

**MEMORANDUM OF UNDERSTANDING**  
**for the implementation of a European Concerted Research Action**  
**designated as**

**COST 726**

**"Long term changes and climatology of UV radiation over Europe"**

The Signatories to this Memorandum of Understanding, declaring their common intention to participate in the concerted Action referred to above and described in the Technical Annex to the Memorandum, have reached the following understanding:

1. The Action will be carried out in accordance with the provisions of document COST 400/01 "Rules and Procedures for Implementing COST Actions", the contents of which the Signatories are fully aware of.
2. The main objective of the Action is to advance the understanding of UV radiation distribution under various meteorological conditions in Europe in order to determine UV radiation climatology and assess UV changes over Europe.
3. The economic dimension of the activities carried out under the Action has been estimated, on the basis of information available during the planning of the Action, at Euro 11 million in 2003 prices.
4. The Memorandum of Understanding will take effect by being signed by at least five Signatories.
5. The Memorandum of Understanding will remain in force for a period of five years, calculated from the date of first meeting of the Management Committee, unless the duration of the Action is modified according to the provisions of Chapter 6 of the document referred to in Point 1 above.

# **TECHNICAL ANNEX**

## **COST 726**

### **Long term changes and climatology of UV radiation over Europe**

#### **A. Background**

The ultraviolet (UV) radiation reaching the ground is only a small portion of the radiation we receive from the sun. Nevertheless, enhanced UV has a wide variety of adverse effects on humans and the environment (i.e., terrestrial and marine ecosystems). The most well-known effects of excessive UV on people include sunburn and snow blindness. UV radiation has also been linked to skin cancer, cataracts, suppression of immune system, as well as a number of dermatological and ocular problems. From the perspective of public health risk assessment, reliable and continuous measurements of UV radiation and studies on factors responsible for the UV variations over different time scales (ranging from minutes up to decades) are necessary.

Since the early 1990s, available resources have been applied to improve our knowledge of the UV changes and understanding of processes that affect surface UV radiation. Many activities have been carried out within the European countries in the frame of EC funded projects (e.g. UVRAPPF, MAUVE, QASUME, SUVDAMA, EDUCE), and COST Action 713 - *UV forecasting*. Research efforts in the area of atmospheric physics have placed a large emphasis on the calibration and maintenance of the existing UV observing systems, the development of new instruments and QA/QC methods, and the data analyses using the results from both ground-based and satellite UV instruments. Difficulties involved in the routine operation and maintenance of these instruments have limited the length of reliable data records to about the past 10-15 years. It is recognised that 10-15 years is not adequate to carry out trend analyses.

Studies on the impact of UV radiation on the environment require knowledge of UV climatology and changes that have occurred in the past. It would be of special importance having the estimates of average and extreme characteristics of the UV impact on various biological systems (including human beings) as well as doses over different time periods, over much longer periods ( $\geq 3$  decades).

Recently, various models based on total solar radiation (pyranometer), total ozone and other meteorological measurements, have been used to reconstruct surface UV radiation. The pyranometer and other meteorological data serve as proxies for the combined clouds and aerosols effects on UV radiation. The reconstructed datasets, which can extend backward in time to as early as the beginning of total ozone and pyranometer observations, would help to construct the climatology, the long-term

variations and trends of UV radiation. The applied UV reconstruction models contain several assumptions on the nature of radiative transfer and are based on statistics reflecting local meteorological conditions. Thus, substantial efforts are evidently needed to obtain a reconstructed UV radiation field on European scale and to evaluate the strength and weakness of various UV reconstruction techniques.

Establishing the climatology and long-term changes of UV irradiance and of selected biologically effective UV radiation doses over Europe, using the reconstructed time series, is a challenging task and the goal of this COST Action.

Joint action of the European scientists is necessary to address the problems of establishing a reliable UV climatology and assessment of UV changes and trends within Europe. The COST framework appears to be the most suitable to achieve these goals in view of its wide European coverage, flexibility in adapting the methodology to existing know-how and its capability to mobilise the various relevant national stakeholders across discipline and institutional remits. This COST Action will exploit achievements of previous European Projects and add new knowledge. This Action will play an important role in better understanding the past UV changes and the role of UV influence on ecosystem. The presentation and dissemination of final results should take into account the needs of the main beneficiaries of the Action: the public, policy makers, health authorities and researchers. Relevant international organisations, World Meteorological Organisation and World Health Organisation, will be consulted.

## **B. Objectives and Benefits**

The main objective of the Action is to advance the understanding of UV radiation distribution under various meteorological conditions in Europe in order to determine UV radiation climatology and assess UV changes over Europe.

Since UV solar radiation plays an important role in many processes in the biosphere, including the influence on human organisms, and may be very harmful if UV exposure exceeds "safe" limits, the knowledge of biologically effective UV radiation doses and their geographical distribution and climatology in Europe is crucial for the European population, who will be addressed as the main end user of the Action.

To achieve its general objective, the Action has the following practical objectives:

- to make an inventory of available solar radiation data sets, including UV data, spectral and broadband, ancillary data (ozone, clouds, sunshine etc.) and available satellite data,
- to advance the understanding of UV reconstruction models for the calculations of UV climatology and assessment of UV changes,
- to advance the understanding of biological UV radiation climatology and changes in Europe,
- to advance the understanding of UV influence on ecosystem, both on the basis of climatology and changes of selected effective UV radiation doses in Europe,
- to use the advanced knowledge under the points above, in order to elaborate a comprehensive analysis and information basis, addressed to beneficiaries,

Additionally, special attention should be paid to application of QC/QA procedures for the UV measurements with broadband instruments. To get homogeneity of the broadband data, an additional objective is:

- to create a European reference group of broadband radiometers.

The major benefits of the Action will be a geographically broader and scientifically deeper knowledge of the climatology of UV radiation and of selected biologically effective UV radiation doses across Europe.

The main beneficiaries will be the public, researchers in atmospheric and medical sciences as well as authorities and policy makers.

## C. Scientific Programme

Obtaining UV radiation data for long time periods and from various places without UV measurements requires modelling tools. This can be done by radiation transfer models, which use available proxy atmospheric data as input parameters, or it can be done by statistical models, using ancillary data. The activity will focus on the following areas:

### **C1 - Inventory of UV measurements and ancillary data for UV reconstruction**

Determination of the ancillary data that are necessary to run the models, considering variable spatial and temporal resolution.

Inventory of high quality UV measurements to validate the results of the reconstruction models.

a) C2 – Model data selection

b) **UV radiation reconstruction models that are available in Europe will be reviewed against the requirements for long time UV climatologies. These requirements are expected to include, in addition to different biological spectral weighting, the geographical extension and time resolution.**

c) **A number of models will be selected as candidates to be the tools for building the UV European climatology.**

d) C3 – Comparison of modelled and measured UV data

UV radiation will be reconstructed for a limited number of UV measuring stations, where high quality data are available.

The requirements for various applications (for instance the accuracy needed to enable UV impact studies is less stringent than for long term change analysis) will be taken into account. An estimation of uncertainties, depending on quality of ancillary data and/or shortcomings of models, will be made.

The quality of the test-datasets will be evaluated by inter-comparison between both reconstructed UV intensities and high quality measurements and between the different reconstruction methods.

The derived methods to get long time series of UV radiation over Europe will be made available for researchers, both from member states of the COST Action and from other European countries.

Detailed recommendations for building up European UV climatologies under different conditions will be produced. In particular, this report will assess to what extent the climatology can fulfil the requirements for UV environmental impact studies, health protection and long-term changes detection.

e) C4 – Action spectra

Action spectra for a variety of photobiological effects were derived during the past, ranging from bacteria and plankton up to skin cancer in mammals (including humans). A collection of action spectra will be undertaken. The most relevant for the climatology and trend analysis will be determined.

i) **C5 – Derivation of requirements**

Depending on this selection, the temporal and spatial requirements for reconstruction as well as trend analysis will be determined. Constraints for ancillary data collection will also result from this investigation. The requirements will be derived for each selected biological effect to correspond to its essential properties, applications and sensitiveness to relevant input parameters.

ii) **C6 – European climatology and trends**

As many as possible long term series of UV radiation over Europe will be modelled. For different biological weighting, different temporal and spatial resolutions will be applied.

Such climatologies will be modelled, both with high spatial and lower temporal resolution and for a limited number of stations with higher temporal resolution.

The general development of UV irradiance in Europe will be shown, taking into account not only the change of ozone, but also that of all relevant meteorological parameters such as cloudiness, turbidity and surface albedo.

iii) **C7 – Exploitation of the long-term UV series**

The long term series of reconstructed UV radiation will be used for the trend calculations and analyses.

The results of climatology and trend analyses will be prepared, depending on the properties of the biological effects, to be appropriate for dissemination. Visualisation should give a clear overview of variability depending on location and time.

The results will give the basis for research of skin cancer development, since this has such a long incubation period that measured instantaneous UV data are not meaningful.

A separation for the reasons of the determined trend change of the UV radiation, as change of total zone, cloudiness or aerosol amount, will be examined to reveal sources of temporal variations of the UV trend patterns over Europe. The regional differences of long-term clouds/aerosols forcing on the UV radiation will be examined.

**C8 - Common Q/A and Q/C procedures for European broadband radiometers**

To get high quality broadband UV measurements over the whole of Europe, common QA/QC procedures will be drafted, based on the results from previous projects (COST-713) and WMO documents. The participating institutions will implement these procedures at their measuring sites, to provide a common assessment methodology of the quality of their measurements.

The main radiometer characteristics to be determined are :

- Calibration
- Spectral responsivity
- Directional response of the entrance optic

For the determination of the broadband UV radiometer calibration and the correction functions, the spectral response function and the cosine response function of the broadband UV radiometers will have to be determined accurately.

A broadband UV radiometer reference group will be established, which will maintain an accurate UV irradiance scale for instruments used in Europe. To maintain the UV irradiance scale at the highest possible level, very accurate and stable reference spectrophotometers are needed, which are available at some places in Europe.

During scheduled intercomparison campaigns, the instruments of the reference group will be installed at European UV radiation sites as a Quality Assurance exercise. These intercomparisons will allow to monitor and assess the homogeneity of the national broadband radiometer networks, based on a very short traceability chain.

## D. Organisation

The Management Committee (MC) will develop a work programme taking into account the research needs and objectives as outlined in Sections A and B. The programme will also take into account expertise, facilities, and interests of the participating institutions. According to the scientific programme in Section C, it is envisaged that four working groups will be established, corresponding to the eight research areas identified.

### **WG1 – Data collection**

- Inventory and collection of measured ancillary data.
- Inventory of available high quality UV-measurements.

### **WG2 – UV modelling**

- Identify models suited for building a European climatological dataset of UV radiation.
- Generate a prototype subset for European UV climatology for evaluation purposes, using different models and ancillary data.
- Quality check of UV climatologies modelled by different algorithms, both against each other and against measured data.
- Modelling long time UV series with high spatial and temporal resolution for selected biological processes.
- Calculation of UV trend patterns and their temporal variability.
- Establishing the sources of UV trend variability over Europe.
- Visualisation with respect to beneficiaries needs.
- European UV climatology assessment.

### **WG3 – Requirements for biological UV effects**

- Collection of action spectra for photobiological effects induced by UV radiation and selection of representative action spectra.
- Derivation of requirements for ancillary data collection, reconstruction, climatology and trend analysis.
- Recommendation of biological action spectra, time resolution and other requirements for UV modelling.
- Dissemination of information on the biological importance of effective UV radiation and gained results to a broader audience.

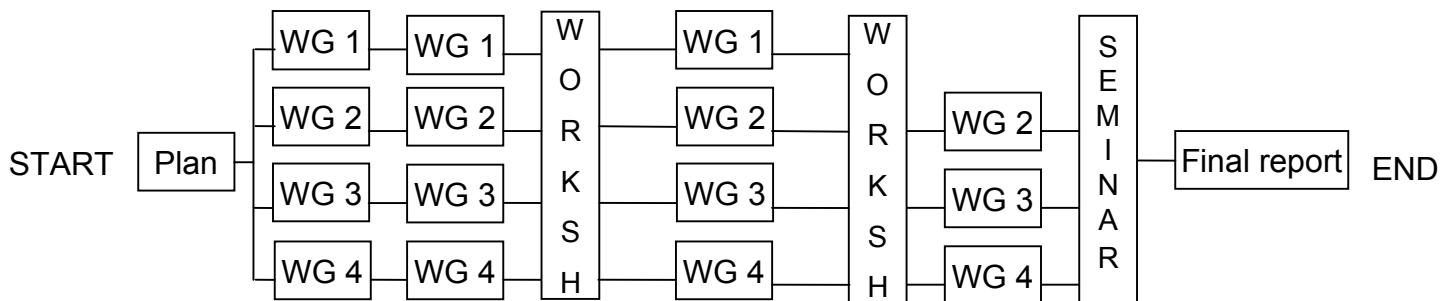
## WG4 – Quality Control

- Drafting and implementation of common Q/A and Q/C procedures.
- Characterisation and intercomparison of selected broadband radiometers.
- Creation of a European reference group of broadband radiometers.

The Action will benefit from the results of *Action 713 - UV forecasting* accomplished in 2000 and will collaborate with the *Action 719 - The Use of Geographical Information Systems in Climatology and Meteorology*, for implementation of GIS for the UV climatology visualisation. The Action will benefit from the UV databases created in the frame of the EC EDUCE project.

The Action will take into account the WMO and WHO publications and guides for UV measurements and UV influence on ecosystems.

## E. TimeTable



B. e a r 1	Year 2	Year 3	Year 4	Year 5

The Action will last 5 years. There are many organisations widely distributed around Europe actively engaged in research in UV radiation, both through gathering observations and development of models. In addition many of these organisations are actively engaged in developing UV informative public services to address user needs. Since the basic goal of the Action is to create an extensive database, UV measurements and ancillary data for UV reconstruction will have to be compiled. Selection and/or further development of models required for specifying the UV radiation environment is necessary to enable the coupling of these models in order to provide the capability for modelling the reconstruction and space distribution of UV radiation for long time UV climatologies. Taking into account that UV radiation climatology will require the unification of both the data inventory and methods of interpretation, and referring to the experiences of COST 713, which strongly contributed to standardising the interpretation of the UV index 5 years duration of Action 726 is required.

After the establishment of WGs at the first Management Committee (MC) meeting, the WGs will start their work. During the first two years the available data and detailed tasks for WGs will be defined. Two Workshops and one seminar will be organised, connected with joined MC/WGs meetings. At the first Workshop at the end of the second year, the final tasks for the WGs will be discussed and formulated, taking into account the reliability of available data. At the second Workshop, at the beginning of the fourth year, the preliminary research results and the outlook for further research will be discussed. At the Seminar (beginning the fifth year), which will be open to scientists outside the COST Action, the achieved results will be presented. After the Seminar, at the MC Meeting, the outlook for the final report will be discussed.

Participants will be encouraged to make propositions for STSMs and study contracts that will be submitted to and accepted by the MC.

A partner, who would be willing to take the chair of WG1, should be responsible for the database of collected data and its updating. The collected database should be available after the end of the Action to all interested scientists.

One of the partners will be responsible for the generating and updating of the web-site.

## 1. Economic Dimension

The following COST countries have actively participated in the preparation of the Action or otherwise indicated their interest:

- |           |                  |           |
|-----------|------------------|-----------|
| - Austria | - Czech Republic | - Estonia |
| - Belgium | - Denmark        | - Finland |

- France
- Germany
- Greece
- Hungary
- Italy
- Luxembourg
- The Netherlands
- Norway
- Poland
- Portugal
- Romania
- Slovenia
- Spain
- Sweden
- Switzerland

On the basis of national estimates provided by the representatives of these countries, the economic dimension of the activities to be carried out under the Action has been estimated, in 2003 prices, at roughly Euro 11 million.

This estimate is valid under the assumption that all the countries mentioned above but no other countries will participate in the Action. Any departure from this will change the total cost accordingly.

## 2. Dissemination plan

Since UV radiation is an important factor for the equilibrium of the ecosystem, the results of UV climatology and trend analyses will be made available to a broader audience than just the atmospheric science community. This can be done through scientific publications, a booklet specially designed for the public and medical authorities and a web-site.

Moreover, the results will be presented to the public in different ways on a national basis (web-sites, scientific publications, brochures etc.).

A UV COST Action web-site will be generated with:

- free access to general information on the Action, proceedings of seminars, final report and publications,
- password protected: working documents, interim reports.

A scientific assessment of UV climatology for Europe will be prepared for publication in the peer-reviewed literature. Cooperation and coordination will be sought with other major scientific activities on UV radiation in Europe and the rest of the world. Dissemination of the results will also target the climate change community through participation to relevant conferences, meetings and clusters of projects as well as by liaising with international organisations such as the WMO and WHO and the European Environment Agency.