Recommendations from COST 713 "UVB Forecasting"

UV observations

UV observations can be used for comparison with models to get a better understanding of the processes influencing the UV levels reaching the ground. Long-term monitoring of UV will create the possibility to detect long-term changes. Spectral data are necessary for the assessment of atmospheric variability and processes and are very useful for the validation of radiative transfer models. Beside these scientific aims, measured data can also be used to inform the public with actual measured UV levels.

1) **UV measurements must continue. The observations should be well documented concerning the status of the instrumentation used, and especially the calibration history must be available.**

Measurement of the UV Index

For the measurement of the UV Index a special type of radiometers has been developed and are used worldwide. The sensitivity of these instruments is similar to the action spectrum for erythemal so their measurements are convertible to units of erythemal irradiance. Ten years of experience in the use of these instruments revealed that erythemal radiometers are very delicate instruments while in many occasions significant changes in their absolute sensitivity have been reported. Frequent calibration checks and characterization of their optical properties are useful for the early detection of instrumental changes and malfunctions. Spectral characterization requires expensive specialized facilities and trained personnel, which are unrealistic at the stations level.

2) **Erythemal radiometers used for the measurement of the UV Index should be calibrated under the Sun at least annually, preferably against a well-calibrated spectroradiometer. It is recommended to perform a full spectral characterization every two to three years, although it would be desirable to conduct this test at the same time with the absolute calibration.**

3) **It is recommended to establish a central facility capable in offering full characterization and calibration of erythemal radiometers, preferably under the supervision of an international organization (e.g. EU, WMO). Until such a facility is available, international intercomparisons should be organized to ensure the calibration status of these instruments, following the recommendations of WMO.**

Ancillary observations

To get a better insight in the relation between measured and modelled UV irradiances, it is essential to have more information about the atmospheric conditions at the time of the measurements.

4) **Whenever possible, ancillary measurements should be performed coincident in time and space with UV measurements. The following types of measurements are suggested: total ozone, cloud properties (amount, type, altitude, optical depth and other relevant characteristics), aerosol optical depth, actual information on the albedo, solar radiation.**

Forecasting of the UV-Index and the relevant atmospheric parameters

To inform the public in advance on the actual levels of UV radiation, different institutions issue regular forecasts of the UV index. This is achieved by modelling the UV irradiance on the basis of the relevant atmospheric parameters. The parameters, which are essential to be taken into account, are the ozone content, the spectral aerosol optical depth, the surface albedo in case of snow, and, if the UV Index is forecasted for all weather conditions, the cloud amount and type and the actual position of the clouds with respect to the sun. Other atmospheric properties, like the ozone or aerosol vertical distribution, are of minor importance or exactly known, e.g. the solar zenith angle. Different sensitivity studies and model comparisons showed that the uncertainty of modelled UV Index values mainly result from insufficient knowledge of the actual atmospheric parameters, which are either uncertain or unavailable. This is true at least for high quality scattering models, as they are used in many cases to calculate the UV Index. Thus, for further improvement of the forecasted UV Indexes it is necessary to improve the forecast of the relevant atmospheric parameters.

Comparisons between different radiative transfer models revealed that models taking into account multiple scattering of radiation are more accurate from simple spectral or from empirical models.

5) **It is recommended to use for UV Index calculations multiple scattering radiative transfer models.**

Ozone forecasting schemes through regression-based models are already available and used in regular UV Index forecasting. More sophisticated procedures involving dynamical models with chemistry and data assimilation are currently under development, though not yet operational and widely available.

6) **Forecasting of total ozone should be centrally produced by global dynamical models, which include chemistry effects and data assimilation techniques. It is essential that such forecasts should be first validated by comparison to reliable ground based or satellite measurements. For regions not covered by these products, empirical regression models may be used, based on forecasted profiles of atmospheric parameters (e.g. temperature, PV, geopotential height) and, if available, total ozone data for the previous day(s).**

Accurate forecasting of the aerosol optical depth and particularly its spectral dependence and optical properties is presently unrealistic. In regular UV Index calculations fixed values of the aerosol optical depth and its properties are used.

7) **It is recommended to include in UV Index calculations aerosol optical depth values variable in space and season, which can be derived from**

climatological data, since local forecasts are impossible in the foreseeable future.

Cloud effects on UV Index will be uncertain always. Nevertheless, substantial effort should be put for further improvement of cloud forecasting.

8) **Although the role of clouds in modifying ultraviolet radiation is sufficiently understood, accurate cloud forecasting schemes suitable for operational UV Index forecasts are not yet attainable. Better methodologies for handling operationally the effects of clouds on UV Index forecasts should be developed.**

The variety of forecasting methodologies currently in use may introduce inconsistencies in the UV forecasts produced for the same location by different forecasting centres. Thus harmonisation of methodologies and produces is required.

9) **A European UV forecasting centre should be established. This centre is expected to serve as a source of large-scale UV forecasts, which would be then locally adjusted and presented to the public through national information channels.**

UV Index: a basic parameter for the public

The UV-Index defined by the international scientific community at the WMO/WHO meetings in Les Diablerets, 1995, 1997 was accepted in the COST-713 project as the basic parameter for information of the public about detrimental effects of UV to the human health. To familiarize the public with the UV-Index scale and skin effects, dissemination of additional information like "sunburn time" was found to be very helpful. To acquaint the users with the proper use of sunscreens in relation to the actual value of the UV-Index systematic education of the public is required. This can be more effective if it is performed in co-operation with producers and sellers of cosmetics and UV specialists.

10) **The UV-Index should be used for public information. The relation of the UV-Index to sunburn times is not recommended to be included in the regular public information to avoid giving a feeling of safety. Systematic education of the public (e.g. by meteorological services, medicine societies, media etc), including information on skin types, is required for the acceptance and proper interpretation of the UV Index in order to achieve optimal UV protection.**

UV information systems in COST-713 countries

As survey that was carried out in the beginning of the Action revealed that UV information systems exist in all COST-713 countries, involving all types of mass media. However, the sources of UV data, the technologies for UV measurements, their geographical cover, the communication channels and the forms of presentation differ significantly between countries. Under COST 713 most of the participating institutions improved and extended significantly their national UV information systems. Some of them, using the Internet, serve presently even as international UV

information sources. Although the infrastructure for presentation of UV nowcasting and forecasting is currently available in all COST-713 countries, a harmonised UV information system is still missing in Europe.

11) The disseminated UV forecasting products should be harmonised to facilitate distribution of information comprehensive by everybody, irrespective of the information source. It is recommended to use the UV-index categories and colour scale which were agreed between COST 713 and WMO/WHO/ICNRP in 2001.

LOW (0, 1, 2)	MODERATE (3, 4, 5)	HIGH (6, 7)	VERY HIGH (8, 9, 10)	EXTREME (> 10)

Cloud effects on UV Index will be uncertain always and everywhere due to the rapid change of cloudiness in combination with the short time of about 30 minutes for which the UV Index is defined. This points to the necessity for distribution to the public additionally UV Index forecasts for cloud-free conditions.

12) If UV Index forecasts modified for clouds are produced, it is recommended to provide the UV Index range up to the maximum expected.

International UV data exchange

To get measured and forecasted UV-Index data from individual participating institutions available to all participants an FTP system for operational data exchange was created under the COST-713 Project. Data formats, communication rules and database procedures were defined by WG4. Three-year operation of the system showed its satisfying function and security of the data transfer. Experiences achieved can be used for creation and implementation of a general international UV data exchange not only via Internet but also through the WMO/GTS telecommunication network.

13) It is recommended to maintain operationally the system for UV Index data exchange through FTP, which was established under COST Action 713. Experiences achieved so far can be used for the definition of WMO/GTS CREX UV codes.

Interpretation of the UV-Index by the public

The UV-Index is a relatively new environmental parameter that needs to be introduced not only to the public but also to some related scientific communities. To assist in its wider implementation the specialists of WG4 prepared a handbook "UV-Index for the Public" that was published as an output of COST Action 713. The handbook is written in English and it was distributed by the EC Secretariat to about 1000 institutions/users both within and outside COST countries. To extend its impact and applicability national versions of the booklet have been prepared, which will be printed and distributed by the participating institutions on national level.

14) The COST publication "UV-Index for the Public" is recommended to be used as an information source for the UV Index properties and applications. Revised or national versions should take into account these recommendations.

Impacts of the dissemination of UV information

A routine use of the UV-Index by the public is closely related to the application of UV protection. The public easily understands the usual and simple protection tools like clothing, shading or controlled exposure. However, the selection of sun protection cosmetic-products can be complicated by confusing the UV-Index values and the Sun Protection Factors that are stated on sunscreens. An investigation of knowledge of the population about UV and health problems is very useful information at the starting point.

15) An investigation of the actual knowledge of the population about UV and its detrimental effects, as well as about the UV Index, is desirable to be performed by periodic public surveys. It is recommended to use in such campaigns the questionnaire developed under COST Action 713.

The future COST Action 713

The members of Action 713 have realised that UVB forecasting has been already exhaustively investigated from the atmospheric sciences perspective. Therefore the initiation of a new action of similar content would not be worthwhile for the time being. This issue should be reviewed again in a few years in the light of new developments and information in this field. On the contrary, the coordination of investigations related to the consequences of UV radiation on humans and the ecosystem in general, regarded from a biological point of view, would be desirable.

16) Topics for new COST Actions could be:

- Consequences of UV radiation
- Reconstruction of past UV series
- Relationships between UV-B and UV-A
- Cloud forecasting and cloud effects on UV radiation
- Problems with broadband instruments