R e p o r t

from the COST-726 Short Term Scientific Mission

Compilation of results of the modelling exercise WG1 and WG2

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The Short Term Scientific Mission's reporter was hosted by the Meteorological Institute of University Munich. As one of the aims of the COST 726 project is reconstruction of the solar ultraviolet (UV) radiation time series over Europe, it is necessary to select the reconstruction method provided the best fit of measured UV radiation based on the input parameters available for long time period in the past. Four sites characterising diverse condition in Europe were selected (Bergen, Davos, Potsdam, Thessaloniki) for creation and verification of the solar UV radiation reconstruction models. Daily doses of UV radiation spectrally weighted by the CIE

(1987) relative weight function were elaborated (CIE-UV). 16 different models were constructed using the same input parameters obtained during year 2002. The 1999 data were used for models verification. The main goals of the STSM were:

- preparation of collective publication of COST-726 action
- comparison of different CIE-UV radiation reconstruction models
- classification of CIE-UV radiation reconstruction models with respect to model technique and requirements for the input parameters
- selection of appropriate statistical criteria for model quality assessment
- selection of appropriate graphical presentation of differences between measured and modelled data, and differences between modelled CIE-UV radiation daily doses provided by all models

The goals of STSM have been full-filed in close cooperation with Dr. Peter Köpke, Dr. Henning Staiger and since June 1 also with Dr. Janusz Krzyscin – members of the WG2 of the COST 726 project.

It was decided that standard deviations of modelled and measured daily totals of UV radiation, their bias, slope and intercept of linear fit representing dependence of modelled data on measured values, Pearson correlation coefficient, root mean square error, reduced variance and also skill score - characteristic related to Taylor's (2000) publication - will be the basic statistical characteristics for the model intercomparison. Description of these statistics will be presented at prepared publication. All mentioned statistical characteristics were calculated for data sets representing cases when pairs of modelled and measured values of daily CIE-UV dose were available (different number and dates of data for each model) and also for situations when measured and modelled data for all 16 investigated models were available (statistical comparison using equal dataset for all models). The next decision was, that statistical characteristics of differences between measured and modelled data will be performed separately for warm half-year and cold half-year (the period between March 21 and September 21 was considered to be warm half-year, rest of the year was considered to be cold half-year). The quality of all 16 models was also compared with 17-th model based on usage of data obtained on day before the date of measured values (model based on persistence). It was also noted, that similar statistical characteristics are needed for comparison of measured and modelled average monthly values of the CIE-UV radiation.

3 types of plots were selected to represent basic relation between measured and modelled daily doses of the CIE-UV radiation: (1.) scatter plot (plot of modelled values as a function of measured data) with linear fit and line representing the ideal agreement between measured and modelled data to depict possible bias, spread and nonlinear relation between modelled and measured data (example is shown in Fig.1 in appendix) (2.) annual course of absolute differences between modelled and measured data *(UVmod - UVmeas)* with different symbols for 3 categories of cloud modification factor (CMF) and with lines separating warm and cold half-year (example is shown in Fig.3 in appendix) (3.) annual course of relative differences between modelled and measured data *((UVmod - UVmeas) / UVmeas)* with different symbols for 3 categories of CMF and with lines separating warm and cold half-year (example is shown in Fig.2 in appendix).

The CMF was calculated as a ratio between measured daily dose of CIE UV radiation and modelled CIE UV daily dose calculated for clear-sky condition. If modelled clear-sky daily doses were not available, categorization of the data with respect to the CMF was omitted. The categories of CMF were decided to be as follows: (1.) $CMF \geq 0.75$, (2.) $0.5 < CMF < 0.75$ (3.) $CMF \leq 0.5$. Mentioned 3 types of plots were prepared for every site, every year and for every model separately.

In the next step, the decision was made, that the models will be divided into 2 groups:

the models using global solar radiation were sorted into the first group, the models which do not require global radiation as an input were separated at the second group.

It was decided, that abbreviation of every model name and designation will be constructed from 4 characters characterising institution and author of the model and from suffix containing 3 characters related to model version. If only one model version was provided by the institution, the suffix was set as ‘day’. The models are presented in alphabetic order at tables depicted the statistics, at the Taylor diagrams and also in tables of plots. Firstly, the 12 models used global radiation are presented and then follows 4 models with no requirements to global radiation. The legend of model abbreviations will be available in complete internal publication. Exceptions of the alphabetic order of tables of plots are one model provided by Deutsche Wetterdienst-

Forschung (Lindenberg) and also model provided by Tartu observatory. These models were involved into data elaboration at the end of the STSM. If any model does not provide data for some year and site, a gap was left in the plot tables. The range of y-axis of plots of relative and absolute differences was decided to be fixed for all places, all models and both years (the range of ±1 was selected for relative differences and the range of ±1000 $J.m^{-2}$ was used for absolute differences). It was decided, that all points laying out of the range of plots will be depicted close to borders of the plots. Strong deterioration of all models was detected applying data from Potsdam 1999. This behaviour of all models probably relates to inferior quality of input data, but it was decided to present also these plots for demonstration of possible application of models for data control. All statistical tables and data plots were available at the end of STSM.

The presentation of model comparison using the Taylor diagram was discussed on the last day of STSM. It was noted that prevailing number of models fit the CIE UV daily doses very well, and large number of models will be concentrated at one bulk of points applying daily CIE UV radiation data for the Taylor diagram construction. Removing of the annual course from the data is necessary for better differentiation between the models. It was decided that annual course will will be obtained at daily base using the Robust locally weighted regression method (RLWR). The Taylor diagrams will be created in another STSM. The intercomparison of all models will be discussed among the contributors and later made available as internal COST 726 publication at the BSCW server. Results of the STSM will be also presented at the SPIE conference in Stockholm as a result of the COST-726 action.

Conclusions

- the main goals of the STSM were full-filled – the statistical pre-elaboration of modelled and measured CIE UV data was done

- the STSM applicant had occasion to work in team of experienced scientists

- the conditions at the host institution were excellent from scientific point of view, all needed software was available and organization of work was also very productive

- results of the STSM are planned to be published as internal COST publication, as an article at the SPIE conference in Stockholm during September 2006 and it is also possible to summarize resulting conclusions into a scientific paper and publish them in any scientific journal in the future

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Tatranská Lomnica June 8 2006 Anna Pribullová

References

CIE,1987 :A refference action spectrum for ultraviolet induced erythema in human skin, CIE Journal, 6, 17-22.

Taylor, K.,E., 2000: Summarizing multiple aspects of model performance in a single diagram, Program for climate model diagnosis and intercomparison report No. 55, University of California, Canada.

Appendix - examples of plots for comparison of modelled and measured CIE UV radiation daily totals

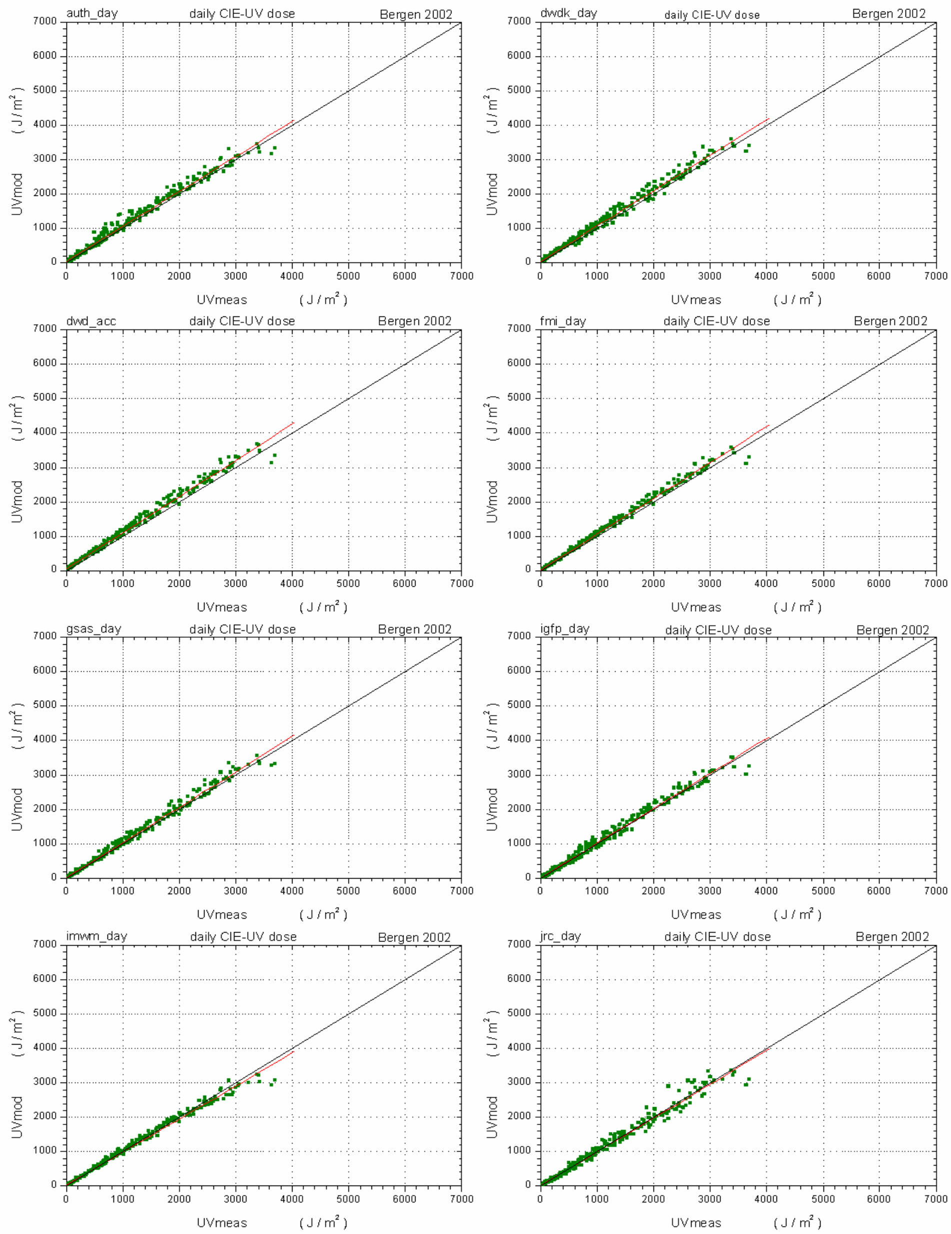

Fig.1 Modelled CIE UV radiation daily dose as a function of measured value for Bergen 2002. The red line represents linear dependence of modelled values on measured ones; black line represents ideal case when modelled values are equal to measured ones. Abbreviation of models is above the left corner of plots.

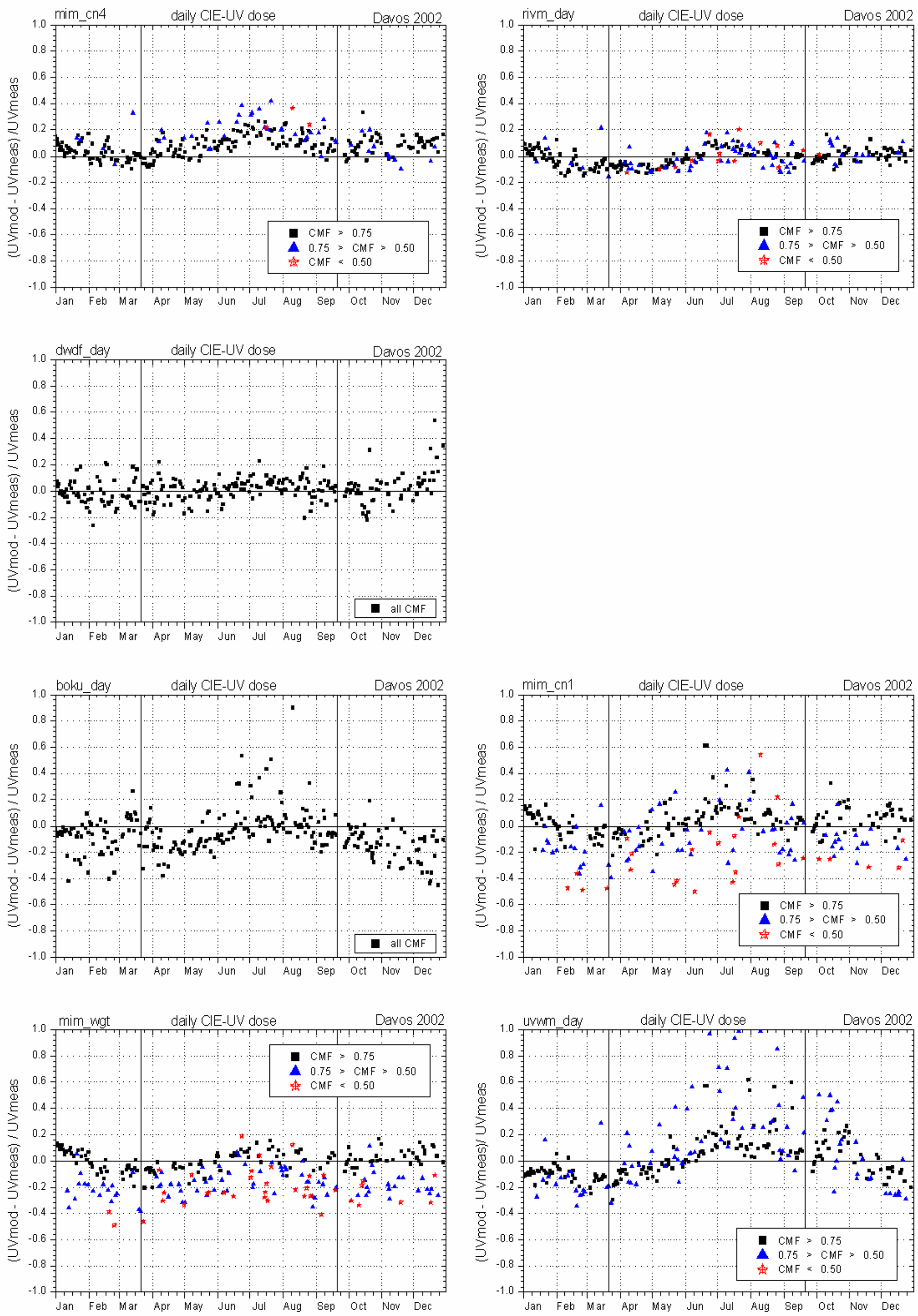

Fig.2 Relative differences between modelled and measured CIE-UV radiation daily doses calculated for Davos 2002. If clear-sky CIE-UV radiation was available, the data points are sorted with respect to cloud modification factor (CMF) calculated as a ratio between modelled and clear-sky CIE-UV daily dose. Abbreviation of models is above the left corner of plots.

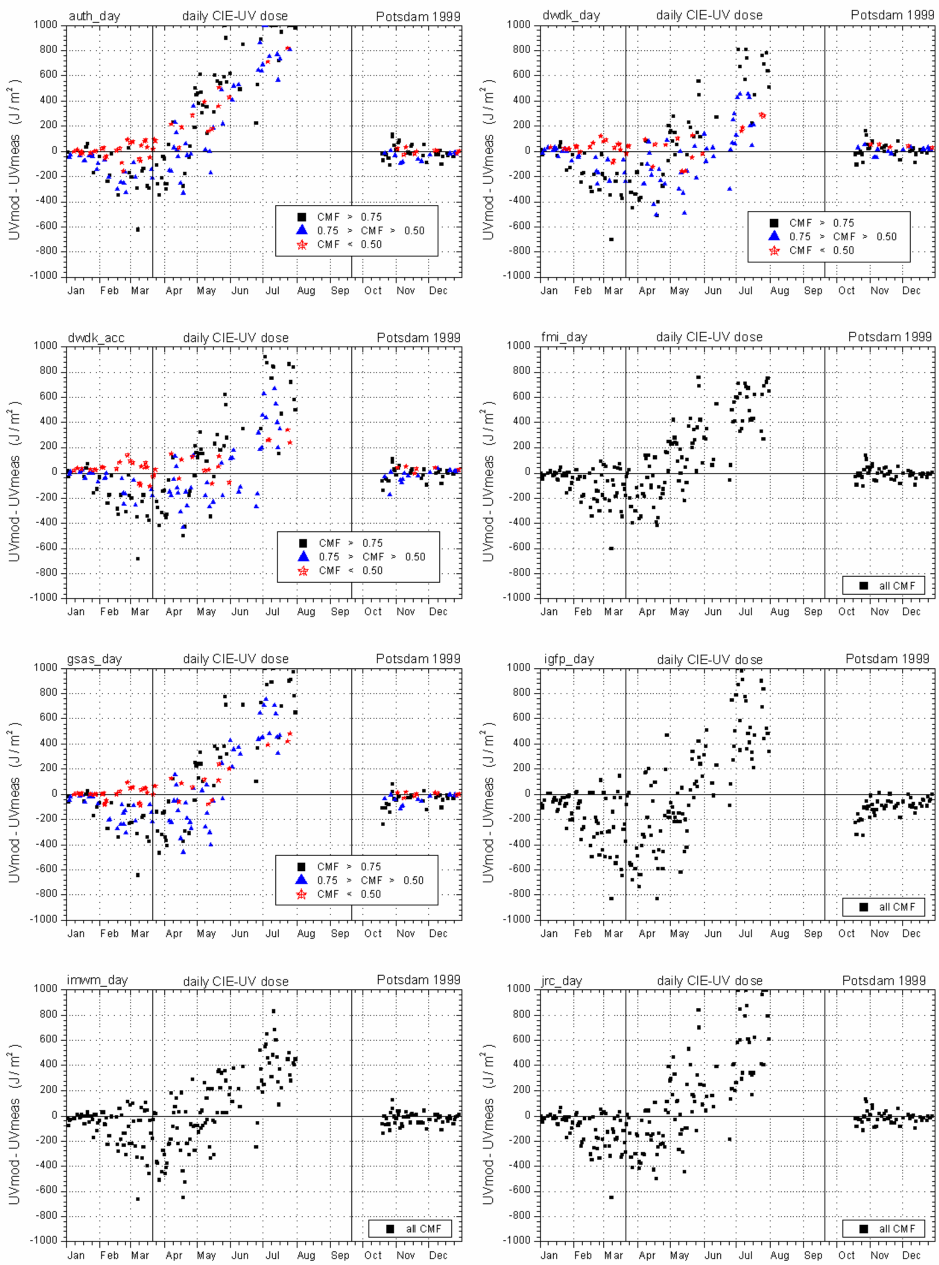

Fig.3 Absolute differences between modelled and measured CIE-UV radiation daily doses calculated for Potsdam 1999. If clear-sky CIE-UV radiation was available, the data points are sorted with respect to cloud modification factor (CMF) calculated as a ratio between modelled and clear-sky CIE-UV daily dose if it was available. Abbreviation of models is above the left corner of plots.