Response to the Reviewer 1 comments and suggestions

The following statement (here in italics) summarises the opinion of reviewer 1 in the 'General comments' section of his review of the manuscript:
"*In general, the presentation of the manuscript is clear and logical. Overall, the manuscript is well written and informative, deserving for publication*."
Thus, the authors' response to reviewer 1's opinion includes responses to specific/technical comments, which in his words are ""*Specific and minor comments on formal aspects, mainly asking for explanations and for improving readability*". These are as follow

1. *Consider including, in the introduction, and if possible, a short revision for long available series of UV and erythemal data. The reference to Chubarova et al. (2000), which appears in Section 4, can be included there*.

Responding to this comment we add following text to the introduction

"Long-term series of surface UV radiation from ground-based observations with a length of at least a few decades are rare. To the authors' knowledge, the longest UV monitoring series began in Moscow in 1968 with a broadband (300−380 nm) instrument developed at the Moscow State University Meteorological Observatory (Chubarova et al., 2000). One of the world's longest measurements of solar UV radiation at the Earth's surface (and probably the longest taken by erythemal broadband instruments) comes from Belsk. Measurements began in 1975 and continuous monitoring started on 1 January 1976. From a global perspective, the first UV monitoring results appeared at the World Ozone and Radiation Data Centre (WOUDC) in 1989, but continuous time series over three decades are only available for a limited number of stations including: Uccle (Belgium), Edmonton, Resolute, Toronto, Churchill, Saturna Island (Canada), Tateno (Japan) and Syowa (Antarctica) (WOUDC 2025). Database Network for the Detection of Atmospheric Composition Change (NDACC) include also stations with at least of three decades of measurements such as Lauder (New Zealand), Mauna Loa (USA) and three Antarctica stations – Arrival Heights, Palmer Station and South-Pole (NDACC 2025)." L. 86-97

2. *The different periods and instruments operating along time are repeated several times along the text. Would it be possible to present a table schematising the time periods, instruments, references, the ancillary information used, and methods/models applied*?

A new Table 1 has been added to the text explaining the instruments and data used in the manuscript. L.172

Table 1. The Belsk's instruments and their working periods.

Data	Instrument/data	Operation period	Reference
Daily ERE and UV Index	Robertson Berger Meter	1976−1994	Krzyścin et al. (2024)
	SL Biometer 501 A # 927	1992−1994	
	SL Biometer 501 A # 2011	1995−2013	Krzyścin (2024)
	Kipp-Zonen UV-AE-T # 30616	2013−present	
TCO_3	Dobson Spectrophotometer # 84	1963−present	Krzyścin (2024)
SunDur	Campbell–Stokes sunshine recorder	1966−1968, 1970−1973, 1975−present	Krzyścin (2024)
G	Kipp CM 6	1965−1980	Krzyścin (2024)
	Sonntag PRM-2	1981−1987	
	Kipp&Zonen CM 5	1988−1991	
	Kipp&Zonen CM 11	1992−2010	
	Kipp&Zonen CM 21	2010−present	
AOD_{340nm}	Sonntag pyrheliometers	1976−2013	Krzyścin (2024)
	CIMEL CE 318-T	2004−present	
G and G_0	ERA5 reanalysis	1940−present	ERA5 (2025)
G_0	MERRA-2 reanalysis	1980−present	GMAO (2025)

3. *Lines 11-12. I suggest moving the parentheses "(i.e. energy weighted…)" before "reaching the Earth's surface…"*

In the revised manuscript, these lines have been changed to:

"However, homogenisation of the amount of biologically effective solar energy (i.e. energy weighted according to the sensitivity of the selected biological process to solar radiation) reaching the Earth's surface over long periods is challenging due to changes in measurement methods and instruments." L.10-13.

4. *Lines 28 and 54-56. Clearness index is usually defined (e.g. Liu and Jordan, 1960) as the ratio between horizontal global irradiance and the extraterrestrial (top of the atmosphere) irradiance. Instead, the authors use the clear sky index: i.e. the ratio between actual horizontal global irradiance and that corresponding to clear sky conditions (which can be simulated). I suggest using the denomination 'clear sky index', instead of 'clearness index'.*

Clear-sky index has been used in the revised manuscript instead of "clearness index" :

"….the clear sky index (CI) (i.e. a quotient of the all-sky global solar irradiance (G) at the surface and the corresponding synthetic clear-sky value (G_0) to account for combined cloud/aerosol scattering effects on UVR)". L. 56-58

5. *Line 91. "well-maintained Brewer". I suggest saying something about the Brewer maintenance and stability.*

A reference to our previous paper of the Belsk's Brewer instrument explaining its maintenance and stability has been added.

"The details of the Brewer maintenance can be found in Czerwińska and Krzyścin (2024a)". L105-106.

6. *Line 120. What's the meaning of 'pre-calibrated'?*

The word "pre-calibrated" has been replaced by "roughly" (see l. 154) to better reflect the status of constants for instruments supplied by the biometers manufacturers. It is clear from our long experience with many instruments that such producer constants required considerable re-evaluation.

"Subsequent UVR measurements included SL501 A # 927 (1993−1994) and #2011 (1995−2013), which were only roughly calibrated by the instrument manufacturer prior to shipment" L.135-136

7. *Line 147. 'radiance' Do the authors mean 'radiation'?*

Yes. It should be "radiation".

"To validate the corrected UV observations at Belsk, the long-term variability of BE radiation was also obtained from the UVR reconstruction models (Section 2.3) using proxies (TCO_3 and DCI) from the ground-based observations and reanalysis datasets". L.164-165

8. *Lines 177-178. Add (eryt), (vitD3), (psor) in the Figure caption, as appears in the plot legend.*

"eryt", "vitD3", and "psor" have been added to Fig.1 caption.

"Figure 1. Normalised action spectra for the specific biological effects: erythema appearance (eryt), photosynthesis of previtamin D_3 in human skin (vitD3), psoriasis clearing (psor). " L. 197-198.

9. *Line 199. Why the authors want to "allow for greater variability in the CC values"? I think the sentences in lines 514-519 do contribute to clarify this question. Thus, I suggest to move that explanation to Section 2.3.2.*

In the submitted manuscript we had "…In order to allow for greater variability in the CC values, different criteria for clear sky conditions were applied, and the smoothing procedure was applied to the long (1976−2013) and short (1993−2013) UV time series for the CC1 and CC2 versions, respectively. " This statement has been rewritten following the reviewer's suggestion:

"Different criteria for the selection of cloudless days would result in even greater differences between the two CC versions. In addition, the smoothing procedure was applied to the long (1976-2013) and short (1993-2013) UVR time series for the CC1 and CC2 versions, respectively. We would like to have two different sets of correction coefficients to find out how the long-term pattern of biologically effective radiation is sensitive to the corrections." L. 234-237.

The sentence (l. 515-519 in previous manuscript) has been moved to Sect. 2.3.3.

"Model simulations of erythemal DRE and noon UVI under cloudless sky provide a basis for the correction procedure of the past UVR data. A selection of clear-sky conditions throughout the entire day from the daily proxy values (relative sunshine duration and DCI), which were available for Belsk, is not straightforward as only the examination of the daily course of these measurements would allow to capture cloudless moments within the day. Thus, two different sets of correction coefficients are proposed, called CC1 and CC2.". L.203-207

10. *Line 231. Reference to Outer (2010) appears as 'den Outer' in the references list (and in line 58).*

"Outer" in line 58 has been replaced by "den Outer" in the revised manuscript (L.60).

11. *Lines 247-248. Include in the heading of Table 1 some reference to the Mod1 empirical model.*

The heading of Table 2 (Table 1 has been added) has been changed to:

"Table 2. Estimates of the regression coefficients, α and β, describing the attenuation of erythemal DRE by the empirical model, Mod 1, defined by Eqs. (5−6), for the three SZA ranges at noon (SZAn). L. 285-286

12. *Section 2.4. Why the authors use statistics over relative values (z_i) and not directly over the values? Could this be biasing the results by giving excessive weight to low values?*

The relative values (in percent of the reference annual level from the observed data) are used after summing all the daily (Mod1) and monthly (Mod2 and Mod3) erythemal radiant exposures (in J/m2) over the whole year and summer for each year between 1976 and 2023. Therefore, the bias mentioned above is not present in this case.

13. *I suggest, when assessing agreement between two series or sets of data, defininig the relative difference by subtracting the reference values in the numerator: this would change the sign of the differences, giving positive values when the tested value overestimates with respect the reference value.*

Eq.(9) has been modified as suggested by the reviewer and the results in the following Tables 4-5 and A1 have different signs for the mean relative deviation.

14. *Also, I suggest using the term 'deviation' instead of 'error'; this would lead to use MRD, MAD, SD and RMSD instead of MRE, MAE, SE and RMSE.*

We agree and the reviewer suggestions has been applied (note new definitions by Eqs. (10−13 and MRD, MAD, SD, and RMSD in Tables)

15. *Line 339. The reference to LOWESS has been already given in line 195.*

This has been corrected and LOWESS definition is in line 219.

16. *Line 609. Reference to Blumthaler et al. (1989) should be before those to Borkowski.*

In the revised manuscript, Blumthaler et al. (1989) appears before Borkowski (1998).

Reviewer 2

General comments:

Reviewer 2 stated that the manuscript needed to be improved before publication, as indicated in the text below:

"*I endorse the publication and feel that the journal of Earth System Science Data is an appropriate place to present this important dataset. However, I also feel that the presentation needs to be improved. The manuscript is not an easy read, in particular Section 2.3.4. Readability and usefulness of the article could be greatly enhanced if the authors were to better describe the principles of the correction methods in one or two sentences at the start of each subsection before delving into details. I also find that the nomenclature is sometimes confusing as explained in more detail in my specific comments*."

To improve the manuscript, we have added explanations at the beginning of the following sections:

- Sect.2.3.1:

"Radiative transfer model simulations for clear sky conditions are used to quantify and correct biases in the output of the Belsk UVR radiometers. To speed up the calculations, the look-up tables were obtained using the Tropospheric Ultraviolet and Visible (TUV) Radiative Transfer Model (TUV, 2024)." L. 184-186.

- Sect.2.3.2

"Model simulations of erythemal DRE and noon UVI under cloudless sky provide a basis for the correction procedure of raw UVR data. A selection of clear-sky conditions throughout the entire day from the daily proxy values (relative sunshine duration and DCI), which were available for Belsk, is not straightforward as only the examination of the daily course of these measurements would allow to capture cloudless moments within the day. Thus, two very different sets of correction coefficients are proposed, called CC1 and CC2." L.203-207

- Sect.2.3.4

"The CCs described in section 2.3.2 were obtained for cloudless conditions and applied to all-sky conditions, where the contribution of the diffuse part of the radiation increases with cloud cover and dominates under overcast conditions. It cannot be excluded that the instruments used to monitor UVR at Belsk have their own specific characteristics for recording diffuse radiation, and that CF^{*}_{EFF} and CF_{EFF} in Eqs. (3−4) should also depend on the combined characteristics of clouds and instruments. To test whether this is the case, we investigated how different regression models, which were trained using the UVR data collected between 2014 and 2023 (for this period, the quality of the broadband radiometer was confirmed by the Brewer Mark II observations), reproduce the daily doses of erythemal radiation throughout the 1976-2023 monitoring period.

The first model (Mod1) is based on clear-sky spectra determined with the RT model discussed in Section 2.3.1 and a cloud modification factor (CMF) derived from DCI data. The second and third models (Mod2 and Mod3) are based on TCO_3 and DCI data evaluated on a monthly basis. TCO_3 and DCI were either taken from observations at Belsk (Mod2) or ERA5 reanalysis (Mod3)." L. 257-268.

We have done our best to improve the readability and usefulness of the manuscript by responding to the reviewer's specific and technical comments

Specific comments

"*L14, L37: I believe the term "biometer" is only used by Solar Light and Yankee Environmental Systems but no other companies. Since the authors also present data from the original Robertson-Berger meter and the Kipp and Zonen UV radiometer, it would be good to use a more neutral term such as "broadband radiometer with erythemal response*".

In the revised text we use the "more neutral term" - erythemal broadband meter (or radiometer). These term has been widely used in the literature when discussing different types of instruments that measure erythema-weighted UV radiation. For example, see the titles of the papers by Hülsen, and Gröbner (2007) Gröbner et al., 2009, Schmalwieser et al., 2022) that appear in the references. In the text, "biometer" appears only when the Solar Light instruments with the commercial name containing the word "biometer" are discussed.

L25-28: This should be better explained. First state that two different homogenization methods were applied to the measurements of the various instruments to derive a consistent dataset for the period 1976–2023. Then state that this dataset was further validated by reconstructing independent datasets of DRE and the UV index from proxy data (i.e., total column ozone, aerosol optical depth, and the global irradiance clearness index). When I first read the article it was not immediately clear to me what the "three regression models" entailed.

These sentences have been changed. In the revised manuscript, we explain that:

"Three regression models of the erythemal data on common UVR indices (total column ozone, aerosol optical depth and global clear sky irradiance index) were used to reconstruct the UVR data from the beginning of the Belsk observations, allowing further validation of the homogenised UVR data" . L.27-30

L68: Please provide a reference for the "Dave-Halpern model". (It is not clear whether the reference Słomka and Słomka (1985) also includes a description of this model.).

Reference to Dave-Halpern model (Dave and Halpern, 1976) has been added (L.69-70)

L88 and L188: The UV index is not the midday value of erythemal irradiance. It is erythemal irradiance multiplied with 40 m2/W.

These two lines have been corrected as UV index is a dimensionless measure of the erythemal irradiance. In the revised manuscript, we have:

"The re-evaluation for the period 1976−2013 is based on a comparison of the measurements with the synthetic daily erythemal radiant exposure and UV index at noon from a radiative model simulation". L.101-103

"For the first period, only the erythemal DRE were archived, whereas for other periods daily maximum of UV index (UVI_{MAX}) was also available (equal to the value of erythemal irradiance at noon during a cloudless day)." L. 211-213

L103: Why "May 1975"? I thought measurements started in 1976 according to the paper's title?

The first observation by the erythemal broadband radiometer was in May 1975, and the regular monitoring started on 1st of January 1976. This was explained in the revised text:

"Recording of erythema irradiance with a standard RB meter (detector recorder No. 40) started in May 1975 at Belsk, but continuous monitoring began on 1 January 1976 and lasted until 1994" L.117-118

L138: A symbol for the "daily CI" should be introduced, such as CI_d. I got confused later in the manuscript because I recalled from line 54 that CI is an instantaneous measurement while later in the manuscript all modelling is based on the daily CI.

In the revised manuscript, DCI abbreviation appears when discussing the daily values of clear-sky index. DCI was defined as follows:

"The daily representative of CI, DCI, which is further used in regression models (Sect. 2.3.4), is calculated as the quotient of the daily integrals (sunrise to sunset) of G and $G_{0,}$" L. 156-157

L147: "To support the quality of the UV observations at Belsk," > "To validate the corrected UV observations at Belsk"

OK. The statement has been changes according use the reviewer's suggestion. L.164

L166: To improve readability, start this section with describing what the radiative transfer model is used for. For example, state that the TUV radiative transfer model is used to quantify and correct biases in the UV radiation measurements of the radiometers.

We added the following lines, taking into account the reviewer's suggestion.

"Radiative transfer model simulations for clear sky conditions are used to quantify and correct biases in the output of the Belsk UVR radiometers. To speed up the calculations, the look-up tables were obtained using the Tropospheric Ultraviolet and Visible (TUV) Radiative Transfer Model (TUV, 2024)." L. 184-186.

L179: Why are you using the monthly mean AOD? Why not higher frequency? Why not use daily AOD on days where AOD is available?

AOD measurements were infrequent (a few per month), especially before the start of automatic AERONET measurements in 2004. We use monthly averages to account for the atmospheric cleaning trend resulting from the government's policy to reduce atmospheric pollution from anthropogenic dust.

L180-181: "RE_EFF,Clear−Sky" > "RE_EFF,CS". ("CS was used earlier to indicate clear sky, please use consistent acronyms of variables throughout the manuscript).

OK. It has been corrected according to the reviewer's comment.

L193: Regarding "for the days when clear sky conditions can be assumed from the ancillary data.": Do you mean days that were clear sky from sunrise to sunset? If not, please clarify.

Yes, the clear sky day is from sunrise to sunset. This statement has been changed to make it clear:

"…for days when ancillary data indicated that the sky was clear throughout the day" L. 217-218.

L192-198: The terms "multiplier" and "calibration coefficients" are not clear and this caused confusion when I first read the manuscript. What you define as "raw erythemal data" on line 192 are not really raw data (which would be volts or amps). They are calibrated data (e.g., erythemal exposure or the UV index) affected by drifts and other artefacts. So what you refer to as "multipliers" or "calibration coefficients" are actually correction factors that are applied to calibrated data. I may sound picky pointing this out, but by using more appropriate terms, the readability of the manuscript could be greatly improved. The term "calibration procedure" that you use on line 192 should also be changed to "correction procedure". To be consistent with this new nomenclature, CC1 and CC2 should also be renamed to CF1 and CF2 for correction factor 1 and 2. (Although this suggestion would be in conflict with using CF for "conversion factor" in Section 2.3.3. So please be creative and find nomenclature that better describes the various factors than that are used in the manuscript.) Also, what does "locally weighted" mean on line 194?

According to the reviewer's comments, in the revised manuscript, the "calibration coefficients" have been changed to the "correction coefficients" and consequently "calibration procedure" has been replaced by "correction procedure". In addition, "Locally weighted" is the name of the smoother introduced by Cleveland (1979). To make it clear, the previous sentence (l. 194)) has been replaced:

"LOcally Weighted Scatterplot Smoothing (LOWESS) proposed by Cleveland (1979) was used to extract the smoothed pattern of the multipliers…" L.218-220

L199: Why would you "allow for greater variability in the CC values". Ideally, the CC values are the best estimate of the correction for a given day. Why would you like to have "greater variability" for this correction?

We would like to have two different sets of the correction coefficients to find out how the results (long-term pattern of biologically effective radiation) are sensitive to such corrections. The statement " allow for greater variability in the CC values" has been deleted and replaced by the following one:

"Different criteria for the selection of cloudless days would result in even greater differences between the two CC versions. In addition, the smoothing procedure was applied to the long (1976-2013) and short (1993-2013) UVR time series for the CC1 and CC2 versions, respectively. We would like to have two different sets of correction coefficients to find out how the long-term pattern of biologically effective radiation is sensitive to the corrections." L. 234-237.

L201: "Accordingly, the following conditions were applied for the selection of clear sky sets:" > "The following conditions were applied for the selection of clear sky data used in the two correction methods:"

The statement proposed by the reviews has been used in the revised manuscript. L.221-222

L207-208: CC2 is based on UVI at noon. If so, why does this depend on sunshine hours for SZA < 85. Whether or not the Sun is shining at times other than noon is irrelevant for the noontime UVI. (If I understand correctly, you only need to ensure that there is clear sky at noon when the comparison between the measurements and model takes place).

Yes, reviewer 2 got it right. The information on all-day clear-sky conditions indicated that this maximum occurred at midday. This means that we can model the irradiance at solar noon.

L209-210: I don't understand this sentence. How can a recalibration in 2011 be informative for a period prior to 1 January 1993? Do you mean that data collected prior to 1993 were assessed in 2011?

The original RB data (1976-1992) were fitted to the reconstructed DRE with a regression model using TCO_3 and G_o as explanatory variables (see Eq. (5) and Figs. (5-6) in Krzyścin et al. (2011)). Figure 6 (this manuscript) confirms that the calibration of the RB data in 2011 was correct, so the current CC2 values can be set to 1 for the entire RB measurement period. The following statement has been added to explain this approach:

"Prior to this date, a re-evaluation of the RB data with a model mimicking the KZ radiometer measurements by Krzyścin et al. (2011) showed that the correction was not necessary, i.e. CC2=1. This choice is also confirmed here by the constant long-term patterns of CC1 in the period 1976-1992 (Fig. 6a), and only a small jump in the differences between CC1 and CC2 in 1992/1993 (Fig. 6b)" L. 230-233.

L220-225: "current D day" > "day D". (If I understand correctly, D indicates a specific day within the period 1996-2023. So it is not the "current" day.) Also the meaning of the asterisk in D is a bit murky. You may say that the course of the SZA on a given day of the year is more or less the same in every year. Hence, the conversion factor only considers the TCO for the day in question plus the course of the SZA for the day of the year that corresponds to that day.*

Yes, we assume that the course of the SZA on a given day of the year is more or less the same in every year, so the multipliers of the erythemal daily radiant exposure depend on actual TCO3 and Julian day of the year (denotes as JD in the revised manuscript). The avoid misunderstanding of previous notation (D and D*) we rewrite the text using notation YY, MM, DD for the calendar day and JD for the corresponding Julian Day:

"Following this concept, the daily radiant exposure for previtamin D_3 synthesis and psoriasis clearance in year (YR), month (MM), and day of month (DD) $RE_{VITD3}(YR, MM, DD)$ and $RE_{PSOR}(YR, MM, DD)$, were estimated using the daily conversion factor, CF^*_{EFF}, applied to the erythemal DRE ($RE_{ERYT}(YR, MM, DD)$):

$$RE_{EFF}(YR, MM, DD) = CF^*_{EFF}(TCO_3, JD) \times RE_{ERYT}(YR, MM, DD),\ EFF = \{VITD3, PSOR\}, \quad (4)$$

where CF^*_{EFF} depends on TCO_3 and JD (Julian day number corresponding to the current day YR:MM:DD). CF^*_{EFF} and CF_{EFF} values were obtained from radiative transfer model simulations. The time series (1976−2023) of the

conversion factors, $RE_{EFF}(YR, MM, DD)$, and the corresponding noon value of the biologically effective irradiance $Ir_{EFF}(t = \text{noon})$ have been archived in the IG PAS Data Portal (Krzyścin, 2024).“ L. 247-255.

L229-230: This sentence should be improved and extended. Please better describe what you did, e.g.: “We developed several regression models from data of the period 2014−2023 by correlating measured radiant UV exposures against UV exposures calculated from proxy data such as TCO and the daily clearness index. We then applied these regression models to proxy data of the entire period (1976-2023) to provide a quality measure of the corrected UV datasets.” Since three regression model are considered, these should also be briefly introduced here so that the reader knows what to expect in the remainder of this section. For example: “The first model (Mod1) is based on clear-sky spectra determined with the RT model discussed in Section 2.3.1 and a cloud modification factor derived from CI data. The second and third model (Mod2 and Mod2) are based on TCO and short-wave irradiance (G) data evaluated on a monthly basis. TCO and short-wave irradiance were either taken from observations at Belsk (Mod2) or ERA5 reanalysis (Mod3).”

The mentioned sentences have been replaced by new text following the reviewer’s comments:

“The CCs described in section 2.3.2 were obtained for cloudless conditions and applied to all-sky conditions, where the contribution of the diffuse part of the radiation increases with cloud cover and dominates under overcast conditions. It cannot be excluded that the instruments used to monitor UVR at Belsk have their own specific characteristics for recording diffuse radiation, and that CF^*_{EFF} and CF_{EFF} in Eqs. (3−4) should also depend on the combined characteristics of clouds and instruments. To test whether this is the case, we investigated how different regression models, which were trained using the UVR data collected between 2014 and 2023 (for this period, the quality of the broadband radiometer was confirmed by the Brewer Mark II observations), reproduce the daily doses of erythemal radiation throughout the 1976-2023 monitoring period.

The first model (Mod1) is based on clear-sky spectra determined with the RT model discussed in Section 2.3.1 and a cloud modification factor (CMF) derived from DCI data. The second and third models (Mod2 and Mod3) are based on TCO_3 and DCI data evaluated on a monthly basis. TCO_3 and DCI were either taken from observations at Belsk (Mod2) or ERA5 reanalysis (Mod3).” L. 257-268

L233: The CI was defined on line 55 as the "quotient of the all-sky global solar irradiance (GSI) at the surface and the corresponding synthetic clear-sky value to account for combined cloud/aerosol scattering effects." Hence, CI is a function of the instantaneous irradiance not a daily value, as CI(D) implies. So what is CI(D)? is it a daily average? Clear definitions of CI, CI(D) and CMF should be provided. (If CI(D) is the daily average, CI(D) is not a good acronym as such a notation would mean “instantaneous clearness index as a function of day D” with D being the argument of CI. CI_D would be a better variable name. (Underscore indicates a subscript.))

CI was mentioned in Introduction as a possible proxy to model the biologically effective irradiance. As our models estimate daily erythemal radiant exposures for all-sky conditions, the daily clear-sky index (DCI) was applied further in reconstructions of the biologically effective radiant exposures. DCI was defined as:

“The daily representative of CI, DCI, which is further used in regression models (Sect. 2.3.4), is calculated as the quotient of the daily integrals (sunrise to sunset) of G and G_0” L. 156-157

L301: Figure 3a does not show a ratio, as the caption states, but is a correlation or scatter plot.

This statement has been rewritten. Taking into account the reviewer’s comment, we have:

" An example of such a monthly comparison (for June 2023) is shown in the scatter plot between the BS064 and KZ616 erythemal irradiances measured under clear-sky conditions (Fig.3a). In addition, Fig. 3b shows the monthly

ratios between these clear sky erythemal irradiances for the entire BS and KZ comparison period (2014-2023).". L. 334-337.

L330: Again the use of the term "calibration coefficients" is confusing in this context. Please use "correction factors" or something similar. (Thank you for using the term "correction method" on line 337 and not "calibration method"!)

In the revised manuscripts, when discussing the raw data multipliers, "calibration" has been replaced by "correction".

L336: "are proposed (Sect. 2.3.2) using" > "were proposed in Sect. 2.3.2 using"

Done. L.376

L341: Please specify range of the "former" period.

"Former" has been replaced by 1976-1992

"In the 1976-1992 period, UVI values were not archived." L.381

L355-356: Describe better and use different colors as those used in panel (a). What's shown are not differences between calibration coefficients but the difference "(Modelled RE - Observed RE) minus (Modelled UVI - Observed UVI)".

Different colours have been used in Fig.6a and Fig.6b (brown and black instead of blue and red). Term "difference" has been used (L.395).

L401: Regarding: "to fill gaps in the proxy data": Do you mean fill gaps in the measurements of the biometers? (I thought the ERA5 reanalysis data _are_ the proxy data.

ERA5 provides proxies (TCO3 and DGI) used in Mod3 to reconstruct monthly erythemal radiant exposures. Thus, the agreement between MOD2 (proxy from the measurements at Belsk) MOD3 means also possibility to simulate UVR for a site without ground-based measurements of the proxy values. The statement regarding 'gap-filling' has been removed as such 'filling' was not necessary.

L518: *I would not conclude that the CC1 and CC2 methods "very different." In fact, they are quite similar. Just one is based on daily exposure while the other one on the noontime UVI. If the responsivity of a biometer is off by a given factor, it would affect daily and noontime values equally. It is therefore not surprising that CC1 and CC2 results are similar.*

In fact, CC1 and CC2 are different as the former coefficients characterise the daily course of UV radiation but the latter ones are related to the maximum of erythemal irradiance usually near the noon. The UVR forcing variables, TCO3 and AOD, can differ throughout the day as these variables sometimes have large intra-day course, affecting values of the former coefficients.

L548: Did the instrument used by Chubarova also have an erythemal response or did it have a constant response over the 300-380 nm range? If the latter, the signal would be dominated by wavelengths in the UV-A; hence, the sensitivity to variations in ozone would be minimal.

The instrument used in Moscow was a broadband instrument and its output was mainly due to the UV-A part of UVR, which is weakly affected by atmospheric ozone. It cannot be used directly to quantify the risk of many biological processes that are sensitive to wavelengths in the UV-B range (290-315 nm) but can be used to parameterise cloud effects on UV-B in a reconstruction of the erythemal radiation.

L560-568: I would think that Sections 6 should come before Section 5.

According to submission guidelines of the journal, data availability should come before conclusions.

Technical comments

"*I presume the article will be prove-read by a copy editor. I therefore keep my comments regarding language to a minimum."*

All reviewer's comments have been incorporated into the revised text. They are as follows:

Always add "radiation" after "UV" or define "UVR" as "ultraviolet radiation" (e.g., in line 52, change "surface UV modelling" to "modelling of surface UV radiation") This comment applies to many instances.

'UVR' is defined (L. 43) and is used throughout the text.

L2, L166, 177: Change "erythema appearance" to just "erythema". The term "erythema appearance" is not commonly used.

The term "erythema appearance" has been replaced by "erythema".

L3: "from erythema biometers" > "derived from broadband radiometers with erythemal response" (The term erythema biometers does not describe the instrument and is not widely used.).

In the revised text, "from erythema biometers" has been deleted and replaced by "derived from erythemal broadband meter". L.3

L17: "the appearance of erythema," > "erythema"

The term "erythema appearance" has been replaced by "erythema".L.17

L40: penetrate > reach

Done. L.42

L41: "were destroyed" > "would be destroyed"

Done. L.43

L73. Please explain acronym "IG PAS" (presumably Institute of Geophysics of the Polish Academy of Sciences, but this is not mentioned).

This acronym was explained earlier in the text. L.68

L76: Mod > Model.

Done. L.78

L107: "MED=210 J_eryt m-2," > "1 MED=210 J_eryt m-2,"

Done. L.122

L126: proved > proven

Done. L.142

L137: "CI is a commonly used" > "The CI is a commonly used"

This expression has been replaced by:

"The daily representative of CI, DCI, which is further used in regression models (Sect. 2.3.4), is calculated as the quotient of the daily integrals (sunrise to sunset) of G and G_0". L.156-157.

CI has been defined earlier:

"the clear sky index (CI) (i.e. a quotient of the all-sky global solar irradiance (G) at the surface and the corresponding synthetic clear-sky value (G_0) to account for combined cloud/aerosol scattering effects on UVR)". L.56-58

L167: Move "irradiance at noon in day D" before "Ir_EFF"

Done. L.188

L172: "$Ir(\lambda, t)$" should be "$Ir\_CS(\lambda, t)$". Change "in time t for the wavelength" to "at time t and at wavelength"

Done. L.192

L192: "The calibration procedure" > "The correction procedure

Done. L.203-204

L204: "difference between observed sunshine duration and theoretical one" > "difference between the observed sunshine duration and the theoretical one"

This has been changes to:

"the daily difference between the observed and the theoretical maximum sunshine …". L.224

L205: "0.5 hour as for higher" > "30 minutes. This limit was chosen because broadband UV measurements at larger SZAs …"

Done. L. 225

L232: "that the erythemal" > "the erythemal"

Done. L.270.

L253: "in the UV explaining variables X" > "in variables X that affect UV radiation"

Done. L.292

L281: Opening parenthesis missing in the formula for F.

Done. L.321

L283: "(for Rk+1 <0, F=1):" > "If Rk+1 is smaller than 1, F is set to 1."

This has been replaced by the statement:

"F is set to 1 if the autocorrelation coefficient in the residual time series is negative." L.323-324

L304: (CC ver. 1) and What does "(CC ver. 1) mean? This was not defined earlier. Is this equal to CC1? Please use consistent nomenclature!

CC ver.1 appeared only here. This has been replaced by CC1. L.346

L307: What do you mean with "CF values" here? CF values were earlier defined as conversion factors from erythema to other weighting functions. I suspect you mean CC1 values here. Again, please use consistent nomenclature!

"CC1" has replaced misprinted "CF". L.349

L311: "as shown by the linear regressions close to the 1-1 perfect agreement line in the three scatter plots (Fig. 5)." > as shown in the scatter plots of Fig. 5, which indicate that Brewer and biometer data cluster about the ideal 1:1 line.

Done. L.353-354

L322: "used in routine" > "measurements used in routine"

Done. L.362

L369: see > Note

Done. L.413

L427: "determination coefficients" > "coefficients of determination"

Done. L.463

L436: thesis > hypothesis

Done. L.472

L497 comes > are

Done. L.90

L521: "as shown by the comparisons with BS64 data" > "because they agreed well with the BS64 data"

Done. L.539

L598-599: the title "References" appears twice.

The second "Reference" has been deleted.