



DUE GLOBVAPOUR

Product Validation Plan




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1 Introduction

1.1 Purpose

This document provides guidelines for the validation of the GlobVapour products generated during the Prototype, Test and Production Phase. The data and methods used are described. In general, validation is performed with satellite data as well as ground-based data and data from aircraft.

1.2 Definitions, acronyms and abbreviations

AATSR	Advanced Along Track Scanning Radiometer
AIRS	Atmospheric Infrared Sounder
AMSU-A	Advanced Microwave Sounding Unit A
ARM	Atmospheric Radiation Measurement
ATOVS	Advanced TIROS Operational Vertical Sounder
ATSR	Along-Track Scanning Radiometer
CM-SAF	Satellite Application Facility on Climate Monitoring
EGVAP	European Global Water Vapour
GRUAN	GCOS Reference Upper Air Network
GPS	Global Positioning System
GUAN	GCOS Upper Air Network
HIRS	High Resolution Infrared Radiation Sounder
MHS	Microwave Humidity Sounder
MOL	Meteorological Observatory Lindenberg
MWR	MicroWave Radiometer
NOAA	National Oceanic and Atmospheric Administration
TCWV	Total Column Water Vapour
TIROS	Television InfraRed Operational Satellite
TZD	Total Zenith Delay
UKMO	United Kingdom Meteorological Office

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1.3 Applicable Documents

- [AD-1] DUE GLOBVAPOUR Requirements Baseline Document (RBD), issue 1, revision 0, dated 16 April 2010.
- [AD-2] DUE GLOBVAPOUR Data Acquisition Plan (DAP), issue 1, revision 0, dated 16 April 2010.
- [AD-3] DUE GLOBVAPOUR Technical Specification Document (TSD), issue 1, revision 0, dated 16 April 2010.
- [AD-4] DUE GLOBVAPOUR Software Development Plan (SDP), issue 1, revision 0, dated 16 April 2010.

1.4 Reference Documents

- [RD-1] DUE GLOBVAPOUR Validation Data Document (VDD), issue 1, revision 0, dated 23 June 2010.
- [RD-2] Pougatchev, N., 2008: Validation of atmospheric sounders by correlative measurements. *Appl. Opt.*, 47, 4739-4748.
- [RD-3] Pougatchev, N., August, T., Calbet, X., Hultberg, T., Oduleye, O., Schluessel, P., Stiller, B., St Germain, K., Bingham, G., 2009: IASI temperature and water vapour retrievals - error assessment and validation. *Atmos. Chem. Phys. Discuss.*, 9, 7972-7989.

1.5 Structure of the document

Section 2 describes the general validation approach and validation methods of each GlobVapour product.

2 General Validation Concept

2.1 Validation Data

Validation of the GlobVapour end products will be performed with a Diagnostic Dataset (DDS) which consists of satellite and ground based validation data.

The satellite data relies on a multitude of sensors operating in the infrared and microwave range with various spatial and spectral resolution.

Table 5-1 of the Data Acquisition Plan (DAP) [AD-2] presents the satellite data required for validation and IASI retrieval assessment. Table 2-1 below provides an overview indicating for which GlobVapour end products those data will be used.

Table 2-1: Satellite data sources for validation and IASI retrieval assessment.

	<i>GOME-SCIAMACHY-GOME-2</i>	<i>SSM/I-MERIS-(MWR)</i>	<i>(A)ATSR</i>	<i>SEVIRI-IASI</i>
AIRS	TCWV	TCWV	TCWV	Profiles, TCWV
ATOVS (HIRS, AMSU-A, AMSU-B/MHS)	TCWV	TCWV	TCWV	Profiles, TCWV
CHAMP (TRSR)	-	-	-	Profiles
IGOR	-	-	-	Profiles
IASI	TCWV	TCWV	TCWV	Profiles, TCWV
GRAS	-	-	-	Profiles
HIRS (on NOAA & METOP)	TCWV	TCWV	TCWV	Profiles, TCWV
MODIS	TCWV	TCWV	TCWV	TCWV

The ground based data sources for validation are:

- Radiosonde data,
- GPS data,
- Microwave radiometer data,
- Lidar data.

Details on providers, data and retrieval methods are described in the Data Acquisition Plan (DAP) [AD-2] and the Validation Data Document (VDD) [RD-1].

Table 2-2 provides a cross matrix of ground based validation data against GlobVapour end product.

Table 2-2: Ground based data sources for validation and IASI retrieval assessment.

	<i>GOME-SCIAMACHY-GOME-2</i>	<i>SSM/I-MERIS-(MWR)</i>	<i>(A)ATSR</i>	<i>SEVIRI-IASI</i>
Radiosonde	TCWV	TCWV	TCWV	Profiles, TCWV
GPS	TCWV	TCWV	TCWV	TCWV
MWR ¹⁾	TCWV	TCWV	TCWV	Profiles, TCWV
Lidar	TCWV	TCWV	TCWV	Profiles, TCWV

¹⁾ Profiles require a Microwave Profiler instrument.

The Radiosonde and GPS stations used for the DDS will be as many as possible from the total list.

Microwave radiometer data from the following GUAN collocated ARM sites has been identified:

- Lindenberg (Germany), lat: 52.21, lon: 14.11
- Nauru (Tropical Western Pacific), lat: -0.521, lon: 166.916
- Barrow (North Slope Alaska), lat: 71.323, lon: -156.616
- Lamont (Southern Great Plains, USA), lat: 36.605, lon: -97.485
- Sodankyla (Finland), lat: 67.367, lon: 26.629


In addition, MWR data from MOL will be used, availability however unclear [AD-2, RD-1]. It has also been envisaged to use MWR data from NDACC, however the altitude range seems outside of the tropospheric region.

Raman lidar data with water vapour retrievals will not be available until early 2011. The envisaged stations are listed in the GDD [RD-1].

2.2 Validation Plan

For the Test Phase of the project, GlobVapour Level 3 products generated for the period 2006 to 2008 (3 years) will have to be validated. A special validation dataset called 'diagnostic dataset' (DDS) will be put together for this period. The initial temporal window for the Prototype Phase is limited to 4 months, for which the months of July and August 2007, and January and August 2008 have been selected.

Data centres generally offer Level 2 and Level 3 data. Level 3 products however typically have a relatively coarse temporal and spatial resolution. For instance, AIRS L3 data are available as daily means on (1 x 1)° grid. If available, Level 2 products with higher spatial and temporal resolution are downloaded. Such Level 2 data will then be re-projected and interpolated to the grid used for the

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GlobVapour products (see Table 2-3 below as extracted from the Technical Specification Document (TSD) [AD-3]), in order to carry out the validation. The Level 3 products from the data centres are nonetheless useful for sanity check of the daily means generated for GlobVapour validation from grid-projected Level 2 products.

Table 2-3: Grid resolution of the GlobVapour products as of [AD-3].

	<i>GOME-SCIAMACHY-GOME-2</i>	<i>SSM/I-MERIS-(MWR)</i>	<i>(A)ATSR</i>	<i>SEVIRI-IASI</i>
TCWV	(0.5 x 0.5)°	Ocean: (0.5 x 0.5)° Land: (0.05 x 0.05)°	(0.05 x 0.05)°	(0.25 x 0.25)°
Profiles	N/A	N/A	N/A	(0.25 x 0.25)°

An explicit section on validation tools is given in [AD-4], which will be applied during GlobVapour validation exercises.

3 Detailed validation plans for project elements


3.1 Total Column Water Vapour

3.1.1 GOME–SCIAMACHY–GOME-2 Validation

Validation of GOME-2 TCWV using radio sonde data is being performed by the O3M-SAF. From experience, the scatter in these comparisons may be quite large, due to the very different pixel sizes involved (point source vs. 80x40 km) and the difference in measurement time (several hours). Inter-comparison with other satellite products will be performed, with SSM/I as the prime reference (over ocean only). Over land, comparisons with MERIS will be performed. MERIS has the advantage of sharing a similar viewing geometry and close time coincidence (30 minutes later than GOME-2, 30 minutes earlier as GOME, same time as SCIAMACHY).

3.1.2 SSM/I-MERIS Product Validation

Above land, the MERIS TCWV product will be mainly validated against instantaneous ground-based validation datasets like radiosonde data, microwave radiometer data and data from ground-based GPS stations, as compiled in the Diagnostic Data Set (DDS). The validation of long term products from MERIS will be based on time series from reference stations as GUAN or ARM sites. Additionally, the MERIS TCWV dataset will be compared to independent satellite observations, as provided by e.g. MODIS (MOD05 product). The validation over ocean will be against other satellite products (AIRS, Radio Occultation, MODIS, etc.). Further sources of satellite-based validation data are given in Table 2-1. Special attention will be given to the removal of a potential bias between MERIS and SSM/I and to inconsistencies of the combined SSM/I-MERIS product above coastal areas.

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MWR results will be compared to SSM/I products.

Further details can be found in section 2.2.3 of [AD-3].

3.1.3 (A)ATSR Product Validation

In addition to the usage of independent ground-based validation datasets like radiosonde data and GPS measurements, the validation of the (A)ATSR TCWV retrieval will be based on satellite inter-comparisons with the SSM/I-MERIS product, as higher accuracies are to be expected from MERIS above land surfaces and SSM/I above ocean. Especially, the temporal simultaneousness and equal spatial resolutions of AATSR and MERIS provide an excellent opportunity for satellite retrieval inter-comparisons. In addition, comparisons with the MODIS total precipitable water products, (MOD05/MYD05 above land, MOD07/MYD07 above ocean) will provide an indication of the AATSR TCWV product accuracy. Further sources of satellite-based validation data are given in Table 2-1.

3.2 Water Vapour Profile Products

3.2.1 IASI-SEVIRI Product Validation

To start with, the separate retrieval products of IASI and SEVIRI as well as the merged product will be compared to each other to assess the relative quality of the products.


As described in [AD-3], a subset of the DDS, which contains ground-based observations as well as satellite estimates of water vapour products, will be used to validate the GlobVapour IASI-SEVIRI water vapour profile product. This subset mainly includes radiosonde measurements and other ground-based observations from GUAN and ARM sites as well as radio occultation satellite data. Furthermore, other satellite water vapour profile retrievals, such as from AIRS, will be included.

3.2.2 IASI Retrieval Assessment

Beside standard validation measures as mean and standard deviation, software will be utilised following the approach of Pougatchev, 2008 and Pougatchev et al., 2009. They developed a model to account for differences in horizontal, vertical, and temporal resolution as well as noise level of the IASI instrument and radiosondes. Their approach further allows an assessment of the error information deduced from validation. We will try to adapt this methodology also to the problem of comparison of TCWV estimates to ground-based observations and to comparisons among the products.

Reference data, namely balloon-based sonde measurements and ground-based microwave radiometer data, are taken from the stations as mentioned in section 2.1.

The sonde measurements are used for water vapour profile validation, while the microwave data will be selected for the TCWV validation. The LWP information, which is also included, is intended to be used as additional cloud contamination indication.

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Initially 4 months (July, August 2007, and June, December 2008) will be covered by this comparison. Depending on reference data availability and the computational cost of the reprocessing of the IASI retrieval at all participating centres, the assessment will be extended.

4 Conclusions

The general validation approach is based on ground data as well as independent satellite data. In general, it is intended to process the satellite data, where possible, from (swath-based) L2 data to (grid-based) L3 data, so as to profit from the higher resolution of the L2 data. This is for instance the case for AIRS and MODIS data. Details of the validation data concerning the specific retrieval parameters, input instruments, temporal and spatial resolution and format aspects are given in the Validation Data Document (VDD) [RD-1]. For each GlobVapour product the validation strategy is briefly discussed. For some GlobVapour products, inter-comparison exercises will be performed.