



GSE – PROMOTE 2
C6 Validation Report

REF : PROMOTE 2 C6
ISSUE : 1.0
DATE : 06.06.2008
PAGE : 1

DOSSIER: COMMON

TASK: -2-



TITLE:

GMES SERVICE ELEMENT
PROMOTE 2

C6 Validation Report

LONG-TERM MULTISENSORAL UV RECORDS
Version 2

	GSE – PROMOTE 2 C6 Validation Report	REF : PROMOTE 2 C6 ISSUE : 1.0 DATE : 06.06.2008 PAGE : II
--	---	---

DOCUMENT STATUS SHEET

	FUNCTION	NAME	DATE	SIGNATURE
LEAD AUTHORS	editor	R. Delgado J. C. Lambert		
CONTRIBUTING AUTHORS	Service leader Service providers	Anders Lindfors Anders Lindfors		
REVIEWED BY	Reviewers			
APPROVED BY	Technical officer (ESA)	C. Zehner		
ISSUED BY	Project manager			



GSE - PROMOTE 2
C6 Validation Report
Long-term UV

REF: PROMOTE-2 C6
ISSUE: 1.0
DATE: 14.05.2007
PAGE: III

DOCUMENT CHANGE RECORD

Issue	Date	Modified Items / Reason for Change
Version 1		
0.1	22.02.2007	Draft template created
0.2	01.03.2007	SLA Specifications implemented in draft template
0.3	04.04.2007	S5 specifications implemented in draft template
0.4	16.04.2007	Draft template reformatted and distributed
0.5	04.05.2007	Input from service provider received
0.6	07.05.2007	Document sent to service provider for revision
0.7	07.05.2007	Input from service provider received and reviewed
0.8	14.05.2007	Document edited
0.9	11.06.2007	Document reviewed and links updated
1.0	25.06.2007	Document and properties updated
Version 2		
1.1	27/05/2008	Template updated and distributed
1.2	06/06/2008	Input from Service Provider concerning validation results
1.8	20.06.2008	Document edited and distributed for final review

LIST OF TABLES

Table 1.2-1 Product characterization.....	2
Table 1.3-1 Description of datasets used for validation	4
Table 1.4-1 Data quality and validation of individual components	6
Table 1.5-1 Validation against specifications and against user requirements.....	8
Table 1.6-1 Validation of quality assessment and control procedures. Service quality.....	10

	<p align="center">GSE - PROMOTE 2 C6 Validation Report Long-term UV</p>	<p>REF: PROMOTE-2 C6 ISSUE: 1.0 DATE: 14.05.2007 PAGE: V</p>
---	--	---

LIST OF FIGURES

Figure 1.1-1 Position of Long-term Multisensoral UV Records service within PROMOTE 2 UV Services. 1

	GSE - PROMOTE 2 C6 Validation Report Long-term UV	REF: PROMOTE-2 C6 ISSUE: 1.0 DATE: 14.05.2007 PAGE: VI
---	--	---

LIST OF ACRONYMS

EUVDB	European UV Database
WOUDC	World Ozone and Ultraviolet Radiation Data Centre
NSF	National Science Foundation
UVI	UV Index
FMI	Finnish Meteorological Institute
UV	Ultraviolet
CIE	Commission International de l'Eclairage, International Commission on Illumination
PNG	Portable Network Graphics
OMI	Ozone Monitoring Instrument
TOMS	Total Ozone Mapping Spectrometer
GOME	Global Ozone Monitoring Experiment
SCIAMACHY	Scanning Imaging Absorption Spectrometer for Atmospheric ChartographY
ISCCP	International Satellite Cloud Climatology Project
GADS	Global Aerosol Data Set

N/A	Not Available
n.a.	not applicable
n.s.	not specified

	<p align="center">GSE - PROMOTE 2 C6 Validation Report Long-term UV</p>	<p>REF: PROMOTE-2 C6 ISSUE: 1.0 DATE: 14.05.2007 PAGE: VII</p>
---	--	---

TABLE OF CONTENTS

DOCUMENT STATUS SHEET II

DOCUMENT CHANGE RECORDIII

LIST OF TABLES.....IV

LIST OF FIGURES..... V

LIST OF ACRONYMS..... VI

1 LONG-TERM MULTISENSORAL UV RECORDS SERVICE 1

1.1 Service Summary 1

1.2 Product Characterization 1

1.3 Validation plan and validation data..... 2

1.4 Validation of individual components 5

1.5 Validation against specifications and against user requirements 6

1.6 Quality assessment and control procedures: Service quality 9

1.7 References 10

1.7.1 Electronic references and online data access paths 10

1.7.2 Bibliographic references 10



GSE - PROMOTE 2

C6 Validation Report

Long-term UV

REF: PROMOTE-2 C6

ISSUE: 1.0

DATE: 14.05.2007

PAGE: VIII

<PAGE INTENTIONALLY LEFT BLANK>

1 LONG-TERM MULTISENSORAL UV RECORDS SERVICE

1.1 Service Summary

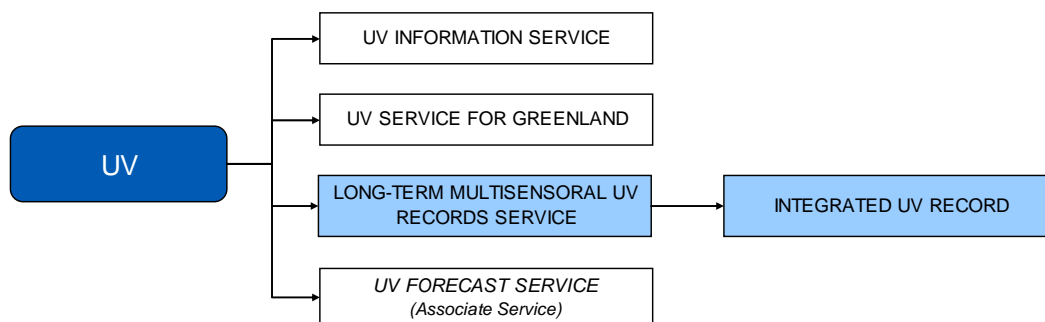


Figure 1.1-1 Position of Long-term Multisensoral UV Records service within PROMOTE 2 UV Services.

This is an integrated service that provides global and homogeneous surface time-series of erythemally weighted daily UV doses. At this stage (June 2008), a prototype of the service is available, providing data for the period July 2002 to June 2005. Later, the service will provide complete, long time coverage of more than 20 years back in time.

Service is operational since: June 2008

Research partners: NASA, NILU, etc (not funded by PROMOTE)

Provider(s): FMI (Finland)

Validation contact: Anders Lindfors (anders.lindfors@fmi.fi)

1.2 Product Characterization

In Phase 1 of PROMOTE2, the primary goal was to ensure continuation of the UV time series with surface UV data based on the OMI instrument. This service included both erythemally weighted daily UV dose and clear-sky UV index at local noon. In Phase 2, the UV algorithm uses assimilated total ozone column (from the Ozone Record Service) and ISCCP cloud data, available every three hours, and the focus is put on long time series of daily erythemal UV doses.

Clear Sky UV-Index (Phase 1)	
Parameter	1 UVI unit equals 25 mW/m ²
Typical range	0 – 15 UVI
Determination of the typical	Ground-based measurements

	GSE - PROMOTE 2 C6 Validation Report Long-term UV	REF: PROMOTE-2 C6 ISSUE: 1.0 DATE: 14.05.2007 PAGE: 2 of 11
---	--	--

range (Method, criteria)	
Maximum range	0-30 UVI
Units	[W/ m ²], [UVI]
<i>Standards</i>	http://www.unep.org/PDF/Solar_Index_Guide.pdf
Daily Erythemal UV Dose (Phase 1 & Phase 2)	
Parameter	Spectrally and temporally (over the day) integrated erythemally weighted irradiance
Typical range	0-10 kJ/m ²
Determination of the typical range (Method, criteria)	Ground-based measurements
Maximum range	0-15 kJ/m ²
Units	[kJ/m ²], [J/m ²]
<i>Standards</i>	<i>ISO/CIE. Erythema reference action spectrum and standard erythema dose. ISO 17166:1999(E) CIE S 007/E-1998. Vienna: CIE Central Bureau; 1999.</i>

Table 1.2-1 Product characterization

1.3 Validation plan and validation data

The validation of the UV Record Service in Phase 1 was documented in a scientific paper by *Tanskanen et al.* (2007). Here follows a short summary of the results of that paper:

The overpass erythemal daily doses derived from OMI data were compared with the daily doses calculated from the ground-based spectral UV measurements from 18 reference instruments. Although systematic differences exist for sites strongly affected by absorbing aerosols or seasonal snow cover, the OMI-derived daily erythemal UV doses are in general in rough agreement with ground-based measurements. For flat, snow-free regions with modest loadings of absorbing aerosols or trace gases, for instance, the OMI-derived daily erythemal doses have a median overestimation of 0–10%, and some 60 to 80% of the daily doses are within ±20% of the ground reference.

In Phase 2, the surface UV algorithm has been exchanged: in order to have more homogeneous information on the cloudiness, we chose to use the cloud data from the International Cloud Climatology Project (ISCCP; <http://isccp.giss.nasa.gov/>). This data is available from 1983 onward on a global 280 km equal area grid, and with a temporal resolution of 3 h. In Phase 2, we performed a similar validation as for Phase 1 (see above) based on daily erythemal UV doses by ground-based instruments at seven European stations ranging from Sodankylä in the north to Thessaloniki in the south. It should be mentioned also, that validation against ground-based reference data is considered



GSE - PROMOTE 2

C6 Validation Report

Long-term UV

REF: PROMOTE-2 C6

ISSUE: 1.0

DATE: 14.05.2007

PAGE: 3 of 11

important by the user. The selected seven high quality stations (see Table 1.3-1) were chosen because their data are conveniently available within the SCOUT-O3 EU funded project, where FMI is also participating. In practice, the aim of the validation in Phase 2 is to determine typical bias and spread of the satellite-retrieved daily UV doses as compared to the ground-based reference. Most reference stations have data starting from the early or mid 1990s. However, the station of Norrköping has data available already since 1983, and will thus make an important contribution to validating the performance of the complete long-term satellite-retrieved UV record. At this stage (June 2008), the UV Record Service provides only a prototype dataset that covers the period July 2002 to June 2005. Consequently, validation was performed for this period only.

VALIDATION DATA	
Ground based observations	
EUVDB (Phase 1)	Data availability and access: http://uvdb.fmi.fi/uvdb/index.html Spatial coverage and resolution: local time series Temporal coverage and resolution: variable (longest time-series start in early 90's, point measurements) Location(s) (coordinates): 43 sites (Europe) Accuracy: typically $\pm 5\%$
WOUDC (Phase 1)	Data availability and access: http://www.woudc.org/ Spatial coverage and resolution: local time series Temporal coverage and resolution: variable (longest time-series start in early 90's, point measurements) Location(s) (coordinates): 29 sites (Global) Accuracy: typically $\pm 5\%$
NSF (Phase 1)	Data availability and access: http://www.biospherical.com/NSF/default.asp Spatial coverage and resolution: local time series Temporal coverage and resolution: variable (longest time-series start in early 90's, point measurements) Location(s) (coordinates): 7 sites (Polar and San Diego) Accuracy: typically $\pm 5\%$
Reconstructed UV (Phase 2)	Data availability and access: from COST 726 and/or SCOUT-O3 Spatial coverage and resolution: local times series Temporal coverage and resolution: daily values, mostly starting around 1980 or earlier Accuracy: n.s.

	<p align="center">GSE - PROMOTE 2</p> <p align="center">C6 Validation Report</p> <p align="center">Long-term UV</p>	<p>REF: PROMOTE-2 C6 ISSUE: 1.0 DATE: 14.05.2007 PAGE: 4 of 11</p>
---	--	---

<p>SCOUT-O3 (Phase 2)</p>	<p>Data availability and access: through SCOUT-O3 EU funded project Spatial coverage and resolution: local time series Temporal coverage and resolution: Daily values, mostly starting in the early or mid 1990s, one station from 1983 onward.</p> <p>Location(s) (coordinates)/orbit/computational domain: 7 sites (Sodankylä, Jokioinen, Norrköping, Bilthoven, Lindenberg, Hradec Kralove, Thessaloniki)</p> <p>Accuracy: typically $\pm 5\%$</p>
-------------------------------	--

Table 1.3-1 Description of datasets used for validation

	GSE - PROMOTE 2 C6 Validation Report Long-term UV	REF: PROMOTE-2 C6 ISSUE: 1.0 DATE: 14.05.2007 PAGE: 5 of 11
---	--	--

1.4 Validation of individual components

Concerning Phase 1, detailed validation results are available in the publication by *Tanskanen et al. (2007)*, the results of which were summarized above. The paper is also linked to the UV Record Service web page.

The central results of the Phase 2 validation are presented in the table beneath. More details, including illustrative figures are available on the UV Record Service web page. Shortly, the results show that the new algorithm for satellite-retrieved UV is working more or less as expected. The performance is similar to that of the OMI-retrieved UV of Phase 1, with quite a clear tendency toward overestimation. The new algorithm shows a median overestimation typically ranging from +3 to +10%, with 58 to 68% of the satellite-retrieved daily doses being within plus/minus 20% from the ground-based reference.

VALIDATION OF INDIVIDUAL COMPONENTS	
Uncertainty assessment	
Bias	<p>mean bias (%) = mean value of percentage deviation as compared to reference data, i.e., $\text{mean}([\text{est-ref}]/\text{ref}*100\%)$</p> <p>median bias (%) = median value of percentage deviation as compared to reference data, i.e., $\text{median}([\text{est-ref}]/\text{ref}*100\%)$</p>
Standard deviation	std = standard deviation of ratio of estimated to reference value, i.e., $\text{std}(\text{est}/\text{ref})$
W20	W20 = amount (relative frequency in %) of values found within plus/minus 20% from the reference
Quality assessment	
Threshold of 200 J/m ²	Following <i>Tanskanen et al. (2007)</i> , a threshold filter of 200 J/m ² was applied, so that only daily doses exceeding that value were included in the validation analysis.
Model/algorithms	
Calculation of surface UV	<p>Look-up-table approach for radiative transfer calculations under various atmospheric conditions. Based on libRadtran radiative transfer simulations.</p> <p>Typically: mean bias=0.5%; std=1.5%.</p>

	GSE - PROMOTE 2 C6 Validation Report Long-term UV	REF: PROMOTE-2 C6 ISSUE: 1.0 DATE: 14.05.2007 PAGE: 6 of 11
---	--	--

FastRT	Not used. http://nadir.nilu.no/~olaeng/fastrt/README.html
libRadtran	libRadtran is a radiative transfer model, that has been developed during many years, and has been validated against both measurements and other models. This has been described more in detail in a paper by <i>Mayer and Kylling</i> (2005). The uncertainty of the radiation quantities produced with libRadtran is almost completely depending on the uncertainties in the input: the calculations themselves are accurate. http://www.libradtran.org/
Consistency	
Validation vs. ground-based UV data	Validation was performed for seven European stations and the period July 2002 to June 2005, comparing satellite-retrieved daily erythemal UV doses against ground-based measurements.
	Typical range of results (including the middle five stations concerning each parameter): mean bias=+11 to +19%; median bias=+3 to +10%; std=0.33 to 0.43; W20=58 to 68%.
Validation vs. reconstructed COST 726 time series	Validation against reconstructed UV cannot be performed until the complete long-term UV Record is available
	[Validation Parameter=Result; Procedure/method – ref data (ref)]

Table 1.4-1 Data quality and validation of individual components

1.5 Validation against specifications and against user requirements

According to the SLA between FMI and University of Manchester, the UV Record Service should provide global UV information time series from 1979 onward and the UV Record should be validated against ground-based data. Data should be made available as ASCII (for time series) and figures in PNG (UV maps).

*Requirements in *Italics* are recommended but not compulsory for Phase 2

VALIDATION AGAINST SERVICE SPECIFICATIONS
No limitations/delays for compliance between theoretical and actual service specifications (phase 2) reported
VALIDATION AGAINST USER REQUIREMENTS



GSE - PROMOTE 2

C6 Validation Report
Long-term UV

REF: PROMOTE-2 C6
ISSUE: 1.0
DATE: 14.05.2007
PAGE: 7 of 11

SPECIFICATION	S5	REQUIRED*	ACTUAL
Product	Clear-sky UV Index (Phase 1) Daily Erythemat UV Dose (Phase 1 & Phase 2) Spectral Surface UV Irradiance (N/A)		
Accuracy	Relative accuracy of 3% per decade	n.s.	N/A (expected ~3%)
Accuracy minimum	n.s.	n.s.	n.s.
Accuracy target	n.s.	n.s.	n.s.
Spatial coverage	Global	Global	Global
Horizontal resolution	1°x1°	<i>Highest available</i>	1°x1°
Vertical resolution	n.a.	n.a.	n.a.
Grid/Projection	Grid at 1x1°	<i>Maximum and optimal resolution</i>	Grid at 1x1°
Temporal coverage	1979-present	n.s.	Phase 1: 2004-2006 Phase 2 (as of June 2008): July 2002 to June 2005 Phase 2 (final expected): 1983- (ISCCP cloud data begins in 1983)
Temporal resolution	Daily, weekly, monthly averages	<i>Daily, weekly, monthly (averages)</i>	Daily
User Interfaces			
PROMOTE Web	Complete, operational and up to date	Complete, operational and up to date	Complete, operational and up to date
Other Webs	Yes	n.s.	yes
On demand	Processed local time-series available	n.s.	Additional local time series of specific sites can be added on request
Data formats and data delivery			

	GSE - PROMOTE 2 C6 Validation Report Long-term UV	REF: PROMOTE-2 C6 ISSUE: 1.0 DATE: 14.05.2007 PAGE: 8 of 11
---	--	--

Data availability (online)	November 1978-September 2004	n.s.	see temporal coverage above
Data access	Maps and local time series Online	Online	Online
Delivery Mode	Offline (Online no NRT)	Online no NRT	Offline (Online no NRT)
Delivery frequency	n.a.	Always accessible	Always accessible
Data Format	n.s.	ASCII; PNG	ASCII, images in various but common formats (mostly PNG)
Historical archive	Yes	Monthly averages 1979-present <i>As long as possible (min 20 years)</i>	PROMOTE: 1979-1993, 1996-2006 PROMOTE2, Phase1: 2004-2006 PROMOTE2, Phase2: 2002-2005 PROMOTE2, final: 1983-
Visualization	n.s.	Figures, maps	Figures, maps

Remarks

Currently (June 2008), a prototype of the UV Record is available covering the period 2002-2005. When the complete long-term total ozone column data set is available, the UV Record can be extended to cover the period from 1983 onward, which is when ISCCP cloud data start to be available.

*Requirements in *Italics* are recommended but not compulsory for Phase 2

Table 1.5-1 Validation against specifications and against user requirements.

	GSE - PROMOTE 2 C6 Validation Report Long-term UV	REF: PROMOTE-2 C6 ISSUE: 1.0 DATE: 14.05.2007 PAGE: 9 of 11
---	--	--

1.6 Quality assessment and control procedures: Service quality

The UV Record Service provides an archive of past UV radiation quantities. It does not include any near-real-time processing. This means that the service is manually updated and checked when new data/algorithms become available.

Service Quality				
Service delivery start date: 6 June 2008				
SPECIFICATION	S5	REQUIRED*	ACTUAL	N checks/Delivery period ° June 2008-
Quality checks	n.s.	<i>Required</i>	n.s.	n.s.
Product confidence interval	n.s.	<i>n.s.</i>	n.s.	n.s.
Error bar definition and representation	1 σ	<i>Estimation of error limits: min-max range of expected true value in the ground for each individual day/month/year</i>	n.s.	n.s.
Representation of missing data	Missing data is indicated	<i>Clearly indicated</i>	Missing data is indicated by ‘-99’ in the UV time series. In the UV maps, missing data is indicated by a grey area.	n.s.
Documentation of process failure	Offline service. Manual process failure control	<i>Clear and complete</i>	Offline service. Manual process failure control	n.s.

	GSE - PROMOTE 2 C6 Validation Report Long-term UV	REF: PROMOTE-2 C6 ISSUE: 1.0 DATE: 14.05.2007 PAGE: 10 of 11
---	--	---

Version control mechanisms and representation	Old versions are still available. Modifications will be shortly documented and introduced to the user	<i>n.s.</i>	All versions of the UV Record (Phase 1, and also older) are available at the web page. Versions are clearly indicated.	<i>n.s.</i>
---	---	-------------	--	-------------

*Requirements in *Italics* are recommended but not compulsory for Phase 2

Table 1.6-1 Validation of quality assessment and control procedures. Service quality.

1.7 References

[Complete/update section and subsections below]

1.7.1 Electronic references and online data access paths

UV Record archive;	http://promote.fmi.fi
EUVDB:	http://uvdb.fmi.fi/uvdb/index.html
WOUDC:	http://www.woudc.org/
NSF:	http://www.biospherical.com/NSF/default.asp
FASTRT:	http://nadir.nilu.no/~olaeng/fastrt/README.html
libRadtran:	http://www.libradtran.org/
ISCCP:	http://isccp.giss.nasa.gov/
GADS:	http://www.lrz-muenchen.de/~uh234an/www/radaer/gads.html

1.7.2 Bibliographic references

Tanskanen, A., Lindfors, A., Maatta, A., Krotkov, N., Herman, J., Kaurola, J., Koskela, T., Lakkala, K., Fioletov, V., Bernhard, G., McKenzie, R., Kondo, Y., O'Neill, M., Slaper, H., den Outer, P., Bais, A., Tamminen, J. (2007): Validation of Daily Erythemal Doses from OMI with Ground-Based UV Measurement Data, *Journal of Geophysical Research*, Vol. 112, D24S44, doi:10.1029/2007JD008830.

	<p>GSE - PROMOTE 2 C6 Validation Report Long-term UV</p>	<p>REF: PROMOTE-2 C6 ISSUE: 1.0 DATE: 14.05.2007 PAGE: 11 of 11</p>
---	---	---

Mayer, B., and A. Kylling (2005): Technical note: The libRadtran software package for radiative transfer calculations—Description and examples of use, *Atmos. Chem. Phys.*, 5, 1855 – 1877, doi:1680-7324/acp/2005-5-1855.