is "Center" (see Section 6.2 of Reference 5).
- Metadata Name: GridSpacing
Mandatory: T
Data Type: HE5T_NATIVE_CHAR
Number of Values: 1
Data Source: PGE
Description: >
Spacing of L3e grid (in degrees). Actual is "(0.25,0.25)".
- Metadata Name: GridSpacingUnit
Mandatory: T
Data Type: HE5T_NATIVE_CHAR
Number of Values: 1
Valid: deg
Data Source: PGE
Description: >
Unit for GridSpacing. Actual is "deg".
- Metadata Name: GridSpan
Mandatory: T
Data Type: HE5T_NATIVE_CHAR
Number of Values: 1
Data Source: PGE
Description: >
Span of L3e grid (in degrees). Actual is "(-180,180,-90,90)".
- Metadata Name: GridSpanUnit
Mandatory: T

Data Type: HE5T_NATIVE_CHAR
Number of Values: 1
Valid: deg
Data Source: PGE
Description: >
Unit for GridSpan. Actual is "deg".

- Metadata Name: NumberOfGridCells
Mandatory: T
Data Type: HE5T_NATIVE_INT
Number of Values: 1
Minimum Value: 1
Maximum Value: 1036800
Data Source: PGE
Description: The total number of cells in the L3e grid.

- Metadata Name: NumberOfLatitudesInGrid
Mandatory: T
Data Type: HE5T_NATIVE_INT
Number of Values: 1
Minimum Value: 1
Maximum Value: 720
Data Source: PGE
Description: The number of latitude bins in the L3e grid.

- Metadata Name: NumberOfLongitudesInGrid
Mandatory: T
Data Type: HE5T_NATIVE_INT
Number of Values: 1
Minimum Value: 1
Maximum Value: 1440
Data Source: PGE
Description: The number of longitude bins in the L3e grid.

- Metadata Name: Projection
Mandatory: T
Data Type: HE5T_NATIVE_CHAR
Number of Values: 1
Valid: Geographic
Data Source: PGE
Description: >
The map projection of the L3e grid. Actual is "Geographic" (see Section 6.2 of Reference 5).

Grid Dimensions:

- Dimension Name: XDim
Data Type: HE5T_NATIVE_INT
Dimension Type: FIXED
Number of Values: 1
Minimum Value: 1
Maximum Value: 1440
Data Source: PGE
Description: >
The longitudes dimension of the L3e grid. There are currently 1440 0.25-degree-wide bins between longitudes -180.0 and 180.0 degrees.

- Dimension Name: YDim
Data Type: HE5T_NATIVE_INT
Dimension Type: FIXED
Number of Values: 1
Minimum Value: 1
Maximum Value: 720
Data Source: PGE
Description: >
The latitudes dimension of the L3e grid. There are currently 720

0.25-degree-wide bins between latitudes -90.0 and 90.0 degrees.

Geolocation Fields:

- Field Name: Latitude
Data Type: HE5T_NATIVE_FLOAT
Dimensions: YDim,XDim
Minimum Value: -90.0
Maximum Value: 90.0
Missing Value: -1.2676506e+30
Offset: 0.0
Scale Factor: 1.0
Units: deg
Data Source: L2G
Title: Geodetic Latitude
Unique Field Definition: TOMS-Aura-Shared
Description: >
The geodetic latitude (in degrees) on the ground at the center of the "best" L2 scene in each L3e grid cell.
- Field Name: LineNumber
Data Type: HE5T_NATIVE_INT
Dimensions: YDim,XDim
Minimum Value: 1
Maximum Value: 1700
Missing Value: -2000000000
Offset: 0.0
Scale Factor: 1.0
Units: NoUnits
Data Source: L2G
Title: Line Number
Unique Field Definition: OMI-Specific
Description: >
The line number for the best L2 scene in each L3e grid cell.
- Field Name: Longitude
Data Type: HE5T_NATIVE_FLOAT
Dimensions: YDim,XDim
Minimum Value: -180.0
Maximum Value: 180.0
Missing Value: -1.2676506e+30
Offset: 0.0
Scale Factor: 1.0
Units: deg
Data Source: L2G
Title: Geodetic Longitude
Unique Field Definition: TOMS-Aura-Shared
Description: >
The geodetic longitude (in degrees) on the ground at the center of the best L2 scene in each L3e grid cell.
- Field Name: OrbitNumber
Data Type: HE5T_NATIVE_INT
Dimensions: YDim,XDim
Minimum Value: 1
Maximum Value: 999999
Missing Value: -2000000000
Offset: 0.0
Scale Factor: 1.0
Units: NoUnits
Data Source: L2G
Title: Orbit Number of L2 Scene
Unique Field Definition: OMI-Specific
Description: >
The orbit number for the best L2 scene in each L3e grid cell.

- Field Name: RelativeAzimuthAngle
 Data Type: HE5T_NATIVE_FLOAT
 Dimensions: YDim,XDim
 Minimum Value: -180.0
 Maximum Value: 180.0
 Missing Value: -1.2676506e+30
 Offset: 0.0
 Scale Factor: 1.0
 Units: deg(EastofNorth)
 Data Source: L2G
 Title: Relative Azimuth Angle (sun + 180 - view)
 Unique Field Definition: TOMS-OMI-Shared
 Description: >
 The relative (sun + 180 - view) azimuth angle (in degrees) on the ground at the center of the "best" L2 scene in each L3e grid cell.

- Field Name: SceneNumber
 Data Type: HE5T_NATIVE_INT
 Dimensions: YDim,XDim
 Minimum Value: 1
 Maximum Value: 60
 Missing Value: -2000000000
 Offset: 0.0
 Scale Factor: 1.0
 Units: NoUnits
 Data Source: L2G
 Title: Scene Number of Candidate Scene
 Unique Field Definition: OMI-Specific
 Description: >
 The cross-track ground-pixel number for the best L2 scene in each L3e grid cell.

- Field Name: SolarZenithAngle
 Data Type: HE5T_NATIVE_FLOAT
 Dimensions: YDim,XDim
 Minimum Value: 0.0
 Maximum Value: 180.0
 Missing Value: -1.2676506e+30
 Offset: 0.0
 Scale Factor: 1.0
 Units: deg
 Data Source: L2
 Title: Solar Zenith Angle
 Unique Field Definition: TOMS-Aura-Shared
 Description: >
 The solar zenith angle (in degrees) on the ground at the center of the best L2 scene in each L3e grid cell.

- Field Name: TerrainHeight
 Data Type: HE5T_NATIVE_INT16
 Dimensions: YDim,XDim
 Minimum Value: -200
 Maximum Value: 10000
 Missing Value: -32767
 Offset: 0.0
 Scale Factor: 1.0
 Units: m
 Data Source: L2
 Title: Terrain Height
 Unique Field Definition: TOMS-Aura-Shared
 Description: >
 The terrain height (in meters) at the center of each L2 candidate scene in each L3e grid cell.

- Field Name: Time
 Data Type: HE5T_NATIVE_DOUBLE

Dimensions: YDim,XDim
Minimum Value: -5.0e+09
Maximum Value: 1.0e+10
Missing Value: -1.2676506002282294e+30
Offset: 0.0
Scale Factor: 1.0
Units: s
Data Source: L2
Title: Time at Start of Scan (TAI93)
Unique Field Definition: TOMS-Aura-Shared
Description: >
The TAI93 time (in seconds) for best L2 candidate scene in each L3e grid cell.

- Field Name: ViewingZenithAngle
Data Type: HE5T_NATIVE_FLOAT
Dimensions: YDim,XDim
Minimum Value: 0.0
Maximum Value: 70.0
Missing Value: -1.2676506e+30
Offset: 0.0
Scale Factor: 1.0
Units: deg
Data Source: L2
Title: Viewing Zenith Angle
Unique Field Definition: TOMS-Aura-Shared
Description: >
The viewing zenith angle (in degrees) on the ground at the center of the best L2 candidate scene in each L3e grid cell.

Data Fields:

- Field Name: ColumnAmountO3
Data Type: HE5T_NATIVE_FLOAT
Dimensions: YDim,XDim
Minimum Value: 50.0
Maximum Value: 700.0
Missing Value: -1.2676506e+30
Offset: 0.0
Scale Factor: 1.0
Units: DU
Data Source: L2
Title: Best Total Ozone Solution
Unique Field Definition: TOMS-OMI-Shared
Description: >
The best total ozone solution (in DU) from OMT03 for the best L2 candidate scene in each L3e grid cell.

- Field Name: ColumnAmountS02_PBL
Data Type: HE5T_NATIVE_FLOAT
Dimensions: YDim,XDim
Minimum Value: -10.0
Maximum Value: 2000.0
Missing Value: -1.2676506e+30
Offset: 0.0
Scale Factor: 1.0
Units: DU
Data Source: L2
Title: Vertical Column Amount S02 (PBL)
Unique Field Definition: OMI-Specific
Description: >
The corrected L2 total vertical column amount S02 using GeosChem (2006) monthly S02 profile shape climatology for the best L2 candidate scene in each L3e grid cell. The corrections are described in Reference 4.

- Field Name: PacificSectorAverage

Data Type: HE5T_NATIVE_FLOAT
Dimensions: 3,YDim
Minimum Value: -10.0
Maximum Value: 2000.0
Missing Value: -1.2676506e+30
Offset: 0.0
Scale Factor: 1.0
Units: DU
Data Source: PGE
Title: PacificSectorAverage
Unique Field Definition: OMI-Specific
Description: >

The key data related to the Pacific Sector Average (PSA). The first column is the calculated daily PSA. The second column is the number of L3 grid cells used to calculate the daily PSA (represented here as a floating point number). The third column is the standard deviation of the daily PSA.

- Field Name: RadiativeCloudFraction
Data Type: HE5T_NATIVE_FLOAT
Dimensions: YDim,XDim
Minimum Value: 0.0
Maximum Value: 1.0
Missing Value: -1.2676506e+30
Offset: 0.0
Scale Factor: 1.0
Units: NoUnits
Data Source: L2
Title: Radiative Cloud Fraction
Unique Field Definition: TOMS-OMI-Shared
Description: >

The radiative cloud fraction (= $fc * lc331 / lm331$) for the best L2 candidate scene in each L3e grid cell.

- Field Name: SlantColumnAmountSO2
Data Type: HE5T_NATIVE_FLOAT
Dimensions: YDim,XDim
Minimum Value: -10.0
Maximum Value: 2000.0
Missing Value: -1.2676506e+30
Offset: 0.0
Scale Factor: 1.0
Units: DU
Data Source: L2
Title: Vertical Column Amount SO2 (PBL)
Unique Field Definition: OMI-Specific
Description: >

The measured SO2 slant column amount (scaled L2 value $0.36 * ColumnAmountSO2_PBL$) for the best L2 candidate scene in each L3e grid cell.

Core Metadata:

None

Archived Metadata:

None.

References: >

1. "OMS02 README File"
(Updated 2014 September 26)
(http://disc.sci.gsfc.nasa.gov/Aura/data-holdings/OMI/omso2_v003.shtml)
2. Li, C., J. Joiner, N. Krotkov, and P. K. Bhartia (2013), A fast

and sensitive new satellite SO₂ retrieval algorithm based on principal component analysis: Application to the ozone monitoring instrument, *Geophys. Res. Letters*, 40, 23, 6314–6318, DOI: 10.1002/2013GL058134.

3. "Definition of OMI Grids for Level 3 and Level 4 Data Products" (OMI-Grids_L3L4, SD-OMIE-KNMI-443, 25 January 2005)
4. Lee, C., R. V. Martin, A. van Donkelaar, G. O'Byrne, N. Krotkov, A. Richter, L. G. Huey, and J. S. Holloway (2009), Retrieval of vertical columns of sulfur dioxide from SCIAMACHY and OMI: Air mass factor algorithm development, validation, and error analysis, *J. Geophys. Res.*, 114, D22303, DOI: 10.1029/2009JD012123.
5. "HDF-EOS Aura File Format Guidelines" (OMI-AURA-DATA-GUIDE, Version 2.12, 24 October 2006)
6. "OMI Science Software Delivery Guide for Version 0.9" (OMI-SSDG-0.9.10, Version 0.9.10, 22 June 2005)