EUMETSAT AC SAF
ATMOSPHERIC COMPOSITION MONITORING

PRODUCT USER MANUAL

GOME-2 Absorbing Aerosol Height

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Document status sheet

Issue	Date	Page(s)	Modified Items / Reason for Change
0.1	05-04-2019	all	first draft version
1.0	24-03-2020	all	first official version of document
1.1	21-08-2020	23	update after ORR: added “RegimeFlag” description to section 2.4
1.2	21-05-2021	22	added solar eclipse corrections flag to table 5

Related AC SAF product ID numbers

Product ID	Instrument	Platform	Product Type
O3M-68	GOME-2	MetOp-A	NRT
O3M-69	GOME-2	MetOp-A	offline
O3M-78	GOME-2	MetOp-B	NRT
O3M-79	GOME-2	MetOp-B	offline
O3M-364	GOME-2	MetOp-C	NRT
O3M-365	GOME-2	MetOp-C	offline
O3M-170	GOME-2	MetOp-A/B/C	DR

Contents

Introduction to EUMETSAT Satellite Application Facility on Atmospheric Composition monitoring (AC SAF)

Background

The monitoring of atmospheric chemistry is essential due to several human caused changes in the atmosphere, like global warming, loss of stratospheric ozone, increasing UV radiation, and pollution. Furthermore, the monitoring is used to react to the threads caused by the natural hazards as well as follow the effects of the international protocols.

Therefore, monitoring the chemical composition and radiation of the atmosphere is a very important duty for EUMETSAT and the target is to provide information for policy makers, scientists and general public.

Objectives

The main objectives of the AC SAF is to process, archive, validate and disseminate atmospheric composition products (O_3, NO_2, SO_2, BrO, HCHO, H_2O, OClO, CO, NH_3), aerosol products and surface ultraviolet radiation products utilising the satellites of EUMETSAT. The majority of the AC SAF products are based on data from the GOME-2 and IASI instruments onboard MetOp satellites.

Another important task besides the near real-time (NRT) and offline data dissemination is the provision of long-term, high-quality atmospheric composition products resulting from reprocessing activities.

Product categories, timeliness and dissemination

NRT products are available in less than three hours after measurement. These products are disseminated via EUMETCast, WMO GTS or internet.

- Near real-time trace gas columns (total and tropospheric O_3 and NO_2, total SO_2, total HCHO, CO) and ozone profiles
- Near real-time absorbing aerosol indexes from main science channels and polarisation measurement detectors
- Near real-time UV indexes, clear-sky and cloud-corrected

Offline products are available within two weeks after measurement and disseminated via dedicated web services at EUMETSAT and AC SAF.

- Offline trace gas columns (total and tropospheric O_3 and NO_2, total SO_2, total BrO, total HCHO, total H_2O) and ozone profiles
- Offline absorbing aerosol indexes from main science channels and polarisation measurement detectors
- Offline surface UV, daily doses and daily maximum values with several weighting functions

Data records are available after reprocessing activities from the EUMETSAT Data Centre and/or the AC SAF archives.

- Data records generated in reprocessing
- Surface Lambertian-equivalent reflectivity
- Total OClO

Users can access the AC SAF offline products and data records (free of charge) by registering at the AC SAF web site.

More information about the AC SAF project, products and services: http://acsaf.org/

AC SAF Helpdesk: helpdesk@acsaf.org

Twitter: https://twitter.com/Atmospheric_SAF

1 Introduction

1.1 Document purpose and scope

This document is the Product User Manual (PUM) for the GOME-2 Absorbing Aerosol Height (AAH) product developed at KNMI in the framework of the AC SAF (Satellite Application Facility on Atmospheric Composition Monitoring). The aim of this PUM is to present the data format used for the data record, and to explain and describe the contents of the fields contained in the HDF-5 files.

1.2 Heritage

The GOME-2 AAH product is a brand new product. However, it uses the Absorbing Aerosol Index (AAI) product produced by the AC SAF [*Tilstra et al.*, 2010] for aerosol detection, and the part of the AAH algorithm code that derives the actual height of the absorbing aerosol layer using the O_2-A band is derived from the FRESCO+ cloud information algorithm [*Wang et al.*, 2008].

1.3 GOME-2 AAH products

The GOME-2 AAH products are created in NRT and offline processing, from the level-1 data generated from the GOME-2 instruments onboard the MetOp-A, MetOp-B, and MetOp-C satellites. Next to this, a GOME-2 AAH data record based on data from all three MetOp satellites will also be produced. An overview of the data products and allocated product identifiers is given in Table 1.

Product ID	Satellite	Platform	Type
O3M-68	GOME-2	MetOp-A	NRT
O3M-69	GOME-2	MetOp-A	offline
O3M-78	GOME-2	MetOp-B	NRT
O3M-79	GOME-2	MetOp-B	offline
O3M-364	GOME-2	MetOp-C	NRT
O3M-365	GOME-2	MetOp-C	offline
O3M-170	GOME-2	MetOp-A/B/C	DR

Table 1: Overview of the AAH offline and NRT data products and data records that are produced, and the product identifiers that are currently allocated to the products and datarecords.

1.4 Further information

1.4.1 The AC SAF website

Further up-to-date information and documentation on the GOME-2 AAH product are available on the AC SAF website via the following URL:

http://acsaf.org

Requests for data and questions with regards to AC SAF products should be directed to the user services. Contact information is also available on the website mentioned above.

Important note:

Before 1 March 2017, the AC SAF had a different name: Satellite Application Facility on Ozone and Atmospheric Chemistry Monitoring (O3M SAF). As of 1 March 2017, this name should no longer be used. Please remember to update your acknowledgement (see section 1.4.2).

1.4.2 Acknowledgement instructions

When AC SAF data are used for operational or scientific purposes, the source of these data should be acknowledged. For example: "The data of the GOME-2 Absorbing Aerosol Height (AAH) product are provided by KNMI in the framework of the EUMETSAT Satellite Application Facility on Atmospheric Composition Monitoring (AC SAF)".

1.5 Abbreviations and acronyms

AAH	Absorbing Aerosol Height
AAI	Absorbing Aerosol Index
AC SAF	Satellite Application Facility on Atmospheric Composition Monitoring
AOT	Aerosol Optical Thickness
ATBD	Algorithm Theoretical Basis Document
BBA	Biomass Burning Aerosol
BRDF	Bidirectional Reflectance Distribution Function
BSA	Black-Sky Albedo
CDOP	Continuous Development & Operations Phase
COT	Cloud Optical Thickness
DAK	Doubling-Adding KNMI
DDA	Desert Dust Aerosols

DOAS	Differential Optical Absorption Spectroscopy
DU	Dobson Units, 2.69×10^{16} molecules cm^{-2}
ENVISAT	Environmental Satellite
EOS-Aura	Earth Observing System – Aura satellite
ERS	European Remote Sensing Satellite
ESA	European Space Agency
ETOPO-4	Topographic & Bathymetric data set from the NGDC, 4 arc-min. resolution
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
FOV	Field-of-View
FRESCO	Fast Retrieval Scheme for Clouds from the Oxygen A band
FWHM	Full Width at Half Maximum
GMTED2010	Global Multi-resolution Terrain Elevation Data 2010
GOME	Global Ozone Monitoring Experiment
HDF	Hierarchical Data Format
IT	Integration Time
KNMI	Koninklijk Nederlands Meteorologisch Instituut
LER	Lambertian-Equivalent Reflectivity
LUT	Look-Up Table
MERIS	Medium Resolution Imaging Spectrometer
METOP	Meteorological Operational Satellite
MLS	Mid-Latitude Summer
MSC	Main Science Channel
NGDC	NOAA's National Geophysical Data Center (Boulder, Colorado, USA)
NISE	Near-real-time Ice and Snow Extent
NOAA	National Oceanic and Atmospheric Administration
NRT	Near-Real-Time
OMI	Ozone Monitoring Instrument
O3M SAF	Satellite Application Facility on Ozone and Atmospheric Chemistry Monitoring
PMD	Polarisation Measurement Device
PSD	Product Specification Document
PUM	Product User Manual
RMSE	Root-Mean-Square Error
RTM	Radiative Transfer Model
SCIAMACHY	Scanning Imaging Absorption Spectrometer for Atmospheric Chartography
SZA	Solar Zenith Angle
TEMIS	Tropospheric Emission Monitoring Internet Service
TOA	Top-of-Atmosphere

TOMS	Total Ozone Mapping Spectrometer
UTC	Coordinated Universal Time
UV	Ultraviolet
VIS	Visible
VR	Validation Report
VZA	Viewing Zenith Angle

2 The GOME-2 AAH product

2.1 Product filename convention

The file names of the AAH product files closely follow the names of the input files:

`S-O3M_GOME_ARS_02_AAA_SSSS_EEEE_W_Z_PPPP.hdf5`

AAA refers to the flight model number. For MetOp-A this number is M02, for MetOp-B it is M01, and for MetOp-C M03. SSSS is a placeholder for the SensingStartTime: YYYYMMDDhhmmssZ. EEEE is a placeholder for the SensingEndTime and PPPP for the processing time (both in the same format as SSSS). The W indicates the ProcessingMode and Z indicates the DispositionMode.

2.2 Structure of the AAH product files

The format of the AAH product level-2 file is HDF-5. The data inside the HDF-5 file is organised into four groups: METADATA, PRODUCT_SPECIFIC_METADATA, GEOLOCATION, and DATA (see Figure 1). The values in all groups are taken from the level-1b, from external input data files, copied from the configuration file, or calculated by the data processor itself.

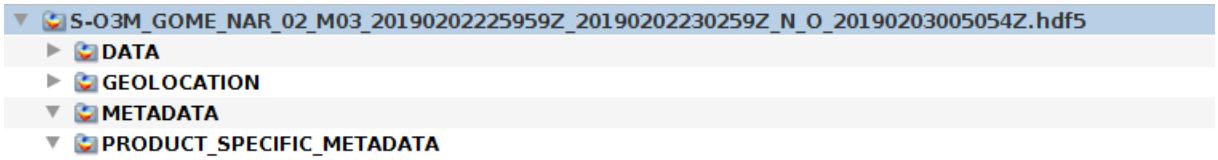

Figure 1: Structure of the AAH HDF-5 file.

The METADATA group contains parameters about the satellite instrument required by UMARF, such as metadata given in the AC SAF software requirements, the scanning mode, the algorithm version and other general information about the product.

The PRODUCT_SPECIFIC_METADATA group is reserved for additional information specific to this product (e.g., parameters related to the algorithm) which has been used to generate the product. All values in the METADATA and PRODUCT_SPECIFIC_METADATA groups are stored as attributes.

The geolocation information of each ground pixel can be found in the GEOLOCATION group. It contains all information such as corner and centre coordinates and viewing and solar angles. See Figure 2 for the definition of the seven points of the GOME-2 ground pixel.

The calculated results are stored in the DATA group. It contains information about the quality of the retrieval, auxiliary information, the definition of the state vector and the retrieval results.

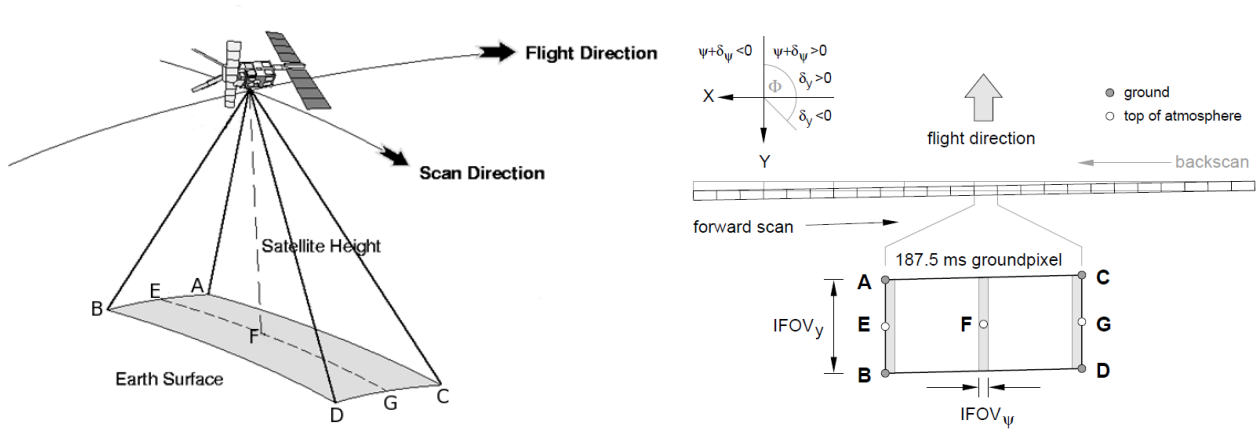

Figure 2: Ground pixel geometry in relation to the flight direction and scanning motion.

Because the output product contains information for series of pixels, all information in the DATA and GEOLOCATION group is organised in multi-dimensional arrays. The first dimension always corresponds to the total number of pixel sets which has been processed, hereafter referred to as NSets. The total number of retrievals per set is referred to as NElements.

If the calculation failed, a fill value is written to the array as a placeholder, indicating "no data" (in contrast to "invalid data"). Each array has five attributes: Title, Unit, FillValue, ValidRangeMin and ValidRangeMax, which are used to describe the contents of the array.

2.2.1 The METADATA group

The content of the METADATA group is listed in Table 2. The allowed values for those parameters that are required by UMARF are consistent with the requirements given in Table 2.

Attribute name	Data type	Description	Allowed values / Example
`SatelliteID`	string 3-byte	Platform identifier	M02 = MetOp-A M01 = MetOp-B M03 = MetOp-C
`InstrumentID`	string 4-byte	Satellite instrument from which the product originates	GOME
`InstrumentMode`	string	Mode of operation of the satellite instrument	NORMAL_VIEW, NARROW_VIEW, STATIC_VIEW, NORTH_POLAR_VIEW, SOUTH_POLAR_VIEW
`OrbitType`	string 3-byte	Type of the orbit	LEO (=Low Earth Orbit)

Attribute name	Data type	Description	Allowed values / Example
Inclination	float	Inclination of the satellite orbit (in degrees)	98.723
AscNodeCrossingTime	string 23-byte	Equator crossing time (in UTC) for the ascending node	Time in CCSDS format, e.g., 2019-01-19T22:28:27.000
AscNodeLongitude	string 9-byte	Equator crossing longitude for the ascending node (in degrees)	-14.9350
SensingStartTime	string 23-byte	Date and time at the beginning of the product (UTC)	Time in CCSDS format, e.g., 2019-01-19T23:32:54.000
SensingEndTime	string 23-byte	Date and time at the end of the product (UTC)	Time in CCSDS format, e.g., 2019-01-19T23:35:54.000
SubSatellitePointStartLat	float	Latitude of the sub-satellite point at the beginning of sensing	-90 to +90
SubSatellitePointStartLon	float	Longitude of the sub-satellite point at the beginning of sensing	-180 to +180
SubSatellitePointEndLat	float	Latitude of the sub-satellite point at the end of sensing	-90 to +90
SubSatellitePointEndLon	float	Longitude of the sub-satellite point at the end of sensing	-180 to +180
StartOrbitNumber	integer	First of the two orbit numbers in the EPS product, valid at the beginning of sensing	32893
ReceivingCentre	string	Centre that received the L0 data	SVL
ProcessingCentre	string 5-byte	Centre that generated the L2 data	O3KNM
ProcessingLevel	string 2-byte	Processing level of the product	02
ProcessingTime	string 23-byte	Date and time at the processing end of the product	Time in CCSDS format, e.g., 2019-01-20T00:12:14.924
ProcessingMode	string 1-byte	Processing mode applied for the generation of the product	N = nominal B = backlog R = reprocessing V = validation
DispositionMode	string 1-byte	Disposition mode applied for the generation of the product	O = operational P = pre-operational D = demonstrational
GranuleType	string 2-byte	Type description of the item	DP

Attribute name	Data type	Description	Allowed values / Example
ProjectID	string 3-byte	Project ID indicating the SAF that created and released the product	O3M
ShortProductName	string 3-byte	Short identifier for the aerosol product group	NAR
ReferenceTime	string 23-byte	Date and time at which the product was generated	Time in CCSDS format, e.g., 2019-01-19T23:32:54.000
ParentProducts	string array	Name of the parent products upon which the L2 product is based	GOME_xxx_1B_M03…
BaseAlgorithmVersion	string 3-byte	Version of the L1B input data	6.3
ConfigurationFileVersion	string 4-byte	Version of the configuration file	1.50
ProductAlgorithmVersion	string 4-byte	Version of the L2 algorithm	1.31
ProductFormatType	string 11-byte	Data format of the L2 product	HDF5/O3MSAF
ProductFormatVersion	string 4-byte	Version of the L2 product format	4.60
ProductSoftwareVersion	string 4-byte	Version of the software	2.02
ProductType	string 6-byte	Abbreviation indicating the product group family	O3MARS, O3MOOP, O3MNOP
ProductID	string 8-byte	Product identifier, following the rules stated in the AC SAF Product Requirement Document	O3M-XXX(.x), where X and the optional x are digits
RevisionID	string	Revision identifier, the optional x in the ProductID	0–9
DOI	string	Digital Object Identifier, issued by EUMETSAT	10.15770/EUM_SAF_O3M_XXXX, where X is a digit
DegradedRecordCount	integer	Number of degraded or incomplete Earthshine MDR records detected by the L2 software	0
DegradedRecordPercentage	integer	Percentage of degraded or incomplete Earthshine MDR records detected by the L2 software	0–100

Attribute name	Data type	Description	Allowed values / Example
MissingDataCount	integer	Number of Earthshine MDR records skipped by the L2 software due to time breaks or orther data requirement failures	0
MissingDataPercentage	integer	Percentage of Earthshine MDR records skipped by the L2 software due to time breaks or orther data requirement failures	0–100
QualityInformation	string	Several miscellaneous quality indicators for the L2 product	Any text information
OverallQualityFlag	string 3-byte	Overall quality flag for the L2 product	OK, NOK

Table 2: METADATA group contents.

2.2.2 The PRODUCT_SPECIFIC_METADATA group

The content of the PRODUCT_SPECIFIC_METADATA group is listed in Table 3.

Attribute name	Data type	Description	Allowed values / Example
ChannelType	string 14-byte	Specifies the channel type (Main Science Channels or PMD bands)	ScienceChannel
Wavelengths	float array	Wavelength pair used for the AAI (in nm)	380, 340
FullWidthTriangle	float	Width of the two AAI wavelength bands (in nm)	1.0
DegCorInUse	integer	Indicates whether the degradation correction was applied (for AAI)	0 = not applied 1 = applied
CorrectionSourceFile	string	Filename of the instrument degradation correction database	GOME_M03_MSC…

Table 3: PRODUCT_SPECIFIC_METADATA group contents.

2.2.3 The GEOLOCATION group

The datasets in the GEOLOCATION group are given in Table 4. The data type, data dimension, unit, and a brief dataset description are given for each dataset.

Dataset name	Data type / dimension	Unit	Description
Time	string array [32,30]	-	UTC time in CCSDS format
LongitudeCenter	float array [32,30]	degrees	Longitude of the centre of the ground pixel
LatitudeCenter	float array [32,30]	degrees	Latitude of the centre of the ground pixel
LongitudeCorner	float array [4,32,30]	degrees	Longitude of the corners of the ground pixel
LatitudeCorner	float array [4,32,30]	degrees	Latitude of the corners of the ground pixel
SolarZenithAngle	float array [32,30]	degrees	Solar zenith angle at the centre of the ground pixel
SolarAzimuthAngle	float array [32,30]	degrees	Solar azimuth angle w.r.t. north at the centre of the ground pixel
LineOfSightZenithAngle	float array [32,30]	degrees	Line of sight zenith angle at the centre of the ground pixel
LineOfSightAzimuthAngle	float array [32,30]	degrees	Line of sight azimuth angle w.r.t. north at the centre of the ground pixel
RelAzimuthAngle	float array [32,30]	degrees	Relative azimuth angle at the centre of the ground pixel
ScatteringAngle	float array [32,30]	degrees	Single scattering angle (defined by viewing and solar direction)
SubSatellitePointLongitude	float array [32,30]	degrees	Geodetic longitude of the subsatellite point
SubSatellitePointLatitude	float array [32,30]	degrees	Geodetic latitude of the subsatellite point

Dataset name	Data type / dimension	Unit	Description
ScannerAngle	float array [32,30]	degrees	Angle of the scan mirror
IndexInScan	integer array [32,30]	-	Position of the ground pixel within the scan line (forward scan: 1–24, backscan: 25–32)
ScanDirection	integer array [32,30]	-	Direction of travel of the scan mirror (1 = forward, 2 = backward)
NrOfPixelsInScan	integer array [30]	-	Number of ground pixels within the scan line
NElements	integer array [30]	-	Number of observations in each set

Table 4: GEOLOCATION group contents.

2.2.4 The DATA group

The datasets in the DATA group are given in Table 5. The data type, data dimension, unit, and a brief dataset description are given for each dataset. The datasets are ordered in such a way that the AAH, AAI, and FRESCO results are grouped together.

Dataset name	Data type / dimension	Unit	Description
AAH_AbsorbingAerosolHeight	float array [32,30]	km	Absorbing aerosol height
AAH_AbsorbingAerosolHeightError	float array [32,30]	km	Estimated error in absorbing aerosol height
AAH_AbsorbingAerosolPressure	float array [32,30]	hPa	Absorbing aerosol pressure
AAH_AbsorbingAerosolPressureError	float array [32,30]	hPa	Estimated error in absorbing aerosol pressure

Dataset name	Data type / dimension	Unit	Description
AAH_RegimeFlag	integer array [32,30]	-	Flag indicating the position in parameter space (0 = no info, 1 = regime A, 2 = regime B, 3 = regime C, 4 = snow/ice)
AAH_ChoiceFlag	integer array [32,30]	-	Flag indicating the height selected by the AAH algorithm (0 = no info, 1 = cloud height, 2 = scene height)
AAH_ErrorFlag	integer array [32,30]	-	Error flag (0 = ok, 1 = no AAI, 2 = no cloud input, 3 = AAI too low, 4 = AAI low, 5 = snow/ice, 6 = SZA too high, 7 = sun glint)
AAH_QualityInput	integer array [32,30]	-	Quality of the AAH input parameters; see parameter QualityInput for meaning
AAH_QualityProcessing	integer array [32,30]	-	Quality of the AAH processing; see parameter QualityProcessing for meaning
AAH_NElements	integer array [30]	-	Number of AAH observations in each set
AAI	float array [32,30]	-	Absorbing aerosol index, corrected for degradation, orbit corrections applied
DegradationCorrectedResidue	float array [32,30]	-	Residue, corrected for degradation, no orbit corrections applied
UncorrectedResidue	float array [32,30]	-	Residue, no corrections applied (should normally not be used)
Reflectance_A	float array [32,30]	-	Measured reflectance at 340 nm
Reflectance_B	float array [32,30]	-	Measured reflectance at 380 nm
CalculatedReflectance_A	float array [32,30]	-	Simulated reflectance at 340 nm
CalculatedReflectance_B	float array [32,30]	-	Simulated reflectance at 380 nm

Dataset name	Data type / dimension	Unit	Description
SceneAlbedo	float array [32,30]	-	Scene albedo calculated at 380 nm
BandNr	integer array [2,32,30]	-	Spectral channels from which the 340/380-nm wavelength bands were determined
SpectralPixelMinNr	integer array [2,32,30]	-	Left-most detector pixel inside the wavelength band (340 and 380 nm)
SpectralPixelMaxNr	integer array [2,32,30]	-	Right-most detector pixel inside the wavelength band (340 and 380 nm)
CorrectionFactor	float array [2,32,30]	-	Correction factors for degradation, to be applied to the 340/380-nm reflectances
OrbitCorrectionValue	float array [32,30]	-	End-of-Orbit AAI correction values
OrbitCrossTrackCorrectionValue	float array [32,30]	-	Across-track AAI correction values
NElements	integer array [30]	-	Number of AAI observations in each set
FRESCO_CloudFraction	float array [32,30]	-	Effective cloud fraction (CF)
FRESCO_CloudHeight	float array [32,30]	km	Cloud height (CH)
FRESCO_CloudTopPressure	float array [32,30]	hPa	Cloud top pressure (CP)
FRESCO_CloudAlbedo	float array [32,30]	-	Cloud albedo (CA)
FRESCO_FSI_SceneAlbedo	float array [32,30]	-	Scene albedo retrieved in FSI mode (SA)

Dataset name	Data type / dimension	Unit	Description
FRESCO_FSI_SceneHeight	float array [32,30]	km	Scene height retrieved in FSI mode (SH)
FRESCO_FSI_ScenePressure	float array [32,30]	hPa	Scene pressure retrieved in FSI mode (SP)
FRESCO_SnowIceFlag	integer array [32,30]	-	Snow/ice flag
PMD_CloudFraction	float array [32,30]	-	Geometric cloud fraction derived from AVHRR data
PMD_SceneHomogeneity	float array [32,30]	-	Homogeneity of the ground pixel according to AVHRR data
PMD_SnowIceFrac	float array [32,30]	-	Snow/ice fraction derived from AVHHR data
SurfaceHeight	float array [32,30]	km	Surface height
SurfacePressure	float array [32,30]	hPa	Surface pressure
OzoneColumn	float array [32,30]	DU	Total ozone column
SunGlintFlag	integer array [32,30]	-	Sun glint flag, sum of the following subflags: 0 = no sun glint 1 = land 4 = CF $>$ 0.3 8 = CP $<$ 850 hPa + CF $>$ 0.1 32 = sun glint angle $<$ 18° 64 = sun glint angle $<$ 11° Use only flag values 0, 1, 4, 8, and 33–63 Do not use flag values 32 or 64 and higher

Dataset name	Data type / dimension	Unit	Description
QualityInput	integer array [32,30]	-	Quality of the input parameters: 1 = non-nominal L1 (instrument degradation) 2 = non-nominal L1 (processing degradation) 3 = groundpixel is in SAA 4 = sunfile missing: older sunfile used 8 = Earthshine radiance data missing 9 = Earthshine radiance data invalid 10 = solar irradiance data missing 11 = solar irradiance data invalid 14 = AAI invalid (input or out-of-bound) 15 = failure in setup of forward model input 17 = sun glint flag 19 = cloud pressure set to surface pressure 20 = solar eclipse corrections applied 21 = other error 22–32 = reserved for future use
QualityProcessing	integer array [32,30]	-	Quality flags for processing: 7 = no retrieval done (due to input errors)

Table 5: DATA group contents.

2.3 File size estimate

The size of the output file can vary for a number of reasons. Near the polar regions the file size can vary because of a change to shorter integration times of the measurements. This also reduces the number of measurements. Also, the number of scans containing Earthshine data can go down as the instrument starts to observe polar night. The compression factor of the HDF-5 files is also a bit different for each individual orbit. On average, the size of a PDU file is about 322 Kb. With about 272 PDUs per day containing sensible data, a complete day of data amounts to about 80 Mb.

2.4 User guideline

Observations with AAI values below 2 index points correspond to scenes with too low amounts of aerosol to result in a reliable AAH. Users will therefore find a fill value in the AAH field for such situations. Also for AAI values larger than 2 index points but smaller than 4 index points the aerosol

layer is not in all cases thick enough for a reliable retrieval. However, for these situations the AAH is calculated and reported. Nevertheless, users should not use these data, unless they have a good (valid) reason for doing so. Users of the AAH should, therefore, always look at the AAI as well.

As described in the ATBD, the AAH algorithm distinguishes three regimes of operation (A, B, and C), each representing a different level of reliability. To which reliability regime the AAH observation belongs depends on the retrieved parameter CF, as explained in the ATBD:

A:	$CF \leq 0.25$	$\rightarrow$	AAH = CH	(high reliability)
B:	$0.25 < CF < 0.75$	$\rightarrow$	AAH = max(SH,CH)	(medium reliability)
C:	$CF \geq 0.75$	$\rightarrow$	AAH = CH	(low reliability)

The associated regime flag parameter is the parameter `AAH_RegimeFlag` described in Table 5. Users can refer to the AAH regime flag to get an indication of the expected reliability of the reported AAH. More background information can be found in the ATBD. Note that the AAH regime flag parameter was studied in a recent validation paper [*Michailidis et al.*, 2020].

3 Product quality

The GOME-2 AAH product has been validated by performing comparisons with lidar measurements taken from satellite (CALIOP) and through ground-based lidar comparisons. Results are described in the validation report (VR) and in [*Michailidis et al.*, 2020].

A Overview of solar eclipse events

The following two tables provide an overview of the major solar eclipse events that have occurred since the launch of MetOp-A and MetOp-B. The second column lists the dates on which the solar eclipse events occurred. The third and fourth columns together define the time intervals in which the measurements were noticeably affected. Data in these time intervals are not used.

satellite	date	start time	end time
MetOp-A	19-03-2007	02:48:52 UTC	03:05:09 UTC
MetOp-A	11-09-2007	11:17:10 UTC	11:23:52 UTC
MetOp-A	11-09-2007	12:51:33 UTC	13:06:19 UTC
MetOp-A	07-02-2008	03:11:08 UTC	03:21:21 UTC
MetOp-A	01-08-2008	03:16:39 UTC	03:22:45 UTC
MetOp-A	01-08-2008	08:18:26 UTC	08:24:26 UTC
MetOp-A	01-08-2008	09:59:50 UTC	10:20:20 UTC
MetOp-A	01-08-2008	11:42:59 UTC	11:49:24 UTC
MetOp-A	01-08-2008	13:24:03 UTC	13:30:31 UTC
MetOp-A	01-08-2008	15:04:20 UTC	15:13:01 UTC
MetOp-A	26-01-2009	05:55:33 UTC	06:10:45 UTC
MetOp-A	22-07-2009	01:07:56 UTC	01:23:31 UTC
MetOp-A	15-01-2010	05:19:17 UTC	05:33:47 UTC
MetOp-A	11-07-2010	17:50:19 UTC	18:02:31 UTC
MetOp-A	04-01-2011	08:00:51 UTC	08:18:07 UTC
MetOp-A	25-11-2011	06:38:19 UTC	06:48:26 UTC
MetOp-A	20-05-2012	14:46:28 UTC	14:53:47 UTC
MetOp-A	20-05-2012	16:28:10 UTC	16:35:10 UTC
MetOp-A	20-05-2012	18:09:10 UTC	18:15:10 UTC
MetOp-A	20-05-2012	23:26:31 UTC	23:41:02 UTC
MetOp-A	13-11-2012	21:05:02 UTC	21:22:45 UTC
MetOp-A	09-05-2013	23:16:45 UTC	23:35:28 UTC
MetOp-A	03-11-2013	11:38:12 UTC	11:56:10 UTC
MetOp-A	29-04-2014	04:16:10 UTC	04:23:05 UTC
MetOp-A	23-10-2014	21:09:51 UTC	21:23:16 UTC
MetOp-A	20-03-2015	09:57:13 UTC	10:13:58 UTC
MetOp-A	13-09-2015	06:05:18 UTC	06:18:25 UTC
MetOp-A	09-03-2016	01:02:19 UTC	01:18:35 UTC
MetOp-A	01-09-2016	07:10:12 UTC	07:26:21 UTC

MetOp-A	26-02-2017	12:42:51 UTC	12:54:12 UTC
MetOp-A	21-08-2017	16:43:30 UTC	16:52:37 UTC
MetOp-A	11-08-2018	06:00:00 UTC	24:00:00 UTC
MetOp-A	12-08-2018	00:00:00 UTC	18:00:00 UTC

Table 6: Solar eclipse events since the launch of MetOp-A. Given are the date and the time interval in which the measurements were noticeably affected.

satellite	date	start time	end time
MetOp-B	09-05-2013	22:32:29 UTC	22:52:41 UTC
MetOp-B	03-11-2013	10:55:02 UTC	11:04:14 UTC
MetOp-B	29-04-2014	05:06:27 UTC	05:18:55 UTC
MetOp-B	23-10-2014	20:23:24 UTC	20:35:23 UTC
MetOp-B	20-03-2015	09:15:23 UTC	09:32:35 UTC
MetOp-B	20-03-2015	10:49:31 UTC	10:58:55 UTC
MetOp-B	13-09-2015	07:06:24 UTC	07:17:31 UTC
MetOp-B	09-03-2016	00:17:31 UTC	00:33:49 UTC
MetOp-B	01-09-2016	08:01:54 UTC	08:19:56 UTC
MetOp-B	26-02-2017	13:34:21 UTC	13:58:24 UTC
MetOp-B	21-08-2017	17:29:51 UTC	17:47:36 UTC
MetOp-B	15-02-2018	20:09:15 UTC	20:15:46 UTC
MetOp-B	11-08-2018	08:03:23 UTC	08:11:41 UTC
MetOp-B	11-08-2018	09:44:23 UTC	09:58:12 UTC

Table 7: Solar eclipse events since the launch of MetOp-B. Given are the date and the time interval in which the measurements were noticeably affected.

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