OMNO2 Version 3.0 Level 2 File Description (Document version 3.1)

Edward A. Celarier[1,2], Lok N. Lamsal[1,2], Eric J. Bucsela[3], Sergey Marchenko[4,2] and Nickolay A. Krotkov[2]

[1]Universities Space Reserch Association (USRA), Columbia MD
[2]Code 614, NASA Goddard Space Flight Center, Greenbelt MD
[3]SSRI, Inc., Menlo Park CA
[4]SSAI, Greenbelt MD

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1 Introduction

1.1 Purpose of the document

This document describes Version 3.0 of the OMI Level 2 NO_2 data product, OMNO2. This product is produced by the OMI NO_2 Level 2 Software, as described in AD1. The files may be found on the Goddard Earth Sciences Data and Information Services Center (GES-DISC):

http://disc.sci.gsfc.nasa.gov/Aura/data-holdings/OMI/omno2_v003.shtml

OMNO2 Version 3.0 is part of ECS Collection 3. Unfortunately, the Collection is sometimes referred to as "Version," or notated "v003," *e.g.* in the file names themselves (see Section 2.1).

1.2 Definitions, acronyms and abbreviations

AMF	Air Mass Factor
APP	Application
CTM	Chemical Transport Model
DEM	Digital Elevation Model
DOAS	Differential Optical Absorption Spectroscopy
ECS	EOS Core System
EOS	Earth Observation System
FOV	Field of view
HDF	Hierarchical Data Format
HDF-EOS	Hierarchical Data Format - Earth Observing System
IDL	Interactive Data Language
NISE	Near-real-time Ice and Snow Extent
NRT	Near Real Time
ODL	Object Description Language
OMI	Ozone Monitoring Instrument
OPF	Operational Parameter File
PGE	Product Generation Executive
SAA	South Atlantic Anomaly
SCD	Slant Column Density
SDP	Science Data Production
TAI	International Atomic Time
TBA	To Be Added
TBC	To Be Confirmed
TBD	To Be Determined
TBU	To Be Updated
UTC	Coordinated Universal Time
VCD	Vertical Column Density

1.3 References

1.3.1 Applicable Documents

AD1 User Requirements Document for the OMI NO_2 Level 2A Operational Software, RS-OMIE-KNMI-354, Version 1.0, 30 August 2002.

AD2 HDF-EOS Aura File Format Guidelines, NCAR SW-NCA-079, Version 1.3, 27 August 2003.

1.3.2 Reference Documents

RD1 HDF-EOS Interface Based on HDF5, 175-TP-511-001, March 2001.

RD2 SDP Toolkit Software Version 2, and the SDP Users Guide for the ECS Project GSFC 333-CD-100-002, Version 2.0, January 1999.

RD3 OMI Level 1B Product Format Specification, SE-OMIE-0562-FS/00, Issue 1 (draft 7), 14 August 2002.

RD4 Near Real-Time SSM/I EASE-Grid Daily Global Ice Concentration and Snow Extent, March 2002, URL: http://nsidc.org/data/docs/daac/nise1_nise.gd.html

RD5 OMIS Activity Definitions, RP-OMIE-KNMI-335, Issue 1, June 17, 2002.

RD6 Release 6A.07 Toolkit Users Guide for the ECS Project, 333-CD-605-001, p. 6-310, May 2002.

1.4 Overview of the document

This document is laid out as follows:

Section 1 is the introduction.
Section 2 gives a general overview of the product.
Section 3 describes the product data file structure and format.
Section 4 describes the geolocation fields.
Section 6 describes the data fields.
Section 8 describes the global file attributes.
Section 10 describes the metadata file.

2 Overview of OMNO2 data product

2.1 File name

OMNO2 Level-2 files are written in HDF-EOS version 5 (HDF-EOS5) format and have the following naming convention

```
<InstrumentID>_<DataType>_<DataID>_<Version>.<Suffix>,
```

where

```
<DataID> = <ObservationDateTime>-<Orbit#>
```

and

```
<Version> = <Collection#>-<ProductionDateTime>
```

Below is an example of an OMNO2 Level-2 file name:

```
OMI-Aura_L2-OMNO2_2011m1010t2318-o38499_v003-2011m1011t154524.he5
```

where:

InstrumentID	=	OMI-Aura
DataType	=	L2-OMNO2
ObservationDateTime	=	2011m1010t2318
Orbit#	=	38499
Collection#	=	003
ProductionDateTime	=	2011m1011t154524
Suffix	=	he5

3 Structure and Format of the Data File

3.1 Description

The OMI Level 2 NO_2 product data file contains the data and metadata produced by the OMI NO_2 Level 2 Software, as described in AD1. Each file contains data pertaining to a single orbital granule. The input for this product can either be Global or Zoom Mode OMI Level 1B products, and other products (e.g. cloud products) also derived from the OMI Level 1B products, as well as data from a variety of other sources. These sources include a USGS digital elevation model (DEM) of the Earth's surface, the National Snow and Ice Data Center's NISE database, climatological NO_2 profiles derived from chemical transport model (CTM) calculations, among others.

3.2 Data types

The HDF specification defines several data types for fixed and floating-point data values. The OMNO2 data product uses many of them. For those that it uses, standard fill-values are defined. However, in some exceptional cases, the fill value actually used is not the standard one for the data type. It is always best to compare field values to the field metadatum `_FILLVALUE`. Table 2 lists the data types, their HDF names, an abbreviation that will be used in this document, and the fill-values that we use, as appropirate.

Table 2: Data types and standard fill values.

Data Type	HDF-EOS-5 designation	`Fill Value (dec, hex)`
1-byte integer	HE5T_NATIVE_INT8	-127 `FF`
Unsigned 1-byte integer	HE5T_NATIVE_UINT8	`255` `FF`
2-byte integer	HE5T_NATIVE_INT16	$-32,767$ `8001`
Unsigned 2-byte integer	HE5T_NATIVE_UINT16	$65,535$ `FFFF`
4-byte integer	HE5T_NATIVE_INT32	$-2,147,483,647$ `8000 0001`
Unsigned 4-byte integer	HE5T_NATIVE_UINT32	$4,294,967,295$ `FFFF FFFF`
8-byte integer	HE5T_NATIVE_INT64	$-9,223,372,036,854,775,807$ `8000 0000 0000 0001`
Unsigned 8-byte integer	HE5T_NATIVE_UINT64	$18,446,744,073,709,551,615$ `FFFF FFFF FFFF FFFF`
4-byte floating-point	HE5T_NATIVE_FLOAT	$-2^{100} \simeq -1.2675 \times 10^{-30}$ `-0X1P+100 = F180 0000`
8-byte floating-point	HE5T_NATIVE_DOUBLE	$-2^{100} \simeq -1.2675 \times 10^{-30}$ `-0X1P+100 = C630 0000 0000 0000`
Character	HE5T_NATIVE_CHAR	`<null_string>` `00`

3.3 Format

The format of the data file is HDF-EOS 5, as described in RD1. To ease the use of Aura data sets, the Aura teams have agreed to make their files match as closely as reasonably possible. To this end, the Aura teams have agreed on a set of guidelines for their file formats, which are described in AD2.

3.4 Structure

The data file uses HDF-EOS Swath[1] format. The general structure of the swath file is:

File→HDFEOS-group→Swath→Group ("Geolocation Fields" or "Data Fields")→ Field

Note that each of these entities, besides containing the subordinate entities, has a set of attributes. (The field data, themselves, are treated as attributes.) The number of Swath structures used in the data file depends on the Level 1B input product. If the product is produced from an OMI Global Level 1B product, the file contains a single swath structure named `ColumnAmountNO2`. Figure 1 shows an example of the structure of a data file produced from Global data.

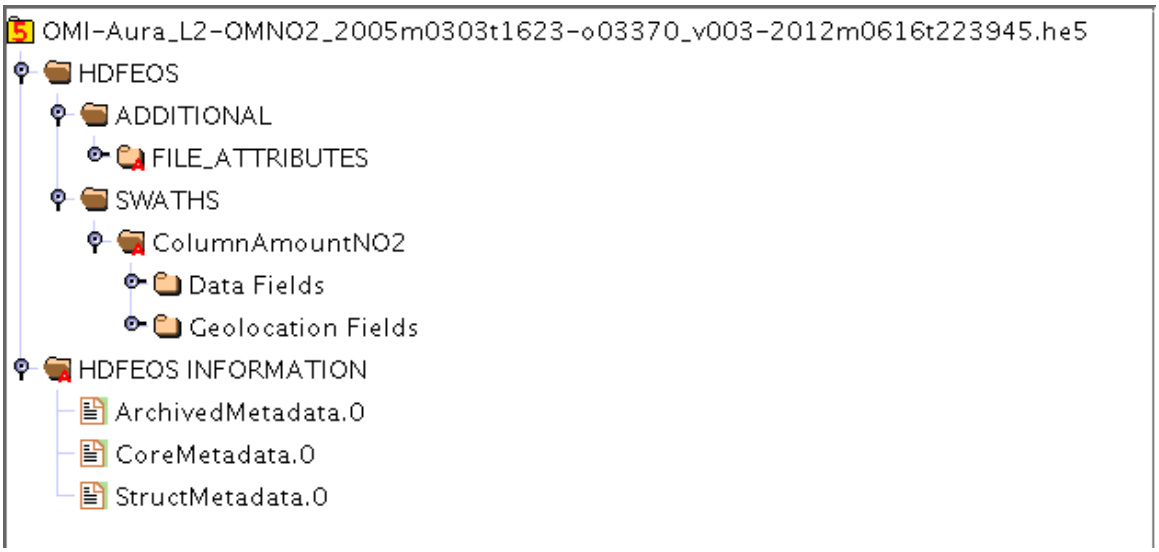

Figure 1: Structure of an NO_2 data file

If the product is produced from an OMI Zoom Product the file may contain more than one swath structures. The names of these swaths always starts with `ColumnAmountNO2`, and is followed by the `<Size>` identifier that follows the L1B Zoom product [RD3]. The `<Size>` identifier has the following format:

`<number_of_rows>x<position_of_stop_column>x<binning_factor>`.

An example of a swath name in the NO_2 product in case of a zoom product is: `ColumnAmountNO2_60x792x4`.

[1]Note that in the OMI community "swath" often refers to the cross-track direction. However, in this document the "swath" is only used for HDF-EOS elements, see RD1.

3.5 Swath Structure

The HDF-EOS 5 Swath structure consists of two groups: Data fields and geolocation fields. All data and geolocation fields are defined by their type, dimension and attributes. The dimensions that are used are listed in Table 3. The `nTimes`, `nXtrack` and `nTimesSmallPixel` dimensions are identical to those used in the Level 1B radiance files. In HDF, a dimension can either be fixed or unlimited. Fixed dimensions are determined when the file is created. Unlimited dimensions can grow and thus cannot be determined when the file is created. Previous versions of the data file were written with some unlimited dimensions. All dimensions are now fixed.

The Swath level attributes are listed in Table 4. Several of them are similar to the names of the swath dimensions (e.g. `nTimes`/`numTimes`). These were created because it is difficult to determine the *actual* size of a field that had been dimensioned `Unlimited`. Since there are now no fields that are dimensioned `Unlimited`, they are no longer strictly necessary. However, there is a body of extant code that ingests the OMNO2 product, and reads those values. Furthermore, we have found that there are programming environments (including IDL) in which it is not possible to find the names and values of the dimensions. Thus, we have retained these as swath level attributes.

All data fields and geolocation fields have attributes. The attributes for data and geolocation fields are listed in Table 5. In case the data is missing, fill values are used. These fill values depend on the data type. Table 2 lists the fill values for all the types used in the product.

Table 3: HDF-EOS5 swath dimensions.

Name	Typ.	Description	Used
`nCorners`	4	Number of corner points to define a ground pixel's geometry.	Yes
`nPresLevels`	35	Number of pressure levels on which the scattering weight is defined.	Yes
`nSmallPixelPointer`	2	Pointer to OMI small pixel measurements.	Yes
`nTimes`	1643	Number of along-track exposures in the current granule.	Yes
`nTimesSmallPixel`	10	Number of OMI small pixel measurements.	Yes
`nXtrack`	60	Number of cross-track OMI fields-of-view.	Yes
`Unlimited`	-1	A special value to indicate that a dimension is not explicitly defined.	No
`nPolynomial`	6	Deprecated.	No
`nUTC`	27	Dimension inherited from OMPIXCOR data product.	No

Table 4: Swath-level attributes.

Dimension Name	Size	Dimension Description
`NumTimes`	`HE5T_NATIVE_INT64`	Actual size of the dimension nTimes.

continued on the next page ...

... Table 4, continued.

Dimension Name	Size	Dimension Description
NumTimesSmallPixel	HE5T_NATIVE_INT64	Actual size of the dimension nTimesSmallPixel.
NumSWLevels	HE5T_NATIVE_INT64	Number of pressure levels where the scattering weight is reported.
VerticalCoordinate	HE5T_NATIVE_CHAR	"Total Column".

Table 5: Field-level attributes.

Attribute name	Attribute Type	Attribute Description
_FillValue	Same type as data field	Contains the value for fill data.
MissingValue	Same type as data field	Contains the value for missing data.
Title	HE5T_NATIVE_CHAR	Title of the field.
Units	HE5T_NATIVE_CHAR	Units after applying scale factor and offset.
ScaleFactor	HE5T_NATIVE_FLOAT	Factor for scaling data.
Offset	HE5T_NATIVE_FLOAT	Value to add to the data.
UniqueFieldDefinition	HE5T_NATIVE_CHAR	Indicates if definition of field is shared with other Aura Instruments ("Aura-Shared", "X-Specific", where X=Instrument Name, "X-Y[-Z]-Shared" where X,Y, and optional Z are instrument names, in alphabetical order)

A list of geolocation fields is given in Table 6, and a list of data fields is given in Table 8. The fields are more fully explained in the next two sections. Lists of global file attributes and metadata are given in the subsequent sections.

4 Geolocation fields

The geolocation fields are stored in the `Geolocation Fields` group of the Swath structure. This section gives a description of all the Geolocation Fields. For each of the fields the `UniqueFieldDefinition` metadata item (see Table 5) indicates if a field is shared with other instruments (see AD2). The default value is "OMI-Specific". In case of a shared field, this is indicated in the field description.

Version 3.0 of the data product contains fields describing the field-of-view geometries, `FoV75CornerLatitude` and `FoV75CornerLongitude`. These have been copied from the OMI Pixel Corner data product (OMPIXCOR). The description as "FoV75" indicates that the FoV corners are computed so that their boundaries contain 75% of the energy in the along-track field of view, taking account of both diffraction due to the edge of the instrument's apperture and the motion of the spacecraft during the integration (exposure) time. The OMPIXCOR product has two different sets of FoV corners: The FoV75, in which the FoVs overlap (mostly in the along-track direction), and the Tiled, in which they do not. The Tiled FoV corners are not available in the OMNO2 data product; users wishing to use tiled FoVs must read them from the OMPIXCOR files.

Table 6 provides a list of the geolocation fields in alphabetical order, with links to the appropriate subsections of this document.

Table 6: List of Geolocation Fields.

Field Name	Sec.	Description
FoV75Area	5.1	Mean area of Field of View for each scan position.
FoV75CornerLatitude	5.2	Field of view corner latitudes.
FoV75CornerLongitude	5.3	Field of view corner latitudes.
Latitude	5.4	Latitude of the center of the groundpixel
Longitude	5.5	Longitude of the center of the groundpixel
OrbitPhase	5.6	The place of OMI in orbit
SolarAzimuthAngle	5.7	Solar azimuth angle.
SolarZenithAngle	5.8	Solar zenith angle at the ground pixel center.
SpacecraftAltitude	5.9	Altitude above WGS84 ellipsoid
SpacecraftLatitude	5.10	Geodetic Latitude above WGS84 ellipsoid
SpacecraftLongitude	5.11	Geodetic Longitude above WGS84 ellipsoid
Time	5.12	Time at Start of Scan (s, TAI93)
ViewingAzimuthAngle	5.13	Viewing azimuth angle at ground pixel center.
ViewingZenithAngle	5.14	Viewing zenith angle at center of ground pixel.
GroundPixelQualityFlags	5.15	Ground Pixel Quality Flags

5 Gelocation field descriptions

5.1 FoV75Area

Field name	FoV75Area
Title	Mean Area for 75% Field of View Pixels on the WGS-85 Ellipsoid
Units	km^2
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack]
Scale, Offset	$\times 1. + 0.$
Fill value	$F149F2CA_{16} = -1.00000e + 30$
Missing value	$F149F2CA_{16} = -1.00000e + 30$
Valid range	
Written by	OMPIXCOR

Mean area of the 75% field of view Pixels on the WGS84 Ellipsoid. The actual area varies slightly with the spacecraft latitude and terrain height. These values are useful for computing relative weighting factors when constructing statistical values (*e.g.* averages) from multiple FOVs. They are used, for example, in constructing the daily NO_2 fields in the data product `OMNO2d`.

The 75% field of view is a quadrangular figure on the Earth (as approximated by the WGS84 Ellipsoid) that represents the area from which 75% of the photons reaching the detector would have originated from a homogeneous radiating surface.

The values included in the `OMNO2` data product have been copied from the `OMPIXCOR` data product.

5.2 FoV75CornerLatitude

Field name	FoV75CornerLatitude
Title	Corner Latitudes for 75% Field of View Pixels on the WGS-85 Ellipsoid (CCW relative to flight direction: LL,LR,UR,UL)
Units	deg
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes,nCorners]
Scale, Offset	$\times 1. + 0.$
Fill value	$F149F2CA_{16} = -1.00000e + 30$
Missing value	$F149F2CA_{16} = -1.00000e + 30$
Valid range	
Written by	OMPIXCOR

Corner geodetic latitudes (see Section 5.4) for 75% field of view pixels on the WGS84 Ellipsoid. The corner points are ordered counterclockwise on the Earth's surface: LL, LR, UR, UL.

The 75% field of view is a quadrangular figure on the Earth (as approximated by the WGS84 Ellipsoid) that represents the area from which 75% of the photons reaching the

detector would have originated from a homogeneous radiating surface.

The values included in the OMNO2 data product have been copied from the OMPIXCOR data product.

5.3 FoV75CornerLongitude

Field name	FoV75CornerLongitude
Title	Corner Longitudes for 75% Field of View Pixels on the WGS-85 Ellipsoid (CCW relative to flight direction: LL,LR,UR,UL)
Units	deg
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes,nCorners]
Scale, Offset	$\times 1. + 0.$
Fill value	$\text{F149F2CA}_{16} = -1.00000e+30$
Missing value	$\text{F149F2CA}_{16} = -1.00000e+30$
Valid range	
Written by	OMPIXCOR

Corner geodetic longitudes (see Section 5.5) for 75% field of view pixels on the WGS84 Ellipsoid. The corner points are ordered counterclockwise on the Earth's surface: LL, LR, UR, UL.

The 75% field of view is a quadrangular figure on the Earth (as approximated by the WGS84 Ellipsoid) that represents the area from which 75% of the photons reaching the detector would have originated from a homogeneous radiating surface.

The values included in the OMNO2 data product have been copied from the OMPIXCOR data product.

5.4 Latitude

Field name	Latitude
Title	Latitude of the center of the groundpixel
Units	deg
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\text{F1800000}_{16} = -1.26765e+30$
Missing value	$\text{F1800000}_{16} = -1.26765e+30$
Valid range	
Written by	OML1BRVG

Geodetic latitude of the nominal centroid of the OMI FOV, referenced to the 1984 World Geodetic System (WGS84) Reference Ellipsoid.

The geodetic latitude is the angle at the Earth's center of mass between the normal to the reference ellipsoid and the equatorial plane. This differs from the geocentric latitude, which is the angle between the radius (from the Earth's center) and the equatorial plane,

by a value between 0 (at the equator and at the poles) to 11.67 minutes of arc at geodetic latitude 45°.

5.5 Longitude

Field name	Longitude
Title	Longitude of the center of the groundpixel
Units	deg
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\text{F1800000}_{16} = -1.26765e + 30$
Missing value	$\text{F1800000}_{16} = -1.26765e + 30$
Valid range	
Written by	OML1BRVG

Geodetic longitude of the nominal centroid of the OMI FOV, referenced to the 1984 World Geodetic System (WGS84) Reference Ellipsoid.

The origin (0-point) of geodetic longitude is at the epoch 1984.0 IERS (International Earth Rotation and Reference Systems Service) Reference Meridian. It is not quite coincident with the traditional Greenwich Meridian, which coincided with the Airy Transit Circle instrument at the Royal Observatory, Greenwich. The IERS (WGS84) meridian remains fixed while the Earth's tectonic plates (including the one the Royal Observatory is on) move around. The deviation is about 5.3 arc-seconds, with the WGS84 meridian passing about 102 m east of the Airy Transit Circle, or 0.15 seconds of time.

Because this deviation is small, compared to the size of an OMI FOV it is generally safe to overlook it in mapping OMI data.

5.6 OrbitPhase

Field name	OrbitPhase
Title	The place of OMI in orbit
Units	NoUnits
Type	H5T_NATIVE_FLOAT
Dimensions	[nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\text{F1800000}_{16} = -1.26765e + 30$
Missing value	$\text{F1800000}_{16} = -1.26765e + 30$
Valid range	
Written by	

The orbit phase is the position along the orbit, from 0 to 1. The end-points are two consecutive Aura night-side equator crossings.

This field appears never to have been filled in with data values.

5.7 SolarAzimuthAngle

Field name	SolarAzimuthAngle
Title	Solar azimuth angle at WGS84 ellipsoid for center co-ordinate of the ground pixel, defined East-of-North
Units	deg
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\mathrm{F1800000}_{16} = -1.26765e + 30$
Missing value	$\mathrm{F1800000}_{16} = -1.26765e + 30$
Valid range	
Written by	OML1BRVG

Solar azimuth angle at WGS84 ellipsoid at the nominal centroid of the ground pixel, defined East-of-North. That is, it is the azimuth of the ray from the centroid to the sun.

5.8 SolarZenithAngle

Field name	SolarZenithAngle
Title	Solar zenith angle at WGS84 ellipsoid for center co-ordinate of the ground pixel
Units	deg
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\mathrm{F1800000}_{16} = -1.26765e + 30$
Missing value	$\mathrm{F1800000}_{16} = -1.26765e + 30$
Valid range	
Written by	OML1BRVG

Solar zenith angle ($\theta_\circ$; SZA) at WGS84 ellipsoid at the nominal centroid of the ground pixel. That is, it is the zenith angle of the ray from the centroid to the sun.

Note that the zenith vector is defined to be tangent to the surface of the WGS84 ellipsoid. This may deviate from the local zenith angle (*e.g.* the astronomical zenith vector, which is defined in the direction of a local plumb line). Deviations may be estimated from the Earth Gravitational Model (*e.g.* EGM2008).

The solar elevation angle is $90^\circ - \theta_\circ$.

5.9 SpacecraftAltitude

Field name	SpacecraftAltitude
Title	Altitude above WGS84 ellipsoid
Units	m
Type	H5T_NATIVE_FLOAT
Dimensions	[nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\text{F1800000}_{16} = -1.26765e+30$
Missing value	$\text{F1800000}_{16} = -1.26765e+30$
Valid range	
Written by	OML1BRVG

The distance of the Aura spacecraft from the subsatellite point on the WGS84 ellipsoid (Sections 5.10 and 5.11).

5.10 SpacecraftLatitude

Field name	SpacecraftLatitude
Title	Geodetic Latitude above WGS84 ellipsoid
Units	deg
Type	H5T_NATIVE_FLOAT
Dimensions	[nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\text{F1800000}_{16} = -1.26765e+30$
Missing value	$\text{F1800000}_{16} = -1.26765e+30$
Valid range	
Written by	OML1BRVG

The geodetic latitude (see Section 5.4) of the subsatellite point, defined as the position where a line drawn from the satellite to the center of the Earth intersects the WGS84 ellipsoid surface.

5.11 SpacecraftLongitude

Field name	SpacecraftLongitude
Title	Geodetic Longitude above WGS84 ellipsoid
Units	deg
Type	H5T_NATIVE_FLOAT
Dimensions	[nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\text{F1800000}_{16} = -1.26765e+30$
Missing value	$\text{F1800000}_{16} = -1.26765e+30$
Valid range	
Written by	OML1BRVG

The geodetic longitude (see Section 5.5) of the subsatellite point, defined as the position where a line drawn from the satellite to the center of the Earth intersects the WGS84 ellipsoid surface.

5.12 Time

Field name	Time
Title	Time at Start of Scan (s, TAI93)
Units	s
Type	H5T_NATIVE_DOUBLE
Dimensions	[nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\mathrm{C630000000000000}_{16} = -1.2676506e + 30$
Missing value	$\mathrm{C630000000000000}_{16} = -1.2676506e + 30$
Valid range	
Written by	OML1BRVG

The TAI-93 time, in seconds. The TAI-93 (*Temps Atomique International*) differs from UTC (a compromise abbreviation between the English Coordinated Universal Time and the French *Temps Universel Coordonné*) by the number of leap-seconds added since a certain epoch. As of OMI's launch in July 2004, this lag (TAI-UTC) was 31 seconds. This has increased by one second at the end of the day on each of the following dates: 2005 December 31, 2008 December 21, 2012 June 30, 2015 June 30, and 2016 December 31.

Equations for conversion between TAI-93, UTC, local civil time (wall clock) and local apparent solar time (sundial time) at the position of an
omi observation may be found in Appendix A of the OMNO2 README document.

5.13 ViewingAzimuthAngle

Field name	ViewingAzimuthAngle
Title	Viewing azimuth angle at WGS84 ellipsoid for center co-ordinate of the ground pixel, defined East-of-North
Units	deg
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\mathrm{F1800000}_{16} = -1.26765e + 30$
Missing value	$\mathrm{F1800000}_{16} = -1.26765e + 30$
Valid range	
Written by	OML1BRVG

Viewing azimuth angle at WGS84 ellipsoid at the nominal centroid of the ground pixel, defined East-of-North. That is, it is the azimuth of the ray from the centroid to the spacecraft.

5.14 ViewingZenithAngle

Field name	ViewingZenithAngle
Title	Viewing zenith angle at WGS84 ellipsoid for center co-ordinate of the ground pixel
Units	deg
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\text{F1800000}_{16} = -1.26765e + 30$
Missing value	$\text{F1800000}_{16} = -1.26765e + 30$
Valid range	
Written by	OML1BRVG

Viewing zenith angle (θ, VZA) at WGS84 ellipsoid at the nominal centroid of the ground pixel. That is, it is the zenith angle of the ray from the centroid to the spacecraft.

Note that the zenith vector is defined to be tangent to the surface of the WGS84 ellipsoid. This may deviate from the local zenith angle (*e.g.* the astronomical zenith vector, which is defined in the direction of a local plumb line). Deviations may be estimated from the Earth Gravitational Model (*e.g.* EGM2008).

The viewing elevation is $90° - \theta$.

5.15 GroundPixelQualityFlags

Field name	GroundPixelQualityFlags
Title	Ground Pixel Quality Flags
Units	NoUnits
Type	H5T_NATIVE_USHORT
Dimensions	[nXtrack,nTimes]
Scale, Offset	
Fill value	$\text{FFFF}_{16} = 65535$
Missing value	$\text{FFFF}_{16} = 65535$
Valid range	
Written by	OML1BRVG

The ground pixel quality flag contains information about the nature of the surface within the OMI FOV, including water and snow/ice cover. Also included are a flag that indicates the possibility of sun glint and one that indicates the possibility that the FOV is affected by a solar eclipse.

The ground pixel quality flag bits are assigned as shown in Table 7 (bit 0 is the least-significant bit).

Table 7: Definitions of Ground Pixel Quality Flags

<table>
<tr><th>Bit</th><th>Description</th></tr>
<tr><td>0-3</td><td>Land/Water flags [RD6]
<table>
<tr><th>Value</th><th>Meaning</th></tr>
<tr><td>0</td><td>Shallow ocean</td></tr>
<tr><td>1</td><td>Land</td></tr>
<tr><td>2</td><td>Shallow inland water</td></tr>
<tr><td>3</td><td>Ocean coastline / Lake shoreline</td></tr>
<tr><td>4</td><td>Ephemeral (intermittent) water</td></tr>
<tr><td>5</td><td>Deep inland water</td></tr>
<tr><td>6</td><td>Continental shelf ocean</td></tr>
<tr><td>7</td><td>Deep ocean</td></tr>
<tr><td>8–14</td><td>Not used</td></tr>
<tr><td>15</td><td>Error flag for Land/Water</td></tr>
</table></td></tr>
<tr><td>4</td><td>Sun glint possibility flag</td></tr>
<tr><td>5</td><td>Solar eclipse possibility flag</td></tr>
<tr><td>6</td><td>Geolocation error flag</td></tr>
<tr><td>7</td><td>Reserved for future use</td></tr>
<tr><td>8-14</td><td>Snow/Ice flags [based on NISE, RD5]
<table>
<tr><th>Value</th><th>Meaning</th></tr>
<tr><td>0</td><td>Snow-free land</td></tr>
<tr><td>1-100</td><td>Sea ice concentration (%)</td></tr>
<tr><td>101</td><td>Permanent ice (Greenland, Antarctica)</td></tr>
<tr><td>102</td><td>Not used</td></tr>
<tr><td>103</td><td>Dry snow</td></tr>
<tr><td>104</td><td>Ocean [NISE-255]</td></tr>
<tr><td>105–123</td><td>Reserved</td></tr>
<tr><td>124</td><td>Mixed pixels at coastline [NISE-252]</td></tr>
<tr><td>125</td><td>Suspect ice value [NISE-253]</td></tr>
<tr><td>126</td><td>Corners (undefined) [NISE-254]</td></tr>
<tr><td>127</td><td>Error</td></tr>
</table></td></tr>
<tr><td>15</td><td>NISE nearest neighbor filling flag</td></tr>
</table>

6 Data Fields

The data fields are stored in the Data Fields group of the Swath structure. The following subsections give descriptions of the individualData Fields. Of these fields the following five fields are used for quality flags: `MeasurementQualityFlags`, `AMFQualityFlags`, `vcdQualityFlags` and `XTrackQualityFlags`. The `MeasurementQualityFlags` and provide information on the Level 1B input radiance and irradiance data, the spectral fitting, the initial air mass factor and on the initial vertical column densities, that are produced by PGE A. The `AMFQualityFlags` and `vcdQualityFlags` provide quality information on the air mass factors and on the vertical column densities.

Table 8: Data fields

Field	Sec.	Description
`AmfStrat`	7.1	Stratospheric air mass factor
`AmfStratClear`	7.2	Stratospheric air mass factor for clear scene
`AmfStratCloudy`	7.3	Stratospheric air mass factor for clouded scene
`AmfStratStd`	7.4	Uncertainty of the stratospheric air mass factor
`AmfTrop`	7.5	Tropospheric air mass factor
`AmfTropClear`	7.6	Tropospheric air mass factor for clear scene
`AmfTropCloudy`	7.7	Tropospheric air mass factor for clouded scene
`AmfTropStd`	7.8	Uncertainty of the tropospheric air mass factor
`CloudFraction`	7.9	Estimated cloud-covered fraction of scene
`CloudFractionStd`	7.10	Uncertainty of cloud fraction
`CloudPressure`	7.11	Estimated optical centroid pressure of the clouds
`CloudPressureStd`	7.12	Uncertainy of cloud pressure.
`CloudRadianceFraction`	7.13	Estimated fraction of photons coming from cloud-covered portion of the scene
`ColumnAmountNO2`	7.14	Total vertical column density of NO_2
`ColumnAmountNO2Std`	7.15	Uncertainty of the total vertical column density of NO_2
`ColumnAmountNO2Strat`	7.16	Stratospheric vertical column density of NO_2
`ColumnAmountNO2StratStd`	7.17	Uncertainty of the stratospheric vertical column density of NO_2
`ColumnAmountNO2Trop`	7.18	Tropospheric vertical column density of NO_2
`ColumnAmountNO2TropStd`	7.19	Uncertainty of the tropospheric vertical column density of NO_2
`InstrumentConfigurationId`	7.20	Instrument configuration indicators.
`ScatteringWeight`	7.21	Vertical profile of scattering weights used for calculating air mass factors

Continued on next page

. . . Table 8, continued.

Field	Sec.	Description
ScatteringWtPressure	7.22	Pressure coordinates for scattering weight vector
ScdApStrat	7.23	*A priori* NO_2 slant column density of the stratosphere
ScdApTrop	7.24	*A priori* NO_2 slant column density of the troposphere
SlantColumnAmountCHOCHO	7.25	Slant column density of glyoxal
SlantColumnAmountCHOCHOStd	7.26	Uncertainty of slant column density of glyoxal
SlantColumnAmountH2O	7.27	Slant column density of water vapor
SlantColumnAmountH2OStd	7.28	Uncertainty of the slant column density of water vapor
SlantColumnAmountNO2	7.29	Slant column density of nitrogen dioxide
SlantColumnAmountNO2Destriped	7.30	Destriped slant column density of nitrogen dioxide
SlantColumnAmountNO2Std	7.31	Uncertainty of slant cloumn density of nitrogen dioxide
SmallPixelRadiance	7.32	
SmallPixelRadiancePointer	7.33	
TerrainHeight	7.34	Height of terrain above mean sea level
TerrainPressure	7.35	Nominal pressure at the terrain height
TerrainReflectivity	7.36	Reflectivity of the terrain
TropopausePressure	7.37	
VcdApBelowCloud	7.38	*A priori* NO_2 vertical column density below the cloud pressure
VcdApStrat	7.39	*A priori* NO_2 vertical column density of the stratosphere
VcdApTrop	7.40	*A priori* NO_2 vertical column density of the troposphere
WavelengthRegistrationCheck	7.41	
WavelengthRegistrationCheckStd	7.42	
AMFQualityFlags	7.43	Flags for the quality of the air mass factor calculations
AlgorithmFlags	7.44	Flags for the vertical column density calculation
MeasurementQualityFlags	7.45	
OMNO2SCD_algoFlags	7.46	Algorithm flags from OMNO2SCD App.
OMNO2SCD_algoxFlags	7.47	Extended algorithm flags from OMNO2SCD App.
OMNO2SCD_procFlags	7.48	Processing flags from OMNO2SCD App.
OMNO2SCD_radFlags	7.49	Radiance quality flags from OMNO2SCD App.
OMNO2SCD_scdFlags	7.50	Slant column density quality flags from OMNO2SCD App.
OMNO2SCD_wvlnFlags	7.51	Wavelength fine tuning flags from OMNO2SCD App.

Continued on next page

. . . Table 8, continued.

Field	Sec.	Description
`VcdQualityFlags`	7.52	Flags for the vertical column amount calculations
`XTrackQualityFlags`	7.53	Flags indicating the state of the row anomaly

7 Data field descriptions

7.1 AmfStrat

Field name	AmfStrat
Title	Stratospheric air mass factor
Units	NoUnits
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\mathrm{F1800000}_{16} = -1.26765e+30$
Missing value	$\mathrm{F1800000}_{16} = -1.26765e+30$
Valid range	
Written by	OMNO2B

Air mass factor of the stratosphere.

Air mass factors are computed from the product of a model-based NO_2 profile and a radiative-transfer-based scattering weight (See 7.21; Model NO_2 profiles used in the calculation are available from the U.S. OMI NO_2 Team.)

Details of the calculation may be found in the OMNO2 Readme file.

7.2 AmfStratClear

Field name	AmfStratClear
Title	Clear-sky stratospheric air mass factor
Units	NoUnits
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\mathrm{F1800000}_{16} = -1.26765e+30$
Missing value	$\mathrm{F1800000}_{16} = -1.26765e+30$
Valid range	
Written by	OMNO2B

Air mass factor of the stratosphere under clear-sky conditions.

Air mass factors are computed from the product of a model-based NO_2 profile and a radiative-transfer-based scattering weight (See 7.21; Model NO_2 profiles used in the calculation are available from the U.S. OMI NO_2 Team.)

Details of the calculation may be found in the OMNO2 Readme file.

7.3 AmfStratCloudy

Field name	AmfStratCloudy
Title	Cloudy-sky stratospheric air mass factor
Units	NoUnits
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\mathrm{F1800000}_{16} = -1.26765e + 30$
Missing value	$\mathrm{F1800000}_{16} = -1.26765e + 30$
Valid range	
Written by	OMNO2B

Air mass factor of the stratosphere under completely-clouded conditions.

Air mass factors are computed from the product of a model-based NO_2 profile and a radiative-transfer-based scattering weight (See 7.21; Model NO_2 profiles used in the calculation are available from the U.S. OMI NO_2 Team.)

Details of the calculation may be found in the OMNO2 Readme file.

7.4 AmfStratStd

Field name	AmfStratStd
Title	Uncertainty of stratospheric air mass factor
Units	NoUnits
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\mathrm{F1800000}_{16} = -1.26765e + 30$
Missing value	$\mathrm{F1800000}_{16} = -1.26765e + 30$
Valid range	
Written by	OMNO2B

Uncertainty of the stratospheric air mass factor.

7.5 AmfTrop

Field name	AmfTrop
Title	Tropospheric air mass factor
Units	NoUnits
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\mathrm{F1800000}_{16} = -1.26765e + 30$
Missing value	$\mathrm{F1800000}_{16} = -1.26765e + 30$
Valid range	
Written by	OMNO2B

Air mass factor of the troposphere.

Air mass factors are computed from the product of a model-based NO_2 profile and a radiative-transfer-based scattering weight (See 7.21; Model NO_2 profiles used in the calculation are available from the U.S. OMI NO_2 Team.)

Details of the calculation may be found in the OMNO2 Readme file.

7.6 AmfTropClear

Field name	AmfTropClear
Title	Clear-sky tropospheric air mass factor
Units	NoUnits
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\mathrm{F1800000}_{16} = -1.26765e+30$
Missing value	$\mathrm{F1800000}_{16} = -1.26765e+30$
Valid range	
Written by	OMNO2B

Air mass factor of the troposphere in clear-sky conditions

Air mass factors are computed from the product of a model-based NO_2 profile and a radiative-transfer-based scattering weight (See 7.21; Model NO_2 profiles used in the calculation are available from the U.S. OMI NO_2 Team.)

Details of the calculation may be found in the OMNO2 Readme file.

7.7 AmfTropCloudy

Field name	AmfTropCloudy
Title	Cloudy-sky tropospheric air mass factor
Units	NoUnits
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\mathrm{F1800000}_{16} = -1.26765e+30$
Missing value	$\mathrm{F1800000}_{16} = -1.26765e+30$
Valid range	
Written by	OMNO2B

Air mass factor of the troposphere in completely clouded conditions.

Air mass factors are computed from the product of a model-based NO_2 profile and a radiative-transfer-based scattering weight (See 7.21; Model NO_2 profiles used in the calculation are available from the U.S. OMI NO_2 Team.)

Details of the calculation may be found in the OMNO2 Readme file.

7.8 AmfTropStd

Field name	AmfTropStd
Title	Uncertainty of tropospheric air mass factor
Units	NoUnits
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\mathrm{F1800000}_{16} = -1.26765e + 30$
Missing value	$\mathrm{F1800000}_{16} = -1.26765e + 30$
Valid range	
Written by	OMNO2B

Uncertainty of the tropospheric air mass factor.

7.9 CloudFraction

Field name	CloudFraction
Title	Effective cloud fraction
Units	NoUnits
Type	H5T_NATIVE_SHORT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 0.001 + 0.$
Fill value	$8001_{16} = -32767$
Missing value	$8001_{16} = -32767$
Valid range	
Written by	OMNO2A

The effective geometric cloud fraction, as determined by the OMCLDO2 algorithm. This value has been copied from the OMCLDO2 data product by the OMNO2A application.

Note that this value is stored as a short (16-bit integer), scaled by a factor 1000.

7.10 CloudFractionStd

Field name	CloudFractionStd
Title	Effective cloud fraction precision
Units	NoUnits
Type	H5T_NATIVE_SHORT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 0.001 + 0.$
Fill value	$8001_{16} = -32767$
Missing value	$8001_{16} = -32767$
Valid range	
Written by	OMNO2A

Uncertainty of the cloud fraction (Section 7.9). This is estimated by the OMCLDO2 application.

Note that this is stored as an integer with the same scaling as the cloud fraction.

7.11 CloudPressure

Field name	CloudPressure
Title	Effective cloud pressure
Units	hPa
Type	H5T_NATIVE_SHORT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$8001_{16} = -32767$
Missing value	$8001_{16} = -32767$
Valid range	
Written by	OMNO2A

Cloud optical centroid pressure, as estimated by the OMCLDO2 algorithm. This value is copied from the OMCLDO2 data product by the OMNO2A App.

Note that this value is stored as an integer.

7.12 CloudPressureStd

Field name	CloudPressureStd
Title	Effective cloud pressure precision
Units	hPa
Type	H5T_NATIVE_SHORT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$8001_{16} = -32767$
Missing value	$8001_{16} = -32767$
Valid range	
Written by	OMNO2A

Uncertainty of the cloud pressure (Section 7.11). This is estimated by the OMCLDO2 App.

7.13 CloudRadianceFraction

Field name	CloudRadianceFraction
Title	Fraction of the radiance from the cloudy part
Units	NoUnits
Type	H5T_NATIVE_SHORT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 0.001 + 0.$
Fill value	$8001_{16} = -32767$
Missing value	$8001_{16} = -32767$
Valid range	
Written by	OMNO2A

The cloud radiance fraction is an estimate of the fraction of photons reaching the satellite instrument that come from cloud-covered parts of the scene.

This is estimated in the OMNO2A application using a lookup table interpolation. The lookup table was generated using radiative transfer code. The seven (7) independent variables of the lookup table are cloud fraction, cloud pressure, solar zenith angle, viewing zenith angle, relative azimuth angle between solar and viewing vectors terrain pressure, and terrain reflectivity.

7.14 ColumnAmountNO2

Field name	ColumnAmountNO2
Title	ColumnAmountNO2
Units	cm$^-$2
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\text{F1800000}_{16} = -1.26765e + 30$
Missing value	$\text{F1800000}_{16} = -1.26765e + 30$
Valid range	
Written by	OMNO2

Estimated total column amount of NO_2. For stratospheric and tropospheric column amounts, see Sections 7.16 and 7.18.

7.15 ColumnAmountNO2Std

Field name	ColumnAmountNO2Std
Title	ColumnAmountNO2Std
Units	cm$^-$2
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\text{F1800000}_{16} = -1.26765e + 30$
Missing value	$\text{F1800000}_{16} = -1.26765e + 30$
Valid range	
Written by	OMNO2

Estimated uncertainty of the total column amount NO_2 (Section 7.14).

7.16 ColumnAmountNO2Strat

Field name	ColumnAmountNO2Strat
Title	ColumnAmountNO2Strat
Units	cm$^-$2
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\text{F1800000}_{16} = -1.26765e+30$
Missing value	$\text{F1800000}_{16} = -1.26765e+30$
Valid range	
Written by	OMNO2

Estimated stratospheric column amount NO_2.

7.17 ColumnAmountNO2StratStd

Field name	ColumnAmountNO2StratStd
Title	ColumnAmountNO2StratStd
Units	cm$^-$2
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\text{F1800000}_{16} = -1.26765e+30$
Missing value	$\text{F1800000}_{16} = -1.26765e+30$
Valid range	
Written by	OMNO2

Estimated uncertainty of the stratospheric column amount of NO_2.

7.18 ColumnAmountNO2Trop

Field name	ColumnAmountNO2Trop
Title	ColumnAmountNO2Trop
Units	cm$^-$2
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\text{F1800000}_{16} = -1.26765e+30$
Missing value	$\text{F1800000}_{16} = -1.26765e+30$
Valid range	
Written by	OMNO2

Estimated tropospheric column amount of NO_2.

Over generally unpolluted areas, this retrieved value is dominated by the *a priori* (model) column amount, but is also affected by the stratosphere-troposphere separation algorithm, which serves to widen the distribution of values considerably. As a result, many of the values over those unpolluted areas (*e.g.* over open ocean) are small, negative numbers.

When forming statistical values (mean, median, variance, *etc.*), the negative values should not be excluded.

7.19 ColumnAmountNO2TropStd

Field name	ColumnAmountNO2TropStd
Title	ColumnAmountNO2TropStd
Units	cm^-2
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$F1800000_{16} = -1.26765e + 30$
Missing value	$F1800000_{16} = -1.26765e + 30$
Valid range	
Written by	OMNO2

Estimated uncertainty of the tropospheric column amount of NO_2.

7.20 InstrumentConfigurationId

Field name	InstrumentConfigurationId
Title	Unique ID for instrument settings for current measurement
Units	NoUnits
Type	H5T_NATIVE_UCHAR
Dimensions	[nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$FF_{16} = 255$
Missing value	$FF_{16} = 255$
Valid range	
Written by	OML1BRVG

The Instrument configuration id identifies the state (configuration) of the OMI instrument. Values greater 7 are not earthshine radiance measurements. Vertical column amounts are only computed when the value is less than or equal to 7. The meaning of the instrument configuration IDs are listed in Table 9.

Table 9: OMI instrument configuration ID codes

Instrument configuration	ID
global tropical	0
global midlatitude	1
global arctic	2
global tropical dark, no FMM	3
global midlatitude dark, no FMM	4
global arctic dark, no FMM	5

continued on the next page ...

... Table 9, continued.

Instrument configuration	ID
global ozone hole dark, no FMM	6
global ozone hole	7
solar cal, volume diffusor, BF8	8
solar cal dark, volume diffusor, BF8	9
LED dark, unbinned	10
LED, unbinned	11
long dark unbinned, short duration	12
long dark unbinned, long duration	13
solar cal, volume diffusor, BF1	14
solar cal dark, volume diffusor, BF1	15
long dark 4 gains	16
long dark 1 gain	17
solar cal, regular diffusor, BF8	18
solar cal dark, regular diffusor, BF8	19
WLS PRNU dark	20
WLS PRNU	21
global tropical dark, FMM	22
global midlatitude dark, FMM	23
global arctic dark, FMM	24
global ozone hole dark, FMM	25
LED stability dark	26
LED stability	27
WLS stability dark BF8	28
WLS stability BF8	29
solar cal, backup diffusor, BF8	30
Solar cal dark, backup diffusor, BF8	31
LED dark, 4 gains used	32
LED dark, 1 gain used	33
LED, 4 gains used	34
LED, 1 gain used	35
WLS dark, 4 gains used	36
WLS dark, 1 gain used	37
WLS, 4 gains used	38
WLS, 1 gain used	39
WLS linearity #1 dark	40
WLS linearity #1	41
spatial tropical	42
spatial midlatitude	43
spatial arctic	44
spatial tropical dark, no FMM	e45
spatial midlatitude dark, no FMM	46
spatial arctic dark, no FMM	47
spatial ozone hole dark, no FMM	48
spatial ozone hole	49

continued on the next page ...

... Table 9, continued.

Instrument configuration	ID
Solar cal, volume diffusor, BF4 (spatial)	50
Solar cal dark, volume diffusor, BF4 (spatial)	51
spatial tropical dark, FMM	52
spatial midlatitude dark, FMM	53
spatial arctic dark, FMM	54
spatial ozone hole dark, FMM	55
spectral tropical	56
spectral midlatitude	57
spectral arctic	58
spectral tropical dark, no FMM	59
spectral midlatitude dark, no FMM	60
spectral arctic dark, no FMM	61
solar cal, volume diffusor, BF4 (spectral)	62
solar cal dark, volume diffusor, BF4 (spectral)	63
spectral tropical dark, FMM	64
spectral midlatitude dark, FMM	65
spectral arctic dark, FMM	66
SLS nadir Port performance	67
LEO solar cal, regular diffusor, BF4	68
LEO solar cal dark, regular diffusor, BF4	69
LEO solar cal, regular diffusor, BF1	70
LEO solar cal dark, regular diffusor, BF1	71
LEO solar cal, backup diffusor, BF4	72
LEO solar cal dark, backup diffusor, BF4	73
LEO solar cal, backup diffusor, BF1	74
LEO solar cal dark, backup diffusor, BF1	75
WLS linearity #2 dark	76
WLS linearity #2	77
WLS linearity #3 dark	78
WLS linearity #3	79
WLS linearity #4 dark	80
WLS linearity #4	81
WLS linearity #5 dark	82
WLS linearity #5	83
WLS linearity #6 dark	84
WLS linearity #6	85
WLS linearity #7 dark	86
WLS linearity #7	87
WLS linearity #8 dark	88
WLS linearity #8	89
WLS linearity #9 dark	90
WLS linearity #9	91
WLS linearity #10 dark	92
WLS linearity #10	93

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... Table 9, continued.

Instrument configuration	ID
WLS linearity #11 dark	94
LS linearity #11	95
LEO Dark, unbinned #1; exp.time 100 msec	96
LEO Dark, unbinned #2; exp.time 500 msec	97
LEO Dark, unbinned #3; exp.time 1000 msec	98
LEO Dark, unbinned #4; exp.time 1500 msec	99
LEO Dark, unbinned #5; exp.time 2000 msec	100
LEO Dark, unbinned #6; exp.time 3000 msec	101
LEO Dark, unbinned #7; exp.time 6000 msec	102
LEO Dark; long exposure middle	103
WLS LEO radiometric dark	104
WLS LEO radiometric	105
WLS LEO stability BF4 dark	106
WLS LEO stability BF4	107
WLS LEO stability BF1 dark	108
WLS LEO stability BF1	109
LED LEO stability dark (60 sec)	110
LED LEO stability (60 sec)	111
LED LEO stability BF4 dark	112
LED LEO stability BF4	113
LED LEO stability BF1 dark	114
LED LEO stability BF1	115
CTE long exposure long	116

7.21 ScatteringWeight

Field name	ScatteringWeight
Title	Scattering weight profile
Units	NoUnits
Type	H5T_NATIVE_FLOAT
Dimensions	[nPresLevels,nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\mathrm{F1800000}_{16} = -1.26765e+30$
Missing value	$\mathrm{F1800000}_{16} = -1.26765e+30$
Valid range	
Written by	OMNO2B

Vector **A** [no units] that describes the relationship between slant column, S_i and the vertical column, V_i, for each atmospheric layer i:

$$S = \sum_i S_i \approx \sum A_i \cdot V_i \tag{1}$$

A is relatively insensitive to the wavelength within the NO_2 spectral region, so only a single value, valid for the entire spectral fitting window, is provided. **A** is a function of the

optical geometry, surface albedo, and cloud parameters, and contains a correction for the temperature dependence of the NO_2 cross section. The grid of pressure levels is available in the file, See Section 7.22.

Partial slant column (*e.g.* tropospheric) densities may be computed from Eq. (1) using ranges of i falling within the partial column, and V_i values derived from measurements or models. The partial column Air-Mass Factor (AMF) (*e.g.* AMFtrop, Section 7.5) can be obtained by dividing Eq. (1) by the corresponding partial vertical column (*e.g.* V_{trop}).

7.22 ScatteringWtPressure

Field name	ScatteringWtPressure
Title	Pressures for scattering weight profile
Units	hPa
Type	H5T_NATIVE_FLOAT
Dimensions	[nPresLevels]
Scale, Offset	$\times 1. + 0.$
Fill value	$\mathrm{F1800000}_{16} = -1.26765e+30$
Missing value	$\mathrm{F1800000}_{16} = -1.26765e+30$
Valid range	
Written by	OMNO2B

Vector of pressures on which scattering weights (Section 7.21)are reported.

7.23 ScdApStrat

Field name	ScdApStrat
Title	A priori stratospheric slant column density of nitrogen dioxide
Units	$\mathrm{molec/cm}^2$
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\mathrm{F1800000}_{16} = -1.26765e+30$
Missing value	$\mathrm{F1800000}_{16} = -1.26765e+30$
Valid range	
Written by	OMNO2B

Stratospheric component of the *a priori* profile (Section 7.39), transformed to the slant column amount via the stratospheric air mass factor (Section 7.1).

7.24 ScdApTrop

Field name	ScdApTrop
Title	A priori tropospheric slant column density of nitrogen dioxide
Units	molec/cm^2
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\text{F1800000}_{16} = -1.26765e+30$
Missing value	$\text{F1800000}_{16} = -1.26765e+30$
Valid range	
Written by	OMNO2B

Tropospheric component of the *a priori* profile (Section 7.40), transformed via the tropospheric air mass factor (Section 7.5) into the slant column amount.

7.25 SlantColumnAmountCHOCHO

Field name	SlantColumnAmountCHOCHO
Title	O3 slant column density
Units	molec/cm^2
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\text{F1800000}_{16} = -1.26765e+30$
Missing value	$\text{F1800000}_{16} = -1.26765e+30$
Valid range	
Written by	OMNO2SCD

Slant column amount of glyoxal (CHOCHO) estimated by the OMNO2SCD algorithm.

7.26 SlantColumnAmountCHOCHOStd

Field name	SlantColumnAmountCHOCHOStd
Title	Precision of the O3 slant column density
Units	molec/cm^2
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\text{F1800000}_{16} = -1.26765e+30$
Missing value	$\text{F1800000}_{16} = -1.26765e+30$
Valid range	
Written by	OMNO2SCD

Estimated uncertainty of the slant column amount of glyoxal.

7.27 SlantColumnAmountH2O

Field name	SlantColumnAmountH2O
Title	H2O slant column density
Units	molec/cm^2
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\mathrm{F1800000}_{16} = -1.26765e+30$
Missing value	$\mathrm{F1800000}_{16} = -1.26765e+30$
Valid range	
Written by	OMNO2SCD

Slant column amount of water vapor, estimated by the OMNO2SCD application.

7.28 SlantColumnAmountH2OStd

Field name	SlantColumnAmountH2OStd
Title	Precision of the H2O slant column density
Units	molec/cm^2
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\mathrm{F1800000}_{16} = -1.26765e+30$
Missing value	$\mathrm{F1800000}_{16} = -1.26765e+30$
Valid range	
Written by	OMNO2SCD

Estimated uncertainty of the retrieved slant column amount of water vapor.

7.29 SlantColumnAmountNO2

Field name	SlantColumnAmountNO2
Title	NO2 slant column density
Units	molec/cm^2
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\mathrm{F1800000}_{16} = -1.26765e+30$
Missing value	$\mathrm{F1800000}_{16} = -1.26765e+30$
Valid range	
Written by	OMNO2SCD

Slant column amount of nitrogen dioxide (NO_2), estimated by the OMNO2SCD application. See also Section 7.30.

7.30 SlantColumnAmountNO2Destriped

Field name	SlantColumnAmountNO2Destriped
Title	SlantColumnAmountNO2Destriped
Units	cm$^-$2
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\text{F1800000}_{16} = -1.26765e + 30$
Missing value	$\text{F1800000}_{16} = -1.26765e + 30$
Valid range	
Written by	OMNO2

Estimate of the slant column amount of NO_2, with row-to-row (iXtrack) variations due to instrumental artifact removed in the OMNO2 application.

7.31 SlantColumnAmountNO2Std

Field name	SlantColumnAmountNO2Std
Title	Precision of the NO2 slant column density
Units	molec/cm^2
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\text{F1800000}_{16} = -1.26765e + 30$
Missing value	$\text{F1800000}_{16} = -1.26765e + 30$
Valid range	
Written by	OMNO2SCD

Estimated uncertainty of the slant column amount of NO_2, estimated by the OMNO2SCD application.

7.32 SmallPixelRadiance

Field name	SmallPixelRadiance
Title	Radiance of small pixel data column
Units	photons/ (s.nm.cm^2.sr)
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimesSmallPixel]
Scale, Offset	$\times 1. + 0.$
Fill value	$\text{F1800000}_{16} = -1.26765e + 30$
Missing value	$\text{F1800000}_{16} = -1.26765e + 30$
Valid range	
Written by	OML1BRVG

7.33 SmallPixelRadiancePointer

Field name	SmallPixelRadiancePointer
Title	Offset and count of nTimesSmallPixel wrt nTimes
Units	NoUnits
Type	H5T_NATIVE_SHORT
Dimensions	[nSmallPixelPointer,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$8001_{16} = -32767$
Missing value	$8001_{16} = -32767$
Valid range	
Written by	OML1BRVG

7.34 TerrainHeight

Field name	TerrainHeight
Title	Terrain height at for center co-ordinate of the ground pixel
Units	m
Type	H5T_NATIVE_SHORT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$8001_{16} = -32767$
Missing value	$8001_{16} = -32767$
Valid range	
Written by	OML1BRVG

The terrain height is estimated using a digital elevation model (DEM) of the Earth's surface. The height is computed at the nominal centroid point for the FOV, and bilinearly interpolated from the DEM grid. Heights are referenced to mean sea level (MSL).

The DEM grid has a horizontal spatial resolution that is much finer than the size of an OMI FOV. Particularly in mountainous regions, the value of the terrain height may not adequately represent the average within the OMI FOV.

Note that the terrain heights are stored as integers, and so have an intrinsic resolution of 1m. Despite the fact that some parts of the Earth have negative heights, referenced to MSL, these points are assigned the value zero. See also notes at Section 7.35.

7.35 TerrainPressure

Field name	TerrainPressure
Title	Pressure of the center of the ground pixel
Units	hPa
Type	H5T_NATIVE_SHORT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$8001_{16} = -32767$
Missing value	$8001_{16} = -32767$
Valid range	
Written by	OML1BRVG

The terrain pressure, which is, in effect, adjusted to mean sea level (MSL), is computed from the terrain height (See 7.34) using the barometric formula and a constant scale height of $H = 8.0 \times 10^3$ m

$$p_s = p_\circ e^{-h_s/H} \tag{2}$$

where p_s is the surface (terrain) pressure, ahd h_s is the surface (terrain) height. $p_\circ$ is the reference sea level pressure of 1013.25 hPa.

It is important to remember that the terrain pressure in this field is *not* the barometric pressure at the observation time: The data product contains no explicit meteorological data.

This value is stored as an integer, so has an intrinsic resolution of 1 hPa. Since the terrain height (Section 7.34) is limited to values ≥ 0, the maximum value for this field is 1013. This may not be appropriate for areas lying significantly below MSL.

For terrain heights blelow about 500 m, the user should recalculate the terrain pressure in floating-point arithmetic.

7.36 TerrainReflectivity

Field name	TerrainReflectivity
Title	Reflectivity of the ground pixel
Units	NoUnits
Type	H5T_NATIVE_SHORT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 0.001 + 0.$
Fill value	$8001_{16} = -32767$
Missing value	$8001_{16} = -32767$
Valid range	
Written by	OML1BRVG

The terrain reflectivity is the terrain reflectivity evaluated at the nominal FOV centroid. It is evaluated using the database of reflectivities assembled by Kleipool *et al.*, using spectral reflectivity measurements from OMI. The values are not interpolated. Rather, they are evaluated as the reflectivity grid value at the nearest grid cell center.

The reflectivity database is gridded with a resolution of $0.25^\circ \times 0.25^circ$ in latitude and longitude. This is comparable to the size of an OMI FOV near nadir, but significantly smaller for the outermost ~ 10 cross-track positions. Thus, the value obtained may not be a good representation of the average reflectivity within the OMI FOV.

Reference

Q.L. Kleipool, M.R. Dobber, J.F. deHaan, and P.F. Levelt, "Earth surface reflectance climatology from 3 years of OMI data," J. Geophys. Res. **113**, D18301, doi:10.1029/-2008JD010290, 2008.

7.37 TropopausePressure

Field name	TropopausePressure
Title	Pressure of the tropopause
Units	hPa
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\text{F1800000}_{16} = -1.26765e + 30$
Missing value	$\text{F1800000}_{16} = -1.26765e + 30$
Valid range	
Written by	OMNO2B

The tropopause pressure is derived by the GMI model. They are averaged over a 1-month period. Thus, the numbers may not represent the actual tropopause pressure at the time and location of the OMI measurement. The tropopause pressure is used as a definition of the boundary between stratosphere and troposphere for the computation of the respective air mass factors and vertical columnn densities.

7.38 VcdApBelowCloud

Field name	VcdApBelowCloud
Title	A priori below-cloud vertical column density of nitrogen dioxide
Units	molec/cm^2
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\text{F1800000}_{16} = -1.26765e + 30$
Missing value	$\text{F1800000}_{16} = -1.26765e + 30$
Valid range	
Written by	OMNO2B

The portion of the *a priori* vertical NO_2 column below the cloud pressure (Section 7.11).

7.39 VcdApStrat

Field name	VcdApStrat
Title	A priori stratospheric vertical column density of nitrogen dioxide
Units	molec/cm^2
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\text{F1800000}_{16} = -1.26765e+30$
Missing value	$\text{F1800000}_{16} = -1.26765e+30$
Valid range	
Written by	OMNO2B

The stratospheric component of the *a priori* NO_2 profile. The lower boundary for the stratosphere is taken to be the model-derived tropopause pressure (Section 7.37).

7.40 VcdApTrop

Field name	VcdApTrop
Title	A priori tropospheric vertical column density of nitrogen dioxide
Units	molec/cm^2
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\text{F1800000}_{16} = -1.26765e+30$
Missing value	$\text{F1800000}_{16} = -1.26765e+30$
Valid range	
Written by	OMNO2B

The tropospheric component of the *a priori* profile. The upper boundary of the troposphere is taken to be the model-derived tropopause pressure (Section 7.37).

7.41 WavelengthRegistrationCheck

Field name	WavelengthRegistrationCheck
Title	Correction applied to the L1B wavelength assignment based on the position of Fraunhofer absorption lines
Units	nm
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\text{F1800000}_{16} = -1.26765e+30$
Missing value	$\text{F1800000}_{16} = -1.26765e+30$
Valid range	
Written by	OML1BRVG

7.42 WavelengthRegistrationCheckStd

Field name	WavelengthRegistrationCheckStd
Title	Precision of the correction which was applied to the L1B wavelength assignment
Units	nm
Type	H5T_NATIVE_FLOAT
Dimensions	[nXtrack,nTimes]
Scale, Offset	$\times 1. + 0.$
Fill value	$\text{F1800000}_{16} = -1.26765e + 30$
Missing value	$\text{F1800000}_{16} = -1.26765e + 30$
Valid range	
Written by	OML1BRVG

7.43 AMFQualityFlags

Field name	AMFQualityFlags
Title	AMF App quality flags
Units	NoUnits
Type	H5T_NATIVE_USHORT
Dimensions	[nXtrack,nTimes]
Scale, Offset	
Fill value	$\text{FFFF}_{16} = 65535$
Missing value	$\text{FFFF}_{16} = 65535$
Valid range	
Written by	OMNO2B

Table 10 shows the meaning of each of the bits, numbered from the least-significant bit (0).

Table 10: AMF Quality Flags Definitions

Bit	Name	Description
0	Table extrapolation flag	Indicates that extrapolations were done beyond the edges of the dAMF lookup tables.
1	dAMF table unexpected contents flag	Flag set indicates suspect values were found in the dAMF (altitude resolved air mass factor) lookup table
2	NO2 profile table cnexpected contents flag	Flag set indicates suspect values were found in the NO2 Profile lookup tables
3	Polluted profile over high terrain flag	Flag set indicates that polluted profile was detected, but over high terrain.
4	Large AMF calculated flag	Flag set indicates the calculated value of any of the AMFs was larger than the maximum threshold specified in the OPF.
5	Small AMF calculated flag	Flag set indicates the calculated value of any of the AMFs was smaller than the minimum threshold specified in the OPF.
6	Suspect stratospheric AMF flag	Flag set indicates the calculated stratospheric component of the AMF is out of the range specified in the OPF.
7	Suspect tropospheric AMF flag	Flag set indicates the calculated tropospheric component of the AMF is out of the range specified in the OPF.

7.44 AlgorithmFlags

Field name	AlgorithmFlags
Title	AlgorithmFlags
Units	NoUnits
Type	H5T_NATIVE_USHORT
Dimensions	[nXtrack,nTimes]
Scale, Offset	
Fill value	$FFFF_{16} = 65535$
Missing value	$FFFF_{16} = 65535$
Valid range	
Written by	

The algorithm flags indicate which branches of the algorithm were taken, or what conditions were found to obtain during the processing. The stratosphere-troposphere separation algorithm distinguishes between both FOVs and cells in the stratospheric field grid that are relatively unpolluted. Table 11 shows the two flags that indicate that the algorithm assumed low pollution levels at the geographical area pertaining to the FOV.

Table 11: Algorithm Flags Definitions

Bit	Name	Description
0	STSUnmaskedFov	Indicates an unmasked FoV was used. (Relatively unpolluted geographic area.)
5	STSUnmaskedCell	Indicates the cell in the grid of the stratospheric field was unmasked. (Relatively unpolluted geographic area.)

7.45 MeasurementQualityFlags

Field name	MeasurementQualityFlags
Title	Bit level quality flags at measurement level
Units	NoUnits
Type	H5T_NATIVE_UCHAR
Dimensions	[nTimes]
Scale, Offset	
Fill value	$FF_{16} = 255$
Missing value	$FF_{16} = 255$
Valid range	
Written by	OML1BRVG

Table 12 shows the significance of all the bits of the measurement quality flags. Bits are numbered from the least significant bit (0).

Table 12: Measurement Quality Flags

Bit	Name	Description
0	Measurement missing flag	Set if all ground pixels give earth radiance missing flag.
1	Measurement error flag	Set if any of the L1B MeasurementQualityFlags bit 0, 1, or 3 are set for the radiance or for the used solar product.
2	Measurement warning flag	Set if any of the L1B MeasurementQualityFlags bit 2, 4, 5, 8, 9 are set for the radiance or for the used Solar product.
3	Rebinned measurement flag	Set if L1B radiance MeasurmentQualityFlags bit 7 is set to 1.
4	SAA flag	Set if L1B MeasurmentQualityFlags bit 10 is set to 1, for the radiance or for the used solar product
5	Spacecraft maneuver flag	Set if L1B MeasurmentQualityFlags bit 11 is set to 1, for the radiance or for the used solar product
6	Instrument settings error flag	The earth and solar InstrumentConfigurationIDs are not compatible.
7	Cloud data not synchronized flag	Set if radiance and cloud data are not synchronized

7.46 OMNO2SCD_algoFlags

Field name	OMNO2SCD_algoFlags
Title	
Units	NoUnits
Type	H5T_NATIVE_UINT
Dimensions	[nXtrack,nTimes]
Scale, Offset	
Fill value	
Missing value	
Valid range	
Written by	OMNO2SCD

This set of flags is assigned by the OMNO2SCD application, and indicate status detection and algorithmic branches encountered in OMNO2SCD. Tables of the meanings of the flags are presented in the OMNO2SCD technical reference manual, which is available on request from the OMI NO_2 Standard Product Team.

7.47 OMNO2SCD_algoxFlags

Field name	OMNO2SCD_algoxFlags
Title	
Units	NoUnits
Type	H5T_NATIVE_UINT
Dimensions	[nXtrack,nTimes]
Scale, Offset	
Fill value	
Missing value	
Valid range	
Written by	OMNO2SCD

This set of flags is assigned by the OMNO2SCD application, and indicate status detection and algorithmic branches encountered in OMNO2SCD. Tables of the meanings of the flags are presented in the OMNO2SCD technical reference manual, which is available on request from the OMI NO_2 Standard Product Team.

7.48 OMNO2SCD_procFlags

Field name	OMNO2SCD_procFlags
Title	
Units	NoUnits
Type	H5T_NATIVE_UINT
Dimensions	[nXtrack,nTimes]
Scale, Offset	
Fill value	
Missing value	
Valid range	
Written by	OMNO2SCD

This set of flags is assigned by the OMNO2SCD application, and indicate status detection and algorithmic branches encountered in OMNO2SCD. Tables of the meanings of the flags are presented in the OMNO2SCD technical reference manual, which is available on request from the OMI NO_2 Standard Product Team.

7.49 OMNO2SCD_radFlags

Field name	OMNO2SCD_radFlags
Title	
Units	NoUnits
Type	H5T_NATIVE_USHORT
Dimensions	[nXtrack,nTimes]
Scale, Offset	
Fill value	
Missing value	
Valid range	
Written by	OMNO2SCD

This set of flags is assigned by the OMNO2SCD application, and indicate status detection and algorithmic branches encountered in OMNO2SCD. Tables of the meanings of the flags are presented in the OMNO2SCD technical reference manual, which is available on request from the OMI NO_2 Standard Product Team.

7.50 OMNO2SCD_scdFlags

Field name	OMNO2SCD_scdFlags
Title	
Units	NoUnits
Type	H5T_NATIVE_UCHAR
Dimensions	[nXtrack,nTimes]
Scale, Offset	
Fill value	
Missing value	
Valid range	
Written by	OMNO2SCD

This set of flags is assigned by the OMNO2SCD application, and indicate status detection and algorithmic branches encountered in OMNO2SCD. Tables of the meanings of the flags are presented in the OMNO2SCD technical reference manual, which is available on request from the OMI NO_2 Standard Product Team.

7.51 OMNO2SCD_wvlnFlags

Field name	OMNO2SCD_wvlnFlags
Title	
Units	NoUnits
Type	H5T_NATIVE_UINT
Dimensions	[nXtrack,nTimes]
Scale, Offset	
Fill value	
Missing value	
Valid range	
Written by	OMNO2SCD

This set of flags is assigned by the OMNO2SCD application, and indicate status detection and algorithmic branches encountered in OMNO2SCD. Tables of the meanings of the flags are presented in the OMNO2SCD technical reference manual, which is available on request from the OMI NO_2 Standard Product Team.

7.52 VcdQualityFlags

Field name	VcdQualityFlags
Title	VcdQualityFlags
Units	NoUnits
Type	H5T_NATIVE_USHORT
Dimensions	[nXtrack,nTimes]
Scale, Offset	
Fill value	$FFFF_{16} = 65535$
Missing value	$FFFF_{16} = 65535$
Valid range	
Written by	OMNO2

Table 13 shows the meaning of each of the bits. Bits are numbered from the least-significant bit (0).

Table 13: VCD Quality Flag definitions

Bit	Name	Description
0	Summary quality flag (Überflag)	This is a flag that can be used by a user who doesn't want to check a lot of flags. If set, then some error flag has been set at some point along the process, and the data should not be used. (User may just inquire whether VCDQualityFlags is an even or odd integer.)
1	Secondary summary quality flag	This is a flag that is set if there were significant warnings at some point along the process. The data should be used with some caution.
2	Reserved	This bit is for possible additional summary flags
3	Algorithm detected polluted	This flag indicates whether the VCD algorithm detected significant pollution in this FoV.
4	Descending orbit flag	Set if the satellite is on the descending portion of the orbit. It is not recommended that these data be used.
5–15	Reserved	Reserved

7.53 XTrackQualityFlags

Field name	XTrackQualityFlags
Title	XTrackQualityFlags
Units	NoUnits
Type	H5T_NATIVE_UCHAR
Dimensions	[nXtrack,nTimes]
Scale, Offset	
Fill value	$FF_{16} = 255$
Missing value	$FF_{16} = 255$
Valid range	
Written by	OML1BRVG,OMNO2

The cross-track quality flags indicate possible or probable effect of the "Row Anomaly" (RA) on the radiances measured by OMI. The most likely cause of the RA is seen to be the occlusion of a portion of OMI's entrance optics by a piece of insulation material that had debonded from the spacecraft body.

The RA is flagged in the OMI Level-1B data product OML1BRVG. However, we found that for most of the period affected by the RA, there are anomalous features in the radiances (and retrieved NO_2 slant colulmn amounts) at cross track positions adjacent to those flagged in OML1BRVG. We have extended the cross-track quality flags to those adjacent positions. Thus, the contents of this field will not be identical to those found in the OML1BRVG data product.

Where a FOV has any XTrackQualityFlag set, the calculation of vertical column densities has been abandoned, and those fields (Sections 7.25–7.31) are assigned fill values.

The meanings of the bits of the cross-track quality flags are shown in Table 14. Bits are numbered from the least-significant bit (bit number 0).

Table 14: Cross-track Quality Flags definitions

Bits	**Value**	**Meaning**
0-2	0	Not affected by row anomaly, pixel can be used
	1	Affected by row anomaly: pixel not corrected, do not use pixel
	2	Somewhat affected by row anomaly: pixel not corrected, pixel can be used with caution
	3	Affected by row anomaly: pixel corrected, but correction is not optimal, use pixel with caution
	4	Affected by row anomaly: pixel corrected and correction is optimal. Pixel can be used, but is still less accurate than pixels that are not affected by row anomaly
	7	Affected by row anomaly. Error during the correction for the row anomaly. Do not use pixel
3		Reserved for future use.
4		Pixel may be affected by the wavelength-shift effect.
5		Pixel may be affected by the blockage effect.
6		Pixel may be affected by the stray sunlight effect.
7		Pixel may be affected by the stray earth radiance effect.

8 Global file attributes

Global file attributes, found in the HDF-EOS5 file in the group HDFEOS → ADDITIONAL → FILE_ATTRIBUTES (See Figure 1), comprise data-product specific metadata.

Some of the global file attributes in this version of the OMNO2 data product have been deprecated, and should be ignored. They have been retained in this version of the data product in order to not break downstream Apps.

Table 15 lists the global file attributes, and indicates whether they are valid or deprecated. Valid attributes are described in the following section.

Table 15: List of Global file attributes.

Attribute	Sec.	Description
BackupSolarProductUsed		*Deprecated.*
CloudAlbedo	9.1	
CloudProductMissing		*Deprecated.*
GranuleDay	9.2	
GranuleMonth	9.3	
GranuleYear	9.4	
InstrumentName	9.5	
IrradianceScienceQualityFlag		*Deprecated.*
NO2ColumnAmountHistogram		*Deprecated.*
OPF_H2OReferenceTemperature		*Deprecated.*
OPF_NO2ReferenceTemperature		*Deprecated.*
OPF_O2O2ReferenceTemperature		*Deprecated.*
OPF_O3ReferenceTemperature		*Deprecated.*
OPF_UseWavelengthFitCoefficient		*Deprecated.*
OPF_XTrackQualityFlagsErrorMask		*Deprecated.*
OPF_albedoDefault		*Deprecated.*
OPF_albedoLandThreshold		*Deprecated.*
OPF_albedoSeaIceNH		*Deprecated.*
OPF_albedoSeaIceSH		*Deprecated.*
OPF_albedoSnow		*Deprecated.*
OPF_albedoWaterThreshold		*Deprecated.*
OPF_amfAngleUpperLimit		*Deprecated.*
OPF_automaticQualityFailed		*Deprecated.*
OPF_automaticQualitySuspect		*Deprecated.*
OPF_fittingPolydegree		*Deprecated.*
OPF_fittingWindow		*Deprecated.*
OPF_fittingWindowColumnRange		*Deprecated.*
OPF_intermediateProductWavelengths		*Deprecated.*
OPF_interpolationMethod		*Deprecated.*
OPF_level1ReadBufferSize		*Deprecated.*
OPF_level2WriteBufferSize		*Deprecated.*
OPF_limitsAMF		*Deprecated.*
OPF_limitsEarthRad		*Deprecated.*
OPF_limitsLatitude		*Deprecated.*

continued on the next page ...

. . . Table 15, continued.

Attribute	Sec.	Description
OPF_limitsLongitude		*Deprecated.*
OPF_limitsRAZ		*Deprecated.*
OPF_limitsSAZ		*Deprecated.*
OPF_limitsSCD		*Deprecated.*
OPF_limitsSZA		*Deprecated.*
OPF_limitsSolarIrrad		*Deprecated.*
OPF_limitsSurfaceAlbedo		*Deprecated.*
OPF_limitsSurfaceHeigth		*Deprecated.*
OPF_limitsSurfacePressure		*Deprecated.*
OPF_limitsVAZ		*Deprecated.*
OPF_limitsVCD		*Deprecated.*
OPF_limitsVZA		*Deprecated.*
OPF_maxEarthRadPrecision		*Deprecated.*
OPF_maxEarthWavelnPrecision		*Deprecated.*
OPF_maxFitRms		*Deprecated.*
OPF_maxNEarthWavelengthsFlagged		*Deprecated.*
OPF_maxNEarthWavelengthsFlaggedMissing		*Deprecated.*
OPF_maxNSolarWavelengthsFlagged		*Deprecated.*
OPF_maxSCDCovariance		*Deprecated.*
OPF_maxScdPrecision		*Deprecated.*
OPF_maxSolarIrradPrecision		*Deprecated.*
OPF_maxSolarIrradianceAgeInDays		*Deprecated.*
OPF_maxSolarWavelnPrecision		*Deprecated.*
OPF_meritFunction		*Deprecated.*
OPF_opfVersion		*Deprecated.*
OPF_wavelengthRegistrationFittingWindow		*Deprecated.*
OPF_wavelengthRegistrationLimit		*Deprecated.*
PGEVersion		*Deprecated.*
ParametersInconsistent		*Deprecated.*
ProcessLevel		*Deprecated.*
ProcessingSystem		*Deprecated.*
QAPctAmfLargeWarning		*Deprecated.*
QAPctAmfPollutedHighTerrain		*Deprecated.*
QAPctAmfProfileProblem		*Deprecated.*
QAPctAmfSmallWarning		*Deprecated.*
QAPctAmfStratWarning		*Deprecated.*
QAPctAmfTableExtrapolation		*Deprecated.*
QAPctAmfTableValueProblem		*Deprecated.*
QAPctAmfTropWarning		*Deprecated.*
QAPctCloudDataError		*Deprecated.*
QAPctCloudDataNotSynchronized		*Deprecated.*
QAPctCloudDataWarning		*Deprecated.*
QAPctEclipse		*Deprecated.*
QAPctIAMFError		*Deprecated.*

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. . . Table 15, continued.

Attribute	Sec.	Description
QAPctIAMFWarning		*Deprecated.*
QAPctIVCDError		*Deprecated.*
QAPctIVCDWarning		*Deprecated.*
QAPctInstrumentSettingsError		*Deprecated.*
QAPctIrradianceWarning		*Deprecated.*
QAPctMeasError		*Deprecated.*
QAPctMeasMissing		*Deprecated.*
QAPctMeasWarning		*Deprecated.*
QAPctRadianceError		*Deprecated.*
QAPctRadianceMissing		*Deprecated.*
QAPctRadianceWarning		*Deprecated.*
QAPctRebinned		*Deprecated.*
QAPctSAA		*Deprecated.*
QAPctSCDError		*Deprecated.*
QAPctSCDWarning		*Deprecated.*
QAPctSnowIceDataError		*Deprecated.*
QAPctSpacecraftManeuver		*Deprecated.*
QAPctSunGlint		*Deprecated.*
QAPctVcdTooLarge		*Deprecated.*
QAPctVcdTooSmall		*Deprecated.*
QAPctWavelengthRegistrationWarning		*Deprecated.*
RadianceParametersMissing		*Deprecated.*
RadianceScienceQualityFlag		*Deprecated.*
SolarIrradianceWarning		*Deprecated.*
SolarIrradianceWavelengthRegistrationWarning		*Deprecated.*
SolarProductMissing		*Deprecated.*
SolarProductOutOfDate		*Deprecated.*
TAI93At0zOfGranule	9.6	
UnpolFldNumberOfOrbits		*Deprecated.*
UnpolFldOrbitList		*Deprecated.*
WavelengthCalibrationMethod		*Deprecated.*

9 Global file attributes descriptions

9.1 CloudAlbedo

The value that is used for the cloud albedo (interpreted as Lambert equivalent reflectivity–LER) in the calculations.

9.2 GranuleDay

The day of the month at the beginning of the granule orbit.

9.3 GranuleMonth

The month of the year at the beginning of the granule orbit.

9.4 GranuleYear

The year at the beginning of the granule orbit.

9.5 InstrumentName

The name of the satellite instrument (OMI).

9.6 TAI93At0zOfGranule

The TAI-93 value at midnight, UTC, at the date of the start of the granule.

10 Metadata

Metadata—data about data—helps with the indexing, identification, and retrieval of files in a complex data warehouse.

10.1 Structure metadata (StructMetadata)

Structure metadata contains the information relevant to the structure of the file: Swath, Grid, Point, and Zonal Average structure type definitions. For the OMNO2 file, onty the Swath structure applies. There is a single swath, `ColumnAmountNO2`.

For the `ColumnAmountNO2` swath, the dimensions' names and sizes are defined. The names, data types, and named dimensions of each data field are specified for all fields in the `Geolocation Fields` and `Data Fields` groups.

10.2 Archived metadata

The archived metadata only contains two objects:
`LongName`

(value: "OMI/Aura Nitrogen Dioxide (NO2) Total & Troposph.Column 1-Orbit L2 Swath 13x24km")
`ESDTDescriptorRevision`

(value: 1.1.12), which is relevant to the Earth Science Data Types (ESDT) database.

10.3 Core metadata (Inventory metadata)

The Core metadata reside both in the `.he5` file itself (in `HDFEOS INFORMATION`→`CoreMetadata.0`) and in the separate file `.he5.met`. Because of this redundancy, it is not necessary to maintain copies of the `.he5.met` files.

The core metadata consists of one master group, called `Inventory Metadata`. This is comprised of a number of subordinate groups and objects within the groups. They are:

```
ECSDataGranule
    LocalGranuleID
    ProductionDateTime
    DayNightFlag
    ReprocessingActual
    LocalVersionID
    ReprocessingPlanned

MeasuredParameter
    QAFlags
        ScienceQualityFlag
        AutomaticQualityFlagExplanation
        AutomaticQualityFlag
        OperationalQualityFlagExplanation
        OperationalQualityFlag
        ScienceQualityFlagExplanation

    QAStats
```

```
        QAPercentMissingdAta
        QAPercentOutOfBoundsData

    ParameterName

OrbitCalculatedSpatialDomain
    EquatorCrossingDate
    EquatorCrossingTime
    OrbitNumber
    EquatorCrossingLongitude

Collection DescriptionClass
    VersionID
    ShortName

InputGranule
    InputPointer

RangeDateTime
    RangeBeginningDate
    RangeBeginningTime
    RangeEndingDate
    RangeEndingTime

PGEVersionClass
    PGEVersion

AssociatedPlatformInstrumentSensor
    AssociatedSensorShortName
    AssociatedPlatformShortName
    OperationMode
    AssociatedInstrumentShortName

Additional Attributes
    NrMeasurements
    NrZoom
    NrSpatialZoom
    NrSpectralZoom
    ExpeditedData
    SouthAtlanticAnomalyCrossing
    SpacecraftManeuverFlag
    SolarEclipse
    InstrumentConfigurationIDs
    MasterClockPeriods
    ExposureTimes
    PathNr
    StartBlockNr
    EndBlockNr
```