Final report for European Database for UV climatology and Evalution, contract EVK2-CT-1999-00028.

Deliverable 1.1.:

Statement of user requirements for data products from the database.

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Objectives

The objectives of this contribution to the EDUCE project was to produce a statement of user requirements for data products from the database (Deliverable 1.1.). Database users could be both internal and external to the project, where the external users could be any user of UV-data not participating in the EDUCE project. The final statement of user requirements should be made available to those within the project responsible for choosing and designing new software tool options to respond to the needs of the user community.

The intention of creating this statement within the first year of the project (June 2000 – May 2001) was to enable implementation of necessary software tool options within the time of the project. Furthermore, it has been important to evaluate the specific needs for tools and products that each EDUCE participant has had for fulfilling their tasks or that could just simplify their work.

An important aim has also been to reach as many users as possible external to the project, so as to publicise the existence of the database and to obtain a broad account of user requirements. The user contact could then possibly also initiate future projects and collaborations involving ground based UV-measurements.

Results of task

Introduction

Detection of the depletion of ozone, and resulting increase in UV Radiation (UVR) reaching the ground, initiated a great deal of international research activity. Activities include a better quantification of the global distribution of ozone, monitoring and understanding loss processes, and to devise numerical models capable of predicting future changes in stratospheric ozone and its distribution. Important activities related to UVR research include measurements and predictions of changes in potential harmful UVR at the Earth's surface and examining the effects of such changes on the environment, including living and dead organisms.

The overall goal of EDUCE is to establish a UV climatology for Europe and investigate potential long-term changes in the UVR environment in the European region. The participants

Two recent reports (1, 2) charts important research within these fields, from the changing distribution of atmospheric ozone, to changes in the UV and UV-B radiation in particular, and consequent effects on photochemistry and biological systems in the aquatic and terrestrial environments, including effects on human health and effects on materials. Contributors to these reports are among those contacted as potential external users of EDUCE.

This user statement is divided into two parts, in which the first concerns requirements submitted by internal users (i.e., EDUCE participants) and the second requirements submitted by external users. The results in both parts are structured in much the same way, described in the method that also describes how the users are selected and how they are contacted. The questionnaire forms and listing of all the different requirements can be found in appendices, whereas the main part summarises the most important findings.

Method

Database users are divided into internal users (i.e., EDUCE participants, Contractors and Subcontractors) and external users (i.e., any user of UV-data not participating in the EDUCE project). Both internal and external users were mostly contacted using questionnaires sent by email, and that are attached in appendices (Appendix 5 for internal users and 6 and 7 for external users). These will be described later.

Both contractors and subcontractors within EDUCE were contacted to provide their requirements, even though subcontractors only have tasks related to data submission and therefore do not directly need data or data products to perform their EDUCE task. They may hopefully still provide valuable input and comments based on their experience and possibly other UV-related projects. All together, the questionnaire was sent to 40 participants, of whom 27 contractors and 13 subcontractors. The received answers represented either only the person who responded or a whole or part of a group/Institute. Some participants and Institutes have tasks belonging to several workpackages, and the answers may therefore possibly be representative for several tasks. In total, the received answers represent 29 of all recipients (72.5% of the total requests sent), of whom 23 (85.2%) contractors and 6 (46.2%) subcontractors. Eight individuals answered that they had no requirements at all. With respect to the different groups (contractors and subcontractors), answers were received from 15 groups (68%), of which 10 contractors (77%) and 5 subcontractors (56%). A more detailed

Clear definitions of auxiliary and ancillary data were made by the EDUCE administrators during the work with the first annual report. They were not known at the time of this survey and therefore not used in the questionnaire sent to the participants. It is however adopted when writing this report for consistency with the other EDUCE reports. Questions about auxiliary and ancillary data are still included, and a few examples were given. These examples are marked with an * in Appendix 1, since they may have influenced the given answers.

The same coarse classification as in the questionnaire is used to summarise the received requirements (Appendix 5), i.e., according to the five categories given below. The requirements listed in the appendix are described in much the same way as given in the original answer to avoid paraphrasing or change of meaning.

a. Data product requirements (Output from database).
b. Search tool requirements (Access to data and database).
c. Data requirements (Input to database, including spectral, auxiliary and ancillary data and information).
d. Other requirements or comments.
e. No requirements.

Whom to include as external users were not defined prior to this survey. A small literature search revealed two recent reports (1, 2) which charted important topics where UVR is an important factor. Contributors to these reports are among those contacted as potential external users of EDUCE data. Others were contacted based on publications or contributions to relevant UV-meetings. Eleven potential users were contacted due to recommendations by EDUCE participants, and quite many due to recommendations by other external users. All together, more than 150 potential external users were contacted, mainly by a questionnaire sent by email (Appendix 6). Requirements from 2 users were achieved via the phone and from another 2 via personal contact.

The first email contained short information about the project, and a question about whether the recipient was interested in providing feedback and a summary of their field of interest. Every email was sent individually with the reason why the recipient was contacted and

with effects of UV radiation (UVR) on aquatic (18%) and terrestrial (16%) ecosystems, as well as with effects on human health (34%), especially users working within public information (15%). Many users were involved with UV monitoring as main or secondary field of interest (19%). Answers were also received from users working with effects on animals (1.5%), atmospheric processes (9%) and materials (3%).

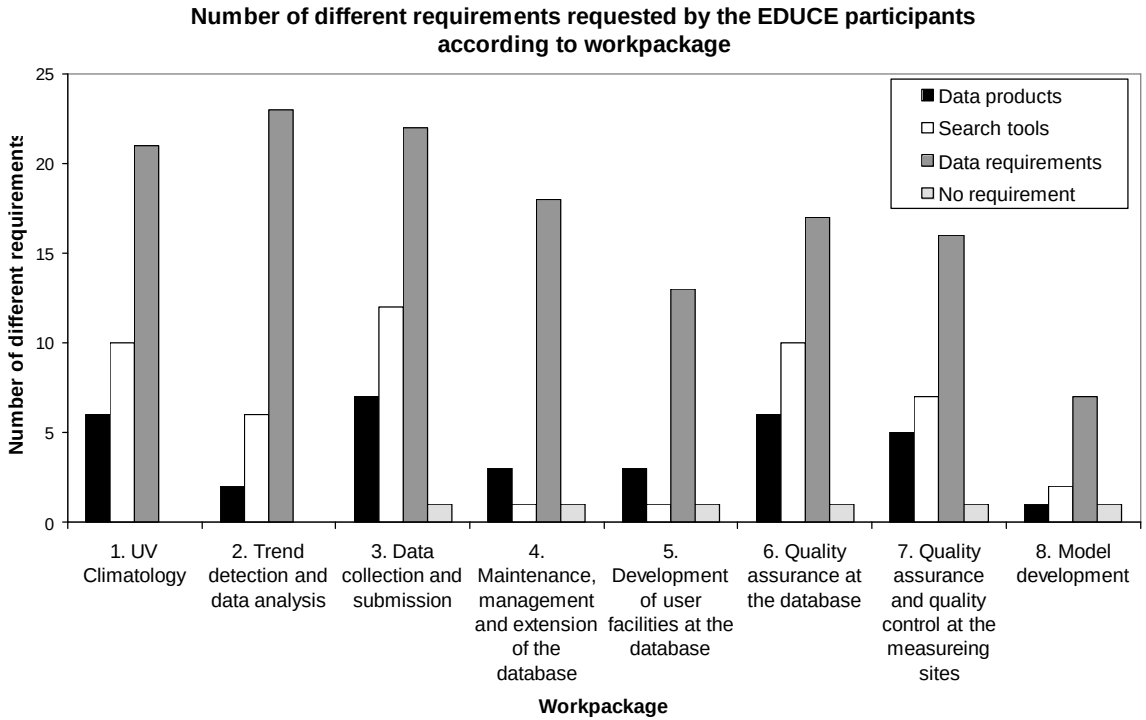
Similarly to the questionnaire sent to the internal users, examples followed the questions in the second email to the external users. These examples are marked with an * in Appendix 2. When the external users were asked for their specific requirements for data or data format, one example was given as "Spectral, broadband, ancillary data". It was, however, not given any definition of what was meant with ancillary data, and it may therefore have resulted in few or no requirements regarding ancillary data in general. The last question about requirements for instruments, stations or other, should, however, partly cover ancillary and auxiliary data.

The EDUCE project with emphasis on user requirements was also presented at two meetings, at the annual meeting for The Norwegian Society for Photobiology and Photomedicine (NOFFOF) held in Oslo 16 February 2001 (3) and at the annual meeting for the Nordic Ozone Group (NOG) held in Trondheim 20-21 April 2001 (4). Letters with information and questions about requirements were handed out to interested participants. This letter was also published as a short article in the Newsletter of European Society of Photobiology (5). None of these approaches resulted in many requirements to the database. Nevertheless, many users were informed about the existence of the database and possibility of using it in future projects.

The same classification as for the internal users is applied to summarise the received requirements (Appendix 2). Only a) to d) is used since the response 'No requirements' to the first email resulted in no further communication with the user.

The received requirements are listed in Appendix 1 and 2 for, respectively, the internal and external users, and each followed by reference numbers. These are included for internal purposes, namely to identify the user if more information is needed to implement the required product or clarify the requested search tool or type of data. The first numbers for the internal users refer to the workpackage that the user is involved in, or workpackages if the user has answered on behalf of a whole or part of a group. The 8 different workpackages are listed in Appendix 1. The second numbers refer to what group or Institute the user belongs to, as given

participant answering the questionnaire may represent several users from the same Institute and thereby several workpackages. Furthermore, some users have not only provided requirements needed to perform their tasks, but also requirements that they would like to find on the web pages in general. The different requirements may therefore not be strictly needed to perform the tasks within the various workpackages, as was the original intention. Even though references to the different workpackages may then be partly misleading, they may give some indications to which workpackages that need the different requirements. Furthermore, the references can identify the user if more information is needed to implement the requirements. Figure 1 gives the number of different requirements requested by the internal users according to the workpackages they or the Institutes are involved in. Most noteworthy is the high number of requested data requirements (totally 97 requirements), and that they are requested by users within all workpackages. Requirements for search tools (totally 28 requirements) are not that evenly distributed among the workpackages. The totally 18 requested requirements for data products are more or less evenly distributed.



Various requirements for search tools are requested by 6 different groups (5 contractors). Most needed are search possibilities with a selection of single values or a limited range of solar zenith angles, selection of specific dates and stations, selection of stations that also measures pyranometer and/or broadband data, and a selection based on the ozone concentration. Some of these search possibilities were presented to all participants some weeks before the user survey, as a prototype interface page for search and retrieval of data from the database (specified in Appendix 1b). Two participants answered that the possibilities given in this prototype were sufficient to perform their tasks. Other requirements, requested by single participants, include search on wavelengths or wavelength range, clarity index or cloud level, and stations providing cosine corrected spectra, CIE-weighted daily doses and all stations providing data for a given period. In addition, some users provided useful comments and suggestions regarding data search and retrieval procedures (Appendix 1d), such as possibilities to check search results before transferring to home site, and possibly make further sub selections from the result of one selection. Regarding data retrieval there was some concern about how to handle output data from the database, in particular when large amount of data was chosen.

Most participants responding to this user survey have some data requirements, either for spectral, broadband, or ancillary and auxiliary data. Most needed are spectral UV-data, but also broadband and pyranometer data. In addition to information about the measurement stations (position), there are quite many requirements regarding auxiliary data, such as measurements or information about cloudiness and visibility, ozone content, albedo and information about the topography. One user also needed information about the aerosol concentration, whereas one user only specify that general information about the conditions during measurements were required. Regarding ancillary data, most users need information about wavelength shifts, cosine corrections, about the slit function, and some also about the wavelength range and sampling frequency for each instrument. Only single users request more detailed information about the instruments.

Eight internal users, from different groups and representing 6 different workpackages, responded to the survey by specifically answering that they had no requirements at all.

The user evaluation was supposed to emphasise output products from the database, but the internal users required rather few products. This may not be surprising, since more or less only

alternative, but would have been much more time consuming. One can also ask whether or not questions about data and data search and retrieval should have been left out of the questionnaire, and thereby focused on data product requirements. Such an approach would at least have given a different distribution of answers. However, the same users would still need data products and it would probably not have resulted in more requirements for data products. Nevertheless, the chosen approach has resulted in valuable input to those working with the necessary software tools for data search and retrieval. Another reason for few data product requirements may be that many users had not started working with their tasks and therefore may not have seen any specific requirements at the time of answering the questionnaire. The internal users know, however, their own tasks quite well and therefore also what is, or will be needed. The provided requirements should therefore be fairly representative for what is needed to fulfil the different EDUCE tasks.

B. User requirements, external users

A detailed list of the provided requirements from external users can be found in Appendix 2 with reference to each user (Appendix 8, Confidential). Table 1 in the appendix gives the distribution of the 50 users according to, respectively, country and field of interest. Best response was received from users working with effects of UVR on Aquatic and Terrestrial Ecosystems and on Human health. Quite many of the users were also involved with UV monitoring in addition to effect-studies.

Most external users welcome a database with high quality ground based UV measurements, regardless of output products being available or not. Given the possibility of already processed data, however, many different requirements for data products were specified. It is noteworthy that the external users request many more data output products than the internal users do. Figure 2, 3 and 4 show, respectively, the output products, the search tools and the type of data most needed by the external users.

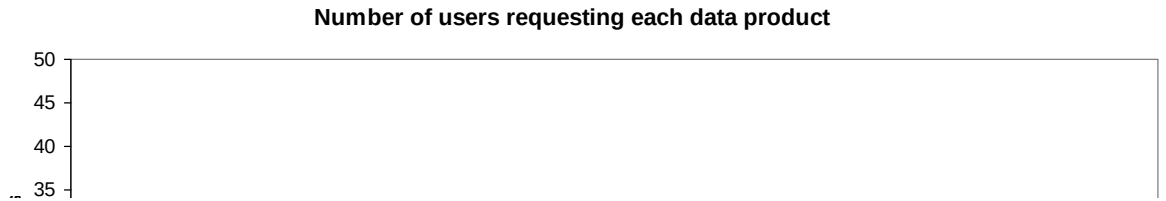


Figure 2. The number of external users requesting various data products. Only products needed by more than 15% of the users are included in the figure.

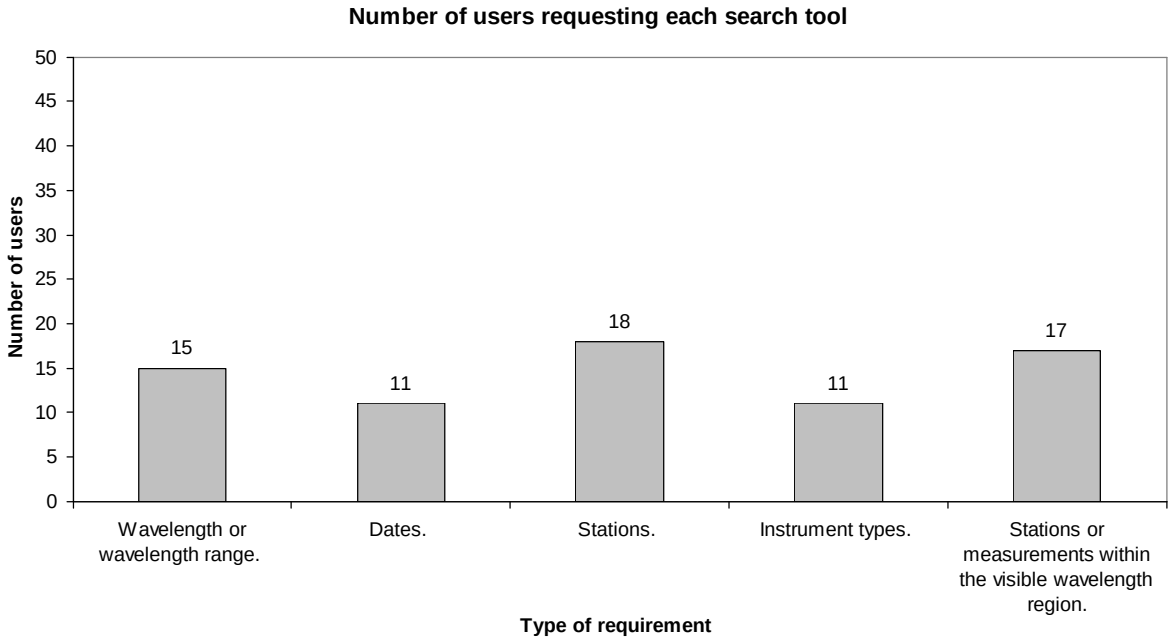


Figure 3. The number of external users requesting various search tools. Only requirements needed by more than 15% of the users are included in the figure.

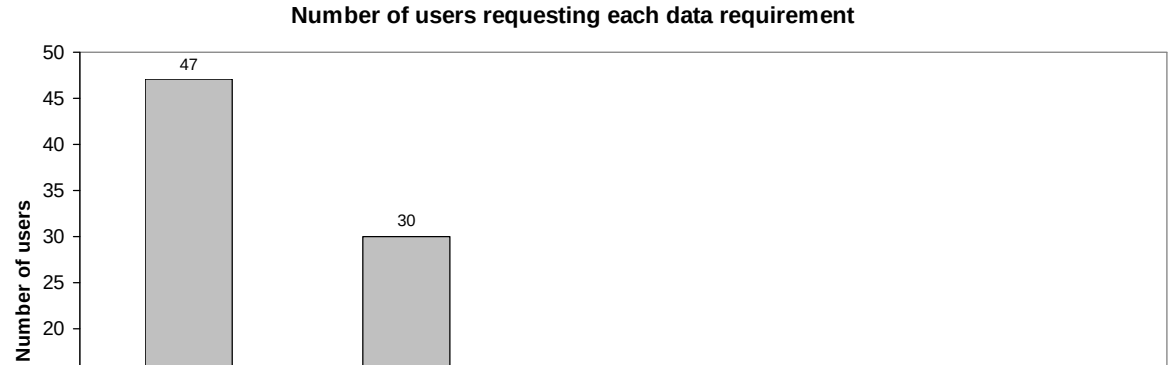


Figure 2 shows the output products most needed by the external users. Only requirements requested by more than 15% of all the external users are included in the figure. Most external users request the daily UV-doses (29 users), in which the daily total dose was most requested (83%), followed by the daily UVB- and UVA- (both 52%) and daily CIE-weighted doses (41%) (Figure 5). The monthly (17 users) and yearly (9 users) UV-doses were also requested by many users, as well as the maximum UV-irradiance (13 users) and UV-index (11 users) each day, and the UV-index throughout the day (9 users). Similarly to the daily UV-dose, the total monthly and yearly UV-doses were most needed followed by the corresponding CIE-weighted doses (Figure 6 and 7). The requirements needed most, besides the daily UV-dose, were different weighting spectra (28 users), in particular by users working with effects of UVR ("The effect-community"). By far the most demanded spectrum is the CIE-weighting spectrum (6) (68%), followed by the generalised plant action spectrum (7) (39%) and the DNA-damage spectrum (8) (32%) (Figure 8). Just having the different weighting spectra available would satisfy most users, although CIE-weighted doses and calculated UV-index throughout the day are requested as output products.

An important finding is that many users within "the effect-community" require interpolated or estimated UVR-data as output products (21 users), since they need to know the UVR-level at the site of their experiment. Furthermore, the resolution is of less importance to most of these users, and simply available algorithms for estimating the UVR-level may be sufficient for some of them. Because of this, measurements with broadband or multi-channel instruments are said to be sufficient. In fact, some users prefer broadband or multi-channel data, since these instruments are more robust and require less maintenance and therefore have fewer interrupted measurements. These instruments may therefore provide long time series of UV-data, also needed by many external users. The sites where users are interested in estimated UV-data are included in the list of requirements (Appendix 2), in case such estimates will be calculated within EDUCE and it will be necessary to reach the specific user needing the data.

Surprisingly due to the international emphasis on ozone depletion the last years, but only 5 users request calculated ozone values and 7 users need forecasted UV-data in some form (Appendix 2a).

Number of users requesting different types of daily UV-dose
(Totally 29 users requesting daily UV-dose)

Figure 5. Distribution of the totally 29 users requesting daily UV-dose. Some users would like more than one type of UV-dose available, and the number of users requesting each type therefore adds up to more than 29.

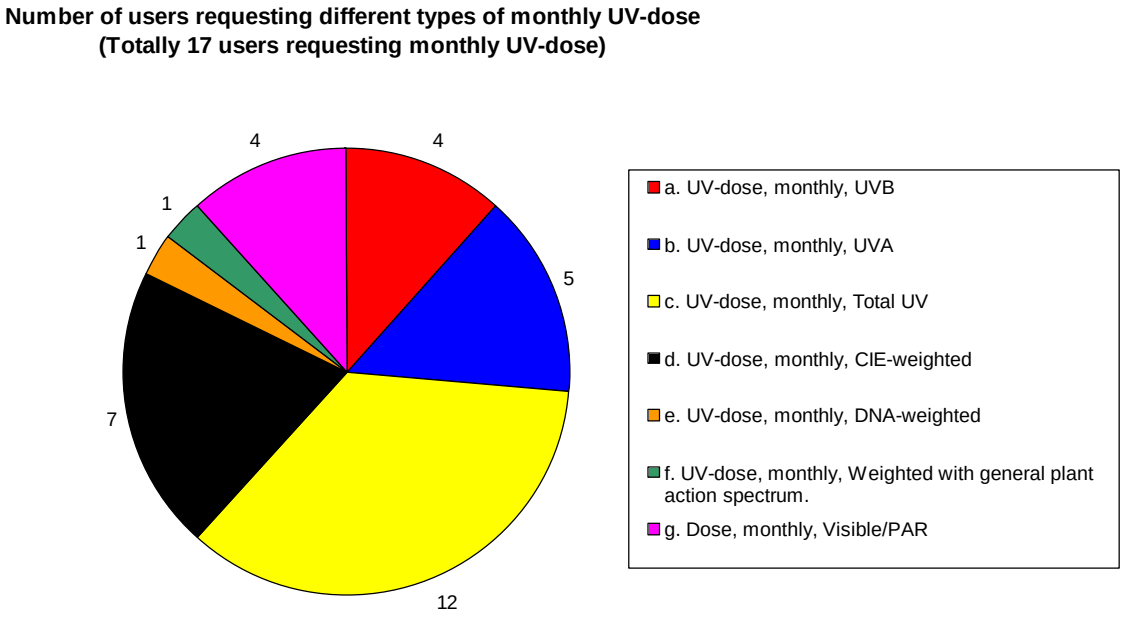


Figure 6. Distribution of the totally 17 users requesting monthly UV-dose. Some users would like more than one type of UV-dose available, and the number of users requesting each type therefore adds up to more than 17.

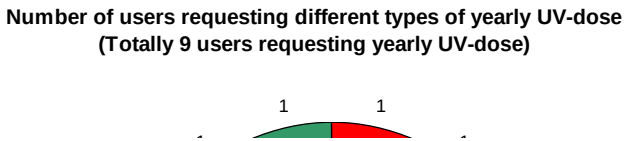


Figure 7. Distribution of the totally 9 users requesting yearly UV-dose. Some users would like more than one type of UV-dose available, and the number of users requesting each type therefore adds up to more than 9.

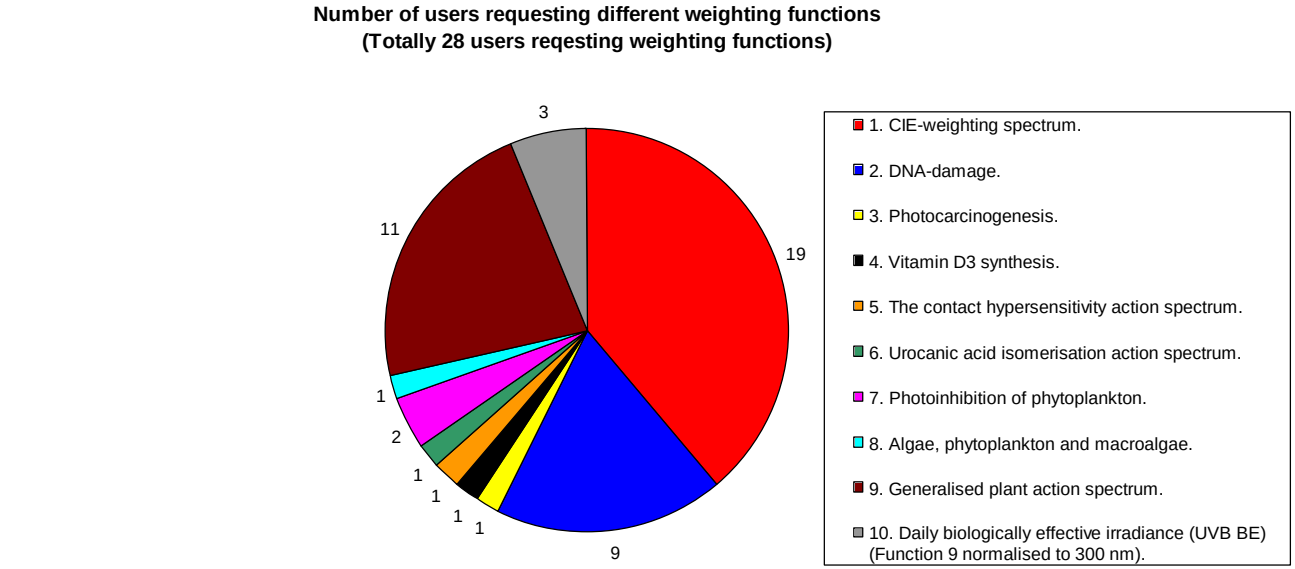


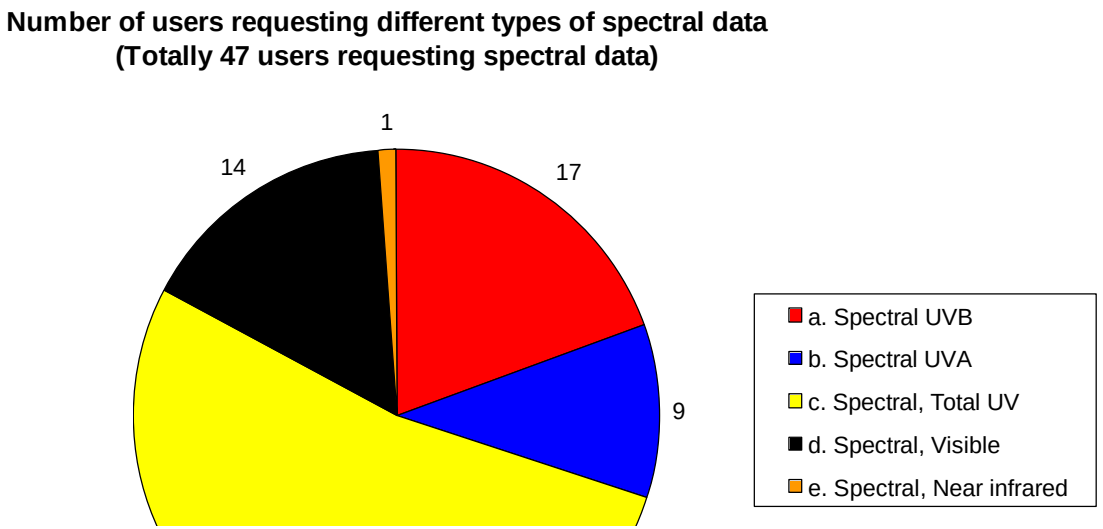
Figure 8. Distribution of the totally 28 users requesting different weighting spectra. Some users would like more than one type of weighting functions available, and the number of users requesting each type therefore adds up to more than 28.

The most needed requirements for search tools are presented in figure 3. Apparently, the first four requirements in the figure are requested by many users, but one should bear in mind that all these were given as examples in the questionnaire (Appendix 7) and might therefore have influenced the answers. The last requirement, however, might be more remarkable. EDUCE cannot provide data from many stations within the visible wavelength range. The search tool is therefore suggested by the author of this report as a solution to user's requests for all types of

It is also a high number of users (30 users) requesting broadband data, mainly within UVB (90%) and UVA (80%), but also within the visible wavelength range (47%) (Figure 10). As mentioned when discussing output products, many external users do not need very high-resolution data. They may therefore be satisfied with broadband data, and certainly if data is then available for the site of their experiments and possibly for much longer time periods than the situation might be for high-resolution spectral data.

Some users require auxiliary data in addition to UV-data, in particular information on cloud cover, ozone level, albedo and topography. Also ancillary data is required by some external users, in particular those working with UV monitoring. In percent, however, such data is not as important as for the internal users.

Besides providing specific requirements for the database content, several users provided comments and suggestions for the database project (Appendix 2d). Some external users have asked for the possibility to calibrate their own spectral or broadband instruments against EDUCE instruments, whereas others would like to use the same calibration procedures as used for the EDUCE monitoring stations. A few users have also asked to get in contact with other scientists and groups within EDUCE working with specific problems or projects.



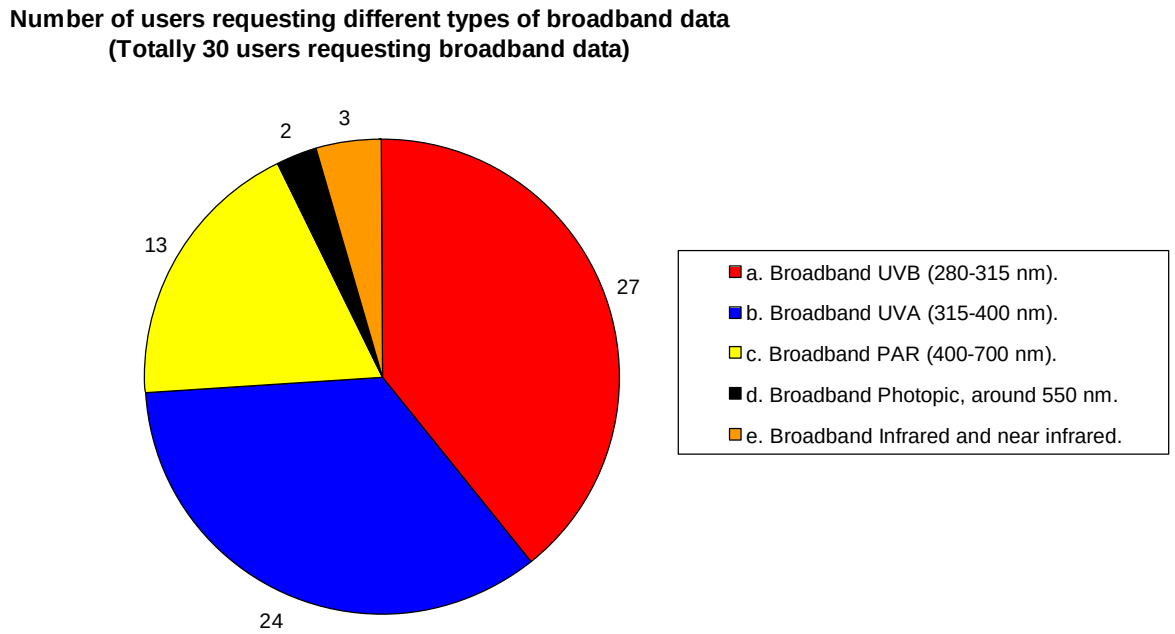


Figure 10. Distribution of the totally 30 users requesting broadband data. Some users would like more than one type of broadband data, and the number of users requesting each type therefore adds up to more than 30.

Similarly to contacting the internal users, the external users were contacted via emails. This approach was chosen to reach as many users as possible, and with the same information and same questions. However, out of the total 150 emails sent, just more than 50 persons or representatives for research groups responded to both enquiries (Appendix 6 and 7) and thus provided detailed requirements for the database. It seems that it has been difficult to motivate external users to provide user requirements if they didn't see an immediate use of UV-data from the database. As for the internal users, the provided answers were most often given in response to the questions asked, and few users provided further comments. However, much information could be drawn out from the users' description of their field of interest and UV

strengthen the database both for the EDUCE project and for the users themselves. Their measurements can thus be directly comparable to a large extent of European measurements. External users have also expressed interest in collaborating with groups within EDUCE in future projects, and hopefully this can solve challenging problems with experts from both the monitoring and the effect communities. All together, through all emails, personal contacts, the presentations and publication in the ESP Newsletter, the existence of the database is disseminated to many potential new users.

Summary

A statement of user requirements for output products from the database is produced, due to provided requirements from most internal users (i.e., the EDUCE participants) and from just more than 50 external users. In total, more than 150 individuals or groups working with UV-data or effects of UV radiation have been contacted directly. In addition, the project with emphasis on user requirements has been presented at two Norwegian and Nordic UV-meetings and publicised in an ESP Newsletter. Thus the existence of the database is publicised to and possibly recruited new users of European UV data.

A detailed report on the provided requirements is made available at the EDUCE web pages and is handed over to those responsible for implementing the various requirements and improving the database facilities.

The internal users provided only a few requirements for output products from the database, including UV and CIE-weighted dose calculations and daily maximum irradiance. Most internal users were more concerned about auxiliary and ancillary data and how to access and retrieve data easily. Most external users providing requirements work with effects of UV, i.e., from "the effect-community". The UV-database was very welcome, regardless of available output products or not. However, several requirements were provided, such as the daily UV and CIE-weighted doses, and maximum UV-irradiance and UV-index each day. The CIE-weighting spectrum and generalised plant action spectrum should be available at the web pages. Different from the requirements from internal users were the need for estimated UV-data at the sites of the different experimental sites, and wishes for measurements in the visible wavelength range in addition to the UV-range. The importance of long time series with UV-

References

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Appendix 1. Internal EDUCE requirements

The requirements are divided according to:

a. Data product requirements (Output from database).
b. Search tool requirements (Access to data and database).
c. Data requirements (Input to database, including spectral, auxiliary and ancillary data and information).
d. Other requirements or comments.
e. No requirements.

Reference is made for each requirement according to the Workpackage (1..8) and Institute that the participant work at (Appendix 3). The reference numbers should identify the user if more information is needed when implementing the required product and is mostly for internal use.

Workpackage number (WP no.), with Partners/Subcontractors indicated in parenthesis:

1. UV Climatology (NTNU, FMI, LAP, RIVM, UG).
2. Trend detection and data analysis (UH, FMI).
3. Data collection and submission (BOKU, UG, and all partners and subcontractors submitting data).
4. Maintenance, management and extension of the database (FMI, BAS, UG, UMIST).
5. Development of user facilities at the database (BAS, FMI, NPI, UG).
6. Quality assurance at the database (LAP, RIVM, BAS, NPI).
7. Quality assurance and quality control at the measuring sites (RIVM, UG, UI).
8. Model development (UJF, NILU, NPI).

All requirements marked with an * were given as examples in the questionnaire (Appendix 5).

The different number of and type of requirements requested by the EDUCE participants are distributed according to Institutes as in table 1.

Table 1. Different numbers and types of different requirements requested by the EDUCE participants according to Institute (Contractors and subcontractors).

Institute	Data products	Search tools	Data	No requirement	Total
1. UH	2	6	22		**30**
2. NTNU					**0**
3. UG	3	1	11		**15**
4. FMI	1		9	1	**11**
5. BAS					**0**
6. LAP	3	7	15		**25**
7. RIVM	3	6	9		**18**
8. NILU			5		**5**
9. UMIST			14		**14**
10. BOKU					**0**
11. NPI				1	**1**
12. UI				1	**1**
13. UJF	1	2	2		**5**
i. IASB					**0**
ii. ENEA				1	**1**
iii. DWD					**0**
iv. BfS					**0**
v. JRC				1	**1**
vi. URO	5	6	10	1	**22**
vii. MI				1	**1**
viii. KNMI					**0**
ix. USTL				1	**1**
Total	**18**	**28**	**97**	**8**	**151**

a) Data product requirements

Type of requirement	**WP no.**	***Contr. / Subcontr. no.***	***Number of Insitutes***

b) Search tool requirements

Search tool requirements include all requests regarding how to access and possibly transfer data from the database.

Type of requirement	**WP no.**	***Contr. / Subcontr. no.***	***Number of Insitutes***
Easy accessible data and easy to understand use of database.	1, 3, 6, 7	7	1
Search possibilities as presented in prototype to participants. [*1)]	2, 3, 4, 5, 7	1, 3	2
Search on wavelength or wavelength range.	1, 6	6	1
Search on dates.	1, 2, 3, 6, 7	1, 6, 7	3
Search on solar zenith angles (range and single values).	1, 2, 3, 6, 8	1, 6, 13, vi	4
Search on stations.	1, 3, 6, 7	6, 7, vi	3
Search on latitude.	3	vi	1
Search on longitude.	3	vi	1
Search on ozone concentration.	1, 2, 3, 6	1, 6, vi	3
Search on clarity index or cloud level.	3, 8	13, vi	2
Search on stations presenting CIE-weighted daily doses.	1, 6	6	1
Search on stations with pyranometer data.	1, 2, 3, 6, 7	1, 6, 7	3
Search on stations with broadband data.	2	1	1
Search on stations with measurements available for given period.	1, 3, 6, 7	7	1
Search on stations with cosine corrected spectra.	1, 3, 6, 7	7	1

[*1)] Search possibilities presented to all participants include the following:

i. Selection of:
   a. Station.

f. Broadband quantity.
g. Ancillary data.

c) Data requirements

Data requirements include all requests regarding input to the database, spectral, auxiliary or ancillary data and information.

Type of requirement	**WP no.**	***Contr. / Subcontr. no.***	***Number of Insitutes***
Spectral UV data. *	1, 2, 3, 5, 6, 7, 8	1, 3, 4, 6, 7, 13, vi	7
Broadband UV data. *	1, 3, 4, 5, 6, 7	3, 6, vi	3
Pyranometer data.	1, 2, 3, 6, 7	1, 6, 7	3
Long time series of UV-data.	2	1	1
All METADAMA information.	4	9	1
Any ancillary data available. *	1, 2, 3, 4, 5, 7	1, 3, 4, 9	4
Information on solar zenith angle.	2	1	1
Information on latitude.	1, 2, 3, 4, 5, 6, 7, 8	1, 3, 6, 8, 9	5
Information on longitude.	1, 2, 3, 4, 5, 6, 7, 8	1, 3, 6, 8, 9	5
Information on altitude.	1, 2, 3, 4, 5, 6, 7, 8	1, 3, 6, 8, 9	5
General information on the conditions during measurements.	1, 2	4	1
Measurements of/information on cloudiness.	1, 2, 6, 8	1, 4, 6, 13	4
Measurements of visibility.	2	1	1
Measurements of ozone content. (Or link to such data or nearest station)	1, 2, 3, 4, 5, 6, 7	1, 3, 4, 6, 7	5
Measurements of aerosol content.	2	1	1
Information on/measurements of albedo.	1, 2, 3, 4	1, 4, 9, vi	4
Information on topography; altitude and slope information.	1, 2, 3, 8	1, 4, 8, vi	4
Information on horizon.	4	9	1
Information on type of instrument	2	1	1

		vi	
Information on cosine error.	1, 6	6	1
Information on angular response.	1, 3, 4, 5, 6, 7	6, 7	2
Information on scanning parameters.	1, 3, 6, 7	7	1
Information on slit function. *	1, 2, 3, 4, 5, 6, 7, 8	1, 4, 6, 7, 8, 9	6
Information on FWHM.	3, 4, 5, 7	3	1
Information on stray light.	3	vi	1
The number of available spectra per day for chosen period.	1, 3, 6, 7	7	1
Information on what data products that are available.	3, 4, 5, 7	3, 9	2

d) Other requirements or comments

Comments or suggestions given from some Contractors did not fit into the other headings a) to c), and are given here.

From Contractor 7, the following comments/suggestions are given:

1. Possibility to search without transferring data to home site/computer.
2. Search procedures should produce:
   a. Overviews of number of spectral data available for each day in a selected time-period for one or more sites.
   b. A list of dates, times and/or SZA of the measurements to enable further choices for one or more sites.
   c. Overview of amount of data selected.
1. There should be an easy way of handling output data from the database. For instance if one retrieves data from several sites and 2 years of measurements, linked with pyranometer data, there should be some handling of the output into traceable files, with an evident filename convention.

From Contractor 3, the following comments/suggestions are given:

1. Description of how to use database tools is required.
2. Description of how to access the database.

Appendix 2. External EDUCE requirements

The requirements are divided according to:

a) Data product requirements (Output from database).
b) Search tool requirements (Access to data and database).
c) Data requirements (Input to database, including spectral, auxiliary and ancillary data and information).
d) Other requirements or comments.

Access to spectral data is sufficient for most users, since they can perform further processing or calculations themselves. The users do, however, mention several requirements, as specified below.

Reference is made for each requirement according to a numbered list with all the external users responding to the questionnaire (Appendix 8, Confidential). The reference numbers should identify the user if more information is needed when implementing the required product and is therefore only for internal use. The number of users requesting each requirement is also given, and with the percentage according to the total number of users (50) providing some requirements. The percentage is only given when it is higher than 15%.

All requirements marked with an * were given as examples in the questionnaire (Appendix 8).

The 50 answers received with specific user requirements, are distributed according to field of interest and according to country as described in the table below. Some users are involved in projects within several fields, and the total number is therefore higher than 50.

Table 1. Number of users providing requirement, distributed according to field of interest and country.

Country	Aquatic Ecosystems	Terrestrial Ecosystems	Human Health	Animals	Atmospheric Processes	Materials	UV Monitoring	Number of users from each country
Czeck Rebublic			1		1		1	**1**
Finland	2	5	1		1		1	**9**

Total	**12**	**11**	**23**	**1**	**6**	**2**	**13**	**50**

a) Data product requirements

A total number of 44 users provided some data product requirements.

Type of requirement	**Reference numbers**	***Total no. of requests***
UV-dose, hourly		**4 (8%)**
a. UVB	3	1
b. UVA	3	1
c. Total UV	3, 32, 39	3
d. CIE-weighted	32, 39, 43	3
e. Visible/PAR	3	1
f. Total solar radiation	39	1
UV-dose, daily*		**29 (58%)**
a. UVB	1, 3, 4, 8, 10, 11, 12, 23, 25, 26, 28, 34, 42, 49, 50	15 (30%)
b. UVA	1, 3, 4, 8, 12, 23, 26, 27, 28, 29, 30, 34, 42, 43, 49	15 (30%)
c. Total UV	1-4, 6, 7, 12, 15, 18, 20, 21, 23, 25-27, 29, 30, 32, 34, 38, 42, 43, 48, 49	24 (48%)
d. CIE-weighted	3, 15, 23, 27-30, 32, 34, 40, 43, 50	12 (24%)
e. DNA-weighted	3, 15, 23, 28	4
f. MED	18	1
g. Weighted with general plant action spectrum.	15*, 48	2
h. Visible/PAR	1, 3, 4, 8, 23, 26, 43, 48	8 (16%)
UV-dose, weekly		**7**
a. UVA	43	1
b. Total UV	21, 32, 43	3
c. CIE-weighted	27, 29, 30, 32, 43	5
d. Visible/PAR	8, 43	2
UV-dose, monthly*		**17 (34)%)**
a. UVB	8, 23, 26, 27	4

d. CIE-weighted e. DNA-weighted f. MED	23, 32 23 18	2 1 1
Integrated UV: a. UVB b. UVA c. Total UV d. Visible/PAR e. Near infrared	 3, 4, 23, 28, 32, 42 3, 4, 23, 28, 32, 42 3, 4, 23, 32, 42, 48 3, 4, 23 4	**7** 6 6 6 3 1
Maximum UV-irradiance during the day* (Maximum peak irradiance over a 1-hour period around local noon).	2, 8, 22, 23, 26-30, 32-34, 38	13 (26%)
Minimum UV-irradiance during the day*	2, 26	2
Maximum UVB- and PAR-irradiance during the day.	15	1
Calculated cloud free daily and monthly UV-doses.	38	1
Calculated cloud free maximum UV-irradiance during each day.	22, 38	2
Weighted spectra with choice from list of weighting function.	6, 10, 11, 21, 50	5
Weighting functions: *		**28 (56%)**
1. CIE-weighting spectrum (McKinlay and Diffey, 1987).	3, 6, 7, 15, 18, 21, 23, 27-30, 32-34, 39, 40, 43, 47, 50	19 (38%)
2. DNA-damage (Setlow, 1974).	3, 6, 7, 13, 15, 21, 23, 28, 32	9 (18%)
3. Photocarcinogenesis (DeGruijl et al., 1993 and 1994).	6	1
4. Vitamin D_3 synthesis (Piazena and Meffert, 1994).	6	1
5. The contact hypersensitivity action spectrum (De Fabo et al., 1983).	21	1
6. Urocanic acid isomerisation action spectrum (De Fabo et al., 1990).	21	1
7. Photoinhibition of phytoplankton	5, 6	2

b. Norway, area around 61°2'N, 8°6'E, and 62°3'N, 11°2'E, and 63°4'N, 9°3'E	37	1
c. Norway, area in Valdres 61°8'N, 9°4'E	42	1
and Luster 61°2'N, 7°2'E	42	1
d. Norway, Svalbard 78°2'N, 15°7'E	3, 4	2
e. Norway, area around Tromsø 69°4'N, 18°6'E, and Lofoten 68°N, 13°4'E.	4	1
f. Norway in general	23	1
g. Norway, Estonia, Northern Ireland, Netherlands, France, Greece and Spain.	25	1
h. France	33	1
i. Europe, areas around 50-60°N, and at, or around 50°S, polar data, and between 30 and 40°N (at popular holiday locations).	43	1
j. Finland, whole country.	12, 17, 28	3
k. Finland, area around 65-70°N	10, 11	2
l. Finland, area around Kuopio.	12, 49	2
m. Finland, area around Jyvaskyla.	8	1
n. Scotland and Northern Europe.	26	1
o. Sweden, around Abisko.	13, 16	2
p. Australia, around 32°S and 115°E.	17	1
q. Slovakia, Poprad-Ganovce (WMO no. 11952, 49.03°N, 20.32°E, 706 m a.s.l) and Bratislava (48.17°N, 17.12°E, 287 m a.s.l) and Kosice (48.70°N, 21.27°E, 230 m a.s.l).	47	1
Maps over Europe with estimated UV-levels:		**5**
a. Isodose maps.	3, 4, 23, 32	4
b. Isodose maps for cloud free conditions.	32	1
c. Horizontal UVR maps.	4	1
d. UV-index.	31, 32	2
Forecasted UV-data or future calculated data.	10, 11, 16, 21, 28, 33, 47	7
Calculated ozone value.	10, 11, 16, 23, 32	5
Forecasted ozone-values or warning of ozone	16, 28	2

VIS irradiance above and into the sea. h. UVR for larger areas connected to topographical information / maps and satellite pictures.	3, 4	2

b) Search tool requirements

Search tool requirements include all requests regarding how to access and possibly transfer data from the database.

A total number of 38 users provided search tool requirements.

Type of requirement	**Reference numbers**	***Total no. of requests***
Easy accessible data and easy to understand use of database.	3, 4, 24, 28, 31, 36	6
Search on wavelength or wavelength range. *	2, 3, 5-8, 10, 11, 14, 16, 17, 24, 26, 32, 34	15 (30%)
Search on dates. *	2, 6-8, 14, 16, 17, 19, 32, 34, 40	11 (22%)
Search on solar zenith angles. *	2, 8, 14, 16, 19, 33, 34	7
Search on stations. *	2, 3, 6-8, 14, 16, 17, 20, 24, 26, 27, 29, 30, 32, 34, 40, 50	18 (36%)
Search on station details.	3, 8, 20	3
Search on altitudes.	6, 7, 8, 17, 26	5
Search on latitude.	8, 17, 24, 26	4
Search on longitude.	8, 17, 26	3
Search on instrument types. *	2, 6, 8, 14, 16, 26, 32, 33, 34, 40, 50	11 (22%)
Search on ozone concentration.	6	1
Search on aerosol concentration.	6	1
Search on clarity index or cloud level.	6, 32	2
Search on air temperature.	12	1
Search for maximum UV irradiance during the day.	38	1
Search on stations or measurements within the	1, 8, 13, 15, 19, 23, 25, 26, 41	17 (34%)

Calculate or plot ratios between spectral measurements at selected wavelengths or channels.	6, 7, 24	3

c) Data requirements

Data requirements include all requests regarding input to the database, either spectral or ancillary data, or ancillary information. A total of 48 users provided some data requirements.

Type of requirement	**Reference numbers**	***Total number of requests***
Spectral data*		**47 (94%)**
a. UVB	1, 2, 8-14, 16, 17, 24, 25, 28, 34, 49, 50	17 (34%)
b. UVA	1, 2, 8, 12, 17, 24, 28, 34, 49	9 (18%)
c. Total UV	1-13, 15-32, 34-44, 46, 48-50	46 (92%)
d. Visible	1-5, 7, 8, 13, 15, 23, 25, 26, 41, 43	14 (28%)
e. Near infrared	4	1
Spectral data with resolution 1 nm.	6, 13, 15	3
Spectral data with resolution 2 nm.	3, 4	2
Spectral UV and VIS irradiance on a minute basis.	1, 2	2
Spectral UV-data with sampling frequency		
a. 10 minutes.	3, 13, 14, 16	4
b. 30 minutes.	13, 40, 41, 48	4
Broadband data *		**30 (60%)**
a. UVB (280-315 nm).	1-6, 9, 13, 17-19, 23-30, 32**, 33, 34, 39, 40, 42, 44, 50	27 (54%)
b. UVA (315-400 nm).	1-6, 13, 17-19, 23-30, 32**, 33, 34, 39, 42, 44	24 (48%)
c. PAR (400-700 nm).	1-6, 13, 15, 19, 23, 25, 26, 48	13 (26%)
d. Photopic, around 550 nm.	26, 43	2
e. Infrared and near infrared.	4, 19, 26	3
Multi-channel data		1
GUV instruments, 5 channels in UV	32**	
** Require absolute spectral function available for broadband and multi-channel instruments		

e. Areas in Central Europe (existing UV-stations, but not included in EDUCE)	39	1
f. Measurements from Belsk.	39	1
g. Europe, measurements in areas 50 to 60°N, and at or around 50°S, polar data and between 30 and 40°N (at popular holiday locations), and from one site at high altitude at latitude similar to sea level measurment between 50 and 60°N.	43	1
h. Scotland and Northern Europe.	26	1
i. Greece, Athens.	27, 29, 30	3
j. Norway, Oslo 59°6'N, 10°4'E	27, 29, 30	3
UV- and ozone-measurements performed at same location.	39	1
Underwater UV-data from lakes and oceans (280-400 nm and 400-700 nm).	4, 5, 7	3
Any ancillary data available.	2, 3, 4, 23, 32, 34, 46, 50	8 (16%)
General information on the conditions during measurements.	8, 34, 41	3
Measurements of global radiation.	40	1
Measurements of/information on cloudiness.	2, 3, 4, 23, 32, 40	6
Measurements of visibility.	4, 40	2
Measurements of ozone content.	4, 40, 44	3
Measurements of aerosol content.	2, 41	2
Measurements of air temperature.	2, 12, 17, 41	4
Measurements of sea temperature.	4	1
Measurements of actinic radiation.	46	1
Measurements of other meteorological parameters like soundings or physical ground parameters.	41	1
Information about albedo.	3, 4, 23, 32	4
Information on topography; altitude and slope information.	3, 4, 15, 23	4
Geo-referenced UV information to be	15, 23	2

requirements and routines given in the guidelines from WMO (WMO TD No. 884).		

d) Other requirements or comments

If the requirements do not fit into any other heading, they are put under this heading. Also relevant comments or suggestions are included.

Eleven of totally 50 users have provided some comments or suggestions (22%).

1. User suggests including existing UV-stations in Central Europe, which are not already included in SUVDAMA/EDUCE (39).
2. User suggests linking EDUCE to the ELDONET network (1).
3. User would like information on intercalibration exercises (6).
4. User would like to participate in intercalibration programmes (4, 6).
5. User would like to use EDUCE stations for calibrating own instruments (4, 14, 16, 17).
6. User would like to compare measurements from own broadband and multi-channel instruments with others in EDUCE (GUV, Eppley, UV-biometers, etc.). User suggests that the instrument value could be converted into a common number, preferably in kJ/m^2, independent on MED factors. This could be a weighted or unweighted number, and whole or part of the UV-range (32).
7. It would be nice to have someone to be an intermediary person, helping users to define their needs for new projects. In particular research groups from the effect community do not necessarily know what UV-data to use (36).
8. User welcome a central site for the management of UV-index information, possibly connected to the EDUCE database (31).
9. User would like to interact with research groups on the effect of UVR on humans, photoprotection, public dissemination and information, and in general UV measurements and in underwater projects (6).
10. User would like to get in contact with other scientists working with double monochromator from Bentham (41).

e) References

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4) De Fabo et al., 1983. Mechanisms of immune suppression by ultraviolet irradiation *in vivo*. *J. Exp. Med.* Vol. 157, pp. 84-98.

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10) Piazena H. and Meffert H., 1994. Humabiologische und medizinische Wirkungenultraviolet Strahlung. *Bundesgesundhbl Sonderheft*, Okt. 94, pp. 11-26.

11) Setlow R.B., 1974. The wavelengths in sunlight effective in producing skin cancer: A

Appendix 3. EDUCE Contractors and Subcontractors

Partner/Contractor number (1..13) and Subcontractor number (i..ix) as referred to in list of specific answers from internal users.

1.	UH	Institute for Meteorology and Climatology, University of Hannover, Germany.
2.	NTNU	Norwegian University of Science and Technology, Trondheim, Norway.
3.	UG	Institute for Geophysics, Astrophysics and Meteorology, University of Graz, Switzerland.
4.	FMI	Finnish Meteorological Institute, Finland.
5.	BAS	British Antarctic Survey, Great Britain.
6.	LAP	Laboratory of Atmospheric Physics, Aristotle University of Thessaloniki, Greece.
7.	RIVM	National Institute of Public Health and the Environment, The Netherlands.
8.	NILU	Norwegian Institute for Air Research, Norway.
9.	UMIST	University of Manchester Institute of Science & Technology, Great Britain.
10.	BOKU	Universität für Bodenkultur, Vienna, Austria.
11.	NPI	Norwegian Polar Institute, Norway
12.	UI	University of Innsbruck, Austria.
13.	UJF	Université Joseph Fourier, Grenoble, France.

Appendix 4 List of measuring sites in EDUCE.

There are altogether 32 stations. For more information see http://www.muk.uni-hannover.de/~martin/database.html:

Austria:
- a. Sonnblick
- b. Vienna-Grossenzersdorf

Belgium:
- a. Brussels

Finland:
- a. Jokioinen Observatory
- b. Sodankylä Observatory

France:
- a. Briancon
- b. Villeneuve d'Ascq
- c.

Germany:
- a. Garmisch-Partenkirchen
- b. Hohenpeissenberg
- c. Lindenberg
- d. Neherberg
- e. Potsdam
- f. Offenbach
- g. Zugspitze

Great Britain:
- a. Reading

Greece:
- a. Thessaloniki

Italy:
- a. Ispra
- b. Lampedusa

a. Norrköping
b. Vindelen

The Netherlands:

a. De Bilt
b. Bilthoven / ISO

Poland

a. Belsk

Appendix 5 Request form;

Internal requirements for data products from EDUCE

This email is sent out to all EDUCE participants, with the purpose of determining requirements for data products that may be obtained from the EDUCE database. We ask you to describe what you need to perform your EDUCE tasks, and to specify clearly *tools and data products* that you need or that would simplify your work.

Which task(s) do you have in the EDUCE project (Work package; Deliverables; Milestones)?

Which data do you require to perform your EDUCE tasks?
(Spectral, broadband, ancillary data, …)

Which data products do you require to perform or simplify your tasks?
(Daily UV or CIE-weighted doses, maximum intensity during the day, …)

What information about the measurement sites do you require to perform your EDUCE tasks?

What information about the instruments do you require to perform your EDUCE tasks?
(Slit function, wavelength range, sampling frequency, …)

Which flagging procedures for data quality do you require to perform your tasks?
(Wavelength-shift, cosine-correction, …)

Which search procedures in the database do you require to perform or simplify your tasks?
(If you have already supplied information on search requirements to Tim, then you do not need to repeat your request here)

Do you have other comments or requirements, please describe them.

Are you involved in other UV-related projects where you will use the EDUCE database?
Which projects?

Finally we ask you to provide names of research groups, institutions or other user

Appendix 6 Request form;

External requirements for data products from EDUCE

A European database with ground based UV-measurements was established in 1996, under the projects SUVDAMA and UVRAPPF. The current project, EDUCE, started in June 2000 and will run for three years. It is supported by the European Commission within the 5th Framework Programme, and the co-ordinator is Prof. Dr. Gunther Seckmeyer, Institute for Meteorology and Climatology, University of Hannover, Germany. EDUCE is a collaboration between 22 research groups from 11 European countries and holds UV spectra and ancillary data submitted from over 25 measuring sites across Europe .

The purpose of EDUCE is to collect high quality UV data and to establish a UV climatology in Europe in combination with investigations into potential long-term changes in the UV radiation environment. The database will be accessible for all users who register. Examples of database products and search possibilities and a more detailed description of the project can be found on the EDUCE web page, http://www.muk.uni-hannover.de/EDUCE . More detailed information about the measurement instruments and stations can be found at http://metadama.phy.umist.ac.uk/hello.html.

To be able to improve access and availability of UV data for the user community the project aims to be in touch with users of UV data and their requirements. Dr. Lill T. N.Nilsen and Dr. Berit Kjeldstad, Department of Physics, NTNU, Norway, are in charge of this task. We would like to get in touch with groups who work in relevant areas and who could give important input to the project as well as being potential users of the data in future.

We ask you kindly to answer a few questions and send it back to us.

- Responsible contact person(s):
- Describe your main area of work or research:
- Do you currently use estimates or measurements of surface UV levels?
- Would you like to use estimates or measurements of UV levels?
- Would you be interested in providing feedback about your needs for UV data or estimates to the project?

Norwegian University of Science and Technology, N-7491 Trondheim, Norway

Appendix 7 Specific questions to external users

Thank you for your interest in the database/project. I hope you can take the time to look at the following questions and respond to me.

If you answer this 'letter' I will register your name to give feedback about the project. For you to get access to the database, if you would like so, you need to contact the EDUCE scientific secretary, Dr. Tim Martin (timothy.martin@gmx.de). He will help you register.

Furthermore, the questions below are meant to help finding out if you and your group have some specific requirements for the database - such as special calculations or weighted numbers you would like to see as outputs from the database.

1. Any specific requirements regarding data and data format? What data do you need? Spectral, broadband, ancillary data? Sampling frequency and wavelength-range?

2. Any specific data products you need? Daily, monthly, yearly UV dose or any weighted numbers - what weighting-function? Interpolated data - which numbers? Max./min. intensities? UV Index?

3. Are there any specific search-possibilities you need? (selection of wavelengths, zenith-angles, dates, instrument-types, stations etc.)

4. Any other requirements for information on instruments, stations or other?

Thank you again for your interest and help. And I look forward to hearing from you again. Good luck with your own UV-work.

Appendix 8 Overview over external users submitted requirements for EDUCE

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Available on request.