



GSE – PROMOTE 2
C6 Validation Report

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DOSSIER: COMMON

TASK: -2-



TITLE:

GMES SERVICE ELEMENT
PROMOTE 2
C6 Validation Report
UV INFORMATION SERVICE
Version 2

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DOCUMENT STATUS SHEET

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DOCUMENT CHANGE RECORD

Issue	Date	Modified Items / Reason for Change
Version 1		
0.1	22.02.2007	Draft template created
0.2	27.02.2007	Specifications and SLA Specifications implemented in draft template
0.3	13.04.2007	Update of S5 information
0.4	10.05.2007	Draft template reformatted and distributed
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0.6	30.05.2007	Document reviewed and edited
0.9	30.05.2007	Document edition finished
1.0	25.06.2007	Document properties updated
Version 2		
1.1	09.06.2008	Template created and distributed
1.2	25.06.2008	Input from service providers received
1.5	07.07.2008	Document reviewed, updated and ready for final review

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 The logo for PROMOTE features a stylized graphic of three colored circles (red, green, yellow) connected by lines to a horizontal bar, with three yellow stars above it. The word "PROMOTE" is written in blue capital letters below the graphic.	GSE - PROMOTE 2 C6 Validation Report UV Information	REF: PROMOTE-2 C6 ISSUE: 1.0 DATE: 25.06.2008 PAGE: V of 46
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LIST OF ACRONYMS

ARPA	Regional Agency for Environment Protection
BVDD	Berufsverband der Deutschen Dermatologen
CIE	International Commission on Illumination
COST	European Cooperation in the field of Scientific and Technical Research
DLR	Deutsches Zentrum für Luft- und Raumfahrt
DU	Dobson Unit
ENVISAT	Environmental Satellite
GOME-2	Global Ozone Monitoring Experiment 2
GTOPO30	Digital Elevation Model of the US Geological Survey
ISPESL	Italian National Institute of Occupational Safety and Prevention
MED	Minimal Erythemal Dose
MetOp	Meteorological Operational Satellite
OEC	Office of the Environment of Corsica
SCIAMACHY	Scanning Imaging Absorption Spectrometer for Atmospheric Cartography
SLA	Service Level Agreement
SMS	Short Message Service
SOAP	Object Access Protocol
SPF	Sun Protection Factor
SZA	Solar Zenith Angle
UV	Ultraviolet
WHO	World Health Organisation
WMO	World Meteorological Organisation

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

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1 UV INFORMATION SERVICE

1.1 Introduction

The PROMOTE UV-Information Service provides local and individualized near-real-time sunburn times, UV-Indices, and sun protection factor recommendations via Short Message Service (SMS) and Internet web-page.

To get into contact with the service a user approaches to the Internet page www.gse-promote.org. Under UV service the UV Information Service offers a European map. By clicking onto specific regions within this map a user will be directed to the internet page of the regionally available UV sub-service providing the requested local UV information.

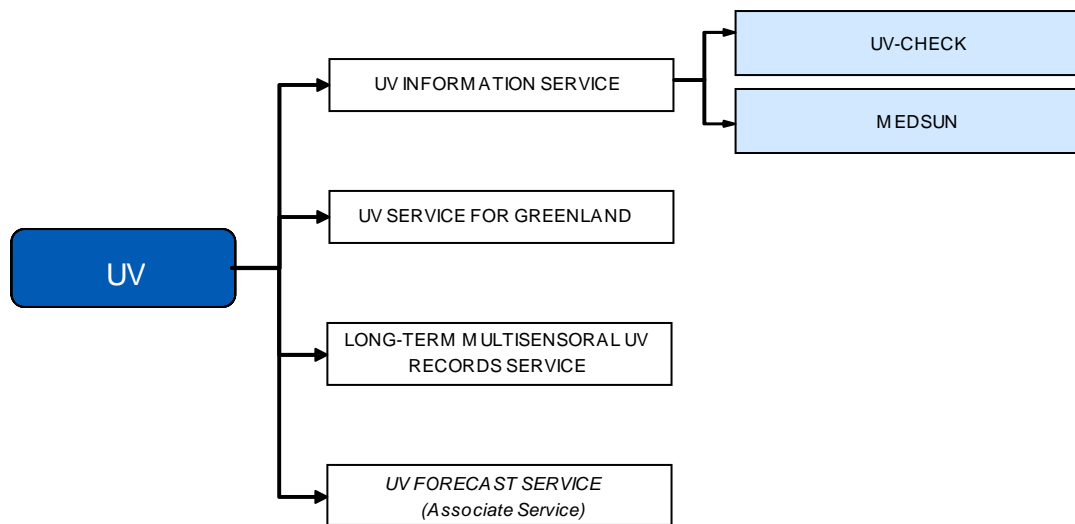


Figure 1.1-1 Structure and position of the UV Information Service within PROMOTE 2 UV.

Elements of each sub-service are personalized and environmental UV relevant input parameters. They are provided by the user himself via an interactive dialogue or questionnaire and by satellite measurements as it is the case for total ozone amount or cloud parameters. Spatial distributions of sunburn times and/or UV-Indices were pre-calculated by validated operational UV algorithms which in turn build the basis for the output as an answer to individual requests via the user interfaces.

1.2 UV-Check

Description: Service provides information on sunburn time, UV-Index, and sun protection factor on the basis of skin type and age of the user and atmospheric UV relevant parameters in order to reduce the risk of skin damages due to solar UV radiation.

Service is operational since: 2003

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Research partners: FlyBy (Italy)

Validation contact: R. Meerkötter (ralf dot meerkoetter at dlr dot de; DLR, Germany)

1.2.1 Product Characterization

Sunburn Time	
Parameter	Time
Typical range	12 - 180
Determination of the typical range (Method, criteria)	Minimum erythemal dose, MED, [Ws/m^2] times 60 divided by erythemally weighted UV irradiance [W/m^2]
Maximum range	10-360
Units	Minutes
Standards	CIE Action Spectrum for calculation of Erythemally weighted UV Irradiance (Skin type 2)
UV Index	
Parameter	Index
Typical range	1 - 8
Determination of the typical range (Method, criteria)	Erythemally weighted irradiance [W/m^2] multiplied by 40 [m^2/W] (WMO/WHO definition)
Maximum range	1 - 12
Units	[-]
Standards	CIE Action Spectrum for calculation of Erythemal weighted UV Irradiance, WMO/WHO definition of UV-Index
Sun Protection Factor (SPF)	
Parameter	Sunscreen SPF
Typical range	1 - 60
Determination of the typical range (Method, criteria)	Sunburn time [min] with sunscreen protection divided by sunburn time without sunscreen protection [min]

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Maximum range	
Units	[-]
Standards	CIE Action Spectrum for calculation of Erythema weighted UV Irradiance

Table 1.2-1 Characterization of the products provided by the sub-service UV-Check

1.2.2 Validation plan and validation data

UV-algorithm of the sub-service UV-Check has been validated in former studies and projects (e.g.: EC-project MAUVE, ENV4-CT97-0401, EC-project UVAC, EVK3-CT-1999-00012). Details about validation data and related references are listed in Table 1.1-2.

Further validation activities have been planned and performed according to the following plan formulated in the document version 1.0 and declared to be valid until May 2008.

- A further validation of the UV-Check products has been started in 2007 (PROMOTE phase-2) and will be continued in 2008. It is based on ground based spectral UV measurements and ancillary data at Davos, Switzerland. Details about validation data are added in Table 1.1-2.
- A cross checking of products of the sub-services UV-Check and Medsun for selected regions has been started and will be continued.
- For sub service UV-Check a check against updated specifications that follow the SLA with BVDD and that are defined in the S5 document under stage 2 goal (Table 3.1.1) will be performed

Typical results of the validation with surface measurements at Davos/Switzerland are meanwhile presented on the documentation page of the sub-service UV-Check under www.gse-promote.org. In the clear sky case a good agreement as in the former studies has been found. In cloudy cases surface measurements are well distributed between diurnal curves valid for the description of a simplified cloud coverage as has been generated for the users.

An intercomparison of the results of the sub-services Medsun and UV-Check has been performed for the region around Pisa/Italy for a number of days in July 2007. Examples of the results are also presented on the documentation page of the sub-service UV-Check under www.gse-promote.org. Figures document that both sub-services, UV-Check and Medsun, are in good agreement.

VALIDATION DATA	
Ground based observations	
Total ozone NILU Multi-channel moderate bandwidth filter	Data availability and access: Contact R. Meerkötter, DLR-OP, Germany Spatial coverage and resolution: local measurements Temporal coverage and resolution: 22. March – 12. June 2001, daily Location(s) (coordinates): Ure, 68°5' N, 13°40' E, Lofoten Islands, Norway,



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instrument, GUV Before Phase: (1,2)	Morkvedbukta near Bodø, 67°16.5' N, 14°34' E, Norway Accuracy: ~ 5%
In-situ observations	
Erythemat UV irradiance Spectrophotometer Brewer 163 Phase: (1 + 2)	Data availability and access: Contact R. Meerkötter, DLR-OP, Germany Spatial coverage and resolution: local measurements Temporal coverage and resolution: April, June, July, 2007, 15 min temporal resolution, every day Location(s) (coordinates): Physikalisches-Meteorologisches Observatorium, Davos, Switzerland, 46.81°N, 9.79°E Accuracy: ~5%
UV daily dose Spectroradiometer, Double monochromator, Bentham DTM 300 Before Phase: (1,2)	Data availability and access: Contact R. Meerkötter, DLR-OP, Germany Spatial coverage and resolution: local measurements Temporal coverage and resolution: 30 days in June 1997 Location(s) (coordinates): Garmisch-Partenkirchen, Germany, 47.48°N, 11.07°E Accuracy: ~ 7% See also Arola et al. (2002)
UV daily dose Multi-channel moderate bandwidth filter instrument, GUV Before Phase: (1,2)	Data availability and access: Contact R. Meerkötter, DLR-OP, Germany Spatial coverage and resolution: local measurements Temporal coverage and resolution: daily, March, April, May, 1996-1999 Location(s) (coordinates): Tromsø, 69.66°N, 18.97°E, Norway, Accuracy: ~ 5% See also Meerkötter et al. (2003)
UV-A daily dose UV-B daily dose Multi-channel moderate bandwidth filter instrument, GUV Before Phase: (1,2)	Data availability and access: Contact R. Meerkötter, DLR-OP, Germany Spatial coverage and resolution: local measurements Temporal coverage and resolution: 22. March – 12. June 2001, daily Location(s) (coordinates): Ure, 68°5' N, 13°40' E, Lofoten Islands, Norway Morkvedbukta near Bodø, 67°16.5' N, 14°34' E, Norway Accuracy: ~ 5% See also Hansen et al. (2003)
Other EO data	



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<p>Total ozone</p> <p>ERS-2/GOME</p> <p>Before Phase: (1,2)</p>	<p>For the site Garmisch-Partenkirchen, Germany:</p> <p>Data availability and access: Contact R. Meerkötter, DLR-OP, Germany</p> <p>Spatial coverage and resolution: Europe, 3 cross track pixels with resolution 40x320 km²</p> <p>Temporal coverage and resolution: Daily, spatial and temporal Kalman filtering</p> <p>Orbits: daily morning overpasses in Europe</p> <p>Accuracy: ~5%</p> <p>See also Arola et al. (2002)</p>
<p>Total ozone</p> <p>ERS-2/GOME</p> <p>Before Phase: (1,2)</p>	<p>For the site Tromsø, Norway:</p> <p>Data availability and access: Contact R. Meerkötter, DLR-OP, Germany</p> <p>Spatial coverage and resolution: Europe, 3 cross track pixels with resolution 40x320 km²</p> <p>Temporal coverage and resolution: Daily by spatial and temporal Kalman filtering the basic satellite data</p> <p>Orbits: daily morning overpasses in Europe</p> <p>Accuracy: ~5%</p> <p>See also Meerkötter et al. (2003)</p>
<p>Cloud optical depth</p> <p>NOAA/AVHRR data</p> <p>Before Phase: (1,2)</p>	<p>For the site Garmisch-Partenkirchen, Germany:</p> <p>Data availability and access: Contact R. Meerkötter, DLR-OP, Germany</p> <p>Spatial coverage and resolution: Europe, swath width 2800km, pixel resolution 1x1 km² at subsatellite point, also averaging over 3x3, 30x30 pixels around Garmisch-Partenkirchen site</p> <p>Temporal coverage and resolution: 1 overpass per day</p> <p>Orbits: daily noon-time overpasses</p> <p>Accuracy: ~ 30%/pixel</p> <p>See also Arola et al. (2002), Bugliaro et al. (2007)</p>
<p>Cloud optical depth</p> <p>NOAA/AVHRR data</p> <p>Before Phase: (1,2)</p>	<p>For the site Tromsø, Norway:</p> <p>Data availability and access: DLR</p> <p>Spatial coverage and resolution: Europe, swath width 2800km, averaging over 5x20 pixels around Tromsø site</p> <p>Temporal coverage and resolution: 1 overpass per day</p> <p>Orbits: daily noon-time overpasses</p> <p>Accuracy: ~ 30%/pixel</p> <p>See also Meerkötter et al. (2003), Bugliaro et al. (2007)</p>



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<p>UV daily dose</p> <p>Cross check of UV-algorithms based on:</p> <p>NOAA/AVHRR data (cloud optical depth) and TOMS and ERS-2/GOME data (total ozone)</p> <p>and based on</p> <p>Meteosat/MVIRI data (cloud optical depth) and TOMS, TOVS, and ERS-2/GOME data (total ozone)</p> <p>Before Phase: (1,2)</p>	<p>For areas within the Lofoten region, Norway</p> <p>Data availability and access: contact: DLR-OP, Germany, R. Meerkötter and at JRC-Ispra, Italy, J. Verdebout</p> <p>Spatial coverage and resolution: see Meerkötter et al. (2003)</p> <p>Temporal coverage and resolution: 1990 - 2001</p> <p>Orbits: see Meerkötter et al. (2003)</p> <p>Accuracy: see Meerkötter et al. (2003)</p>
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Table 1.2-2 Data used for the validation of the UV algorithm in the UV-Check sub service

1.2.3 Validation of individual components

VALIDATION OF INDIVIDUAL COMPONENTS	
Uncertainty estimators	
Accuracy	<p>rms difference in %</p> <p>mean absolute difference</p>
Quality assessment	
Process control: Daily availability of EO input data, i.e. total ozone data	Regular check of processes, protocols and data by whole UV-Check team, also immediate personal communication in case of interruptions.
Process control: Daily check of UV pre-calculation	Regular check of processes, protocols and data by whole UV-Check team, also immediate personal communication in case of interruptions.
Process control: Daily check of the user interfaces, i.e. Internet service, SMS service	Regular check of processes, protocols, and data output by whole UV-Check team, M-SQUAD GmbH, and core user BVDD. Immediate personal communication in case of interruptions.



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Product control: Daily quality checks of service output. i.e. total ozone, sunburn time and UV-Indices	Regular check of products by whole UV-Check team, M-SQUAD GmbH, and core user BVDD. Immediate personal communication in case of irregularities. Products must be within the typical range as given under 1.2.1 depending on regional environment, atmospheric conditions, season, and daytime.
Model/assimilation	
Radiative transfer model (Matrix-Operator -Model)	Pre-calculation of service output parameters based on an efficient UV-algorithm that has been derived from look-up-tables generated by use of a 1-D radiative transfer model including high spectral resolution, multiple scattering, and absorption of all UV relevant parameters in the atmosphere-surface system. See also Arola <i>et al.</i> , 2002
Basic studies for validation	
Ozone input against WOUDC ground-based data	(See Ozone Service-ROSE Products)
Validation of IDL fit routine	Fits of radiative transfer calculations of clear sky erythemally weighted UV-irradiances (look-up-tables) as a function of total ozone, solar zenith angle, surface elevation for different surface albedo values, e.g. snow and no snow. Validation by comparison of fitted UV irradiances to values from radiative transfer calculations. Results: Agreement in the order of 1 % for SZA < 80.
Analysis of cloud effects	A priori constraints: Instantaneous UV relevant 3-D optical and geometrical parameters of clouds are generally difficult to measure. Clouds are highly variable in time and space. Cloud influence on surface UV investigated by use of 1-D and 3-D radiative transfer models in several theoretical studies Ref: Meerkötter and Degünther (2001); Degünther and Meerkötter (2000), Bugliaro <i>et al.</i> (2007) In the UV-Check service instantaneous cloud cover estimates are user input. UV-Check offers to the user a simple classification as clear sky, partly cloudy and overcast conditions. Correction factors are derived from results of radiative transfer studies (see above).

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Validation of DLR UV Algorithm	<p>A priori constraints: Calculated UV irradiance depends on accuracy of input parameters (e.g. total ozone, surface albedo, cloud parameters)</p> <p>UV daily doses derived with the DLR UV-algorithm for clear sky and all sky conditions are validated by comparison to surface measurements within the EC-projects MAUVE (ENV4-CT97-0401) and UVAC (EVK3-CT-1999-00012).</p> <p>Results, i.e. validation against surface measurements: UV daily doses clear sky ~ 5-10%, UV daily doses cloudy sky >5-10%, i.e. UV daily doses for all sky conditions: rms difference ~ 30 - 35% UV daily doses for all sky conditions: mean rel. difference ≤ 5%</p> <p>Reference for comparison of UV algorithm against surface measurements: Arola <i>et al.</i> (2002) and Meerkötter <i>et al.</i> (2003).</p> <p>Reference for comparison of DLR UV algorithm against JRC UV algorithm: Meerkötter <i>et al.</i> (2003)</p> <p>Reference for assessment of effects of spatial and temporal cloud variability on UV daily doses: Bugliaro <i>et al.</i> (2007)</p>
Validation of UV-Index	UV-Index directly derived from erythemal UV irradiance, see Table 1.1.-1. Therefore rms differences and mean relative differences for UV daily doses (see above) represent the error estimation also for the UV-Index.
Validation of sunburn time	Sunburn time directly derived from erythemal UV irradiance, see Table 1.1. Therefore rms differences and mean relative differences for UV daily doses (see above) represent the error estimation also for the sunburn time.

Table 1.2-3 Validation of the individual components of the UV-Check sub-service

1.2.4 Validation against specifications and against user requirements

Sunburn Time, UV-Index and Sun Protection Factor are treated in one Table since these parameters are per definition directly derived from the basic parameter UV irradiance.

The user requirements have been specified in the Service Level Agreement (SLA) agreed with the core user BVDD. The following contributions to a service up-grading are part of the UV baseline service funded within the frame of the GSE-PROMOTE project:



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- Phase 1: Setup, first up-scaling (new language, use of MetOp/GOME-2 total ozone, service maintenance)
- Phase 2: Upgrade (new language, 2 days forecast, integration of user feedback, service maintenance)
- Phase 3: Up-scaling (integration into a joint European portal for UV information, service maintenance, demonstration of sustainability)

Except for the 2 days UV forecast (Phase 2) -being in the late stage of development- all commitments listed above have already been fulfilled, even the integration into a joint European portal for UV information as mentioned under Phase 3.

*Requirements written in *Italics* are recommended and not compulsory for Phase 2

VALIDATION AGAINST SERVICE SPECIFICATIONS			
UV-Check service is in compliance with actual service specifications			
VALIDATION AGAINST USER REQUIREMENTS			
SPECIFICATION	S5	REQUIRED*	ACTUAL
Products	Sunburn time, UV-Index, Sun Protection Factor		
Accuracy (UV Irradiance)	Clear sky ~ 5-10% Cloudy sky >5-10%	n.s.	Clear sky ~ 5-10% Cloudy sky >5-10%
Accuracy minimum	n.s	n.s	Clear sky ~ 5-10% Cloudy sky >5-10% See also Table 1.1-3
Accuracy target	n.s	n.s	Clear sky ~ 5-10% Cloudy sky >5-10% See also Table 1.1-3
Spatial coverage	20°N – 72°N, 32°W – 48°E, including EU27	Global; EU27 and site specific forecasts; 20°N-72°N, 32°W-45°E	20°N – 72°N, 32°W – 48°E, including EU27, Acores and Canary Islands
Horizontal resolution	0,0833° x 0,833° ~10x10 km ²	<i>Highest available</i>	0,0833° x 0,833° ~10x10 km ² for the clear



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			<p>sky ozone affected UV parameters.</p> <p>Resolution for all UV relevant parameters corresponds to the location of the user, since some local UV relevant parameters are provided via user input</p>
Vertical resolution	n.a.	n.a.	n.a.
Grid/Projection	Two-dimensional data fields on a regular grid	<i>Highest available resolution (projection n.s.)</i>	Two-dimensional data fields on a regular grid
Temporal coverage	n.a.	2 days	n.a.
Temporal resolution	Product data fields pre-calculated for local solar zenith angles from 7:00 to 18:00 UTC. The end user products are interpolated to the actual time of user request. Products are based on daily data of total ozone.	<i>Hourly resolution of UV Index cloudy</i>	Product data fields pre-calculated for local solar zenith angles from 7:00 to 18:00 UTC. The end user products are interpolated to the actual time of user request. Products are based on daily data of total ozone and local user input, i.e. UV relevant conditions on clouds, water, snow etc. at request time
Standards	CIE (1987) action spectra. WMO (1997) and COST-713 (2001) recommendations on UV-B forecasting.	CIE (1987) action spectra for the calculation of the basic quantity, the erythemally weighted UV irradiance	<p>CIE (1987) action spectra for the calculation of the basic quantity, the erythemally weighted UV irradiance.</p> <p>WMO (1997) and COST-713 (2001) recommendations on UV-B forecasting.</p>
Ozone forecast	n.s.	Dynamic and based on data assimilation with hourly resolution	See ROSE model
Cloud correction	n.s.	n.a. (user defined input)	Information on cloud conditions is local user input at request time



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User Interfaces			
PROMOTE Web	Complete, operational and up to date	Complete, operational, and up to date	Complete, operational, and up to date
ftp	n.a.	n.a.	n.a.
SMS	Available	Available	Available
On demand	n.s.	yes	yes
Warning system	n.s.	yes	
Data formats and data delivery			
Data availability	Daily forecast, monthly means	Daily forecast, monthly means, time-series, graphics	Daily UV parameters, pre-calculated hourly, 2 day forecasts in PROMOTE-2 Phase 2 Data basis for calculation and graphic representation of monthly means and time series archived
Data access	At any time of the day	At any time of the day	At any time of the day
Delivery Mode	Online/SMS	Online/Offline/SMS	Online/Offline/SMS
Delivery frequency	NRT	NRT	NRT
Data Format	ASCII, SMS	ASCII, Gridded ASCII, SMS	ASCII, SMS
Historical archive	None	yes	Yes, for internal use and validation purposes
Visualization	Maps, *.gif, other according to end user displays of mobile phones and web pages	European maps of sunburn times or UV-Indices <i>Global maps of daily maximum, graphics</i>	Daily European maps of sunburn times on PROMOTE web-page. Text messages via SMS Data for further visualization available from internal archive

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*Requirements written in *Italics* are recommended and not compulsory for Phase 2

Table 1.2-4 Validation against specifications and against user requirements of the UV-Check sub service

1.2.5 Quality assessment and control procedures

Service delivery start date: First version of service operational since start of Phase 1. Modifications according to SLA during Phase 1 and Phase 2.				
SPECIFIC ATION	S5	REQUI RED*	ACTUAL	# checks, occurrence frequency
Quality checks	Permanent process control	n.s.	Check of processing chain.	1 – 3 / day
Product confidence data	n.s.	n.s.	Check whether parameters in reasonable range	1 – 3 / day
Error bar definition and representation	Standard deviation of percent differences	Estimate of error limits	n.a.	
Representation of missing data	<ul style="list-style-type: none"> - Cron-job protocols (see above) - Storage of input (European total ozone) and output data (European sunburn tims) with documentation of processing date (data archive) - Text messages internally 	Clear and documented	Text messages, internal and for users	1 / day 1 / day if necessary



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<p>Documentation of process failure</p>	<ul style="list-style-type: none"> - Cron-job protocols containing information on date and time of computing processes and data transfers. Herewith documentation about operation failures and data availability is given - Personnel supervision - Text messages, internally and for core user <p>Information on UV-Check web page for end users</p>	<p>n.s.</p>	<p>Text messages, internal and for users</p>	<p>1 / day</p> <p>1 / day</p> <p>if necessary</p> <p>if necessary</p>
<p>Version control mechanisms and representation</p>	<p>Internal documentation for UV-Check team and core user (ideally, the version control process should be documented by very short reports with a brief description of the motivation, modifications made on the previous version and improvement achieved with the new version.)</p>	<p>n.s.</p>	<p>n.a.</p>	
<p>End user formulaire</p>	<p>n.s.</p>	<p>required</p>	<p>Questionnaire to doctors performed by core user BVDD</p> <p>Online questionnaires in discussion</p>	

*Requirements written in *Italics* are recommended and not compulsory for Phase 2

Table 1.2-5 Quality assessment and control procedures for the final UV-Check products



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1.3 MEDSUN

Description: It provides information on UV-Index, sunburn time on the basis of skin type and sun protection factor in order to reduce the risk of skin damages due to solar UV radiation.

Service is/will be operational since/after: since 2005 (Summer season only)

Research partners: DLR (Germany), KNMI (Netherlands)

Validation contact: F.Flore (Flyby, Italy)

1.3.1 Product Characterization

Sunburn Time	
Parameter	Time
Typical range	10 - 90
Determination of the typical range (Method, criteria)	<p>Minimum erythemal dose, MED, [J/m²] divided by erythemally weighted UV irradiance [W/m²] (then divide by 60 to convert seconds to minutes)</p> <p>The UV irradiance is calculated by RTM, taking into account ozone and clouds, and adjusted to include reflection by surrounding terrain in the way: $UV_{eff} = UV (1 + A_L)$, where A_L is the terrain albedo</p> <p>When SPF is specified: multiply sunburn time by SPF, then divide by 2 to account for low amount of cream typically used</p>
Maximum range	1 - 180
Units	Minutes
<i>Standards</i>	CIE Action Spectrum for calculation of Erythemally weighted UV Irradiance
UV Index	
Parameter	Index
Typical range	1 - 9
Determination of the typical range (Method, criteria)	Weighted irradiance [W/m ²] multiplied by 40 [m ² /W]



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Maximum range	1 - 11
Units	[-]
<i>Standards</i>	The WMO/WHO standard UV-Index
Sun Protection Factor (SPF)	
Parameter	Sunscreen SPF
Typical range	4 - 30
Determination of the typical range (Method, criteria)	Suggested SPF as function of UV index and phototype, according to European guideline (see “Standards”)
Maximum range	1 - 60
Units	[-]
<i>Standards</i>	COLIPA for SPF numbering SPF assignment according to: (Working Group 4 - EC, 2000)
Phototype	
Parameter	Type
Typical range	1, 2, 3, 4
Determination of the typical range (Method, criteria)	Nine user characteristics acquired by means of on-line questionnaire are processed by an expert system to calculate user phototype.
Maximum range	1, 2, 3, 4
Units	[-]
<i>Standards</i>	Phototype levels according to DIN5050. Use of questionnaire according to: (Weinstock, 1992)
UV-Eye Index	
Parameter	Index
Typical range	1 – 10
Determination of the typical range (Method, criteria)	$UVI\text{-Eye} = a * UVI^2 + b * UVI$
Maximum range	1 - 12

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Units	[-]
<i>Standards</i>	UV-Eye is derived from WMO/WHO's UVI. Coefficients "a" e "b" are determined by simulating both UVI and UVI-Eye and correlating them. UV-Eye simulation consists in integrating simulated solar spectrum and action spectrum for the eye (provided by ISPESL).

1.3.2 Validation plan and validation data

1. In 2005 UV Index and ozone were validated against on-ground measurements. It is planned the validation of UV-eye index.

VALIDATION DATA	
Ground based observations	
Ozone	Data availability and access: Flyby measurements Spatial coverage and resolution: single punctual Temporal coverage and resolution: 14-03-2006, 04-04-2006 (clear-sky conditions) Location(s) (coordinates): Livorno, 43.5092N, 10.3249E Accuracy: 5% relative error at 350 DU
<i>In-situ</i> observations	
UV-Index Source: ISPESL user Phase: 1+2	Data availability and access: ISPESL measurements with YES UVB-1 radiometer Spatial coverage and resolution: single punctual Temporal coverage and resolution: Jun, Jul, Aug, Sep 2007 Location(s) (coordinates): Monte Porzio Catone Lat= 41° 49' 22" Lon= 12° 42' 28" Accuracy: cosine response better than ±5% for 0°-60° SZA
UV Index	Data availability and access: ARPAT measurements Spatial coverage and resolution: single punctual Temporal coverage and resolution: June, July, August 2005 Location(s) (coordinates): Livorno, 43.5416N, 10.3149E Accuracy: 16% for SZA < 40°
Model outputs	
Fit of cloud indices to correct UV index	Data availability and access: Flyby measurements Spatial coverage and resolution: single punctual Temporal coverage and resolution: summer 2005 Location(s) (coordinates)/computational domain: Livorno, 43.5092N, 10.3249E / SpectrAIR spectroradiometer / local processing Accuracy: SpectrAIR 8% (NIST)
Other EO Data	

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n.a.	Data availability and access: Spatial coverage and resolution: Temporal coverage and resolution: Orbits: Accuracy:
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Table 1.3-1 Data used for the validation of the MEDSUN Service

1.3.3 Validation of individual components

VALIDATION OF INDIVIDUAL COMPONENTS	
Uncertainty estimators	
Accuracy estimator	Relative error - percentage
Quality assessment	
Process control: Daily availability of EO ozone data	Ozone is mandatory for UV products calculation. In case of its lacking, no map/graph is produced and an error message is displayed to operator and logged.
Process control: Daily availability of EO cloud coverage data	Cloud coverage is mandatory for UV products calculation. In case of its lacking, maps/graphs are not updated, lack is shows on graphs as empty and a warning message is sent via SMS to operator and logged. Also UVI value set to -1 for not valid data in archive files.
Process control: Daily check of UV pre-calculation	Regular check of processes, protocols and data by whole MEDSUN team, also immediate personal communication in case of interruptions.
Process control: Daily check of the user interfaces, i.e. Internet service, SMS service	Regular check of processes, protocols, and data output by whole MEDSUN team. Immediate personal communication in case of interruptions.
Product control: Daily quality checks of service output. i.e. SPF, phototype, sunburn time and UV-Indices	Regular check of products by whole MEDSUN team. Immediate personal communication in case of irregularities. Products must be within the typical range as given under 1.3.1 depending on regional environment, atmospheric conditions, season, and daytime.
Model/assimilation	

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Radiative Transfer Model (RTM) (modified FastRT, proprietary FLYBY)	<p>Look-up tables generated by modified FastRT code (to take into account action spectrum). Use of empirical model to calculate UV-index in cloudy conditions. Empirical model obtained by fitting cloud parameters (derived from MSG images) with ground measurements.</p> <p>To speed up final calculation, pre-calculated clear sky UV-Index values are stored in look-up tables as a function of discrete values of solar zenith angle SZA (3° step), ozone value (4 DU step), albedo value (0.04 step) and day of year (15 days step). Once that the precise spatial and temporal inputs are specified, the precise clear sky UV-Index is calculated by interpolation and then corrected taking into account the cloud indices.</p>
Other	
Ozone input (KNMI) against ground-based data	(Flore et al, Frascati., 2006)
Validation of UV-Index against ground based data	(Flore <i>et al.</i> , Frascati, 2006; Simeone <i>et al.</i> , Catania, 2005; Meerkötter <i>et al.</i> , Stockholm, 2006)
Validation of Phototype	A QTan Skin Analyser was used to measure the MED values required by the expert system to calculate the phototype (see Monfrecola et al., 2004)
Validation of UV-Eye index	Not done yet. To be done together with ISPESL user.
Validation against in-situ data	
Comparison between MEDSUN UV-Index and in-situ data measured by ISPESL during Summer 2007	Measurement with UV radiometer YES mod. UVB-1. Date: 7-7-2007 Monte Porzio Catone (ISPESL premises) The maximum relative error between the punctual values of the two synchronized series is: 8.1 %

Table 1.3-2 Validation of individual components of the MEDSUN Service



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1.3.4 Sunburn time

1.3.4.1 Validation against specifications and against user requirements

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

VALIDATION AGAINST SERVICE SPECIFICATIONS			
No limitations/delays for compliance between theoretical and actual service specifications reported			
VALIDATION AGAINST USER REQUIREMENTS			
SPECIFICATION	S5	REQUIRED*	ACTUAL
Product	Sunburn Time		
Accuracy	Not directly assessed (depends on UV-Index, MED, SPF)	n.s.	P1: n.a. P2: 28%
Accuracy minimum	n.s.	n.s.	28%
Accuracy target	n.s.	n.s.	18%
Spatial coverage	Italy, Balearic Islands, Corsica Island	Italy, Balearic Islands, Corsica Island	P1: Italy, Mallorca Island, Southern Corsica P2: Italy, all Balearic Islands, whole Corsica
Horizontal resolution	about 1 x 1 Km ² (same as UV-Index)	1 x 1 Km ²	1 x 1 Km ²
Vertical resolution	n.a.	n.a.	n.a.
Grid/Projection	DEM (GTOPO30 version)	n.s.	DEM (GTOPO30 version)
Temporal coverage	From present time up to 4 hours nowcasting between June and September	4 hour nowcasting between June and September	From present time up to 4 hours nowcasting between June and September
Temporal resolution	1 minute	15 minutes - <i>1 minute</i>	1 minute
Languages	n.s.	Italian; English; Spanish; French	P1: Italian; English

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			P2:Italian, English; Spanish; French, German
User Interfaces			
PROMOTE Web	Complete, operational and up to date	Complete, operational and up to date	Complete, operational and up to date
Other Webs	web pages	web pages	One web site dedicated to each user
ftp	n.a.	n.a.	n.a.
On demand	SMS	SMS	SMS
Data formats and data delivery			
Data availability	Spring/Summer, from 8:00 A.M. to 7:00 P.M. every day	Spring/Summer ; 3 minutes after EO acquisition	Spring/Summer, from 8:00 A.M. to 7:00 P.M. every day
Data access	n.s.	Link in PROMOTE website	Link in PROMOTE website to dedicated websites. Mobile phone SMS. Registration required
Delivery Mode	Online, SMS	Online, SMS	NRT Online, SMS
Delivery frequency	NRT, nowcasted up to 4 hours ahead (UV-Index dependence)	NRT, up to 4 h forecast	NRT, nowcasted up to 4 hours ahead (UV-Index dependence)
Data Format	ASCII/SMS	ASCII/SMS	ASCII/SMS
Historical archive	none	n.s.	none
Visualization	ASCII on web pages and SMS	n.s.	Text field on web, text message via SMS
REMARKS			
None			

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

Table 1.3-3 Validation against specifications and against user requirements for Sunburn Time



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1.3.4.2 Quality assessment and control procedures

Service delivery start date:				
Phase2: 1 st June 2008 = all functionalities in English and Italian languages; 20 th June 2008 = all functionalities in English, Italian, Spanish (FDSIB user only), French (OEC user only) and German languages				
SPECIFICATION	S5	REQUIRED*	ACTUAL	N checks/Delivery period ° Theoretical delivery period: June 1st 2008 – September 30th 2008
Quality checks	Permanent	yes	Daily check of processing chain efficiency	1 check/day
Product confidence data	n.s.	n.s.	Daily check to be within 0 – 180 minutes	1 check/day
Error bar definition and representation	n.s.	n.s.	n.a.	n.a.
Representation of missing data	n.s.	n.s.	n.a.	n.a.
Documentation of process failure	n.s.	n.s.	Linked to UVI product Problem Report (internal) when system failure occurs	1 check/day (2 failures so far)
Version control mechanisms and representation	n.s.	n.s.	Version tracking of running SW (internal historical record)	when needed (4 changes so far at global level)

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

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Table 1.3-4 Quality assessment and control procedures for Sunburn Time

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1.3.5 UV Index

1.3.5.1 Validation against specifications and against user requirements

VALIDATION AGAINST SERVICE SPECIFICATIONS			
Local languages foreseen for Corsica (French) and Balearic Islands (Spanish) which were overdue since Phase 1, have been implemented in Phase 2. More languages also added in Phase 2 (German)			
VALIDATION AGAINST USER REQUIREMENTS			
SPECIFICATION	S5	REQUIRED*	ACTUAL
Product	UV Index		
Accuracy	Relative error < 16% for SZA < 40° (even with partially clouded sky)	n.s.	Relative error < 16% for SZA < 40° (even with partially clouded sky)
Accuracy minimum	n.s.	n.s.	16%
Accuracy target	n.s.	n.s.	10%
Spatial coverage	Italy, Balearic Islands, Corsica Island	Italy, Balearic Islands, Corsica Island	P1: Italy, Mallorca Island, Southern Corsica P2: Italy, all Balearic Islands, whole Corsica
Horizontal resolution	0.00833° x 0.00833° (about 1 km x 1 km in areas of interest)	1x1 Km ²	1 x 1 Km ²
Vertical resolution	n.a.	n.a.	n.a.
Grid/Projection	DEM (GTOPO30 version)	n.s.	DEM (GTOPO30 version)
Temporal coverage	From present time up to 15 minutes nowcasting between June and September	15 Minutes nowcasting during spring/ summer season (between June and September)	From present time up to 4 hours nowcasting between June and September
Temporal resolution	n.s.	<i>15 minutes – 1 minute</i>	N.A.



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Languages	n.s.	Italian; English; Spanish; French	P1: Italian; English P2: Italian, English; Spanish; French; German
User Interfaces			
PROMOTE Web	Complete, operational and up to date	Complete, operational and up to date	Complete, operational and up to date
Other Webs	web pages	web pages	One web site dedicated to each user
ftp	n.a.	n.a.	n.a.
On demand	SMS	SMS	SMS
Data formats and data delivery			
Data availability	Spring/Summer, from 8:00 A.M. to 7:00 P.M. every day	Spring/Summer; 3 minutes after EO acquisition	Spring/Summer, from 8:00 A.M. to 7:00 P.M. every day
Data access	Online	Online, link in PROMOTE website	Link in PROMOTE website to dedicated websites. Mobile phone SMS. Registration required
Delivery Mode	NRT Online, SMS	NRT Online, SMS	NRT Online, SMS
Delivery frequency	NRT: 15 min. update rate + 3 min. nowcasting in between)	NRT: 15 min. update rate + 3 min. nowcasting in between)	NRT (15 min. update rate + 3 min. nowcasting in between)
Data Format	ASCII + GUI (maps & graphs)	n.s.	ASCII + colours according to WMO/WHO
Historical archive	None	n.s.	None
Visualization	ASCII + GUI (maps & graphs)	Graphically georeferenced UV Index	Text field on web, text message via SMS. GUI on web (webGIS maps & graphs)
REMARKS			

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None

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

Table 1.3-5 Validation against specifications and against user requirements of UV-Index

1.3.5.2 Quality assessment and control procedures

Service delivery start date: Phase2: 1 st June 2008 = all functionalities in English and Italian languages; 20 th June 2008 = all functionalities in English, Italian, Spanish (FDSIB user only), French (OEC user only) and German languages				
SPECIFICATION	S5	REQUIRED*	ACTUAL	N checks/Delivery period ° (Theoretical delivery period June 1 st 2008 – September 30 th 2008)
Quality checks	Permanent	yes	Daily check of processing chain efficiency	1 check/day
Product confidence data	n.s.	n.s.	Daily check for UVI to be within 0 – 11	1 check/day
Error bar definition and representation	n.s.	n.s.	n.a.	n.a.
Representation of missing data	Empty columns shown on UVI daily graph evolution to account for missing data UVI value set to -1 for not valid data in archive files	n.s.	empty bar in UVI graph old timetag in UVI map -1 value for archived not valid data	when needed (about 10 records so far)



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Documentation of process failure	Supervision by personnel Permanent recording on log files of service status SMS automatically sent to System Administrator in case of service interruption beyond 30 min (in case automatic re-boot does not resume the system completely). Text advice on web pages for end users	n.s.	Problem Report (internal document) when system failure occurs	when needed (2 failures so far)
Version control mechanisms and representation	Program version updated at each software upgrade Version visible on each web page History maintained internally	n.s.	Version tracking of running SW (internal historical record)	when needed (4 changes so far at global level)

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

° Till 25 June 2008

Table 1.3-6 Quality assessment and control procedures for UV-Index

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1.3.6 Sun Protection Factor

1.3.6.1 Validation against specifications and against user requirements

VALIDATION AGAINST SERVICE SPECIFICATIONS			
No limitations/delays for compliance between theoretical and actual service specifications reported			
VALIDATION AGAINST USER REQUIREMENTS			
SPECIFICATION	S5	REQUIRED*	ACTUAL
Product	Sun Protection Factor (recommended)		
Accuracy	N/A	n.s.	N/A
Accuracy minimum	N/A	n.s.	N/A
Accuracy target	N/A	n.s.	N/A
Spatial coverage	Italy, Balearic Islands, Corsica Island	Italy, Balearic Islands, Corsica Island	P1: Italy, Mallorca Island, Southern Corsica P2: Italy, all Balearic Islands, whole Corsica
Horizontal resolution	N/A	n.s.	N/A
Vertical resolution	N/A	n.s.	N/A
Grid/Projection	N/A	n.s.	N/A
Temporal coverage	From present time up to 4 hours nowcasting (depending on UV index)	From present time up to 15 minutes nowcasting	From present time up to 15 minutes nowcasting (depending on UV index)
Temporal resolution	15 min (depending on UV index)	15 min	15 min (depending on UV index)
Languages	n.s.	Italian; English; Spanish; French	P1: Italian; English P2: Italian, English; Spanish; French; German

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User Interfaces			
PROMOTE Web	Complete, operational and up to date	Complete, operational and up to date	Complete, operational and up to date
Other Webs	web pages	web pages	One web site dedicated to each user
ftp	n.s.	n.a.	n.a.
Data formats and data delivery			
Data availability	Spring/Summer, from 8:00 A.M. to 7:00 P.M. every day	Spring/Summer	Spring/Summer, from 8:00 A.M. to 7:00 P.M. every day
Data access	n.s.	Link in PROMOTE website	Link in PROMOTE website to dedicated websites. Registration required.
Delivery Mode	NRT, nowcasted up to 4 hours ahead (UV-Index dependence)	NRT, nowcasted up to 4 hours ahead (UV-Index dependence)	NRT, nowcasted up to 4 hours ahead
Delivery frequency	15 min. update rate + 3 min. nowcasting in between	15 min update rate + 3 min. nowcasting in between (On demand)	NRT (15 min. update rate + 3 min. nowcasting in between)
Data Format	ASCII	n.s.	ASCII
Historical archive	none	n.s.	none
Visualization	n.s.	n.s.	Text field on web
REMARKS			
None			

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

Table 1.3-7 Validation against specifications and against user requirements of the SPF

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1.3.6.2 Quality assessment and control procedures

Service delivery start date: Phase2 : 1 st June 2008 = all functionalities in English and Italian languages; 20 th June 2008 = all functionalities in English, Italian, Spanish (FDSIB user only), French (OEC user only) and German languages				
SPECIFICATION	S5	REQUIRED*	ACTUAL	N checks/Delivery period ° (Theoretical delivery period: June 1 st 2008 – September 30 th 2008)
Quality checks	Permanent	yes	Daily check of processing chain efficiency	1 check/day
Product confidence data	n.s.	n.s.	Daily check to be within 0 – 60	1 check/day
Error bar definition and representation	n.s.	n.s.	n.a.	n.a.
Representation of missing data		n.s.	n.a.	n.a.
Documentation of process failure		n.s.	Linked to UVI product Problem Report (internal document) when system failure occurs	when needed (2 failures so far)
Version control mechanisms and representation		n.s.	Version tracking of running SW (internal historical record)	when needed (4 changes so far)

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

Table 1.3-8 Quality assessment and control procedures of the SPF product

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1.3.7 Phototype

1.3.7.1 Validation against specifications and against user requirements

VALIDATION AGAINST SERVICE SPECIFICATIONS			
No limitations/delays for compliance between theoretical and actual service specifications reported			
VALIDATION AGAINST USER REQUIREMENTS			
SPECIFICATION	S5	REQUIRED*	ACTUAL
Product	Phototype		
Accuracy	N/A	n.s.	12% (MED)
Accuracy minimum	n.s.	n.s.	20% (MED)
Accuracy target	n.s.	n.s.	10%
Spatial coverage	Italy, Balearic Islands, Corsica Island	Italy, Balearic Islands, Corsica Island	P1: Italy, Mallorca Island, Southern Corsica P2: Italy, all Balearic Islands, whole Corsica
Horizontal resolution	N/A	N/A	N/A
Vertical resolution	N/A	N/A	N/A
Grid/Projection	N/A	N/A	N/A
Temporal coverage	N/A	N/A	N/A
Temporal resolution	N/A	N/A	N/A
Languages	n.s.	Italian; English; Spanish; French	P1: Italian; English P2: Italian, English; Spanish; French; German
User Interfaces			
PROMOTE Web	Complete, operational and up to date	Complete, operational and up to date	Complete, operational and up to date

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Other Webs	web pages	web pages	One web site dedicated to each user
ftp	n.s.	n.a.	n.a.
Data formats and data delivery			
Data availability	Spring/Summer, from 8:00 A.M. to 7:00 P.M. every day	Spring/Summer	Spring/Summer, every day, every hour
Data access	n.s.	Online/SMS. Link in PROMOTE website	Link in PROMOTE website to dedicated websites. Registration required.
Delivery Mode	Online, upon request after questionnaire	Upon request	Online, upon request after questionnaire completion
Delivery frequency	On demand	On demand	On demand
Data Format	ASCII	ASCII	ASCII
Historical archive	n.a.	n.a.	n.a.
Visualization	n.a.	n.a.	Text field on web

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

Table 1.3-9 Validation against specifications and against user requirements of the product Phototype

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1.3.7.2 Quality assessment and control procedures

SPECIFICATION	S5	REQUIRED*	ACTUAL	N checks/Delivery period ° (Theoretical delivery period: June 1 st 2008 – September 30 th 2008)
Quality checks	Permanent	yes	Daily check of on-line questionnaire functionality	1 check/day
Product confidence data	n.s.	n.s.	Daily check to be within 1 - 4	1 check/day
Error bar definition and representation	n.s.	n.s.	n.a.	n.a.
Representation of missing data	Phototype always assigned upon questionnaire completion, except when user is too sensitive to UV (questions 1 and 2 are blocking); user is warned in this case.	n.s.	Registration completed only after questionnaire completion	n.a.
Documentation of process failure	Phototype is determined once only, upon completion of nine-fold on-line questionnaire. If questionnaire fails it must be repeated until success.	n.s.	Problem Report (internal document) when system failure occurs	when needed (0 failures so far)

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Version control mechanisms and representation	Program version updated at each software upgrade Version visible on each web page History maintained internally	n.s.	Version tracking of running SW (internal historical record)	when needed (4 changes so far at global level)
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- Requirements in *Italics* are recommended and not compulsory for Phase 2
- ° Till 25 June 2008

Table 1.3-10 Procedures for the quality assessment and quality control of the product Phototype

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1.3.8 UV-Eye Index

UV-eye is an experimental product, developed together with ISPESL user.

In Phase 2, UV-eye index is delivered via web only, as the involvement of ISPESL user in Phase 2 was initially not planned.

1.3.8.1 Validation against specifications and against user requirements

VALIDATION AGAINST SERVICE SPECIFICATIONS			
No limitations/delays for compliance between theoretical and actual service specifications reported			
VALIDATION AGAINST USER REQUIREMENTS			
SPECIFICATION	S5	REQUIRED*	ACTUAL
Product	UV-Eye Index		
Accuracy	N/A	n.s.	about same as UVI
Accuracy minimum	N/A	n.s.	about same as UVI
Accuracy target	N/A	n.s.	about same as UVI
Spatial coverage	Italy	Italy	Italy
Horizontal resolution	0.00833° x 0.00833° (about 1 km x 1 km in areas of interest)	1 x 1 Km ²	1 x 1 Km ²
Vertical resolution	n.a.	n.a.	n.a.
Grid/Projection	DEM (GTOPO30 version)	n.s.	DEM (GTOPO30 version)
Temporal coverage	From present time up to 15 min. nowcasting	15 min. update, between June and September	15 min. update, between June and September
Temporal resolution	N.A.	N.A.	N.A.
Languages	n.s.	Italian; English	Italian; English
User Interfaces			

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PROMOTE Web	Complete, operational and up to date	Complete, operational and up to date	Complete, operational and up to date
Other Webs	web pages	web pages	dedicated ISPESL user web site
ftp	n.s.	n.a.	n.a.
On demand	SMS	SMS	no
Data formats and data delivery			
Data availability	Spring/Summer, from 8:00 A.M. to 7:00 P.M. every day	Spring/Summer	Spring/Summer, from 8:00 A.M. to 7:00 P.M. every day
Data access	n.s.	Link in PROMOTE website	Link in PROMOTE website to dedicated website. Registration required
Delivery Mode	Online/SMS	Online/SMS	Online
Delivery frequency	NRT (15 min. update rate + 3 min. nowcasting in between)	NRT (15 minutes resolution)	NRT (15 min. update rate + 3 min. nowcasting in between)
Data Format	ASCII + GUI (maps & graphs)	n.s.	ASCII + colours according to custom format
Historical archive	none	n.s.	none
Visualization	ASCII + GUI (maps & graphs)	Graphically georeferenced UV-eye Index	Text field on web. GUI on web (webGIS maps & graphs)
REMARKS			
None			

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

Table 1.3-11 Validation against specifications and against user requirements of the UV-eye Index product

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1.3.8.2 Quality Assessment and Control procedures

Service delivery start date: Phase2: 1 st June 2008 = all functionalities in English and Italian languages				
SPECIFICATION	S5	REQUIRE D*	ACTUAL	N checks/Delivery period ° (Theoretical delivery period: June 1 st 2008 – September 30 th 2008)
Quality checks	Permanent	yes	Daily check of processing chain efficiency	1 check/day
Product confidence data	n.s.	n.s.	Daily check to be within 0 – 12	1 check/day
Error bar definition and representation	n.s.	n.s.	n.a.	n.a.
Representation of missing data	n.s.	n.s.	empty bar in UV-eye graph old timetag in UV-eye map -1 value for archived not valid data	when needed (about 10 records so far)
Documentation of process failure	n.s.	n.s.	Problem Report (internal document) when system failure occurs	when needed (2 failures so far, linked to UVI product)
Version control mechanisms and representation	n.s.	n.s.	Version tracking of running SW (internal historical record)	when needed (4 changes so far at global level)

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

°Until 25 June 2008

Table 1.3-12 Procedures for quality assessment and control of the UV-Eye Index

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1.4 REFERENCES

1.4.1 Electronic references and online data access paths

<http://www.uv-check.de> Service in German language

<http://www.medsun.it/> access page to dedicated websites

1.4.2 Bibliographic references

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