



GSE – PROMOTE 2
C6 Validation Report
UV Information for Greenland

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TASK: -2-



TITLE:

GMES SERVICE ELEMENT
PROMOTE 2
C6 Validation Report
Chapter 5
UV FORECAST FOR GREENLAND
Version 3

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DOCUMENT STATUS SHEET

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CONTRIBUTING AUTHORS	Service leader Service providers	H. Jonch-Sorensen		
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DOCUMENT CHANGE RECORD

Issue	Date	Modified Items / Reason for Change
Version 1		
N/A		
Version 2		
1.01	01/04/2008	Template with draft validation plan created
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1.3	09/07/2008	Second iteration completed
1.5	11/07/2008	Document ready for final review
Version 3		
2.1	14.05.2009	Editorial changes
2.2	13.06.2009	Phase 3 preliminary update
2.3	02.09.2009	Phase 3 final update
3	05.09.2009	Header and chapter number updated

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**FIGURE -1 POSITION OF THE UV FORECAST FOR GREENLAND SERVICE
WITHIN PROMOTE 2 UV SERVICES. 1**

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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

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

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5 UV FORECAST FOR GREENLAND

5.1 Service Summary

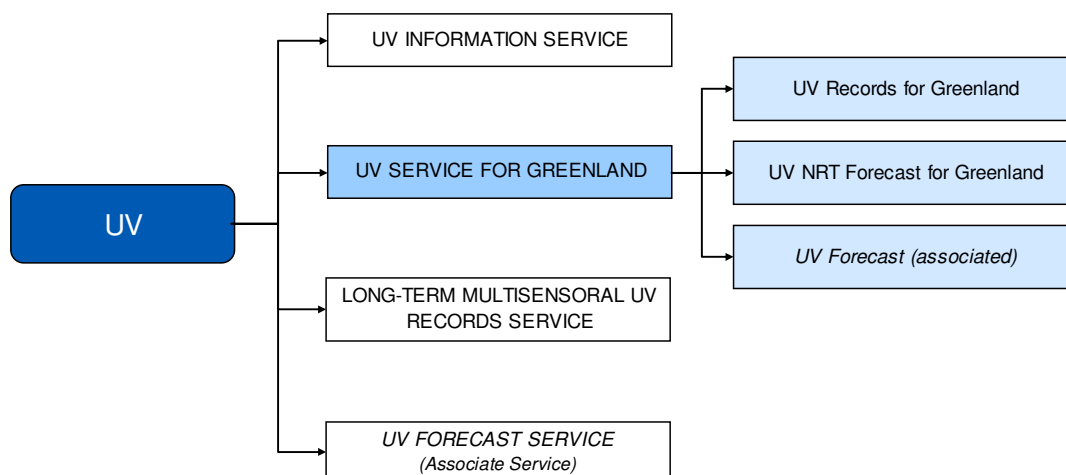


Figure -1 Position of the UV Forecast for Greenland service within PROMOTE 2 UV Services.

The UV service for Greenland delivers forecasts of UV-index for Greenland in the period from March to October. The UV-index is valid for local noon (maximum solar elevation) and clear sky conditions and is thus the maximum UV-index obtainable on a given day. During 2008 an UV index forecast including correction for expected cloud cover will be included in the service.

The service will also provide presentation of time series of UV- and Ozone measurements from six locations in Greenland.

Service is operational since: March 2008

Research partners: ASIAQ

Provider(s): DMI (Denmark)

Validation contact: H. Jonch-Sorensen, hjs@dmı.dk

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5.2 Product Characterization

Sub-service/Product	
Clear Sky UV index	
Parameter [give name]	UV index
Typical range	0 - 9
Determination of the typical range (Method, criteria)	Calculated on the basis of ozone climatology
Maximum range [New!]	0 - 15
&é²	dex
<i>Standards</i>	WMO/WHO
Cloud Cover corrected UV index	
Parameter [give name]	UV index
Typical range	0 - 9
Determination of the typical range (Method, criteria)	Calculated on the basis of ozone climatology
Maximum range [New!]	0 - 15
Units	dex
Spring time UV warning	
Parameter [give name]	UV index
Typical range	0 - 9
Determination of the typical range (Method, criteria)	Calculated on the basis of ozone climatology
Maximum range [New!]	0 - 15
Units	dex
Time series of UV and Ozone	
Parameter: JUV index and Total ozone	
Typical range 0-9 and 200-500	
Determination of the typical range (Method, criteria)experience (?)	

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Maximum range 0-15 and 150-550
Units dex and Dobson Unit
<i>Standards-</i>

Table -1Product characterization

5.3 Validation plan and validation data

The UV index forecast for Greenland shall be validated against available ground based UV measurements. The service provider (DMI) and the sub-contractor (ASIAQ) can at present provide these measurements from 9 locations in Greenland . Furthermore, the NSF data base includes UV measurements from the Summit station.

The first validation will be on the clear sky UV index product. Measurements from the ground based locations under clear sky conditions will be compared to the forecasted UV index and the results will be available on the web page.

Since meteorological observations may not always be available, clear sky measurements can be selected in the 5 minutes average measurements by a procedure developed for this project. The deviation between forecast and measured clear sky UV index will be calculated and presented for all stations in the delivery period, March – October. The quality of the 5 day forecast will be evaluated in the same manner.

During Phase 2 the cloud cover corrected UV index forecast shall be implemented and validated during Phase 3 using measurements from the above mentioned stations.

Finally the input total ozone (SCIAMACHY) used for calculating the UV-index shall be compared with ground based observations available from the two DMI stations in Greenland.

VALIDATION DATA	
Ground based observations	
Name UV-index ASIAQ Phase 2	<p><i>Data availability and:</i> Data are available directly from ASIAQ after a quality assurance procedure, monthly delivery</p> <p><i>Spatial coverage and resolution:</i> Populated areas on the east coast of Greenland.</p> <p><i>Temporal coverage and resolution:</i> In the sun light period from March-October, 5 minutes average measurements.</p> <p><i>Location(s) (coordinates):</i> Narsaq (46W, 57N), Uummannaq (52W, 41N), Qeqertarsuaq (53W, 69N), Nuuk (51W, 64N), Sisimiut (53W, 67N), Paamiut (50W, 62N), Nanortalik (45W,60N)</p> <p><i>Uncertainty quantification (e.g. Accuracy):</i> N/A</p>

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Name UV-index DMI Phase 2	<p><i>Data availability and access:</i> Data are available directly from DMI after a quality assurance procedure, monthly delivery</p> <p><i>Spatial coverage and resolution:</i> Two sites in Greenland</p> <p><i>Temporal coverage and resolution:</i> In the sun light period from March-October, 5 minutes average measurements.</p> <p><i>Location(s) (coordinates):</i> Pittufik (69W, 77N) , Kangerlussuaq (51W, 67N)</p> <p><i>Uncertainty quantification (e.g. Accuracy):</i> N/A</p>
<i>In-situ observations n.a.</i>	
EO Data n.a.	

Table -2 Description of datasets used for validation

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5.4 Validation of individual components

The UV index (clear sky and cloud cover corrected) is validated against the ground based data mentioned in Table 2. For each day the difference between predicted and measured value is calculated and the mean difference (bias) and r.m.s for the whole validation period is calculated.

VALIDATION OF INDIVIDUAL COMPONENTS	
Uncertainty assessment	
Bias	$\Sigma(\text{UV}_{\text{observed}} - \text{UV}_{\text{forecast}}) / N$ and $\Sigma((\text{UV}_{\text{observed}} - \text{UV}_{\text{forecast}}) / \text{UV}_{\text{forecast}}) / N$
RMS	
On-time delivery factor	Number of on-time delivery/Number of days
Input file format	Full grid covering Greenland, correct date and longitude, latitude step size as expected.
Ozone input outliers check	Total ozone values above 600 DU or below 40 DU are not included. If the number of grid points with out of limit or NaN values exceeds 1% of the total number the input file is skipped.
Error estimates	The $\sigma(\text{UV}_{\text{forecast}})$ is calculated for each grid point by propagation of assumed input errors as described in (REF)
Model/algorithms	
Calculation of clear sky UV Index	Total ozone is the only dynamical input parameter. Solar zenith angle and sun-earth distance are calculated. Radiative transfer calculations in look-up tables. Surface albedo and aerosol optical depths found from climatologies. Algorithm described in (REF)
Cloudy sky UV Index correction	As for clear sky UV index with cloud cover forecast input. The procedure to be developed and implemented during 2008.
Consistency	
N/A	

Table -3 Data quality and validation of individual components

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5.5 Validation against specifications and against user requirements

5.5.1 Clear Sky UV Index Forecast

*Requirements in *italics* were not compulsory for Phase 2.

The service start planned for March 1 st 2008 was delayed 7 days.			
VALIDATION AGAINST SERVICE SPECIFICATIONS & USER REQUIREMENTS			
SPECIFICATION	S5	REQUIRED*	ACTUAL
Product	Near real time UV Index (erythema) forecast for clear sky on a 5 day span		
Accuracy			
Uncertainty	0.5 dex	+	0.2 dex
Uncertainty minimum	n.s.	+	
Uncertainty target	n.s.	+	0.5 dex
Spatiotemporal characteristics			
Spatial coverage	58-86 N , 10-75 W	+	+
Geometric resolution	0.25 x 0.25 degrees	<i>Highest available</i>	0.25 x 0.25 degrees
Grid/Projection	Grid	<i>Maximum and optimal resolution</i>	+
Temporal coverage	NRT+5 days	n.s.	NRT+5days
Temporal resolution	24 h	<i>Daily, weekly, monthly (averages)</i>	24h
User Interfaces			
PROMOTE Web	n.s.	Complete, operational and up to date	Operational and up to date.
Other Webs	Yes	n.s.	DMI
On demand	n.s.	n.s.	n.s.
Data formats and data delivery			

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Data availability	Operational implementation based on SCIAMACHY assimilated ozone since March 2008	+	+
Data access	Online	Online	+
Delivery Mode	NRT	NRT	+
Delivery frequency	24 h	Always accessible	24h
Data Format	PNG , ascii, html	+	+
Historical archive	N/A	<i>As long as possible (min 20 years)</i>	Since March 2008
Visualization	html pages	+	+
Remarks			
None			


*Requirements in *italics* were not compulsory for Phase 2.

Table -4 Validation against specifications and against user requirements for UV Clear Sky Index Forecast

5.5.2 Cloud Cover Corrected UV Index Forecast

*Requirements in *italics* were not compulsory for Phase 2.

This service will be implemented during 2008.			
VALIDATION AGAINST USER REQUIREMENTS			
SPECIFICATION	S5	REQUIRED*	ACTUAL
Product	Cloud cover corrected NRT UV Index (erythema) forecast on a 5 day span		
Uncertainty	1.0 dex	N/A	2.8
Uncertainty minimum	n.s.	N/A	N/A
Uncertainty target	n.s.	N/A	1.0 dex
Spatial coverage	58-86 N , 10-75 W	+	+

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Geometric resolution	0.25 x 0.25 degrees	<i>Highest available</i>	0.25 x 0.25 degrees
Grid/Projection	Grid	<i>Maximum and optimal resolution</i>	+
Temporal coverage	NRT+5 days	n.s.	NRT
Temporal resolution	24 h	<i>Daily, weekly, monthly (averages)</i>	24h
User Interfaces			
PROMOTE Web	n.s.	Complete, operational and up to date	+
Other Webs	Yes	n.s.	DMI
On demand	n.s.	n.s.	n.s.
Data formats and data delivery			
Data availability	Operational implementation based on SCIAMACHY assimilated ozone since March 2008	+	+
Data access	Online	Online	+
Delivery Mode	NRT	NRT	+
Delivery frequency	24 h	Always accessible	24h
Data Format	PNG , ascii, html	+	+
Historical archive	N/A	<i>As long as possible (min 20 years)</i>	Since August 2009
Visualization	html pages	+	+
Remarks			
None			

*Requirements in *italics* were not compulsory for Phase 2.

Table -5 Validation against specifications and against user requirements for Cloud Cover Corrected UV Index Forecast

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5.5.3 Time Series of UV Index and Ozone

*Requirements in *italics* were not compulsory for Phase 2.

Service started April 2008 when the first month of data was received.

VALIDATION AGAINST USER REQUIREMENTS			
SPECIFICATION	S5	REQUIRED*	ACTUAL
Product	Time series of UV index and total ozone		
Uncertainty	N/A	N/A	N/A
Uncertainty minimum	N/A	N/A	N/A
Uncertainty target	N/A	N/A	N/A
Spatial coverage	8 locations in Greenland	N/A	9 locations
Geometric resolution	0.25 x 0.25 degrees	<i>Highest available</i>	Six/five locations
Grid/Projection	Grid	<i>Maximum and optimal resolution</i>	Grid
Temporal coverage	n.s.	N/A	March-October
Temporal resolution	Monthly	<i>Daily, weekly, monthly (averages)</i>	Daily
User Interfaces			
PROMOTE Web	n.s.	Complete, operational and up to date	Complete, operational and up to date
Other Webs	n.s.	n.s.	DMI
On demand	n.s.	n.s.	n.s.
Data formats and data delivery			
Data availability	Operational implementation based on SCIAMACHY assimilated ozone since March 2008	+	+

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Data access	Offline	+	+
Delivery Mode	n.s.	Offline	
Delivery frequency	n.s.	N/A	Monthly
Data Format	PNG , ascii, html	+	+
Historical archive	N/A	<i>As long as possible (min 20 years)</i>	From March 2008
Visualization	n.s.	N/A	html pages
Remarks			
None			

*Requirements in *italics* were not compulsory for Phase 2.

Table -6 Validation against specifications and against user requirements for Time series of UV index and total ozone

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5.5.4 Spring time UV warning

*Requirements in *italics* were not compulsory for Phase 2.

VALIDATION AGAINST SERVICE SPECIFICATIONS			
This service has been in operation since April 2008. However no cases of sever ozone depletion occurred during the season,thus no warnings has been issued.			
VALIDATION AGAINST USER REQUIREMENTS			
SPECIFICATION	S5	REQUIRED*	ACTUAL
Product	Warning in case of high UV radiation level absed on UV-index (erythema)		
Uncertainty	10%	+	10%
Uncertainty minimum	N/A	+	N/A
Uncertainty target	N/A	+	N/A
Spatial coverage	58-86 N , 10-75 W	+	58-86 N , 10-75 W
Geometric resolution	0.25 x 0.25 degrees	<i>Highest available</i>	0.25 x 0.25 degrees
Grid/Projection	Grid	<i>Maximum and optimal resolution</i>	Grid
Temporal coverage	March-June	+	March-October
Temporal resolution	24h	<i>Daily, weekly, monthly (averages)</i>	24h
User Interfaces			
PROMOTE Web	n.s.	Complete, operational and up to date	Complete, operational and up to date
Other Webs	n.s.	n.s.	DMI.DK
On demand	n.s.	n.s.	N/A
Data formats and data delivery			

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Data availability	Operational implementation based on SCIAMACHY assimilated ozone since March 2008	+	[indicate actual]Operational implementation based on SCIAMACHY assimilated ozone since March 2008
Data access	Online	+	Online
Delivery Mode	NRT	NRT	NRT
Delivery frequency	24h	+	24h
Data Format	PNG , ascii, html	+	PNG , ascii, html
Historical archive	N/A	ssued warnings will be archived	+
Visualization	html pages	+	html pages
Remarks			
None			

*Requirements in *italics* were not compulsory for Phase 2.

Table -7 Validation against specifications and against user requirements for Spring time warning

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5.6 Quality assessment and control procedures: Service quality

5.6.1 Clear and cloud corrected Sky UV Index Forecast and Spring time UV Warning

Service Quality				
Service delivery start date: N/A				
SPECIFICATION	S5	REQUIRED*	ACTUAL	N checks/Delivery period °
Quality checks	Internal control of ozone input outliers. Deviations are flagged. Two validations per season.	<i>Required</i>	Total ozone values outside the interval [50:600] are not used. Number and location of those grid points are printed to log-file. Validation against ground based data will be performed for the season March - October	daily 1per year
Product confidence interval	n.s.	<i>n.s.</i>	N/A	N/A
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/A	N/A

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Representation of missing data	In case of missing input (assimilated total ozone) the processing is performed using ozone climatology stored locally. Reporter to operator.	<i>Clearly indicated</i>	If the correct input file is not received at the time of processing (04 UT) the processor use the ozone climatology. Tested and occurred once during delivery period,	Daily
Documentation of process failure	e-mail to operator	<i>Clear and complete</i>	Status of process (success/failure) logged and mailed to operator.	Daily
Version control mechanisms and representation	Old versions are still available. Modifications will be shortly documented and introduced to the user	<i>n.s.</i>	Old versions will be available. Modifications will be shortly documented and introduced to the user	No changes yet

*Requirements written in *italics* were not compulsory for Phase 2.

°Between 1st March and 30th of Mayor delivery date (you can send this information separately if this document is delivered at an earlier date.

Table -8 Validation of quality assessment and control procedures for Clear and cloud corrected Sky UV Index Forecast and Spring time UV Warning

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5.6.2 Time series of UV index and ozone

Service Quality				
Service delivery start date:				
SPECIFICATION	S5	REQUIRED*	ACTUAL	N checks/Delivery period °
Quality checks	Internal control of ozone input outliers. Deviations are flagged. Two validation per season.	<i>Required</i>	Total ozone values outside the interval [50:600] are not used. Number and location of those grid points are printed to log-file. Validation against ground based data will be performed for the periods March-July and August-October	Daily
Product confidence interval	n.s.	<i>n.s.</i>	N/A	N/A
Error bar definition and representation	n.s.	<i>Estimation of error limits: min-max range of expected true value in the ground for each individual day/month/year</i>	N/A	N/A
Representation of missing data	Not enabled/monthly manual	<i>Clearly indicated</i>	Missing data points are not represented in the time series plot.	Monthly
Documentation of process failure	Not enabled/monthly manual	<i>Clear and complete</i>	If no data available for time series, an explanatory text will be placed instead.	Monthly

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Version control mechanisms and representation	n.s.	<i>n.s.</i>	N/A	N/A
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*Requirements written in *italics* were not compulsory for Phase 2.

°Between 1st March and 30th of May or delivery date (you can send this information separately if this document is delivered at an earlier date).

Table -9 Validation of quality assessment and control procedures for time series of UV index and Ozone

5.7 References

5.7.1 Electronic references and online data access paths

UV Record archive

http://promote.fmi.fi/promote_fmi.html

<http://promote.dmi.dk/>

<http://ozone2.fmi.fi/uvdb/index.html>

<http://www.woudc.org/>

<http://www.biospherical.com/NSF/default.asp>

<http://nadir.nilu.no/~olaeng/fastrt/README.html>

<http://www.libradtran.org/>

5.7.2 Bibliographic references