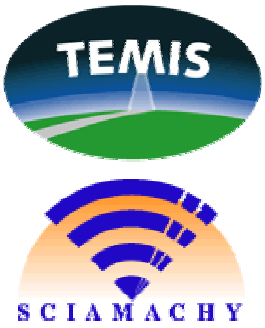
Belgian Institute
for Space Aeronomy
BIRA-IASB



SCIAMACHY BrO total column

Product Specification Document

Document: BIRA_BrO_PSD

Issue: 1.0 – rev. 1

Date: 30-01-2006

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Summary contents:	Product Specification Document – SCIAMACHY BrO total column product
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1 Introduction

1.1 Purpose of this document

Bromine compounds, which have both anthropogenic and natural sources, cause about half of the chemical loss that results in the Antarctic ozone hole in the stratosphere. Low levels of ozone in the atmosphere's lowermost layer, the troposphere, during the polar spring result from bromine released from melting sea ice and 'frost flowers'. But it is also becoming evident that bromine produced by natural processes in the ocean can influence the composition of both the troposphere and the stratosphere. Much research is currently being devoted to understanding the sources and sinks of these organic bromine compounds, and their effects in the atmosphere.

Bromine monxyde (BrO) is the most abundant bromine bearing inorganic trace gas during daylight. BrO columns have been monitored globally since 1996 by the GOME instrument onboard the ESA ERS-2 platform allowing to document the extent and the time evolution of inorganic bromine in both the troposphere and the stratosphere. Due to problems with tape storage on ERS-2, GOME lost its ability to provide global coverage. In order to ensure long-term monitoring of the atmospheric inorganic bromine content, it is of great importance to link GOME records to measurements from new satellites. SCIAMACHY, the successor of GOME, has been launched in 2002 on the ESA ENVISAT platform. In the context of the ESA DUP II TEMIS project, a scientific BrO vertical column product has been developed at BIRA-IASB, based on the expertise previously developed with GOME processing.

The present document comes in addition to the Algorithm Description document (ADD). It describes the format of the BIRA-IASB SCIAMACHY BrO product delivered on the TEMIS web site (http://www.oma.be/BIRA-IASB/Molecules/BrO/). The available data cover the measurement period from July 2002 to December 2005.

1.2 Acronyms and abbreviations

AMF	Air-Mass Factor
ASCII	American Standard Code for Information Interchange
BIRA-IASB	Belgian Institute for Space Aeronomy
BrO	Bromine monoxyde
DOAS	Differential Optical Absorption Spectroscopy
DUP	Data User Programme
ENVISAT	Environmental Satellite
ERS	European Remote Sensing Satellite
ESA	European Space Agency
FTP	File Transfer Protocol
GOME	Global Ozone Monitoring Experiment
KNMI	Royal Netherlands Meteorological Institute
NDSC	Network for the Detection of Stratospheric Change
RMS	Root Mean Square
SCD	Slant Column Density
SCIAMACHY	SCanning Imaging Absorption spectroMeter for Atmospheric

	CartograpHY
SZA	Solar Zenith Angle
TEMIS	Tropospheric Emission Monitoring Internet Service
TOA	Top Of Atmosphere
VCD	Vertical Column Density

1.3 Applicable documents

[ADD] Algorithm Description Document: BIRA_BrO_ADD_v08r1.doc
[PSD] Product Specification Document: BIRA_BrO_PSD_v08r1.doc

1.4 Credits

The BrO Data Service is set up and distributed as part of the TEMIS project

TEMIS -- Tropospheric Emission Monitoring Internet Service

http://www.temis.nl/

by the Belgian Institute for Space Aeronomy (BIRA-IASB, Brussels, Belgium). TEMIS is an ESA project lead by KNMI (De Bilt, The Netherlands) and funded within the DUP II programme.

The following people at BIRA-IASB are involved in the generation of the SCIAMACHY BrO product:

- Michel Van Roozendael, michelv@oma.be
- Nicolas Theys, nicolast@oma.be
- Isabelle De Smedt, isad@oma.be
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Furthermore the following people are aknowledged for discussions, suggestions, information and other help:

- Claus Zehner (ESA-ESRIN)
- Rob Spurr (RT Soluctions, Inc.)
- Andreas Richter (University of Bremen)

2 General product description

The BIRA-IASB SCIAMACHY BrO product consists in the bromine monoxyde slant column and vertical column densities (Level-2 product) retrieved for each ground pixel of the nadir observations of SCIAMACHY using the DOAS technique described in the Algorithm document (ADD). The data delivery is limited to observations at solar zenith angles less than or equal to 80 degrees. The retrieval error on the SCD and the RMS of the fit are provided in the files. In the current stage of the product, BrO vertical columns are derived using stratospheric AMFs (the tropospheric BrO content is assumed negligible).

The product also includes daily, 3-daily composite and monthly average maps (Level-3 product) in three different projections (Northern hemisphere, Southern hemisphere and global projection). Time series over ground-based stations known for carrying on BrO measurements completes both Level-2 and Level-3 product.

3 Data product format specification

The Level-2 product is delivered as a collection of ASCII files. There is one entry per ground pixel (all geolocation data are provided), one level-2 file per level-1 file.

3.1 Data file name

The Level-2 data files have been given a version number, in order to track changes in the different parts of the processing. Actually, the format of files names looks like :

SCIABrO**YYYYMMDD_hhmmss_nnnn_v<v>**.ASC

Where **YYYYMMDD_hhmmss_nnnn** are respectively the orbit start date (**YYYYMMDD**) and start time (**hhmmss**) and the orbit number (**nnnn**) retrieved from the original orbit file name and **<v>** indicates the version number. As it's the first consolidated version of the product, <v> is given number 1.

3.2 Data file format

Each data file has a header with comment lines (starting with the ; mark), giving information on the data columns. Below, a typical data file. Some remarks regarding the entries in the file header are given further down.

```
; ------------------------------------------------------------------------------------
; SCIAMACHY BrO VERTICAL COLUMNS
;
; Processing: BIRA-IASB, 3 Avenue Circulaire, 1180 Brussels, Belgium
; Contact : Nicolas THEYS (theys@oma.be) , Michel VAN ROOZENDAEL (michelv@oma.be)
; ------------------------------------------------------------------------------------
;
;  Level 1 file: SCI_NL__1PPDPA20020915_231144_000060262009_00288_02847_7445.N1.BrO
;  Algorithm version : WDS_BrO v 1.0
;  Analysis date   : 2006/01/23
;  Orbit date/time : 20020915_231144
;  Orbit number : 02847
;  Documentation : see AD (Algorithm Document) and PSD (Product Spec. Documentation)
;
; ------------------------------------------------------------------------------------
;
; Data columns
;
;     1 = measurement UTC time as YYYYMMDDhhmmss.mmm
;     2 = orbit number
;     3 = state id
;     4 = pixel id: 0=forward, 3=backscan
;   5-8 = pixel corner longitudes
;     9 = pixel center longitude
; 10-13 = pixel corner latitudes
;    14 = pixel center latitude
;    15 = solar    zenith  angle (SZA)
;    16 = viewing  zenith  angle (VZA)
;    17 = relative azimuth angle (RAA)
;    18 = BrO vertical column density (VCD), in units of 1e13 molec/cm².
;    19 = BrO slant column density  (SCD), in units of 1e13 molec/cm².
;    20 = BrO slant column density error (SCDE), in units of 1e13 molec/cm².
;    21 = Air mass factor (AMF)
;    22 = RMS of the DOAS fit (RMS)
;
; ------------------------------------------------------------------------------------
;
```

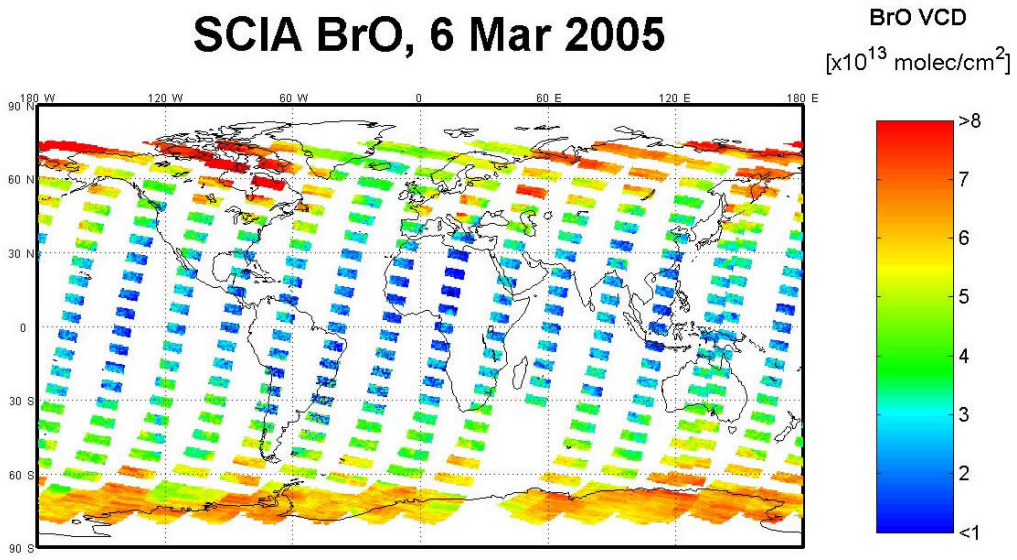
Which is followed by two lines spanning all the columns and giving a header to each column. Then follow the data lines themselves.

Remarks regarding some of the entries in the above file header:

- Column 4 gives the type of ground pixel. For SCIAMACHY data there is only a distinction between forward (0) and backward (3) scan pixels. For GOME data the forward pixels come in three types, for which the number 0, 1 and 2 will be used.
- The zenith and azimuth angles (columns 15, 16 and 17) are given at the top-of-atmosphere (TOA) for the centre of the ground pixel.
- The BrO vertical column value in column 18 is used for making the maps (daily, 3-day composite and monthly maps)
- The error value given in column 20 is the error following from the DOAS slant column retrieval. Its value is based on the RMS of the fit between the measured and the fitted spectrum. The RMS in column 22 is also a measure of the quality of the fit.

4 Data presentation

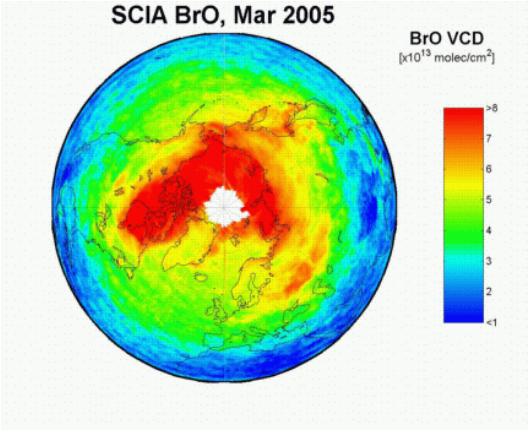
The product also includes daily, 3-daily composite and monthly average maps (Level-3 product) in three different projections (Northern hemisphere, Southern hemisphere and global projection).

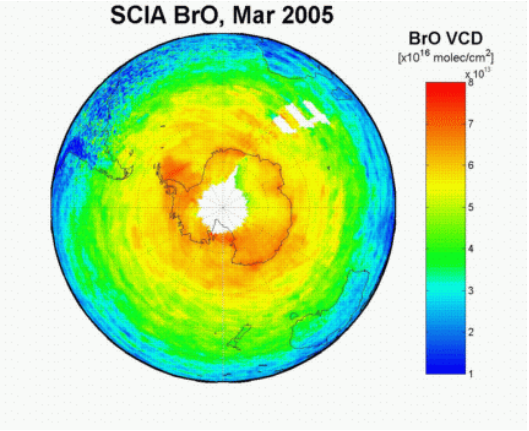


Example of daily map – Global projection (GL)

To build these maps, BrO VCD data have been averaged on latitude-longitude grids of 0.5 by 0.5 degrees (which is about 50 km at the equator). The length of the individual pixels and the sphericity of the earth are taken into account to distribute and weight the BrO Vertical Columns in the different graticules of the grid.

Composite 3-days maps are calculated by averaging data on periods of 3 days, the minimum period necessary for the satellite to achieve global coverage at the equator. Monthly maps are calculated by averaging data over a complete month (see below).





Maps covering a given period can be selected on the TEMIS web pages at the URL :

http://www.oma.be/BIRA-IASB/Molecules/BrO/level3.php

They are also available at a better resolution (1200x900, JPEG format), on the BIRA-IASB FTP server :

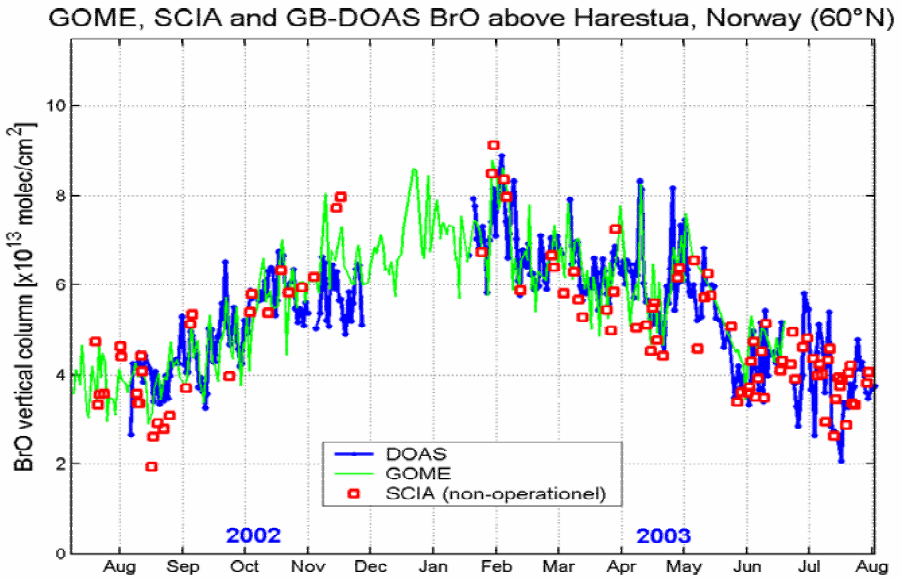
ftp://ftp.oma.be/dist/TEMIS/SCIAMACHY/SCIAMACHYBrO/

Just go down through MapsD1, MapsD3 or MapsM folder according to the desired type of map (daily, composite or monthly map) and still through NH, SH and GL folders to select the projection (northern hemisphere, southern hemisphere or global projection).

5 Overpasses

BrO measurements are regularly performed at various ground-based stations worldwide, most of them being part of the international Network for the Detection of Stratospheric Change (NDSC). In order to make possible comparisons between ground-based and satellite measurements, the SCIAMACHY BrO product is completed with times series calculated for these stations.

Below, a comparison plot between ground-based BrO observations at the NDSC station of Harestua (Norway, 60°N, coincident pixels of SCIAMACHY and GOME measurements. The plot shows a good agreement between the three types of instruments (see the ADD for further information).



GB-DOAS, GOME and SCIAMACHY BrO vertical columns derived above Harestua (60°N).

SCIAMACHY data over a non-exhaustive list of stations well-known for carrying on BrO measurements are delivered as ASCII files through the TEMIS web site at the URL :

http://www.oma.be/BIRA-IASB/Molecules/BrO/level3_overpasses.php?cmd=init

Below a typical file :

```
; ------------------------------------------------------------------------------
; SCIAMACHY BrO VERTICAL COLUMNS
; Station : Alert (Canada), 82.5°N, 62.33°W
; Last update : 26-Jan-2006
; ------------------------------------------------------------------------------
; RMS<=0.0025 dist<=200 km
; Include all pixels with SZA<=80 deg
; ------------------------------------------------------------------------------
; Year Month Day   CDay    lat    long   dist    SZA     BrOSCD      BrOVCD
; ------------------------------------------------------------------------------
  2002     8    8 220.89  81.70 293.74 107.68  71.99  1.64e+014   3.84e+013
…
```

A header gives information on the station the file refers and on the pixels selection applied. Then a line with columns title presents the data. Each entry is the daily average calculated for pixels falling within a radius of 200 km around the selected station.

The different columns in the file are :

Year, Month, Day	date of the measurement;
Cday	fractional calendar day;
Lat, long	averaged geolocation data (latitude and longitude);
Dist	the mean distance in kilometers from the station;
SZA	the averaged solar zenith angle;
BrOSCD, BrOVCD	the averaged slant column and vertical column densities.