EUMETSAT Satellite Application Facility on Climate Monitoring

ATOVS tropospheric humidity and temperature data set

Product User Manual

ATOVS edition 1

DOI: 10.5676/EUM_SAF_CM/WVT_ATOVS/V001

Vertically integrated water vapour	**CM-123**
Layered water vapour and temperature	**CM-132**
Specific humidity and temperature at pressure levels	**CM-138**

Reference Number:	SAF/CM/DWD/PUM/ATOVS
Issue/Revision Index:	1.1
Date:	04.02.2013

Document Signature Table

	Name	Function	Signature	Date
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Distribution List

Internal Distribution	
Name	**No. Copies**
DWD Archive	1
CM SAF Team	1

External Distribution		
Company	**Name**	**No. Copies**
PUBLIC		1

Document Change Record

Issue/ Revision	Date	DCN No.	Changed Pages/Paragraphs
1.0	16/11/2012	SAF/CM/DWD/PUM/ATOVS	Version presented to the DRI 7 review board.
1.1	04/02/2013	SAF/CM/DWD/PUM/ATOVS	Updated the text according to the review RIDs LSc-01 to LSc-10, DF-02a DF-02d, and CS-1 to CS-11. - editorial update of the cover page to account for the DOI number and the edition name. - editorial update of the section on “The EUMETSAT SAF on Climate Monitoring (CM SAF)”. - update of the section on "Data ordering via the Web User Interface (WUI)" including a dedicated new section on copyrights. -The accuracy requirements were added in the appendix. - Corrections of typos.

Applicable documents

Reference	Title	Code
AD 1	CM SAF Product Requirements Document	SAF/CM/DWD/PRD/2.0

Reference documents

Reference	Title	Code
RD 1	Validation Report ATOVS data set edition 1	SAF/CM/DWD/VAL/ATOVS/1.1
RD 2	Algorithm Theoretical Basis Document ATOVS data set edition 1	SAF/CM/DWD/ATBD/ATOVS/1.0
RD 3	Product User Manual Water Vapour and Temperature from ATOVS	SAF/CM/DWD/PUM/WVT/1.0
RD 4	Validation Report Water Vapour and Temperature from ATOVS Version 300/310/320	SAF/CM/DWD/SR/WVT/4.0

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1 The EUMETSAT SAF on Climate Monitoring (CM SAF)

The importance of climate monitoring with satellites was recognized in 2000 by EUMETSAT Member States when they amended the EUMETSAT Convention to affirm that the EUMETSAT mandate is also to “contribute to the operational monitoring of the climate and the detection of global climatic changes". Following this, EUMETSAT established within its Satellite Application Facility (SAF) network a dedicated centre, the SAF on Climate Monitoring (CM SAF, http://www.cmsaf.eu).
The consortium of CM SAF currently comprises the Deutscher Wetterdienst (DWD) as host institute, and the partners from the Royal Meteorological Institute of Belgium (RMIB), the Finnish Meteorological Institute (FMI), the Royal Meteorological Institute of the Netherlands (KNMI), the Swedish Meteorological and Hydrological Institute (SMHI), the Meteorological Service of Switzerland (MeteoSwiss), and the Meteorological Service of the United Kingdom (UK MetOffice). Since the beginning in 1999, the EUMETSAT Satellite Application Facility on Climate Monitoring (CM SAF) has developed and will continue to develop capabilities for a sustained generation and provision of Climate Data Records (CDR’s) derived from operational meteorological satellites.
In particular the generation of long-term data sets is pursued. The ultimate aim is to make the resulting data sets suitable for the analysis of climate variability and potentially the detection of climate trends. CM SAF works in close collaboration with the EUMETSAT Central Facility and liaises with other satellite operators to advance the availability, quality and usability of Fundamental Climate Data Records (FCDRs) as defined by the Global Climate Observing System (GCOS). As a major task the CM SAF utilizes FCDRs to produce records of Essential Climate Variables (ECVs) as defined by GCOS. Thematically, the focus of CM SAF is on ECVs associated with the global energy and water cycle.

Another essential task of CM SAF is to produce data sets that can serve applications related to the new Global Framework of Climate Services initiated by the WMO World Climate Conference-3 in 2009. CM SAF is supporting climate services at national meteorological and hydrological services (NMHSs) with long-term data records but also with data sets produced close to real time that can be used to prepare monthly/annual updates of the state of the climate. Both types of products together allow for a consistent description of mean values, anomalies, variability and potential trends for the chosen ECVs. CM SAF ECV data sets also serve the improvement of climate models both at global and regional scale.
As an essential partner in the related international frameworks, in particular WMO SCOPE-CM (Sustained COordinated Processing of Environmental satellite data for Climate Monitoring), the CM SAF - together with the EUMETSAT Central Facility, assumes the role as main implementer of EUMETSAT’s commitments in support to global climate monitoring. This is achieved through:

- Application of highest standards and guidelines as lined out by GCOS for the satellite data processing,
- Processing of satellite data within a true international collaboration benefiting from developments at international level and pollinating the partnership with own ideas and standards,
- Intensive validation and improvement of the CM SAF climate data records,
- Taking a major role in data set assessments performed by research organisations such as WCRP (World Climate Research Program). This role provides the CM SAF with deep contacts to research organizations that form a substantial user group for the CM SAF CDRs,

- Maintaining and providing an operational and sustained infrastructure that can serve the community within the transition of mature CDR products from the research community into operational environments.

A catalogue of all available CM SAF products is accessible via the CM SAF webpage, www.cmsaf.eu. Here, detailed information about product ordering, add-on tools, sample programs and documentation is provided.

2 Introduction

This CM SAF Product User Manual provides information on the CM SAF ATOVS data set derived from the ATOVS instruments flying onboard the NOAA (-15 to -19) and Metop-A satellites. ATOVS is a sounding instrument system composed of three sounders, two microwaves sounders, AMSU-A (Advanced Microwave Sounding Unit-A) and AMSU-B (Advanced Microwave Sounding Unit-B), later replaced by MHS (Microwave Humidity Sounder) and an infrared sounder HIRS (High-resolution InfraRed Sounder).

This manual provides a technical description of the data set including information on the file format as well as on the data access. Details on the implementation of the processing chain and on the retrieval algorithm are available in the Algorithm Theoretical Basis Document [**RD 2**]. Basic accuracy requirements are defined in the Product Requirement Document [**AD 1**], and a detailed validation of the ATOVS products is available in the validation report [**RD 1**].

3 Product definition

The CM SAF ATOVS data set provides global water vapour and temperature products as well as random error (for the daily mean products), extra-daily standard deviation (for monthly products) and number of observations. The products are available as daily and monthly means on a cylindrical equal area projection of 90km×90km. The temporal coverage of the data set ranges from the 1st of January 1999 to the 31st of December 2011. The data are available in NetCDF format including extensive metadata which are described in Section 5 of this document together with the data format and the CM SAF filename convention.

The products covered by this document are:

- HTW (CM-123): Vertically integrated water vapour
- HLW (CM-132): Layered products in 5 layers:
  - layer vertically integrated water vapour [kg/m^2]
  - mean temperature [K]
- HSH (CM-138): Products at 6 pressure levels:
  - Specific humidity [g/kg]
  - Temperature [K]

Relative humidity in 5 layers, which is part of the HLW products, is provided as additional, auxiliary data.

The vertically integrated water vapour, also called total precipitable water (TPW) is the total atmospheric water vapour contained in a vertical column of unit cross-sectional area extending between any two specified levels (in our case from the surface to 100 hPa). The

definition is the same for the layer integrated water vapour products except that the vertical column corresponds then to a layer of the atmosphere which boundaries are given in Table 1. TPW might be expressed in terms of the height to which that water substance would stand if completely condensed and collected in a vessel of the same unit cross section, so in mm or when considering the SI units in mass of water per unit cross section, in kg/m^2. Both units mm and kg/m^2 are equivalent. Table 1 also gives the definition of the pressure levels for which the HSH products are available. In the HSH products, the water vapour is given as specific humidity. The specific humidity is defined as the ratio of water vapour mass density over the total mass density of air (including water vapour).

Any layer or level based product is undefined if the corresponding layer or level is not filled with valid observations (but the other layers and levels of the profile remain available).

Table 1: Layer and level definitions for the ATOVS products.

HLW layer	1	2	3	4	5	-
Pressure [hPa]	300-200	500-300	700-500	850-700	Surface-850	-
HSH level	1	2	3	4	5	6
Pressure [hPa]	200	300	500	700	850	1000

An example of a monthly product, the total precipitable water vapour for September 2007, is shown in Figure 1, and an example of a daily product, the mean temperature for the layer between 500 and 700 hPa for the 27th of September 2007, is shown in Figure 2.

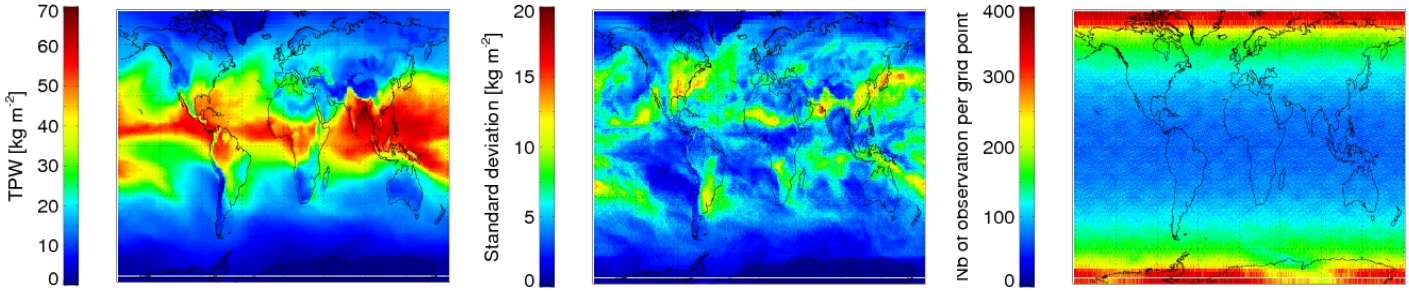

Figure 1: The left panel shows the global monthly total precipitable water vapour (TPW) for September 2007, the middle panel shows the corresponding extra-daily standard deviation and the right panel shows the corresponding number of observations per grid point.

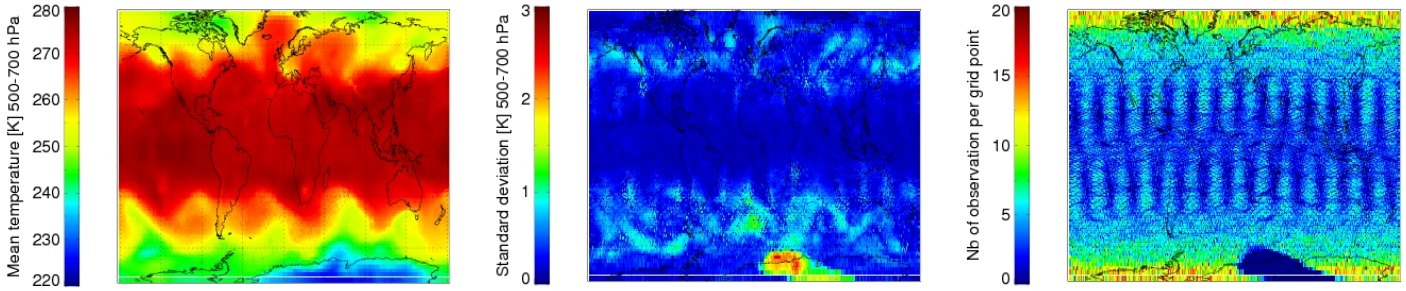

Figure 2: The left panel shows the global daily averaged temperature for the layer between 500 and 700 hPa for the 27th of September 2007, the middle panel shows the corresponding random error and the right panel shows the corresponding number of observations per grid point.

In addition to the official CM SAF products the so called instantaneous products are also available on request. The instantaneous products are the output of the retrieval software and have not been averaged nor gridded but are available on swath basis. Because of the processing scheme design, those files contain 3-hourly swath based parameters (retrieval outputs, as well as retrieval inputs) for a single satellite. The time slots are 00:00, 03:00,

06:00, 09:00, 12:00, 15:00, 18:00, 21:00, 24:00 and are arranged as follows: for example, for the 18:00 time slot the file contains data from 16:30 to 19:30, consequently the files corresponding to the 24:00 and 00:00 time slots contain only data from 22:30 to 24:00 and from 00:00 to 01:30, respectively. The instantaneous data are available in NetCDF format. The non-official instantaneous products do not undergo an official review process and are not validated. The instantaneous products are available on request from the CM SAF User Help Desk.

4 Products generation, validation and limitations

4.1 Instruments

ATOVS flies since the 13th of May 1998 on NOAA and Metop polar orbiting satellites. So far six platforms carry the sounding instrument system composed of HIRS and AMSU, namely, NOAA-15, NOAA-16, NOAA-17, NOAA-18, NOAA-19, and Metop-A. The AMSU instrument is composed of two separate radiometers, AMSU-A and AMSU-B (which is replaced by MHS on NOAA-18, NOAA-19 and Metop-A). AMSU-A and –B are cross track scanning total power radiometers with instantaneous fields of view of 3.3° and 1.1° providing a nominal spatial resolution at nadir of 48 km and 16 km, respectively. The 15 AMSU-A channels primarily provide temperature sounding of the atmosphere through channels located on the 57 GHz O_2 absorption band. It has also three channels (at 23.8, 31.4, and 89 GHz) that provide information on tropospheric water vapour, precipitation over ocean, sea ice coverage, and other surface parameters. AMSU-B has five channels that mainly measure water vapour and liquid precipitation over land and sea. Three of its channels at 183.31±1, 183.31±3, and 183.31±7 GHz are located on the water vapour band while the two other ones at 89, and 150 GHz are located in the atmospheric window.

The third ATOVS instrument, HIRS/3 (replaced by HIRS/4 on NOAA-18, and -19, and on Metop-A) is an infrared 20 channel cross track scanning sounder with an instantaneous field of view of 1.3° providing a nominal spatial resolution of 18.9 km (improved to 10 km for HIRS/4). HIRS infrared channels are affected by contributions from the troposphere.

The number of available/operational satellites is varying with time. Consequently different combinations of satellites were used depending on when the different satellites were available/operational. Table 2 gives the details about when which satellite combination was used for the retrieval.

Table 2: The different satellite combinations used to generate the ATOVS products with the corresponding time period for which those combinations were used.

Time period	Satellite used
1999 01 01 – 2000 10 31	NOAA-15
2000 01 11 – 2001 01 31	NOAA-16
2001 02 01 – 2002 10 31	NOAA-15, NOAA-16
2002 11 01 – 2003 09 30	NOAA-15, NOAA-16, NOAA-17
2003 10 01 – 2005 08 31	NOAA-15, NOAA-16
2005 09 01 – 2007 05 31	NOAA-15, NOAA-16, NOAA-18
2007 06 01 – 2009 01 31	NOAA-15, NOAA-16, NOAA18, Metop-A
2009 02 01 – 2009 04 30	NOAA-15, NOAA16, Metop-A
2009 05 01 – 2009 06 30	NOAA-16, Metop-A
2009 07 01 – 2011 12 31	NOAA-16, Metop-A, NOAA-19

Furthermore, all the available satellites are used for the processing as far as all their ATOVS instruments are declared operational on the NOAA POES (Polar Orbiting Environmental Satellites) status page: http://www.oso.noaa.gov/poesstatus/. When an instrument onboard a given satellite was not operational anymore, the satellite was removed from the processing.

The retrieval of the geophysical parameters is done with the IAPP (International ATOVS Processing Package) software version 3.0 which normally uses the following ATOVS channels: HIRS channels 1 to 17 (18, 19, and 20 are not used), AMSU-A channels 3 to 14 (1,2, and 15 are not used), and AMSU-B channel 17 to 20 (16 is not used). However, when an instrument channel became faulty on one of the satellites, it was removed from the retrieval for that particular satellite and for the entire time period for which the products are generated using this satellite. Those channels are the following: AMSU-A channel 11 and 14 on NOAA-15, AMSU-A channel 4 on NOAA-16 and AMSU-A channel 7 on Metop-A.
For the months November 2000 to January 2001, NOAA-15 is not used to retrieve the products because the NOAA-15 data are corrupted in the ECMWF MARS archive.

4.2 Retrieval algorithm and processing chain

Figure 3 describes the algorithm used to process the ATOVS data at CM SAF.

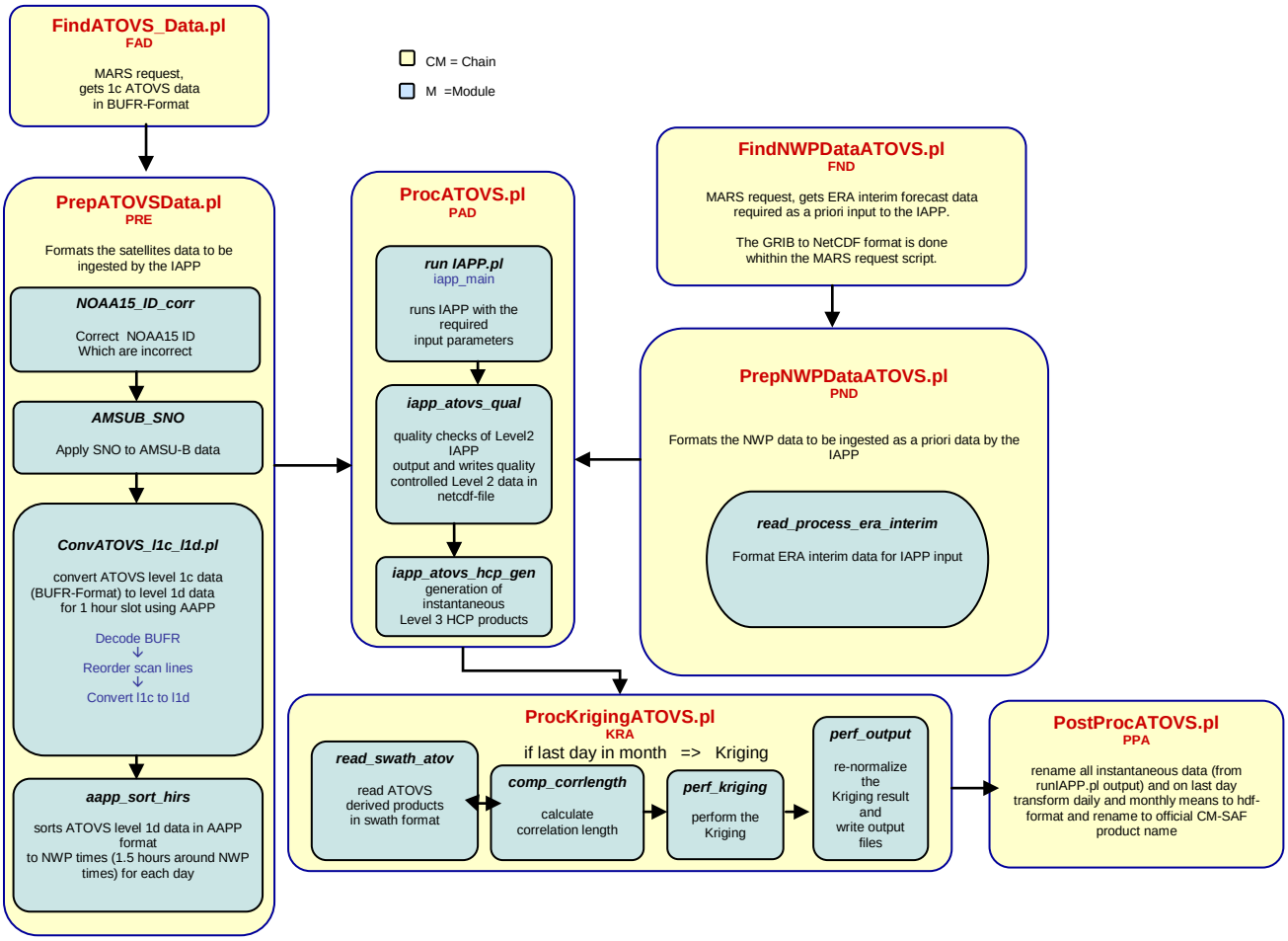

Figure 3: CM SAF ATOVS reprocessing chain flow chart (".pl" is the extension of the Perl based routines).

The water vapour and temperature retrieval is done using the IAPP version 3.0. The IAPP is an optimal estimation scheme, it was developed by the University of Wisconsin in Madison

and is described in Li et. al. (2000). ERA Interim reanalysis is used as a priori input data to IAPP. The following ERA Interim fields are used: temperature profile, relative humidity profile, 2 m dew point, 2 m temperature, skin temperature, surface pressure, geopotential, sea ice cover, land sea mask, total column water vapour , and u and v winds at 10 m. The AMSU-B data are intercalibrated using SNO (Simultaneous Nadir Overpass) coefficients (John et. al., 2012). Afterwards, the ATOVS l1c data are converted to l1d using the AAPP (AVHRR and ATOVS Pre-processing Package) software version 6.15 developed by the NWP SAF. At the time the processing was carried out, the version 6.15 was the latest AAPP version available. The IAPP is then fed with the ATOVS l1d data and the ERA Interim data (both arranged in 3-hourly time slot files). The water vapour and temperature profiles are retrieved on 42 pressure levels. A quality control is applied to the IAPP outputs and afterwards the profiles are sampled, integrated and averaged. Finally, a Kriging routine (Lindau and Schröder, 2010) is applied to obtain the daily and monthly means. A post-processing routine is applied to the data, mostly to rename the files according to the CM SAF filename convention.

For more details on the processing chain and on the retrieval scheme the user can refer to the Algorithm Theoretical Basis Document for the ATOVS data set products [**RD 2**]. Furthermore, details about the retrieval and the IAPP can be found in Li et. al. (2000).

4.3 Summary of Validation results

The products have been compared to the GUAN (GCOS Upper-Air Network) radiosondes and to AIRS (Atmospheric InfraRed Sounder) data, the validation results are available from the validation report [**RD 1**], the accuracy requirements are available from the CM SAF Product Requirements Document [**AD 1**] and from the Appendix of this document in Section 10.3.

The validation against the GUAN radiosondes shows that the total precipitable water vapour (TPW) always exhibits a bias within ± 1 kg m^{-2}. For the HLW products, the maximal bias of the layer mean temperature is about - 0.8 K. However most of the data exhibit a bias within the ± 0.5 K range (for the time period between 2001 and 2011; for 1999 and 2000, the data set shows a lower quality for the temperature products). For the HLW layered water vapour products, the difference depends upon the different layers. For the surface closest layer the bias oscillates between -0.3 kg m^{-2} and -1.2 kg m^{-2}, for the two middle layers (700-500 hPa and 850-700 hPa), the bias is most of the time between 0 and 0.5 kg m^{-2}, and for the two highest layers the mean bias is 0.0014 kg m^{-2} for the highest layer (between 300 and 200 hPa) and 0.0029 kg m^{-2} for the layer between 500 and 300 hPa. For the HSH products the bias for the temperature products oscillate mostly between -0.5 and 0.5 K. For the HSH specific humidity products, the bias is within ±0.4 kg m^{-2} for the three lower levels (1000, 850, and 700 hPa), between 0 and 0.3 kg m^{-2} for the 500 hPa level and for the 200 and 300 hPa levels the mean bias is 0.0032 kg m^{-2} and -0.013 kg m^{-2}, respectively.

For the decadal stability the results vary depending upon the different products, and the different layers and levels, however, the decadal stability is less than 4 % for most of the products. For more details the users should refer to the validation report [**RD 1**].

The CM SAF recommends the use of the ATOVS data set for global and regional climate variability analysis, for global and regional climate modelling and finally for climate services.

4.4 General limitations

The CM SAF ATOVS data set offers a large range of products (total water vapour column, layered water vapour, layered temperature, water vapour and temperature at given levels)

and was processed with a frozen processing system and up-to-date retrievals. However, the CM SAF ATOVS data set also presents few limitations which are described below.

The products are not independent from the ERA Interim model fields since those are used as first guess input to the retrieval. Considering the weighting functions of the ATOVS instruments, the results in the lower troposphere over land surface may be significantly influenced by the model fields. Another related limitation is that the ERA Interim model fields are not independent from ATOVS since the ATOVS data are assimilated in the reanalysis model.

As shown in Table 2, different satellites are used to generate the data set and the number of satellites which are used for the processing also varies from one to four. The satellites have different satellite local overpass times and some of them drifted with time, these two factors might affect the performance of the data. It is also evident that the data will exhibit a lower quality if only one satellite is used to generate the data set.

The AMSU-A and HIRS brightness temperatures have not been intercalibrated. This missing intercalibration might lead to artefact trends especially in the temperature products. Furthermore, the AMSU-B SNO intercalibration coefficient are used only for the time period 2001-2010 (John et. al. (2012)). It is also shown in John et. al. (2012), that the measurements taken into account in the SNO occur only at the poles, so that only a small part of the dynamic range of the global measurements is represented in the SNO. Consequently, potential non-linear effects as a function of scene brightness temperature are not considered. Intercalibrations for HIRS and AMSU-A are available (Shi and Bates, 2011 and Zou and Wang, 2011) but due to the applied limb corrections can not be used as input to IAPP. Global SNOs have been developed for AMSU-B but it was not available yet at the time of the CM SAF ATOVS data set processing.

It has also been shown that there might be scan asymmetry in AMSU-B brightness temperatures (Buehler et. al., 2005), which has not been accounted for here.

The water vapour retrieval is not reliable in case of very elevated terrain (mostly in the Himalaya region), because in such regions the sounders “see” through the entire atmosphere down to the ground and the signal is contaminated with surface contributions.

5 Data and filename format description

This section describes the filename and data format of the CM SAF ATOVS data set products.

CM SAF ATOVS products are provided as NetCDF (Network Common Data Format) files (http://www.unidata.ucar.edu/software/netcdf/). The data files are created following the NetCDF Climate and Forecast (CF) Metadata Convention version 1.5 (http://cf-pcmdi.llnl.gov/).

For data processing, conversion to a regularly lat/lon grid and conversion to various graphical packages input format, CM SAF recommends to use the climate data operators (CDO), available under GNU Public License GPL from MPI-M (http://www.mpimet.mpg.de/~cdo). Furthermore, CM SAF has developed, as part of its training activities, a pool of R (http://www.r-project.org/) scripts to analyse and postprocess the CM SAF data. Those scripts are available on request or from http://www.cmsaf.eu/tools.

5.1 Filename convention

The product filenames follow the CM SAF filename convention and are consequently built as the following:
<Product><Averaging_type><Date><Version><Projection_identifier><Data_index>01GL.nc

- Product: product name, can be “HTW”, “HLW”, “HSH”.
- Averaging type: can be “dm” for daily mean product files or “mm” for monthly mean product files.
- Date: date in yyyymmddhhmm format. The time part of the date (“hhmm”) is always 0000 for the daily and monthly mean files. For the monthly mean files the first day of the month is taken for the day value (“dd”).
- Version: version number of data set to which the product file belongs. For the data set described in this document the version number is “001”.
- Projection identifier: for the cylindrical equal area projection which is used for the ATOVS products, the projection identifier is “11”.
- Data index: each product has a corresponding data index as described in Table 3.

Table 3: List of the CM SAF ATOVS products and their corresponding data index used in the filename composition.

Product	Data index
HTW	00173
HLW	00171
HSH	00172

Examples:

- HLWmm2009060100000001110017101GL.nc is a file containing the HLW monthly mean (mm) products, for June 2009.
- HTWdm2009063000000001110017301GL.nc is a file containing the HTW daily mean (dm) product for the 30th of June 2009.

The filenames of the instantaneous products mentioned in Section 3 follow the CM SAF filename convention as well (however, they might not follow the CF convention mentioned above). In that case the product name is “HPA”, the averaging type is “in” for instantaneous, the date includes the time stamp (the “hhmm” part of the date is 0000, 0300, 0600, 0900, 1200, 1500, 1800, 2100, or 2400), the version is “001”, the projection identifier is “09”, and the data index depends upon the satellite as shown on Table 4.

Table 4: Satellite and their corresponding data index used in the filename generation of the HPA (instantaneous) ATOVS CM SAF products.

Satellite	Data index
NOAA-15	00225
NOAA-16	00226
NOAA-17	00356
NOAA-18	00227
NOAA-19	00303
Metop-A	00281

5.2 Data file contents

A common NetCDF file consists of dimensions, variables and attributes. All CM SAF ATOVS products are built following the same design principles.
The attributes assigned to the variables, as well as the global attributes are listed in the appendix.

Coordinate variables (similar for the 3 products):

lon (longitude)

Geographical longitude of the grid [degree_east]

lat (latitude)

Geographical latitude of the grid [degree_north]

lev (level)

Layer or level of the pixel (for HLW in 5 layers and HSH on 6 levels) [level]

Time

For daily mean files: date [days since 19990101].
For monthly mean files: date of the first day in the month [days since 19990101].

3-dimensional variables:

The variable names are always composed of three parts:

- the product name:
  - HTW: total column
  - HLW: layered parameters
  - HSH: parameters on pressure levels
- the parameter name:
  - TPW: total water vapour column
  - LPW: layered mean water vapour
  - T : temperature
  - Q: specific humidity
  - RH: relative humidity
- the type of data:
  - m: parameter mean value for the pixel
  - n: number of observations for the pixel
  - s: standard deviation for the pixel

All three types of data (mean value (m), number of observations (n), and standard deviation (s)) are available for all the parameters contained in each product.

As explained in section 3, the HTW products contain only the total water vapour column (TPW). The HLW products contain the layered mean water vapour, the mean relative humidity (as additional auxiliary data), and the mean temperature, for the five layers defined in Table 1. The HSH products contain the specific humidity and the temperature at six pressure levels as defined in Table 1. Consequently, the products files are composed as the following:

- The HTW files contain:
  - HTW_TPWm, HTW_TPWn, and HTW_TPWs.

- The HLW files contain:
  - HLW_LPWm, HLW_LPWn, HLW_LPWs,
  - HLW_RHWm, HLW_RHWn, HLW_RHWs,
  - HLW_Tm, HLW_Tn, and HLW_Ts.

- The HSH files contain:
  - HSH_Qm, HSH_Qn, HSH_Qs,
  - HSH_Tm, HSH_Tn, and HSH_Ts.

6 Data ordering via the Web User Interface (WUI)

The Web User Interface is available at http://wui.cmsaf.eu. This platform gives the user direct access to the CM SAF data ordering interface, together with a description of its diverse functionalities (such as product searching or product ordering). The user is refered to this description since it is the central and most up to date WUI documentation available. However, the WUI key features are briefly described in the following sections.
Further user services, including information and documentation about CM SAF and CM SAF products, are available from the CM SAF homepage (http://www.cmsaf.eu).

6.1 Product ordering process

The user needs to be registered and logged in to order products. A login is provided upon registration, and all products are delivered free of charge (please note the copyright disclaimer given in Section 8.1). After product selection, it is possible to choose a type of data transfer (temporary ftp account (the default setting), CD/DVD, or email). Each order will be confirmed per email. A second email will inform the user when the data is ready; if the ftp data transfer was selected, this second email will provide the information on how to access the ftp server.

6.2 Contact User Help Desk staff

Shall a user encounter any problem or have questions, the CM SAF User Help Desk (email: contact.cmsaf@dwd.de) is available at any time. Further User Help Desk contact information (phone/fax,etc) are available on the CM SAF homepage (www.cmsaf.eu) or on the Web User Interface homepage (http://wui.cmsaf.eu).

6.3 User Problem Report

The users are encouraged to report any problems or difficulties encountered while using CM SAF products or services and to provide feedback to the CM SAF team. Users can either contact the User Help Desk (see Section 6.2) or use the “User Problem Report” page. A link to the “User Problem Report” is available either from the CM SAF homepage (www.cmsaf.eu) or the Web User Interface homepage (http://wui.cmsaf.eu).

6.4 Service Messages / log of changes

Service messages and a log of changes are also available from the CM SAF homepage (http://www.cmsaf.eu) and provide useful information on product status, versioning and known deficiencies.

7 Feedback

7.1 User feedback

Users of CM SAF products and services are encouraged to provide feedback on CM SAF products and services to the CM SAF team throught the User Help Desk (contact.cmsaf@dwd.de). Furthermore, the CM SAF team is always keen to learn about the user’s applications or field of expertise, so it is highly appreciated that the users provide CM SAF with feedback on their particular applications and experiences with CM SAF data.

7.2 Specific requirements for future products

EUMETSAT CM SAF is a user-driven service and is committed to considering the needs and requirements of its users when planning new products or for improvements of existing ones. Consequently, beside general feedback, the users are cordially invited to provide CM SAF with their specific requirements for future products. The users can provide their requirements directly to the CM SAF staff or by emailing the User Help Desk (contact.cmsaf@dwd.de).

7.3 User Workshops

In order to widen its audience and support its users with the exploitation of its data, CM SAF organizes training workshops on regular basis (approximatly every year). Furthermore, through regular (approximately every four years) CM SAF user workshops the CM SAF product baseline is revisited. The participation of the users in any of these workshops is highly appreciated. at the users are refered to the CM SAF webpage (www.cmsaf.eu) to get the latest news on the upcoming events.

8 Copyright

The user of CM SAF data agrees to respect the following regulations:

8.1 Copyright

All intellectual property rights of the CM SAF products belong to EUMETSAT. The use of these products is granted to every interested user, free of charge. If a user wishes to use these products in publications, presentations, web pages etc., ***EUMETSAT's copyright credit must be shown by displaying the words "copyright (year) EUMETSAT" on each of the products used.***

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When exploiting EUMETSAT/CM SAF data, the user is kindly requested to acknowledge this contribution accordingly and to make reference to CM SAF, e.g. by stating "The work performed was done (i.a.) by using data from EUMETSAT's Satellite Application Facility on Climate Monitoring (CM SAF)". Furthermore, it is highly recommended to clearly refer to the product version used, for example by identifying the CM SAF data records using the digital object identifier (doi). All information about the CM SAF doi are available from http://www.cmsaf.eu/DOI.
The doi for this data set is provided on the title page of this document.

8.3 Re-distribution of CM SAF data

The user is not allowed to re-distribute CM SAF data to third parties. The use of CM SAF products is granted free of charge to every interested user, but it is essential for the sustainability of CM SAF that the CM SAF team keeps track of the CM SAF users and how many they number. This helps to maintain the CM SAF operational services and ensures that the evolution of its products is in accordance with user needs and requirements. Each new user must become registered with CM SAF in order to have access to the data.

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10 Appendix

10.1 Global NetCDF attributes

Table 5: Global NetCDF attributes.

Name	Description
Title	data set title CM SAF ATOVS data set
conventions	convention followed: “CF-1.5” for all files
institution	institution where the data was produced
identifier_product_doi	doi
creator_url	URL contact information of the creator of the data
creator_email	email contact information of the creator of the data
filename	original filename
Time_coverage_start	temporal coverage start of the data [ISO8601 date]
Time_coverage_end	temporal coverage end of the data [ISO8601 date]
Time_coverage_duration	temporal coverage duration of the data [ISO8601 date]
processed_satellite_id	satellite WMO id processed for this product
cmsaf_parameter_id	CM SAF product identifier
cmsaf_parameter_code	CM SAF product name
intercalibration	intercalibration methos applied
history	provides an audit trail for modification to the original data

10.2 NetCDF attributes assigned to the variables

Table 6: NetCDF attributes assigned to the variables.

Name	Description
long_name	Long descriptive name
standard_name	Standard name that references a description of a variable’s content in the CF standard name table
units	Physical unit
_FillValue	This value represent missing or undefined data. Missing values are to be filtered before scaling.

10.3 Accuracy requirements

Table 7: Bias threshold and target accuracies requirements for the HTW and HLW products (LPW: Layered Precipitable Water, LT: Layer (mean) Temperature) from the Products Requirements Document [AD 1].

	LPW bias threshold [kg/m^2]	LPW bias target [kg/m^2]	LPW RMSE threshold [kg/m^2]	LPW RMSE target [kg/m^2]	LT bias threshold [K]	LT bias target [K]	LT RMSE threshold [K]	LT RMSE target [K]
TPW	2	1.5	5	3				
L1	0.02	0.01	0.1	0.05	1.5	0.5	3	2
L2	0.2	0.1	0.75	0.5	1.0	0.5	3	2
L3	0.25	0.1	2	1.3	1.0	0.5	3	2
L4	1.0	0.4	2.5	1.5	1.0	0.5	3	2
L5	1.0	0.4	3.0	2.0	1.0	0.5	3	2

Table 8: Similar to Table 7 but for the HSH products (Q: specific humidity, T: Temperature).

	Q bias threshold [g/kg]	Q bias target [g/kg]	Q RMSE threshold [g/kg]	Q RMSE target [g/kg]	T bias threshold [K]	T bias target [K]	T RMSE threshold [K]	T RMSE target [K]
L1	0.02	0.01	0.08	0.03	1.5	0.5	3	2
L2	0.03	0.01	0.5	0.15	1.25	0.5	3	2
L3	0.2	0.05	1.5	0.75	0.75	0.3	3	2
L4	0.3	0.1	1.75	1.25	0.5	0.2	3	2
L5	0.75	0.2	2	1.5	0.5	0.2	3	2
L6	1.0	0.2	2.25	1.5	0.5	0.2	3	2

11 Glossary

AAPP	AVHRR and ATOVS Pre-processing Package
AD	Applicable Documents
AIRS	Atmospheric InfraRed Sounder
AMSU	Advanced Microwave Sounding Unit
AMSU-A	Advanced Microwave Sounding Unit-A
AMSU-B	Advanced Microwave Sounding Unit-B
ATOVS	Advanced TIROS-N Operational Vertical Sounder
AVHRR	Advanced Very High Resolution Radiometer
AVHRR-GAC	Advanced Very High Resolution Radiometer Global Area Coverage
CD	Compact Disc
CDO	Climate Data Operators
CDR	Climate Data Record
CF	Climate and Forecast
CM SAF	Climate Monitoring Satellite Application Facility
doi	Digital Object Identifier
DVD	Digital Versatile Disc
DWD	Deutscher Wetterdienst
ECMWF	European Center for Medium-range Weather Forecast
ECV	Essential Climate Variable
ERA	ECMWF ReAnalysis
EUMETSAT	EUropean organisation for the exploitation of METeorological SATellites
FCDR	Fundamental Climate Data Record
FMI	Finnish Meteorological Institute
ftp	file transfer protocol
GCOS	Global Climate Observing System
GPL	General Public License
GUAN	GCOS Upper-Air Network
HIRS	High-resolution InfraRed Sounder
IAPP	International ATOVS Processing Package
KNMI	Koninklijk Nederlands Meteorologisch Instituut
MARS	Meteorological Archive and Retrieval System
Metop	METeorological Operational satellite
MHS	Microwave Humidity Sounder
MPI-M	Max Planck Institute for Meteorology
NetCDF	Network Common Data Format
NMHS	National Meteorological and Hydrological Service
NOAA	National Oceanic and Atmospheric Agency
NWP	Numerical Weather Prediction
POES	Polar Orbiting Environmental Satellites
RD	Reference Documents
RMIB	Royal Meteorological Institute of Belgium
SAF	Satellite Application Facility
SCOPE-CM	Sustained COordinated Processing of Environmental satellite data for Climate Monitoring
SI	Système International d'unités (international unit system)
SMHI	Swedish Meteorological and Hydrological Institute
SNO	Simultaneous Nadir Overpass
TIROS	Television Infrared Observation Satellites

TPW	Total Precipitable Water
WCRP	World Climate Research Program
WMO	World Meteorological Organization
WUI	Web User Interface