PRODUCT USER MANUAL

IASI reprocessed L2 SO2 CDR

(O3M-540)

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DOCUMENT STATUS SHEET

Issue	Date	Modified items/Reason for change
1.0	15/12/2022	First version of the IASI SO2 CDR PUM.
1.1	03/04/2023	New version of the IASI SO2 CDR PUM after discussion with validation team (M. Koukouli, University of Thessaloniki).
1.2	14/09/2023	New version of the IASI SO2 CDR PUM, addition of NWP variables after discussion with users (R. Ribas, A. Inness, ECMWF).
1.3	25/01/2024	New version of the IASI CO CDR PUM after DRR reviewer's comments.

RELATED PRODUCT LIST

Product ID	Product name	Platform
O3M-379	IASI NRT SO2 altitude	Metop-A, Metop-B
O3M-57	IASI NRT total SO2	Metop-A, Metop-B

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1. INTRODUCTION

1.1 Purpose and scope

This document is the Product User Manual for reprocessed IASI Level 2 sulfur dioxide climate data record (L2 SO_2 CDR) including SO_2 altitude retrieved within the context of the Satellite Application Facility on Atmospheric Composition Monitoring (AC SAF) fourth Continuous Development and Operations Phase (CDOP-4). This document gives a brief overview on the IASI Brescia retrieval algorithm and explains how to use and interpret the reprocessed IASI SO_2 CDR.

The IASI SO_2 CDR (DOI: 10.15770/EUM_SAF_AC_0046) is produced at EUMETSAT using the Metop-A&B NRT IASI SO_2 Brescia v20180401_sp20200222.

The reprocessing for Metop A and B covers the following dates:

Start date: IASI-A: 10/07/2007, IASI-B: 20/02/2013

End date: IASI-A: 31/12/2019, IASI-B: 31/12/2022

1.2 Acronyms

AC SAF: Atmospheric Composition Monitoring Satellite Application Facility
AUTH: Aristotle University of Thessaloniki
BIRA: Belgian Institute for Space Aeronomy
CDOP-4: fourth Continuous Development and Operations Phase
CDR: Climate data record
CNES: Centre National d'Études Spatiales
DEM: Digital Elevation Model
ECMWF: European Centre for Medium-Range Weather Forecasts
EUMETSAT: European Organisation for the Exploitation of Meteorological Satellites
GTS: Global Telecommunication System
IASI: Infrared Atmospheric Sounding Interferometer
LATMOS: Laboratoire Atmosphères, Observations Spatiales
NetCDF: Network Common Data Form
NRT: Near Real Time
ULB: Université Libre de Bruxelles
WMO: World Meteorological Organization

1.3 Applicable and reference documents

1.3.1 Applicable documents

[AD1] IASI Brescia SO_2 Algorithm Theoretical Basis Document SAF/AC/ULB/ATBD/002 Issue 1.3, 01/02/2021
[AD2] NRT IASI SO2 PUM SAF/AC/ULB/PUM/005 Issue 1.5, 03/04/2023

[AD3] Product Requirements Document SAF/AC/FMI/RQ/PRD/001 Issue 1.9.1, 03/02/2022

[AD4] ACSAF validation report on the EUMETSAT IASI/Metop CDR SO2 datasets SAF/AC/AUTH/IASI/SO2/Repro, Issue 001, 31/03/2023.

1.3.2 Reference documents

[RD1] Hilton, F.; August, T.; Barnet, C.; Bouchard, A.; Camy-Peyret, C.; Clarisse, L.; Clerbaux, C.; Coheur, P.-F.; Collard, A.; Crevoisier, C.; Dufour, G.; Edwards, D.; Faijan, F.; Fourrié, N.; Gambacorta, A.; Gauguin, S.; Guidard, V.; Hurtmans, D.; Illingworth, S.; Jacquinet-Husson, N.; Kerzenmacher, T.; Klaes, D.; Lavanant, L.; Masiello, G.; Matricardi, M.; McNally, T.; Newman, S.; Pavelin, E.; Péquignot, E.; Phulpin, T.; Remedios, J.; Schlüssel, P.; Serio, C.; Strow, L.; Taylor, J.; Tobin, D.; Uspensky, A. and Zhou, D.: Hyperspectral Earth Observation with IASI. *Bull. Am. Meteorol. Soc., 93(3)*, 347-370, doi: 10.1175/BAMS-D-11-00027.1, 2012.

[RD2] Camy-Peyret, C. & Eyre, J. The IASI Science Plan. Technical report, A Report From The IASI Sounding Science Working Group, 1998.

[RD3] Clerbaux, C.; Boynard, A.; Clarisse, L.; George, M.; Hadji-Lazaro, J.; Herbin, H.; Hurtmans, D.; Pommier, M.; Razavi, A.; Turquety, S.; Wespes, C. & Coheur, P. F. Monitoring of atmospheric composition using the thermal infrared IASI/MetOp sounder. *Atmos. Chem. Phys*., 9(16):6041-6054, 2009.

[RD4] Clarisse, L., Hurtmans, D., Clerbaux, C., Hadji-Lazaro, J., Ngadi, Y. and Coheur, P. F.: Retrieval of sulphur dioxide from the infrared atmospheric sounding interferometer (IASI), Atmos. Meas. Tech., 5, 581-594, doi:10.5194/amt-5-581-2012, 2012.

[RD5] Carn, S.A., Clarisse, L., Prata, A.J.: Multi-decadal satellite measurements of global volcanic degassing, Journal of Volcanology and Geothermal Research, 311, 99-134, http://dx.doi.org/10.1016, 2016.

[RD6] Clarisse, L., Coheur, P.-F., Theys, N., Hurtmans, D., and Clerbaux, C.: The 2011 Nabro eruption, a SO2 plume height analysis using IASI measurements, Atmos. Chem. Phys., 14, 3095-3111, doi:10.5194/acp-14-3095-2014, 2014.

[RD7] Clarisse, L., Hurtmans, D., Clerbaux, C., Hadji-Lazaro, J., Ngadi, Y. and Coheur, P.-F.: Retrieval of sulphur dioxide from the infrared atmospheric sounding interferometer (IASI), Atmos. Meas. Tech., 5, 581–594, doi:10.5194/amt-5-581-2012, 2012.

[RD8] EUMETSAT Data Store https://www.eumetsat.int/eumetsat-data-store

2. IASI REPROCESSED SO_2 CDR

2.1 NetCDF climate data record (CDR) file name convention

The naming of the IASI SO_2 CDR products distributed on EUMETSAT data store follow the convention:

W_XX-EUMETSAT-Darmstadt,HYPERSPECT+SOUNDING,METOPX+SO2+IASI_C_EUMP_ DateAndTimeStart _DateAndTimeEnd_eps_r_l2_version.nc

where:

- W = For all products
- XX-EUMETSAT-Darmstadt = Location Identifier
- HYPERSPECT+SOUNDING = Data designator
- METOPX+SO2+IASI = Free description: satellite (with X = A or B)+product+instrument
- C = For all products
- EUMP = Originator code for Operational
- DateAndTimeStart and DateAndTimeEnd are written in the form: YYYYMMDDhhmmssZ

with YYYYMMDD = the UTC year, month and day of the data start and end sensing times.
hhmmss = the UTC hour, minute, second of the data start and end sensing times.

- eps = Native format
- r = reprocessing
- l2 = Level of data
- version = release version

2.2 CDR file size estimate

The size of the SO_2 CDR files is on average 20 MB with ~14 files per day per instrument, with a total of around 290 MB/day/instrument or 105 GB/year/instrument or 210 GB/year for the two instruments.

2.3 Description of the content of the netCDF file

The IASI SO_2 CDR netCDF files include Brescia-SO_2 variables, and auxiliary variables (mainly meteorological) used to build atmospheric pressure profiles associated with SO_2 observations. First we give an example of the file's global attributes. Table 1 details dimensions of Brescia-SO_2 and auxiliary variables. In Tables 2 and 3 we list Brescia-SO_2 and auxiliary variables, respectively.

```
// global attributes:
:creator_name = "EUMETSAT" ;
:creator_url = "http://www.eumetsat.int" ;
:creator_email = "ops@eumetsat.int" ;
:institution = "EUMETSAT" ;
:Conventions = "CF-1.7" ;
:Metadata_Conventions = "Unidata Dataset Discovery v1.0" ;
```

:data_format_type = "NetCDF-4 classic model" ;
:producer_agency = "EUMETSAT" ;
:platform = "M01" ;
:platform_type = "spacecraft" ;
:sensor = "IASI" ;
:processing_level = "02" ;
:spacecraft_id = "M01" ;
:processor_major_version = "6" ;
:product_minor_version = "5" ;
:format_major_version = "11" ;
:format_minor_version = "0" ;
:orbit_start = "48195" ;
:orbit_end = "48196" ;
:start_orbit_number = 48195 ;
:end_orbit_number = 48196 ;
:orbit_semi_major_axis = 7.204494e+09f ;
:orbit_eccentricity = 0.00121f ;
:orbit_inclination = 98.686f ;
:orbit_perigee_argument = 75.809f ;
:orbit_right_ascension = 63.334f ;
:orbit_mean_anomaly = 284.378f ;
:x_position = 5123897.f ;
:y_position = -5061554.f ;
:z_position = 6550.077f ;
:x_velocity = -1169.753f ;
:y_velocity = -1162.231f ;
:z_velocity = 7355.053f ;
:rev_orbit_period = 6081.7f ;
:equator_crossing_longitude = -5061554.f ;
:summary = "This file contains the Release 1 IASI L2 reprocessed for one orbit. The reprocessing was done on Linux using an adapted version of the EUMETSAT operational algorithm V6.6. Until december 2016, the reprocessed Metop-A IASI L1C input data were used (doi:10.15770/EUM_SEC_CLM_0014), after this date and for Metop-B the operational IASI L1c were used; this is to produce an homogeneous CDR. ERA5 were used as auxiliary model data";
:processing_mode = "R" ;
:start_sensing_data_time = "2022-01-01T00:56:53Z" ;
:end_sensing_data_time = "2022-01-01T02:41:57Z" ;
:start_sensing_data_time_theoretical = "2022-01-01T00:57:00Z" ;
:end_sensing_data_time_theoretical = "2022-01-01T02:42:00Z" ;
:production_date_time_start = "2023-02-22T18:44:32Z" ;
:production_date_time_end = "2023-02-22T18:44:33Z" ;
:equator_crossing_date_time = "2022-01-01T00:29:19Z" ;
:parent_name = "IASI_xxx_1C_M01_20220101005653Z_20220101024157Z_N_O_20220101014546Z" ;
:processing_centre = "EUM" ;
:source = "Metop-B IASI" ;
:platform_long_name = "Metop-B" ;
:project = "This data is provided as part of the EUMETSAT Satellite Application Facility on Atmospheric Composition Monitoring service, AC-SAF" ;
:id = "DOI: 10.15770/EUM_SAF_AC_0046" ;
:history = "Release 1" ;
:title = "IASI SO2 CDR Release 1" ;
:title_short_name = "IASI SO2 CDR" ;
:keywords = "IASI SO2 CDR Climate" ;

Table 1: Dimensions of Brescia-SO_2 and auxiliary variables

Dimension name	Dimension value	Dimension description
along_track	depends on the files	number of IASI scanlines included in the files
across_track	120	number of IASI pixels per scanline
nlt	101	number of vertical levels in temperature profiles
nlq	101	number of vertical levels in humidity profiles
nl_so2	5	number of vertical layers in SO_2 profiles

Table 2: Description of Brescia-SO_2 variables in the netCDF file.

Variable name in SO_2 CDR product	Dimensions	Variable description and unit	Variable name in NRT SO_2 product	Units
so2_altitudes	along_track, across_track	Retrieved plume altitude (above sea level)	SO2_ALTITUDE	m
so2_bt_difference	along_track, across_track	SO_2 brightness temperature difference	SO2_BT_DIFFERENCE	K
so2_col	along_track, across_track	SO_2 column at the retrieved plume altitude	SO2_COL	DU*
so2_col_at_altitudes	along_track, across_track, nl_so2	SO_2 column at an estimated altitude (above sea level) of 7000, 10000, 13000, 16000 and 25000 m	SO2_COL_AT ALTITUDES	DU*
so2_qflag	along_track, across_track	General quality flag, gives piece of information about the pressure and temperature profiles used in the retrievals: so2_qflag =**9** (default value) or so2_qflag =**11** (T/P from forecasts in the absence of IASI L2 Products), so2_qflag =**0** (missing value)	SO2_QFLAG	N/A

brescia_altitudes_so2	nl_so2	Altitudes in m of the 5 plume levels (7000, 10000, 13000, 16000 and 25000 m).	HEIGHT	m

*1 DU=2.69 10^{16} molecules /cm^2

Table 3: Description of auxiliary variables

Variable name in SO_2 CDR product	Dimensions	Variable description and unit
atmospheric_temperature	along_track, across_track nlt	Atmospheric temperature (for 120 IFOV with up to 101 vertical levels, in K)
atmospheric_water_vapor	along_track, across_track, nlq	Atmospheric water vapour (for 120 IFOV with up to 101 vertical levels, in kg/kg)
fg_atmospheric_temperature	along_track, across_track, nlt	A-priori atmospheric temperature profile (for 120 FOV with up to 101 vertical levels, in K)
fg_atmospheric_water_vapor	along_track, across_track, nlq	A-priori water vapour (for 120 FOV with up to 101 vertical levels, in kg/kg)
fg_surface_temperature	along_track, across_track	A-priori surface temperature (for 120 FOV, in K)
flag_daynit	along_track, across_track	Discrimination between day and night (0: day, 1: night, 2: twilight)
flag_landsea	along_track, across_track	Specifies surface type (0: water, 1: land low, 2: land high, 3: land water low, 4: land water high)
lat	along_track, across_track	Latitude
lon	along_track, across_track	Longitude
pressure_levels_humidity	nlq	Pressure levels on which atmospheric humidity profiles are retrieved (Pa)
pressure_levels_temp	nlt	Pressure levels on which atmospheric temperature profiles are retrieved (Pa)

record_start_time	along_track	Observation time at the start of the scanline (in seconds since 01/01/2000 at 00:00:00)
record_stop_time	along_track	Observation time at the end of the scanline (in seconds since 01/01/2000 at 00:00:00)
satellite_azimuth	along_track, across_track	angular relation for the earth view: satellite azimuth in degrees
satellite_zenith	along_track, across_track	angular relation for the earth view: satellite zenith in degrees
solar_azimuth	along_track, across_track	angular relation for the earth view: solar azimuth in degrees
solar_zenith	along_track, across_track	angular relation for the earth view: solar zenith in degrees
surface_pressure	along_track, across_track	Surface pressure (Pa)
surface_temperature	along_track, across_track	Surface temperature (for 120 IFOV, in K)
surface_z	along_track, across_track	Altitude of surface (m)
height	along_track, across_track	EUMETSAT averaged surface elevation on each IASI pixel (m)
NWP_Ps	along_track, across_track	ERA5 surface pressure (hPa)
NWP_Ts	along_track, across_track	ERA5 surface temperature (K)
NWP_T	along_track, across_track nlt	ERA5 temperature profile (interpolated to 101 IASI vertical levels, in K)
NWP_W	along_track, across_track nlq	ERA5 water vapour profile (interpolated to 101 IASI vertical levels, in kg/kg)

3. THE BRESCIA SO_2 PRODUCT

3.1 Product description

The Brescia-SO_2 product includes several variables, described above in Table 2. Here we describe the output of the algorithms.
The retrieval scheme includes two algorithms. The first algorithm, for the sounding of SO_2 above ~5 km altitude, includes as main features a wide applicable total column range (over 4 orders of magnitude, from 0.5 to 5000 Dobson units), a low theoretical uncertainty (3-5 %) and near real time applicability. The output consists of 5 different hypothetical SO_2 columns (variable name: so2_col_at_altitudes, see Table 2), which depend on assumed a priori SO_2 plume altitudes (for this version at 7, 10, 13, 16 and 25 km), and is meant to be used with auxiliary altitude data. A typical use-case is where a user will have an estimate of the SO_2 altitude (provided by e.g. a model or independent measurements), and in that case, the user can interpolate the 5 SO_2 columns to this estimate to obtain a single SO_2 column. The different SO2 columns must under no circumstances be added together.

Information on the SO_2 altitude can also be retrieved directly from the IASI measurements, and this is what the second algorithm aims at. This product (variable name: so2_altitudes, see Table 2) has its applications in its own right. In addition, an interpolated SO_2 column (from the first algorithm), at the retrieved SO_2 altitude (from the second algorithm) is also provided (variable name: so2_col, see Table 2). If the user has no information on the SO_2 altitude and is interested in the SO_2 column, it is recommended that this interpolated SO_2 column product is used.

All IASI SO_2 altitudes are above sea level (even though it is specified in Table 2).

3.2 Using the product

3.2.1 Quality flags

All retrieved SO_2 columns are considered best quality retrievals and can be used. The following 2 flags give the piece of information about the pressure and temperature profiles used in the retrievals:
so2_qflag = 9 when the values are calculated with the IASI L2;
so2_qflag = 11 means that the pressure and temperature profiles are missing in the IASI L2 data and that model/forecast data have been used instead.
so2_qflag = 0 for missing values.

3.2.2 Data filtering

First, we recommend identifying the observations for which so2_bt_difference > 1K. These are the most reliable. Around these observations, data for which 0.4K <= so2_bt_difference <= 1K are also reliable.. See Figure 1 for an example.

In cases where large amounts of SO_2 are present, IASI L2 temperature and water vapour profiles can be missing and the Brescia algorithm then uses ECMWF forecast fields to provide an SO_2 retrieval (so2_qflag = 11). However, in this case the forecast temperature fields used are not provided as output

by the IASI L2 retrieval. For users who need this missing information, we suggest following recommendations in section 5.2.4.
In cases where the surface_z data is missing, we recommend using the variable height, which is the average surface elevation of each IASI pixel computed by EUMETSAT using a Digital Elevation Model (DEM).

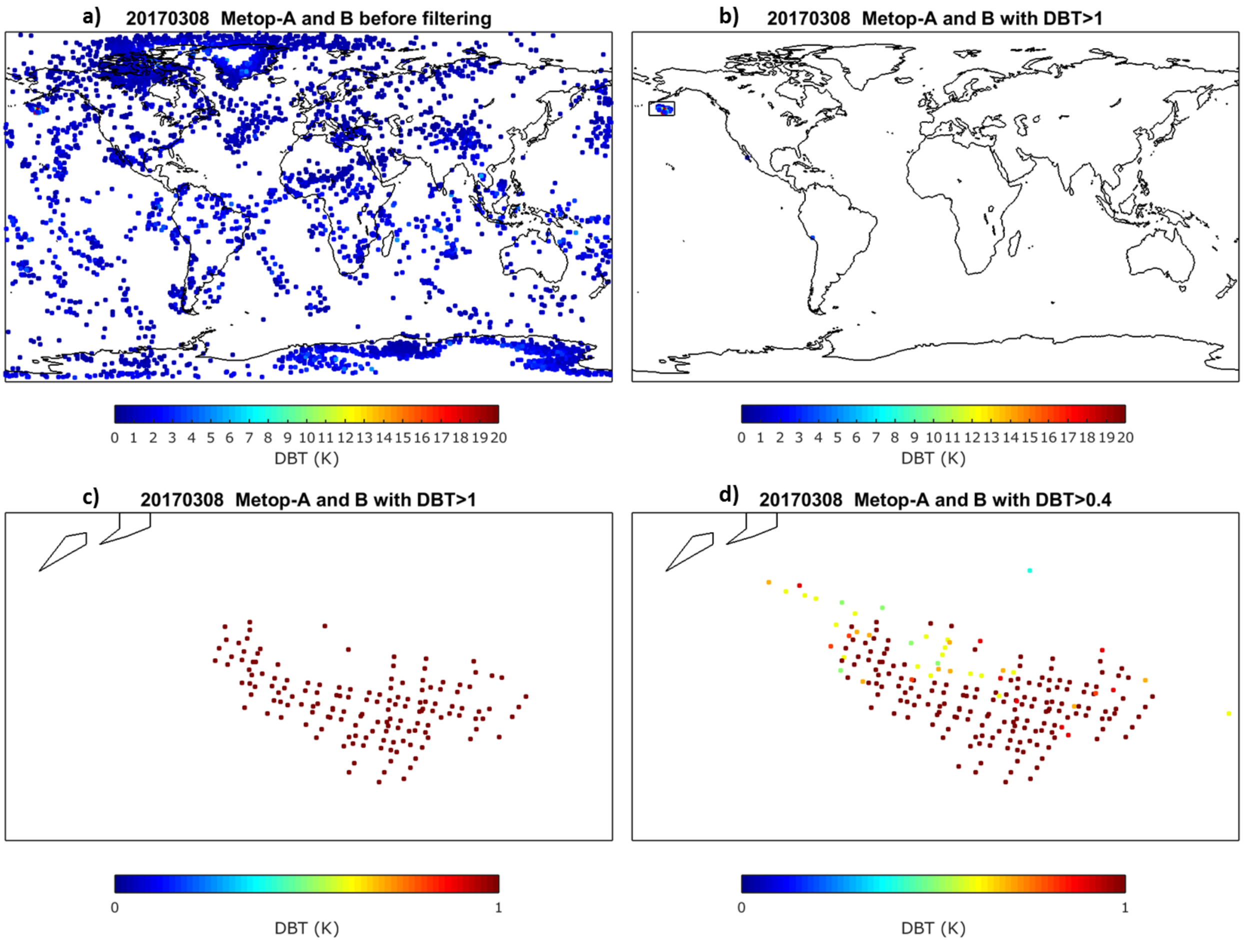

Figure 1: Filtering example using so2_bt_difference (DBT) for 8 March 2017: (a) all Metop-A and B retrievals where SO_2 is detected, (b) only pixels with DBT > 1, (c) zoom in the Alaska Gulf (rectangle in subplot b), (d) in the neighborhood of pixels with DBT > 1, one can consider pixels with DBT > 0.4.

3.2.3 SO_2 column, altitude and uncertainty characterization

In the current algorithm version, the altitude of the SO_2 plume is given (so2_altitudes), as well as the SO_2 corresponding column (so2_col**)**. If the user has no information on the SO_2 altitude and is interested in the SO_2 column, the user should use this interpolated SO_2 column product (so2_col**)**.

If the user has an estimate of the SO_2 altitude (provided by e.g. a model or independent measurements), the user can use the 5 SO_2 columns (so2_col_at_altitudes) in order to pick the proper SO_2 column or do the interpolation to estimate his/her own single SO_2 column.

Careful, under no circumstance should the different SO_2 columns (at 7, 10, 13, 16 and 25 km) be added up. Only one SO_2 column must be used for one location. Examples of applications can be found in [RD5] and [RD6].

A characterization of how the uncertainty in the assumed altitude translates to an uncertainty in the final column can be obtained using the variance formula:

$$\sigma_{SO2} = \frac{\partial SO2}{\partial alt}\sigma_{alt} \quad (1)$$

Here, σ_{alt} is the uncertainty on the altitude (user provided, e.g. 1 km) the derivative of the SO_2 column with respect to altitude $\left(\frac{\partial SO2}{\partial alt}\right)$ can be calculated numerically from the 5 SO_2 columns. This uncertainty can be relatively small for high altitudes (e.g. 10-20% around the tropopause, see Figure 7 in [RD7]), while for lower altitudes can reach over 100%.

3.2.4 Altitude-pressure conversion

Temperature and humidity vertical profiles extracted from the IASI L2 SO_2 CDR product are given on 101 pressure levels (in Pa). The information of the temperature and humidity can be used to calculate 101 corresponding altitude levels as outlined below. After that, the pressure at a specific altitude can be obtained by interpolating (linear interpolation should be sufficient) the pressure grid at the desired altitude.

From temperature and humidity vertical profiles, available in the CDR netcdf file, the correspondence between altitude and pressure could be calculated by iterating from the surface to the top of the atmosphere. When "atmospheric_temperature" profile is set to filling values, we replace "atmospheric_temperature" and "atmospheric_water_vapor" profiles by "fg_atmospheric_temperature" and "fg_atmospheric_water_vapor" profiles. In case these files values are also not provided we recommend using NWP_T and NWP_W profiles instead, these correspond to NWP ERA5 temperature and water vapour profiles interpolated to the 101 IASI vertical levels respectively.
The assumptions on the surface characteristics are:

surface altitude = z_0 ("surface_z", from CDR netCDF files)
surface pressure = p_0 ("surface_pressure" from CDR netCDF files)
surface temperature = T_o, extrapolation of the temperature profile T at the surface pressure ("atmospheric_temperature" or "fg_atmospheric_temperature" from CDR netCDF files)
surface humidity = q_o, first level of the humidity profile q ("atmospheric_water_vapor" or "fg_atmospheric_water_vapor" from CDR netCDF files)

The acceleration due to the gravity is function of the geographic latitude ϕ and of the altitude z_i:

$$g(z_i, \phi) = g_\phi - (3.085462 \times 10^{-6} + 2.27 \times 10^{-9}\cos(2\phi))z_i + (7.254 \times 10^{-13} + 1.0 \times 10^{-20}\ \cos(2\phi))\, z_i^{\,2} - (1.517 \times 10^{-19} + 6 \times 10^{-22}\cos(2\phi))z_i^{\,3} \quad (2)$$

where

$$g_\phi = 9.806160(1 - 0.0026373\cos(2\phi) + 0.0000059\ \cos^2(2\phi))\ \mathrm{ms^{-2}} \quad (3)$$

The mean virtual temperature between two pressure levels p_i and p_{i+1} (just above level i) is then:

$$\overline{Tv_{i,i+1}} = \frac{T_i(1+0.608\, q_i)+T_{i+1}(1+0.608\, q_{i+1})}{2} \quad (4)$$

with T_i and q_i, the temperature and humidity at p_i, respectively, and T_{i+1} and q_{i+1}, the temperature and humidity at p_{i+1}, respectively.

Then the altitude of the pressure level p_{i+1} can be estimated from the pressure level p_i (just below level i+1):

$$z_{i+1} = z_i + \frac{R \times \overline{Tv_{i,i+1}}}{g(z_i, \Phi)} \times \ln \frac{p_i}{p_{i+1}} \quad (5)$$

with R = 287.06 $JK^{-1}kg^{-1}$, the gas constant for dry air.

We obtain the altitude profile corresponding to the CDR “(fg_)atmospheric_temperature” and “(fg_)atmospheric_water_vapor” products.

The conversion between pressure and altitude is done as in the “IASI Level2 Product Generation specification” document.

3.3 Product requirements

The product requirements are given in terms of threshold, target and optimal values in Table 4 below. This information is taken from the Product Requirements Document [AD3]. The product performance is given in the Validation Report of this product.

Table 4: Brescia-SO_2 product requirements.

		Error*			**Spatial resolution**	**Spatial coverage**	**NRT**
		Threshold	**Target**	**Optimal**			
Total column	Below 10km	200%	100%	50%	IASI pixel	Global	<3h
	Above 10 km	100%	35%	20%	IASI pixel	Global	<3h
SO_2 altitude	Below 10km	<3km	<2km	<1km	IASI pixel	Global	<3h
	Above 10 km	<6km	<4km	<2km	IASI pixel	Global	<3h

*difference of quantity value obtained by measurement and true value of the quantity intended to be measured, as defined by CEOS/ISO:19159 (ISO/TS 19159-1:2014(en), Geographic information - Calibration and validation of remote sensing imagery sensors and data — Part 1: Optical sensors).

3.4 Validation of the product

The validation of the IASI SO_2 CDR product is performed by AUTH and BIRA. The 'IASI SO_2 CDR validation report' [AD4] reports the validation of this product and possible processing errors as well as abnormal behavior are noticed and checked.

3.5 Product dissemination and archiving

The IASI CDR Level 2 products are disseminated to users through EUMETSAT Data Store [RD8]. The data are disseminated in netCDF format. A full description of the IASI SO_2 CDR Level 2 netCDF content is given in Section 4.

3.6 Product ordering

Access to this data record is granted to all users without charge but accepting the EUMETSAT Data Policy provided in the corresponding EUMETSAT webpage:
https://www.eumetsat.int/legal-framework/data-policy
To access data, you need to register with the EUMETSAT Data Centre. When registered, you can order the data through a written request send to EUMETSAT's helpdesk.

3.6.1 Register with the Data Centre

Do this to register with the EUMETSAT Data Centre:
- Register in the EUMETSAT EO-Portal (https://eoportal.eumetsat.int) by clicking on the New User – Create New Account tab;
- After finalisation of the registration process, an e-mail is sent to the e-mail address entered in the registration. Click the confirmation link in the e-mail to activate your account;
- Login and subscribe to the Data Centre Service by going to the Service Subscription Tab and selecting Data Centre Service. Follow instructions issued from the web page to add needed information.

3.6.2 Order Data

The data record described in this product user guide can also be ordered via the EUMETSAT User Service Helpdesk in Darmstadt, Germany. Please send a written request to the helpdesk, email ops@eumetsat.int, indicating the data record that you want to order including its Digital Object Identifier (DOI) number: 10.15770/EUM_SAF_AC_0046.

ANNEX 1: 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 threats 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 are to process, archive, validate and disseminate atmospheric composition products (O_3, NO_2, SO_2, BrO, HCHO, H_2O, OClO, CO, NH3), 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 high-resolution ozone profiles
- Near real-time absorbing aerosol indexes from main science channels and polarization 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 high-resolution ozone profiles
- Offline absorbing aerosol indexes from main science channels and polarization measurement detectors
- Offline surface UV, daily doses and daily maximum values with several weighting functions

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

- Data records generated in reprocessing
- 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: https://acsaf.org/

AC SAF Helpdesk: helpdesk@acsaf.org

Twitter: https://twitter.com/Atmospheric_SAF

ANNEX 2: IASI BRESCIA-SO2 RETRIEVAL ALGORITHM

IASI instrument

IASI is an infrared Fourier transform spectrometer developed jointly by CNES (the French spatial agency) with support of the scientific community (for a review see [RD1]), and by EUMETSAT. IASI is mounted on-board the European polar-orbiting Metop satellites with the primary objective to improve numerical weather predictions, by measuring tropospheric temperature and humidity with high horizontal resolution and sampling, with 1 km vertical resolution, and with respectively 1 K and 10% accuracy [RD2]. IASI also contributes to atmospheric composition measurements for climate and chemistry applications [RD3]. To reach these two objectives, IASI measures the infrared radiation of the Earth's surface and of the atmosphere between 645 and 2760 cm^{-1} at nadir and along a 2200 km swath perpendicular to the satellite track. A total of 120 views are collected over the swath, divided as 30 arrays of 4 individual Field-of-views (FOVs) varying in size from 36 x π km^2 at nadir (circular 12 km diameter pixel) to 10 x 20 x π km^2 at the larger viewing angle (ellipse-shaped FOV at the end of the swath). IASI offers in this standard observing mode global coverage twice daily, with overpass times at around 9:30 and 21:30 mean local solar time. The very good spatial and temporal sampling of IASI is complemented by fairly high spectral and radiometric performances: the calibrated level 1C radiances are at 0.5 cm^{-1} apodized spectral resolution (the instrument achieves a 2 cm optical path difference), with an apodized noise that ranges below 2500 cm^{-1} between 0.1 and 0.2 K for a reference blackbody at 280 K [RD1].

Brescia overview

This version includes an SO_2 total column, given at 5 estimated altitudes: 7, 10, 13, 16 and 25 km and an SO_2 total column associated with a retrieved SO_2 plume altitude.

The algorithm description is given in the Brescia ATBD [AD1] and in [RD4].

Information on how to use the SO_2 product including SO_2 altitude retrieval can be found in the NRT SO2 + SO2 altitude PUM [AD2].