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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Hourly resolved cloud modification factors in the ultraviolet" *by* H. Staiger et al.

Anonymous Referee #1

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The method described in the manuscript estimates erythemal UV Indices (UVI) under clouds by multiplying modeled clear-sky UVIs with cloud modification factors (UV_CMF). The parameterization of UV_CMFs was established using measured and modeled daily integrals of total irradiance and erythemal irradiance. The parameterization was developed with data from Bilthoven, the Netherlands. Although the parameterization is based on daily integrals, it was applied to instantaneous (hourly) measurements from six locations. While the paper demonstrates that this approach is adequate for estimating the UVI under cloudy conditions, I believe better results would have been achieved if the parameterization had been based on instantaneous measurements instead of daily sums. My assumption is supported by the authors, who admit on page 192, L12 that "an hourly application should result in slightly too high UV_CMFS for

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Interactive Discussion
Discussion Paper

small [cloud modification factors for total global radiation] (SPO_CMF)." To correct for the error resulting from applying a parameterization developed for daily doses to hourly samples, another parameterization is introduced (P196, L1-17, Eq. (5), and Figure 4). I believe this correction could have been avoided if the original parameterization had been based on hourly data.

In my opinion, data from Bilthoven could have been easily used to develop a parameterization based on instantaneous data. I suspect that this alternative parameterization would have the same form as Eq. (3), but employ a different exponent as well as different coefficients for the parameterization of p(SZA) (Eq. (4)). The authors should explain why they chose their parameterization rather than this alternative (and in my opinion obvious) approach. I encourage the authors to develop the suggested alternative parameterization and apply it to a subset of data from one of the six locations. If results obtained with the alternative method lead to better results, a recalculation of the paper's data should be considered. I realize that this is a lot of work but the reward is a higher accuracy when the methodology is operationally applied to UV forecasting schemes.

The abstract should be shortened substantially. Particularly lines 6-13 can be omitted or moved to the introduction.

Sections 2.2 - 2.6 provided ample information on UV data but little information on total global radiation measurements. At least the instrument types should be mentioned. If possible, also the uncertainty of total radiation measurements should be specified. Some of the information on UV has been published elsewhere. The sections could be shortened by citing this material.

Section 4.3.2. (Taylor diagram) is hard to understand, in particular the smoothing schemes described on page 199. I believe the main purpose of Section 4.3.2. is to compare the results of the paper with those described by Koepke et al., [2006], which are based on daily doses. It would have been better to calculate daily doses from the

ACPD
8, S1–S8, 2008

hourly data, and compare the performance of this data set with the results presented by Koepke et al. [2006]. With this approach, the parameters of the Taylor diagram would be consistently based on the day-to-day changes for all data sets. This approach would also eliminate the somewhat obscure smoothing scheme. If smoothing is used, all data sets have to be treated equally to ensure a fair comparison.

The standard of English is mostly adequate, but needs to be improved in some parts. There are many run-on sentences, which should be split in two. Punctuation is frequently inaccurate. Some suggestions for improvements are provided below. I strongly recommend that the paper is proofread by a native English speaker.

The font used for figures, and in particular figure legends, is generally too small. Legends will be unreadable if figures are not changed for the ACP print (PDF) edition.

Specific comments

P183, L3: I doubt that clouds can enhance UV radiation (and in particular erythemal UV) by a factor of two or more. Such enhancements are only possible for visible radiation. If the authors believe that such large increases are possible in the UV, a reference should be provided.

P183, L18: Snow can have a very large effect on UV transmission (or CMFs). In particular over high-latitude ice sheets, albedo moderates the effects of clouds considerably. See for example: Nichol et al., Moderation of cloud reduction of UV in the Antarctic due to high surface albedo. J. Appl. Meteorol., 42(8), 1174-1183, 2003.

P184, L4: is always modelled -> is typically modelled (clear sky data can also be based on a climatology based on historical clear-sky data)

P182, L25: The phrase "a measured mean smoothed dependent on SZA" is incomprehensible

ACPD
8, S1–S8, 2008

P188, L25: A silicon diode is only sensitive to about 1200 nm. Instruments for measuring total radiation should be sensitive to at least 3000 nm. Was there a correction applied? What is the uncertainty of the measurements?

P190, L12: Change "Measurements are likely to underestimate the actual irradiance at high SZA" to "Due to incomplete corrections for the instrument's cosine errors, measurements are typically smaller than the actual irradiance at high SZA" (If this is meant).

P190, L20: Is Eq. (2) applied to data of all sites? If so, why is a parameterization that was developed for Bergen appropriate for other sites?

P192, L14-22: The algorithm by den Outer et al. [2000] is not being used in Section 4 (the ESRA method is being used). Why is the description of the den Outer method necessary?

P194, L23: "somewhat" is a trivialization. I estimate that the model overestimates the measurements by about 10%.

P195, L18: I don't see much difference between the 1999 and 2002 data sets for Thessaloniki.

P195, L25ff: I don't understand why applying Eq. (3) with an hourly resolution is a particular problem for the clean-air site Lauder.

P196, L11-17: Is this parameterization specific to Lauder or can it be applied to other locations also?

P196, L22: I doubt that it is meaningful to calculate the RMSE from all data points considering that measured values vary over a large range. How was the bias (alias "absolute difference") calculated? Was it "SUM (modelled - measured)," where the summation goes over all data points? In this case, the results would be dominated by the largest UVIs and the numbers would say little about the agreement at low radiation levels. Rather than presenting Table 2, it would be more interesting to calculate statistics from the results shown in Figure 5. For example, the average bias and stan-

ACPD
8, S1–S8, 2008

dard deviation (both absolute and relative) could be calculated from data contributing to 10°-wide SZA-bins, and presented in a table.

P198, L28: "The smoothed ..." I don't understand this sentence. What is meant with "a window of the next 12% of the data"?

P199, L8: "If it would ..." I don't understand what is meant here - rephrase.

Technical corrections:

P 182, L16: bases -> basis

P184, L2: in the cloudy sky -> under the cloudy sky

P184, L15: I don't understand the sentence: "This algorithm is conforms ..."

P184, L18: parameters as liquid -> parameters such as liquid

P184, L19: The subordinate clause "... which are less ..." should be rephrased

P185, L3: Delete "Natural Resource ...80523" This information is already provided in the acknowledgements. Change sentence to: "Measured erythemal UV and total global radiation from the Everglades, Florida, and Lauder, New Zealand, were downloaded from ..."

P185, L21: Rephrase: "Hourly sums of global radiation are used ...[...] ... The latter enables the calculation of ..."

P186, L4: Delete "Provided"

P186, L4: Provide reference for CIE 1987 action spectrum; Rephrase: "... by taking into account the ..."

P186, L23: Either delete "PMOD" or spell out "Physikalisch-Meteorologisches Observatorium Davos"

ACPD

8, S1–S8, 2008

Interactive Comment

P187, L18: appears too low -> appears to be too low

P188, L24: is the base -> is the basis

P189, L1: Rework the phrase: "... from the ...UTC h"

P189, L2: ozone -> ozone data

P189, L7: Rework the phrase: "... and is in the used ..."

P189, L9: The NIWA's -> NIWA's

P189, L14: ozone -> ozone data

P190, L1: Change to: "This assures that deviations between measured and actual profiles are less than 3% ..."

P190, L3: "... calculated adjusting ..." -> "... calculated by adjusting ..."

P190, L13: "Models as STAR ..." -> "Models such as STAR..."

P190, L13: Replace "spherical" with "model"

P190, L20, Equation (2): Remove superscript "+" from mu_Zˆ+

P190, L23: "... in UV ..." -> "... in the UV ..."

P192, L3: "... last 6d." -> "... last 6 days."

P192, L14: "... clear sky valid ..." -> "... clear sky value valid ..."

P192, L18: Delete "given"

P193, L2: "... from the both ..." -> "... from both ..."

P194, L15: Change to: "This is performed by integrating the ... and plotting them ..."

P194, L17: "... be a close envelope ..." -> "... form a tight group ..." or "... form a tight cluster of points ..."

ACPD

8, S1–S8, 2008

P193, L26: "The absolute low ..." -> "The low absolute ..."

P194, L3: Change to: "At Potsdam, the envelope of measured daily doses closely matches the clear-sky model results both for global and UV radiation ..."

P194, L5: Change to: "For Davos, only the data set for 2002 is shown because Davos ..."

P194, L6: Change to: "... sums are close to the highest daily doses measured."

P194, L6: Change to: "... may be derived from the differences of modelled clear-sky sums of total global radiation and the upper limit of the measured daily doses."

P194, L13: Change to "... (˜6.0) than in June and August (˜4.5)."

P194, L13: overestimates -> overestimate

P194, L26: "... the modelled UV doses clear sky ..." > "... the modelled clear-sky UV doses ..."

P195, L8: Change to: "However, the maximum UVI observed at Everglades and Lauder are comparable due to the smaller Sun-Earth distance in the southern hemisphere during summer. Despite the difference in latitude between Davos and Thessaloniki, maximum UVIs at the two sites are similar due to the larger altitude of Davos."

P195, L11: Change to "... ideal value of one. Exceptions are Everglades (due to the overestimated clear sky total global radiation) and the 2002 data set for Bergen because of the degradation of TOMS: TOMS total ozone values of the year 2002 have an error of -2% to -4% for latitudes higher than 50°, which is more pronounced in the northern hemisphere."

P195, L16: Split sentence in two (or three).

P195, L22: "... load that is ..." -> "load. In Europe, these conditions are more ..."

P196, L2: Change to "... applying Eq. (3) - which was originally developed for daily

ACPD
8, S1–S8, 2008

doses - for hourly data."

P197, L13: Split sentence in three!

P197, L26: "... reduced due to lacking measured UV ..." -> reduced because UV data for January and February (months with small UVI) are not available."

P197, L27: "The too high ..." Sentence is incomprehensible.

P198, L12: "... deviation normalised ..." -> "...deviation of the modeled data normalised ..."

P198, L14: "... and is indicated by a red triangle ..."

P198, L15: Include citation of Taylor (2001) after "pattern RMSE difference" since this is a term defined by Taylor rather than a standard term in statistics

P198, L18: "There is a strong ..." I don't understand this sentence - rephrase

Figure 1: Change to " Data are from 183 European sites and include measurements from 2000 and 2001."

Figure 2a: Change to: "Daily global irradiation (left) and daily erythemal UV doses (right). Measured data were integrated from hourly observations and are indicated by black squares. Clear-sky model values are indicated by red lines."

Figure 6: Please emphasize that symbols A - K denote different models of the Koepke et al. [2006] paper.

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 181, 2008.