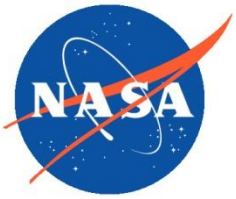

National Aeronautics and Space Administration
Goddard Earth Science
Data Information and Services Center (GES DISC)

README Document for the Creating a Long Term Multi-Sensor Ozone Data Record project

Solar Backscattered Ultraviolet
Ozone (O_3) Nadir Profile and Total Column Daily L2 Products:

BUVN04L2
SBUVN07L2
SBUV2N09L2
SBUV2N11L2
SBUV2N14L2
SBUV2N16L2
SBUV2N17L2
SBUV2N18L2
SBUV2N19L2

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Revision History

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1. Introduction

This document provides basic information for using the Solar Backscattered Ultraviolet (SBUV) Ozone (O3) Nadir Profile and Total Column Daily L2 products, part of the Creating a Long Term Multi-Satellite Ozone Data Record project.

1.1 Data Product Description

The SBUV Level 2 daily ozone nadir profile and total column products are derived from the Level 2 retrieved ozone profiles. The L2 data products consist of daily files each containing approximately 14 sunlit orbit swaths which are generated for each satellite separately and span the entire time series for that satellite. Individual satellite time series begin with the first full month and end with the last full month in the data record. Each individual profile is derived from a sequential scan through 12 wavelengths. The profiles are separated in time by 32 seconds. All radiance values for each scan were interpolated to the geolocation values (latitude, longitude, solar zenith angle, time) corresponding to the 305.8 nm sample before processing with the ozone retrieval algorithm.

1.1.1 BUV aboard Nimbus-4

The Nimbus 4 Backscatter Ultraviolet (BUV) spectrometer experiment was designed to monitor the vertical distribution and total amount of atmospheric ozone on a global scale by measuring the intensity of UV radiation backscattered by the earth/atmosphere system during daylight, using 12 wavelengths in the 2500 to 3400 Å spectral band. The primary instrumentation consisted of a double monochromator (Ebert-Fastie type) containing all reflective optics and a photomultiplier detector. An interference filter photometer was designed to make measurements of the UV radiation in an ozone non-absorbing 50 Å band centered at 3800 Å. In the South Atlantic Anomaly (SAA) region the detector was affected by high energy particles such that data in this region near the equator are usually rejected.

The BUV instrument was launched on the Nimbus-4 spacecraft on April 8, 1970, in to a sun synchronous polar orbit at an altitude of 1100 km. BUV provided full global daylight coverage between 80°S and 80°N. The sub-satellite point at nadir crossed the equator in increments of 27 degrees in longitude between successive passes. The horizontal resolution provided by BUV was 200 km x 200 km.

The BUV instrument was operational from April 10, 1970 until May 6, 1977. In July of 1972 the solar power array on Nimbus 4 partially failed such that operation of BUV had to be curtailed.

Data in the later years was increasingly sparse as the period of operation was decreased, particularly in the equatorial zone. This is reflected as sporadic zonal means in the later years.

1.1.2 SBUV aboard Nimbus-7

The Nimbus-7 Solar Backscatter Ultraviolet (SBUV) instrument consisted of a double Ebert-Fastie spectrometer and a filter photometer similar to the BUV on Nimbus 4. The SBUV spectrometer measured solar UV backscattered by the earth's atmosphere at 12 wavelengths between 255 and 340 nm, with a spectral bandpass of 1 nm. The SBUV used three detectors: a photomultiplier tube (PMT) and a photodiode for the monochromator, and one photodiode for the photometer. The addition of a chopper to the detector largely eliminated the problem of particle contamination in the SAA (South Atlantic Anomaly) that had been a problem with BUV.

SBUV was launched on the Nimbus-7 spacecraft on October 24, 1978 into a sun synchronous polar orbit at an altitude of 995 km. The local equator-crossing time (LECT) of Nimbus-7 was approximately 11:45 initially, and drifted slightly earlier after maneuvering fuel ran out in 1984. SBUV measurements are made along the orbital track from approximately 81°S to 81°N, with orbits spaced approximately 26 degrees apart in longitude. The horizontal resolution provided by SBUV was 180 km x 180 km. The SBUV instrument was operational from October 30, 1978 until June 26, 1990, when increasing chopper errors made the data unusable.

1.1.3 SBUV/2 aboard NOAA-9, -11, -14, -16, -17, -18, and -19

The second generation Solar Backscatter Ultraviolet Radiometer (SBUV/2) instruments have been flown on the NOAA Polar-orbiting Operational Environment Satellites (POES). The SBUV/2 instruments are designed to map total ozone concentrations on a global scale, and to provide the vertical distribution of ozone in the earth's atmosphere. The instrument design is based upon the technology developed for the first SBUV flown on Nimbus 7. The SBUV/2 instrument measures backscattered solar radiation in an 11.3-degree field of view in the nadir direction at 12 discrete wavelength bands between 252.0 and 339.8 nm, with a spectral bandpass of 1.1 nm. Solar irradiance is determined at the same 12 wavelength bands by deploying a diffuser which reflects sunlight into the instrument's field of view. The SBUV/2 also measures the solar irradiance or the atmospheric radiance with a continuous spectral scan from 160 to 400 nm in increments of 0.148 nm. The SBUV/2 has another narrowband filter photometer channel, called the cloud cover radiometer (CCR), which continuously measures the earth's surface brightness at 378.6 nm, with a field of view of 11.3 degrees.

The NOAA series satellites are launched in Sun-synchronous polar orbits with altitudes of about 850 km. The SBUV/2 horizontal resolution is slightly smaller than Nimbus-7 SBUV

(approximately 168 km x 168 km). There are about 14 orbits per day each separated by about 26 degrees at the equator. Most SBUV/2 instruments have been launched into afternoon orbits with an initial Equator-crossing time of approximately 1400 (NOAA-17 was launched into a morning orbit). These satellites drift towards later Equator-crossing times (earlier for NOAA-17) during their mission, leading to higher solar zenith angles at all latitudes. This orbit drift affects the availability of the SBUV/2 measurements, since the data are less accurate when the orbit is near-terminator (LECT outside the 0800-1600 range). Table 1-1 lists the launch and dates that SBUV/2 measurements were used in this study. Note that NOAA-16 and NOAA-19 continue to operate at this time (September 2013). The NOAA-17 satellite was decommissioned on March 20, 2013. The chopper wheel of the NOAA-18 SBUV/2 instrument stalled on December 12, 2012, and no ozone data have been collected since that time. Table 1-2 lists the approximate dates when the NOAA-9, NOAA-11, NOAA-14, and NOAA-16 orbits transitioned from afternoon Equator-crossing time (ascending node in daylight) to morning Equator-crossing time (descending node in daylight).

Satellite	Launch	Data Measurements Used
NOAA-9	Dec. 12, 1984	Feb. 1985 – Jan. 1998
NOAA-11	Sept. 24, 1988	Jan. 1989 – Mar. 2001
NOAA-14	Dec. 30, 1994	Mar. 1995 – Sep. 2006
NOAA-16	Sept. 21, 2000	Oct. 2000 – Jul. 2013
NOAA-17	June 24, 2002	Aug. 2002 – Mar. 2013
NOAA-18	May 20, 2005	Jul. 2005 – Dec. 2012
NOAA-19	Feb. 06, 2009	Mar. 2009 – Jul. 2013

Table 1-1

Satellite	Terminator Crossing Date
NOAA-9	December 1990
NOAA-11	October 1995
NOAA-14	July 2002

NOAA-16	September 2009

Table 1-2

1.2 Algorithm Background

SBUV V8.6 ozone profiles are retrieved from the measured radiance data using an optimal estimation approach. First, an *a priori* ozone profile for the measurement location is determined from a climatology data set that varies by month and latitude. The corresponding top-of-the-atmosphere radiances for each SBUV wavelength for the viewing conditions of that scan are then calculated using a forward model. These theoretical radiances are then compared to the measured radiances, and adjusted iteratively to reach convergence. The final radiance values are then inverted to create the retrieved ozone profile. Total ozone values are determined by summing up all layers in the profile. Bhartia et al (2013) describes the V8.6 algorithm in more detail.

1.3 Data Disclaimer

These data were produced under the NASA MEaSUREs program. While the goal was to apply a consistent instrument-to-instrument calibration so that the data could be used for long term trend analysis, the quality of the data varies depending on the instrument. Data from NOAA-9, 11, and 14 in particular are of somewhat lower quality. Papers currently being produced (e.g. DeLand et al (2012), McPeters et al (2013)) should be consulted for our evaluation of the quality of the data.

The SBUV instruments are designed to provide continuous measurements of the sunlit hemisphere of the Earth. However, instrument and spacecraft problems sometimes interfere with this objective. The following list identifies intervals of three or more days where data coverage is limited or unavailable for each instrument. Note that this list does not address Nimbus-4 BUV, which has a complex operational history, particularly after July 1972.

Nimbus-7: No Northern Hemisphere descending node data due to special solar measurements.

1980/198 – 1980/324

1981/183 – 1981/261

1984/139 – 1984/204

1986/177 – 1986/219

NOAA-9: No data available.

1991/060 – 1991/090

1993/213 – 1993/243

1995/213 – 1995/258

1996/143 – 1996/170

NOAA-9: Limited longitude coverage.

1997/189 – 1998/050: 30-80°W at Equator

1997 (late August, early September): 100-150°E at Equator also available

NOAA-11: No data available

1991/060 – 1991/090

1995/100 – 1997/195

NOAA-14: No data available (grating drive lock-up).

1996/158 – 1996/163

1996/334 – 1996/341

1998/159 – 1998/161

2003/335 – 2003/337

NOAA-18: No data available (chopper wheel stalled)

2008/144 – 2008/238

2008/315 – 2008/317

2012/347 – 2013/252 (*current*)

A volcano contamination index (VCI) flag has been developed to identify effects in the L2 product following eruptions of El Chichón (April 1982) and Mt. Pinatubo (July 1991). The VCI flag uses the absolute value of monthly zonal mean profile ozone in layer 1 (639-1013 hPa) and the standard deviation of monthly zonal mean profile ozone values in layer 10 (10.1-16.1 hPa) as indicators of possible volcano effects in the data. This flag is currently relevant for Nimbus-7 SBUV data following the El Chichón eruption, and for NOAA-11 SBUV/2 data following the Mt.

Pinatubo eruption. VCI screening for NOAA-9 SBUV/2 data after Mt. Pinatubo is more complicated because of the high solar zenith angle values observed in the near-terminator orbit at this time. It should be noted that the VCI flag is not a definitive technique, and that some NOAA-11 data do have this flag set for months prior to the Mt. Pinatubo eruption.

2. Data Organization

The products contain time-series of monthly zonal means of data from the BUV, SBUV and SBUV/2 instruments as well as Level-2 data. Level-1 data consist of the measured radiances, level-2 data are the individual retrieved profiles, while level-3 data are the profiles gridded by latitude / longitude. Each individual satellite instrument is saved to its own collection or data product, with a single data file per collection.

2.1 File Naming Convention

The L2 data product files are named according to the following convention:

<Instrument>-<Satellite>_<Level>-<Product>_<Date>_<Version>.<Suffix>

where:

- Instrument = either BUV, SBUV or SBUV2.
- Satellite = either Nimbus04 (for BUV), Nimbus07 (for SBUV), or one of NOAA09, NOAA11, NOAA14, NOAA16, NOAA17, NOAA18, or NOAA19 (for SBUV2)
- Level = L2 (Level-2)
- Product = short name identifier (e.g. SBUV2N18L2)
- Date = start date of file in format YYYYmMMDD (e.g. 2010m0106)
- Version = product collection version in format <Major>-<Minor> where
    1. Major = 2 digit major version (e.g. 01)
    2. Minor = 2 digit minor version (e.g. 01)
    3. Created = file creation time in format YYYYmMMDDtHHMMSS (e.g. 2012m0907t100534)
- Suffix = the file format (always h5)

```
File name example: SBUV2-NOAA18_L2-SBUV2N18L2_2010m0106_v01-01-2012m0907t100534.h5
```

2.2 File Format and Structure

The SBUV L2 data product files are written in HDF5 which is developed by the HDF Group, formerly the National Center for Supercomputing Applications (http://www.hdfgroup.org/). Each data file contains a single HDF5 group object (akin to a directory or folder) named Data_Fields which contains the measured parameters and ancillary information which are stored as HDF5 dataset (n-dimensional array) objects. Within each file there is a set of global attributes which define the metadata for that data product. Section 3.0 (below) describes the dimensions, global attributes, and data fields in more detail.

2.3 Key Science Data Fields

The primary science data fields are the vertical ozone profiles and mixing ratios, as well as the total column ozone. The full list of measured parameters and ancillary data fields is given in section 3.3 below.

2.3.1 Ozone Profiles (DU)

The data contain profiles of ozone (in Dobson units or DU) at 21 pressure layers: 1013.25, 639.318, 403.382, 254.517, 160.589, 101.325, 63.9317, 40.3382, 25.4517, 16.0589, 10.1325, 6.39317, 4.03382, 2.54517, 1.60589, 1.01325, 0.639317, 0.403382, 0.254517, 0.160589 and 0.101325 hPa (referenced from the bottom of the layer)

2.3.2 Ozone Mixing Ratio (ppmv)

The data contain ozone mixing ratios (in parts per million by volume or ppmv) at 15 pressure levels: 0.5, 0.7, 1.0, 1.5, 2.0, 3.0, 4.0, 5.0, 7.0, 10.0, 15.0, 20.0, 30.0, 40.0 and 50.0 hPa.

2.3.3 Total Column Ozone (DU)

The data contain the total column ozone (in Dobson units or DU) measured from the surface to the top of the atmosphere. This is the sum of the profile layer amounts.

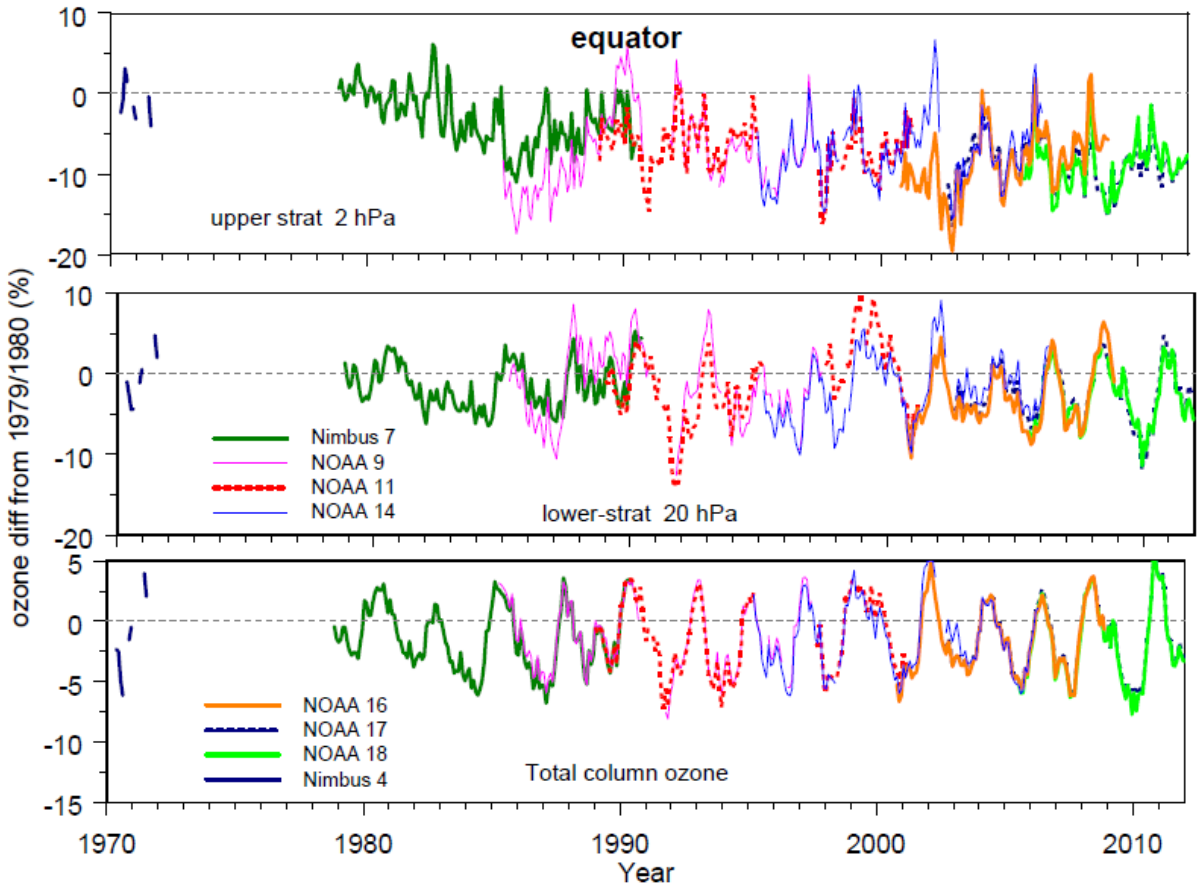

Figure 1: Ozone changes at the Equator relative to the 1979-1980 period [in percent] as observed by different SBUV instruments. The top panel shows data for the upper stratosphere (2 hPa), the middle panel shows data for the lower stratosphere (20 hPa), and the bottom panel shows total column ozone data. The paper by McPeters et al (2013) provides further discussion of this comparison.

3. Data Contents

3.1 Dimensions

Name	Size	Description
nChannels03	3	The dimension representing the 3 SBUV channels for the Lambertian Equivalent Reflectivity (channels 10 to 12).
nChannels08	8	The dimension representing the 8 SBUV channels that correspond to multiple scattering (channels 5 to 12).
nChannels10	10	The dimension representing the 10 SBUV channels for the profile computation (channels 1 to 10).
nChannels12	12	The dimension representing the 12 SBUV channels that correspond to single and multiple scattering (channels 1 to 12).
nChannels13	13	The dimension representing all of the SBUV channels (channels 1 to 13)
nLayers11	11	The dimension representing Umkehr layers 0 to 9 and layers 10 plus. The pressure corresponds to the bottom of the layer.
nLayers13	13	The dimension representing Umkehr layer 12 plus to layer 0. The pressure corresponds to the bottom of the layer.
nLevels15	15	The dimension representing the pressure levels for the ozone volume mixing ratio.
nLevels20	20	The dimension representing the pressure levels for the ozone retrievals (total number of levels minus one).
nLevels20b	20	An additional dimension representing the pressure levels for the ozone retrievals (total number of levels minus one).
nLevels21	21	The dimension representing the total number of pressure levels. There are five levels of pressure per decade spanning four decades.
nTimes	varies	The dimension representing the observation times in the granule.

Table 3-1: List of dimensions associated with data fields.

3.2 Global Attributes

Name	Type	Size	Description
AlgorithmVersion	STRING	Scalar	The SBUV algorithm version.
AuthorAffiliation	STRING	Scalar	The affiliation of the author of the product.
AuthorName	STRING	Scalar	The name of the author of the product.
CalibrationVersion	STRING	Scalar	The designation for the SBUV calibration version.
CloudPressureSource	STRING	Scalar	The source of cloud height pressure used in derived total ozone.
Conventions	STRING	Scalar	The metadata conventions used.
CorrelationLength	32-BIT FLOAT	1	The correlation length in layers for the a priori error matrix.
DayNightFlag	STRING	Scalar	The flag that indicates whether the product includes day-side observations, night-side observations, or both.
EastBoundingCoordinate	32-BIT FLOAT	1	The terrestrial longitude (in degrees) of the easternmost data in the granule.
InstrumentError	32-BIT FLOAT	1	The assumed fractional instrumental error in the radiance/flux (a.k.a. measurement error).
GranuleDay	32-BIT SIGNED INTEGER	1	The UTC day of the month at the start of the granule.
GranuleDayOfYear	32-BIT SIGNED INTEGER	1	The UTC day of the year at the start of the granule.
GranuleMonth	32-BIT SIGNED INTEGER	1	The UTC month at the start of the granule.
GranuleYear	32-BIT SIGNED INTEGER	1	The (four-digit) UTC year at the start of the granule.
HDFVersion	STRING	Scalar	The version of HDF used to create the product.
InputFilesHDF	STRING	Scalar	A space-separated list of every file used as input for the PMF to HDF5 conversion processing.
InputFilesPMF	STRING	Scalar	A space-separated list of every file used as input for the PMF processing.
InstrumentError	32-BIT FLOAT	1	The assumed fractional instrumental error in the radiance/flux (a.k.a. measurement error).

InstrumentShortName	STRING	Scalar	The Short Name of the instrument.
LocalGranuleID	STRING	Scalar	The actual name of the product file.
LocalityValue	STRING	Scalar	The geographic locality of the product.
LongName	STRING	Scalar	The ESDT Long Name of the product.
NorthBoundingCoordinate	32-BIT FLOAT	1	The terrestrial latitude (in degrees) of the northernmost data in the granule.
NumTimes	32-BIT SIGNED INTEGER	1	The number of times in the granule, which is also the size of the nTimes dimension.
OrbitMode	STRING	Scalar	The satellite orbital mode at day-side equator crossing (A = Ascending, D = Descending or T = Terminator).
ParameterName	STRING	Scalar	Nadir Profile and Total Column Ozone
PGEVersion	STRING	Scalar	The version of the PGE or App that was used to create the product file.
PlatformShortName	STRING	Scalar	The Short Name of the platform.
ProcessingCenter	STRING	Scalar	The processing center where the product was created.
ProcessLevel	STRING	Scalar	The process level of the product.
ProductionDateTimeHDF	STRING	Scalar	The date and time of the PMF to HDF5 conversion processing.
ProductionDateTimePMF	STRING	Scalar	The date and time of the v8.6 SBUV processing that produced the PMF.
ProductType	STRING	Scalar	The temporal type of the product.
ProfileO3APrioriError	32-BIT FLOAT	1	The assumed fractional error in the ozone profile (a priori error).
RangeBeginningDate	STRING	Scalar	The UTC year, month and day when the granule began.
RangeBeginningTime	STRING	Scalar	The UTC hour, minute and second when the granule began.
RangeEndingDate	STRING	Scalar	The UTC year, month and day when the granule ended.
RangeEndingTime	STRING	Scalar	The UTC hour, minute and second when the granule ended.
ReflectivityWavelengthIndex	32-BIT SIGNED INTEGER	1	The channel index for the Reflectivity field.
ReflectivityWavelengthIndex HighSZA	32-BIT SIGNED INTEGER	1	The channel index for the Reflectivity field at high solar zenith angle.
SensorShortName	STRING	Scalar	The Short Name of the sensor.
ShortName	STRING	Scalar	The ESDT Short Name of the product.

SnowIceSource	STRING	Scalar	The source of Snow/Ice coverage used in derived total ozone.
SouthBoundingCoordinate	32-BIT FLOAT	1	The terrestrial latitude (in degrees) of the southernmost data in the granule.
StartOrbitNumber	32-BIT SIGNED INTEGER	1	The first orbit number contained in the granule.
StopOrbitNumber	32-BIT SIGNED INTEGER	1	The final orbit number contained in the granule.
TemperatureSource	STRING	Scalar	The source of temperature profile used in derived total ozone.
TerrainPressureSource	STRING	Scalar	The source of terrain pressure used in derived total ozone.
VersionID	STRING	Scalar	The Collection Version of the product.
VerticalCoordinate	STRING	Scalar	The vertical coordinate of the product.
WestBoundingCoordinate	32-BIT FLOAT	1	The terrestrial longitude (in degrees) of the westernmost data in the granule.
identifier_product_doi	STRING	Scalar	The Digital Object Identifier (DOI) value.
identifier_product_doi_authority	STRING	Scalar	The authoritative service for use with DOI values in resolving to the URL.

Table 3-2: Global metadata attributes associated with the file.

3.3 Data Fields

3.3.1 Ancillary Data

Name	CloudPressure
Type	32-BIT FLOAT
Dimensions	nTimes
Description	The effective cloud pressure (in atmospheres) from OMCLDRR climatology.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	atm
long_name	STRING	Scalar	Effective Cloud Pressure
valid_min	32-BIT FLOAT	1	0.0
valid_max	32-BIT FLOAT	1	1.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	PressureLevels
Type	32-BIT FLOAT
Dimensions	nLevels21
Description	The atmospheric pressures (in hPa) at the bottoms of the 21 solution pressure levels ordered from sea-level up. The actual values are 1013.25, 639.318, 403.382, 254.517, 160.589, 101.325, 63.9317, 40.3382, 25.4517, 16.0589, 10.1325, 6.39317, 4.03382, 2.54517, 1.60589, 1.01325, 0.639317, 0.403382, 0.254517, 0.160589 and 0.101325 hPa.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	hPa
long_name	STRING	Scalar	Pressures at Bottoms of Solution Pressure Levels
valid_min	32-BIT FLOAT	1	0.101325
valid_max	32-BIT FLOAT	1	1013.25
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	PressureLevelsMixingRatio
Type	32-BIT FLOAT
Dimensions	nLevels15
Description	The atmospheric pressure (in hPa) of the 15 levels for ozone volume mixing ratio ordered from the upper to lower stratosphere. The actual values are 0.5, 0.7, 1.0, 1.5, 2.0, 3.0, 4.0, 5.0, 7.0, 10.0, 15.0, 20.0, 30.0, 40.0 and 50.0 hPa.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	hPa
long_name	STRING	Scalar	Mixing Ratio Pressure Levels
valid_min	32-BIT FLOAT	1	0.5
valid_max	32-BIT FLOAT	1	50.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	ProfileO3AprioriLayer
Type	32-BIT FLOAT
Dimensions	nLevels21 x nTimes
Description	The a priori ozone profile. The value for each of the 21 layers corresponds to the a priori ozone amount (in DU) in the layer.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	DU
long_name	STRING	Scalar	21-Layer a priori Ozone Profile
valid_min	32-BIT FLOAT	1	0.0
valid_max	32-BIT FLOAT	1	150.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	SnowIceIndicator
Type	32-BIT SIGNED INTEGER
Dimensions	nTimes
Description	The snow-ice probability times ten associated with the ground pixel (from lookup table).

Attributes

Name	Type	Size	Value
units	STRING	Scalar	1
long_name	STRING	Scalar	Snow-Ice Indicator
valid_min	32-BIT SIGNED INTEGER		0
valid_max	32-BIT SIGNED INTEGER		10
_FillValue	32-BIT SIGNED INTEGER	1	-2147483647

Name	SurfaceCategory
Type	32-BIT SIGNED INTEGER
Dimensions	nTimes
Description	The surface category code associated with the ground pixel (from lookup table): 0 = water, 1 = land, 2 = low inland (below sea level), 3 = land and water, 4 = land and low-inland, 5 = water, land and low-inland.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	1
long_name	STRING	Scalar	Surface Category
valid_min	32-BIT SIGNED INTEGER		0
valid_max	32-BIT SIGNED INTEGER		5
_FillValue	32-BIT SIGNED INTEGER	1	-2147483647

Name	TemperatureProfile
Type	32-BIT FLOAT
Dimensions	nLayers13 x nTimes
Description	The input temperature profile (in degrees Kelvin) ordered from Umkehr layer 12 plus to layer 0.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	Kelvin

long_name	STRING	Scalar	Temperature Profile in Umkehr Layer 12 Plus to Layer 0
valid_min	32-BIT FLOAT	1	0.0
valid_max	32-BIT FLOAT	1	1000.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	TerrainPressure		
Type	32-BIT FLOAT		
Dimensions	nTimes		
Description	The terrain pressure (in atmospheres) that corresponds to the ground pixel (from lookup table).		
Attributes			
Name	Type	Size	Value
units	STRING	Scalar	atm
long_name	STRING	Scalar	Terrain Pressure
valid_min	32-BIT FLOAT	1	0.0
valid_max	32-BIT FLOAT	1	1.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Tables 3-3-1: Data fields are located under the HDF5 group object named ANCILLARY_DATA.

3.3.2 Geolocation Data

Name	DayOfYear		
Type	32-BIT SIGNED INTEGER		
Dimensions	nTimes		
Description	The UTC day of the year at the start of the observation.		
Attributes			
Name	Type	Size	Value
units	STRING	Scalar	1
long_name	STRING	Scalar	Day of Year
valid_min	32-BIT SIGNED INTEGER	1	1
valid_max	32-BIT SIGNED INTEGER	1	366
_FillValue	32-BIT SIGNED INTEGER	1	-2147483647

Name	Latitude		
Type	32-BIT FLOAT		
Dimensions	nTimes		
Description	The terrestrial latitude (in degrees) at the center of the ground pixel for retrieved ozone (306 nm).		
Attributes			
Name	Type	Size	Value
units	STRING	Scalar	degrees_north
long_name	STRING	Scalar	Latitude
valid_min	32-BIT FLOAT	1	-90.0

valid_max	32-BIT FLOAT	1	90.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	Longitude
Type	32-BIT FLOAT
Dimensions	nTimes
Description	The terrestrial longitude (in degrees) at the center of the ground pixel for retrieved ozone (306 nm).

Attributes

Name	Type	Size	Value
units	STRING	Scalar	degrees_east
long_name	STRING	Scalar	Longitude
valid_min	32-BIT FLOAT	1	-180.0
valid_max	32-BIT FLOAT	1	180.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	OrbitNumber
Type	32-BIT SIGNED INTEGER
Dimensions	nTimes
Description	The satellite orbit number for each observation. The orbit changes at the first equator crossing after 0 UTC.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	1
long_name	STRING	Scalar	Orbit Number
valid_min	32-BIT SIGNED INTEGER	1	1
valid_max	32-BIT SIGNED INTEGER	1	1000000
_FillValue	16-BIT SIGNED INTEGER	1	-2147483647

Name	SecondsInDay
Type	32-BIT FLOAT
Dimensions	nTimes
Description	The time (in s) after UTC midnight at the start of the observation.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	s
long_name	STRING	Scalar	Seconds After UTC Midnight
valid_min	32-BIT FLOAT	1	0.0
valid_max	32-BIT FLOAT	1	86401.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30).0

Name	SolarZenithAngle
Type	32-BIT FLOAT
Dimensions	nTimes
Description	The solar zenith angle (in degrees) at the center of the ground pixel for retrieved ozone (306 nm).

Attributes

Name	Type	Size	Value
units	STRING	Scalar	Degrees
long_name	STRING	Scalar	Solar Zenith Angle
valid_min	32-BIT FLOAT	1	0.0
valid_max	32-BIT FLOAT	1	90.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	Year
Type	32-BIT SIGNED INTEGER
Dimensions	nTimes
Description	The (four-digit) UTC year at the start of the granule.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	1
long_name	STRING	Scalar	Year
valid_min	32-BIT SIGNED INTEGER	1	1970
valid_max	32-BIT SIGNED INTEGER	1	2020
_FillValue	16-BIT SIGNED INTEGER	1	-2147483647

Tables 3-3-2: Data fields are located under the HDF5 group object named GEOLOCATION_DATA.

3.3.3 Science Data

Name	AveragingKernel
Type	32-BIT FLOAT
Dimensions	nLevels20b x nLevels20 x nTimes
Description	The 20x20 averaging kernel matrix.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	1
long_name	STRING	Scalar	Averaging Kernel
valid_min	32-BIT FLOAT	1	-500.0
valid_max	32-BIT FLOAT	1	500.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	AveragingKernelTrace
Type	32-BIT FLOAT
Dimensions	nTimes
Description	The trace of the 20x20 averaging kernel. Also known as Information Content.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	1
long_name	STRING	Scalar	Trace of Averaging Kernel

valid_min	32-BIT FLOAT	1	0.0
valid_max	32-BIT FLOAT	1	20.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	CloudFraction
Type	32-BIT FLOAT
Dimensions	nTimes
Description	The cloud fraction for Channel 8 (306 nm). It is set to zero when SnowIceIndicator equals ten.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	1
long_name	STRING	Scalar	Cloud Fraction
valid_min	32-BIT FLOAT	1	0.0
valid_max	32-BIT FLOAT	1	1.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	dN_dOmega
Type	32-BIT FLOAT
Dimensions	nChannels08 x nTimes
Description	dN/dOmega for Channels 5 to 12.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	1
long_name	STRING	Scalar	dN/dOmega
valid_min	32-BIT FLOAT	1	-100.0
valid_max	32-BIT FLOAT	1	100.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	dN_dR
Type	32-BIT FLOAT
Dimensions	nChannels08 x nTimes
Description	The reflectivity sensitivity ratio dN/dR for Channels 5 to 12.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	1
long_name	STRING	Scalar	Reflectivity Sensitivity Ratio dN/dR
valid_min	32-BIT FLOAT	1	-200.0
valid_max	32-BIT FLOAT	1	0.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	dN_dR_CCR
Type	32-BIT FLOAT
Dimensions	nTimes
Description	The reflectivity sensitivity ratio dN/dR at 331 nm monochromator channel.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	1
long_name	STRING	Scalar	Reflectivity Sensitivity Ratio dN/dR at 331 nm Monochromator Channel
valid_min	32-BIT FLOAT	1	-200.0
valid_max	32-BIT FLOAT	1	0.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	IndexLongestProfileChannel
Type	32-BIT SIGNED INTEGER
Dimensions	nTimes
Description	The index of the longest channel used in the profile retrieval computation.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	1
long_name	STRING	Scalar	Index of Longest Profile Channel Used
valid_min	32-BIT SIGNED INTEGER	1	1
valid_max	32-BIT SIGNED INTEGER	1	12
_FillValue	32-BIT SIGNED INTEGER	1	-2147483647

Name	KMatrix
Type	32-BIT FLOAT
Dimensions	nChannels10 x nLevels20 x nTimes
Description	The "K Matrix". Also known as the weighting function matrix. Also known as the Jacobian from the internal forward model. Also known as "dN/dx".

Attributes

Name	Type	Size	Value
units	STRING	Scalar	1
long_name	STRING	Scalar	K Matrix
valid_min	32-BIT FLOAT	1	-100.0
valid_max	32-BIT FLOAT	1	100.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	LambertianEquivalentReflectivity
Type	32-BIT FLOAT
Dimensions	nChannels03 x nTimes
Description	The Lambertian Equivalent Reflectivity at 317.5, 331 and 340 nm.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	1
long_name	STRING	Scalar	Lambertian Equivalent Reflectivity
valid_min	32-BIT FLOAT	1	0.0
valid_max	32-BIT FLOAT	1	1.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	LayerEfficiency
Type	32-BIT FLOAT
Dimensions	nLayers11 x nTimes
Description	The total ozone algorithmic efficiency Umkehr layers 0 to 9 and layers 10 plus.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	1
long_name	STRING	Scalar	Total Ozone Algorithmic Efficiency
valid_min	32-BIT FLOAT	1	0.0
valid_max	32-BIT FLOAT	1	10.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	NValue
Type	32-BIT FLOAT
Dimensions	nChannels12 x nTimes
Description	The measured N-values from monochromator for Channels 1 to 12. N is defined as -100 times the logarithm of the ratio of the measured radiance to the solar irradiance.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	1
long_name	STRING	Scalar	Measured N-Values from Monochromator
valid_min	32-BIT FLOAT	1	0.0
valid_max	32-BIT FLOAT	1	600.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	NValueAdjustmentFactors
Type	32-BIT FLOAT
Dimensions	nChannels13
Description	The N-value adjustment factors for Channels 1 to 13.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	1
long_name	STRING	Scalar	N-Value Adjustment Factors
valid_min	32-BIT FLOAT	1	-5.0
valid_max	32-BIT FLOAT	1	5.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	NValuePhotometer
Type	32-BIT FLOAT
Dimensions	nChannels12 x nTimes
Description	The measured photometer N-values simultaneous with the monochromator measurements for Channels 1 to 12.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	1
long_name	STRING	Scalar	Measured N-Values from Photometer

valid_min	32-BIT FLOAT	1	0.0
valid_max	32-BIT FLOAT	1	600.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	NValueResidualsFinal		
Type	32-BIT FLOAT		
Dimensions	nChannels10 x nTimes		
Description	The final N-value residuals for Channels 1 to 10.		
Attributes			
Name	Type	Size	Value
units	STRING	Scalar	1
long_name	STRING	Scalar	Final N-Value Residuals
valid_min	32-BIT FLOAT	1	-100.0
valid_max	32-BIT FLOAT	1	100.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	NValueResidualsInitial		
Type	32-BIT FLOAT		
Dimensions	nChannels10 x nTimes		
Description	The initial N-value residuals for Channels 1 to 10.		
Attributes			
Name	Type	Size	Value
units	STRING	Scalar	1
long_name	STRING	Scalar	Initial N-Value Residuals
valid_min	32-BIT FLOAT	1	-100.0
valid_max	32-BIT FLOAT	1	100.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	NValueSingleScattering		
Type	32-BIT FLOAT		
Dimensions	nChannels10 x nTimes		
Description	The N-values corrected to single scattering for monochromator Channels 1 to 10.		
Attributes			
Name	Type	Size	Value
units	STRING	Scalar	1
long_name	STRING	Scalar	Computed Single-Scattering N-Values
valid_min	32-BIT FLOAT	1	0.0
valid_max	32-BIT FLOAT	1	600.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	NumberOfIterations
Type	32-BIT SIGNED INTEGER
Dimensions	nTimes
Description	The number of iterations required for convergence of the profile retrieval computation.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	1
long_name	STRING	Scalar	Number of Iterations for Solution Convergence
valid_min	32-BIT SIGNED INTEGER	1	1
valid_max	32-BIT SIGNED INTEGER	1	100
_FillValue	32-BIT SIGNED INTEGER	1	-2147483647

Name	O3BelowCloud
Type	32-BIT FLOAT
Dimensions	nTimes
Description	The estimate of the ozone below fractional cloud (in DU).

Attributes

Name	Type	Size	Value
units	STRING	Scalar	DU
long_name	STRING	Scalar	Ozone Below Fractional Cloud
valid_min	32-BIT FLOAT	1	0.0
valid_max	32-BIT FLOAT	1	100.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	O3MixingRatio
Type	32-BIT FLOAT
Dimensions	nLevels15 x nTimes
Description	The ozone volume mixing ratio (in ppmv) at 15 pressure levels.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	ppmv
long_name	STRING	Scalar	Ozone Mixing Ratio
valid_min	32-BIT FLOAT	1	0.0
valid_max	32-BIT FLOAT	1	1.0e+05
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	O3MixingRatioError
Type	32-BIT FLOAT
Dimensions	nLevels15 x nTimes
Description	The precision of the ozone volume mixing ratio (in percent) at 15 pressure levels.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	%
long_name	STRING	Scalar	Estimated Errors in Ozone Mixing Ratio
valid_min	32-BIT FLOAT	1	0.0
valid_max	32-BIT FLOAT	1	100.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	PhotometerReflectivity
Type	32-BIT FLOAT
Dimensions	nChannels08 x nTimes
Description	The photometer reflectivity for Channels 5 to 12.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	1
long_name	STRING	Scalar	Photometer Reflectivity
valid_min	32-BIT FLOAT	1	0.0
valid_max	32-BIT FLOAT	1	1.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	PhotometerResidual
Type	32-BIT FLOAT
Dimensions	nTimes
Description	The photometer residual (CCR) at 331 nm.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	1
long_name	STRING	Scalar	Photometer Residual (CCR) at 331 nm
valid_min	32-BIT FLOAT	1	0.0
valid_max	32-BIT FLOAT	1	100.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	ProfileO3ErrorFlag
Type	32-BIT SIGNED INTEGER
Dimensions	nTimes
Description	The profile ozone error flag: 0 = good retrieval, 1 = SolarZenithAngle > 84 degrees, 2 = absolute value of (TotalO3 - ProfileTotalO3) > 25 DU, 3 = average absolute value of NValueResidualsFinal > 0.20 N-value, 4 = absolute value of NValueResidualsFinal at any wavelength > (3 * InstrumentError * 43.4294), 5 = absolute value of (ProfileO3Retrieved/ProfileO3APrioriLayer - 1) in any layer > (3 * APrioriError), 6 = non-convergent solution, 7 = upper level profile anomaly, 8 = NValueResidualsInitial at any wavelength greater than 18.0 N-value units, and 9 = total ozone algorithm failure (first guess not available). The value of this flag is increased by 10 for descending data. The value of this flag is increased by 100 (or 200) during broad periods of lesser quality data.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	1
long_name	STRING	Scalar	Profile Ozone Error Flag
valid_min	32-BIT SIGNED INTEGER	1	0
valid_max	32-BIT SIGNED INTEGER	1	300
_FillValue	32-BIT SIGNED INTEGER	1	-2147483647

Name	ProfileO3FirstGuess
Type	32-BIT FLOAT
Dimensions	nLevels21 x nTimes
Description	The first guess (initial) for 21-layer ozone profile (in DU).

Attributes

Name	Type	Size	Value
units	STRING	Scalar	DU
long_name	STRING	Scalar	21-Layer Ozone Profile First Guess
valid_min	32-BIT FLOAT	1	0.0
valid_max	32-BIT FLOAT	1	150.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	ProfileO3Retrieved
Type	32-BIT FLOAT
Dimensions	nLevels21 x nTimes
Description	The retrieved ozone profile for 21 layers.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	DU
long_name	STRING	Scalar	21-Layer Retrieved Ozone Profile
valid_min	32-BIT FLOAT	1	0.0
valid_max	32-BIT FLOAT	1	150.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	ProfileO3RetrievedError
Type	32-BIT FLOAT
Dimensions	nLevels20 x nTimes
Description	The estimated error of retrieved ozone profile (top layer excluded).

Attributes

Name	Type	Size	Value
units	STRING	Scalar	%
long_name	STRING	Scalar	Estimated Error of Retrieved Profile (Top Layer Excluded)
valid_min	32-BIT FLOAT	1	0.0
valid_max	32-BIT FLOAT	1	100.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	ProfileTotalO3
Type	32-BIT FLOAT
Dimensions	nTimes
Description	The sum of the ozone profile (in DU).

Attributes

Name	Type	Size	Value
units	STRING	Scalar	DU
long_name	STRING	Scalar	Profile Total Ozone
valid_min	32-BIT FLOAT	1	50.0
valid_max	32-BIT FLOAT	1	700.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	ProfileTotalO3Error		
Type	32-BIT FLOAT		
Dimensions	nTimes		
Description	The estimated error in the sum of the ozone profile (in DU).		
Attributes			
Name	Type	Size	Value
units	STRING	Scalar	%
long_name	STRING	Scalar	Estimated Error of Profile Total Ozone
valid_min	32-BIT FLOAT	1	0.0
valid_max	32-BIT FLOAT	1	100.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	QualityFitParameter		
Type	32-BIT FLOAT		
Dimensions	nTimes		
Description	The quality of fit parameter (average final residual). The average of the absolute values of the solution N-value residuals for the profile computation. It includes only those channels that are used in the retrieval, as indicated by IndexLongestProfileChannel.		
Attributes			
Name	Type	Size	Value
units	STRING	Scalar	1
long_name	STRING	Scalar	Quality of Fit Parameter (Average Final Residual)
valid_min	32-BIT FLOAT	1	0.0
valid_max	32-BIT FLOAT	1	20.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	Reflectivity		
Type	32-BIT FLOAT		
Dimensions	nTimes		
Description	The reflectivity at the wavelength corresponding to the channel designated by ReflectivityWavelengthIndex or ReflectivityWavelengthIndexHighSZA.		
Attributes			
Name	Type	Size	Value
units	STRING	Scalar	1
long_name	STRING	Scalar	Reflectivity
valid_min	32-BIT FLOAT	1	-0.15
valid_max	32-BIT FLOAT	1	1.15
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	ReflectivityCorrection		
Type	32-BIT FLOAT		
Dimensions	nTimes		
Description	The correction for reflectivity.		
Attributes			
Name	Type	Size	Value
units	STRING	Scalar	1
long_name	STRING	Scalar	Reflectivity Correction

valid_min	32-BIT FLOAT	1	-0.5
valid_max	32-BIT FLOAT	1	0.5
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	Sigma
Type	32-BIT FLOAT
Dimensions	nTimes
Description	The ratio of ozone scale height to pressure scale height in the upper stratosphere.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	1
long_name	STRING	Scalar	Sigma
valid_min	32-BIT FLOAT	1	0.0
valid_max	32-BIT FLOAT	1	100.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	StepOneO3
Type	32-BIT FLOAT
Dimensions	nTimes
Description	The step 1 total ozone solution (in DU) from the total ozone computation.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	DU
long_name	STRING	Scalar	Step 1 Ozone Solution
valid_min	32-BIT FLOAT	1	50.0
valid_max	32-BIT FLOAT	1	700.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	StepTwoO3
Type	32-BIT FLOAT
Dimensions	nTimes
Description	The step 2 total ozone solution (in DU) from the total ozone computation.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	DU
long_name	STRING	Scalar	Step 2 Ozone Solution
valid_min	32-BIT FLOAT	1	50.0
valid_max	32-BIT FLOAT	1	700.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	TotalO3
Type	32-BIT FLOAT
Dimensions	nTimes
Description	The total ozone column amount derived from a TOMS-like wavelength-pair algorithm.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	DU
long_name	STRING	Scalar	Total Column Ozone
valid_min	32-BIT FLOAT	1	50.0
valid_max	32-BIT FLOAT	1	700.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	TotalO3AlgorithmFlag
Type	32-BIT SIGNED INTEGER
Dimensions	nTimes
Description	The total ozone algorithm flag: 0 = no retrieval, 1 = nominal B-pair retrieval (318 nm, 331 nm) with aerosol index adjustment (SolarZenithAngle <= 70 degrees), 2 = nominal B-pair retrieval (318 nm, 331 nm) with A-pair residual adjustment (SolarZenithAngle > 70 degrees), and 3 = C-pair retrieval (331 nm, 340 nm). The value of this flag is increased by 10 if the value of SnowIceIndicator is 10.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	1
long_name	STRING	Scalar	Total Ozone Algorithm Flag
valid_min	32-BIT SIGNED INTEGER	1	0
valid_max	32-BIT SIGNED INTEGER	1	100
_FillValue	32-BIT SIGNED INTEGER	1	-2147483647

Name	TotalO3APrioriProfile
Type	32-BIT FLOAT
Dimensions	nLayers11 x nTimes
Description	The total ozone a priori profile in Umkehr layers 0 to 9 and layers 10 plus.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	DU
long_name	STRING	Scalar	Total Ozone a priori Profile
valid_min	32-BIT FLOAT	1	0.0
valid_max	32-BIT FLOAT	1	125.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	TotalO3ErrorFlag
Type	32-BIT SIGNED INTEGER
Dimensions	nTimes
Description	The total ozone error flag: 0 = good retrieval, 1 = bad aerosol information or NOAA-16 radiance anomaly, 2 = SolarZenithAngle > 84 degrees, 3 = absolute value of PhotometerResidual > limit (= 10.0, 5.0, 99.0 for TotalO3AlgorithmFlag = 1, 2, 3), 4 = absolute value of Residual at 313 nm > limit (= 3.5, 5.0, [Residual at 318 nm > 5.0] for TotalO3AlgorithmFlag = 1, 2, 3),

	5 = absolute value of (TotalO3 - ProfileTotalO3) > 25 DU, 6 = StepOneO3 iteration did not converge, and 7 = NValueResidualsInitial at any wavelength greater than 18.0 N-value units or bad radiance value. The value of this flag is increased by 10 for descending data. The value of this flag is increased by 100 for possible poorer quality data.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	1
long_name	STRING	Scalar	Total Ozone Error Flag
valid_min	32-BIT SIGNED INTEGER	1	0
valid_max	32-BIT SIGNED INTEGER	1	200
_FillValue	32-BIT SIGNED INTEGER	1	-2147483647

Name	TOVSCloudPressure
Type	32-BIT FLOAT
Dimensions	nTimes
Description	The TOVS cloud pressure (SBUV2 only).

Attributes

Name	Type	Size	Value
units	STRING	Scalar	hPa
long_name	STRING	Scalar	TOVS Cloud Pressure
valid_min	32-BIT FLOAT	1	0.0
valid_max	32-BIT FLOAT	1	1013.15
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Name	UVAerosolIndex
Type	32-BIT FLOAT
Dimensions	nTimes
Description	The UV aerosol index.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	1
long_name	STRING	Scalar	UV Aerosol Index
valid_min	32-BIT FLOAT	1	-30.0
valid_max	32-BIT FLOAT	1	30.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Tables 3-3-3: Data fields are located under the HDF5 group object named SCIENCE_DATA.

3.3.4 Sensor Data

Name	ChannelWavelengths
Type	32-BIT FLOAT
Dimensions	nChannels13
Description	The channel wavelengths. Channels 1 to 12 are measured by the monochromator in sequence. Channel 13 (378.6 nm) is measured by the photometer simultaneously with each monochromator measurement to monitor scene changes.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	nm
long_name	STRING	Scalar	Channel Wavelengths
valid_min	32-BIT FLOAT	1	250.0
valid_max	32-BIT FLOAT	1	380.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30).0

Name	Gain
Type	32-BIT SIGNED INTEGER
Dimensions	nChannels12 x nTimes
Description	The instrument gain for Channels 1 to 12.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	1
long_name	STRING	Scalar	Gain
valid_min	32-BIT SIGNED INTEGER	1	0
valid_max	32-BIT SIGNED INTEGER	1	100
_FillValue	32-BIT SIGNED INTEGER	1	-2147483647

Name	GratingPositionError
Type	32-BIT FLOAT
Dimensions	nChannels12 x nTimes
Description	The grating position error for Channels 1 to 12. A value of zero means no error.

Attributes

Name	Type	Size	Value
units	STRING	Scalar	1
long_name	STRING	Scalar	Grating Position Error
valid_min	32-BIT FLOAT	1	-10.0
valid_max	32-BIT FLOAT	1	10.0
_FillValue	32-BIT FLOAT	1	-1×2.0^{100} (-1.2676506e+30)

Tables 3-3-4: Data fields are located under the HDF5 group object named SENSOR_DATA.

4. Options for Reading the Data

There are many tools and visualization packages (free and commercial) for viewing and dumping the contents of HDF5 files. Libraries are available in several programming languages for writing software to read HDF5 files. A few simple to use command-line and visualization tools, as well as programming languages for reading the L2 HDF5 data files are listed in the sections below. For a comprehensive list of HDF5 tools and software, please see the HDF Group's web page at http://www.hdfgroup.org/products/hdf5_tools/.

4.1 Command Line Utilities

4.1.1 h5dump (free)

The h5dump tool, developed by the HDFGroup, enables users to examine the contents of an HDF5 file and dump those contents, in human readable form, to an ASCII file, or alternatively to an XML file or binary output. It can display the contents of the entire HDF5 file or selected objects, which can be groups, datasets, a subset of a dataset, links, attributes, or datatypes. The h5dump tool is included as part of the HDF5 library, or separately as a stand-alone binary tool at:

http://www.hdfgroup.org/HDF5/release/obtain5.html

4.1.2 ncdump (free)

The ncdump tool, developed by Unidata, will print the contents of a netCDF or compatible file to standard out as CDL text (ASCII) format. The tool may also be used as a simple browser, to display the dimension names and lengths; variable names, types, and shapes; attribute names and values; and optionally, the values of data for all variables or selected variables. To view HDF5 data files, version 4.1 or higher is required. The ncdump tool is included with the netCDF library. **NOTE: you must include HDF5 support during build.**

http://www.unidata.ucar.edu/downloads/netcdf/

4.1.3 H5_PARSE (IDL/commercial)

The H5_PARSE function recursively descends through an HDF5 file or group and creates an IDL structure containing object information and data values. You must purchase an IDL package, version 8 or higher, to read the L2 HDF5 data files.

http://www.exelisvis.com/language/en-US/ProductsServices/IDL.aspx

4.2 Visualization Tools

4.2.1 HDFView (free)

HDFView, developed by the HDFGroup, is a Java-based graphic utility designed for viewing and editing the contents of HDF4 and HDF5 files. It allows users to browse through any HDF file, starting with a tree view of all top-level objects in an HDF file's hierarchy. HDFView allows a user to descend through the hierarchy and navigate among the file's data objects. Editing features allow a user to create, delete, and modify the value of HDF objects and attributes. For more info see:

http://www.hdfgroup.org/hdf-java-html/hdfview/

4.2.2 Panoply (free)

Panoply, developed at the Goddard Institute for Space Studies (GISS), is a cross-platform application which plots geo-gridded arrays from netCDF, HDF and GRIB dataset required. The tool allows one to slice and plot latitude-longitude, latitude-vertical, longitude-vertical, or time-latitude arrays from larger multidimensional variables, combine two arrays in one plot by differencing, summing or averaging, and change map projections. One may also access files remotely into the Panoply application.

http://www.giss.nasa.gov/tools/panoply/

4.2.3 H5_BROWSER (IDL/commercial)

The H5_BROWSER function presents a graphical user interface for viewing and reading HDF5 files. The browser provides a tree view of the HDF5 file or files, a data preview window, and an information window for the selected objects. The browser may be created as either a selection dialog with Open/Cancel buttons, or as a standalone browser that can import data to the IDL main program. You must purchase an IDL package, version 8 or higher to view the L2 HDF5 data files.

http://www.exelisvis.com/language/en-US/ProductsServices/IDL.aspx

4.3 Programming Languages

Advanced users may wish to write their own software to read HDF5 data files. The following is a list of available HDF5 programming languages:

Free:

C/C++ (http://www.hdfgroup.org/HDF5/release/obtain5.html)
Fortran (http://www.hdfgroup.org/HDF5/release/obtain5.html)
Java (http://www.hdfgroup.org/hdf-java-html/)
Python (http://alfven.org/wp/hdf5-for-python/)
GrADS (http://www.iges.org/grads/)

Commercial:

IDL (http://www.exelisvis.com/language/en-US/ProductsServices/IDL.aspx)
Matlab (http://www.mathworks.com/products/matlab/)

5. Data Services

5.1 Mirador

The GES DISC provides basic temporal and advanced (event) searches through its Mirador search and download engine:

http://mirador.gsfc.nasa.gov/

Mirador offers various download options that suit users with different preferences and different levels of technical skills. Users can start from a point where they don't know anything about these particular data, its location, size, format, etc., and quickly find what they need by just providing relevant keywords, such as a data product (e.g. "SBUV2N09L2"), or a parameter such as "ozone".

5.2 OPeNDAP

The Open Source Project for a Network Data Access Protocol (OPeNDAP) provides remote access to individual variables within datasets in a form usable by many OPeNDAP enabled tools, such as Panoply, IDL, Matlab, GrADS, IDV, McIDAS-V, and Ferret. Data may be subsetted dimensionally and downloaded in an ASCII, netCDF3 or binary (DAP) format. The GES DISC offers the SBUV L2 data products through OPeNDAP:

http://measures.gsfc.nasa.gov/opendap/Ozone/contents.html

6. More Information

6.1 Web Resources

For other ozone and related data, please search NASA's Global Change Master Directory at http://gcmd.nasa.gov.

6.2 Point of Contact

Name: GES DISC Help Desk
URL: http://disc.gsfc.nasa.gov/
E-mail: gsfc-help-disc@lists.nasa.gov
Phone: 301-614-5224
Fax: 301-614-5228
Address: Goddard Earth Sciences Data and Information Services Center
Attn: Help Desk
Code 610.2
NASA Goddard Space Flight Center
Greenbelt, MD 20771, USA

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