Review of the paper:

THE INFLUENCE OF THE SPATIAL RESOLUTION OF TOPOGRAPHIC INPUT DATA ON THE ACCURACY OF 3-D UV ACTINIC FLUX AND IRRADIANCE CALCULATIONS

By:

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General comments

This paper presents both irradiance and actinic flux measurements and calculations in a mountainous region in order to study the influence of the spatial resolution of a digital elevation map on 3D radiative transfer calculations. Results are shown for 305 nm and for three case studies. I found the paper very interesting. It is well written and the subject is original and within the scope of ACP. The challenging geographical conditions to perform the measurements make it even more valuable. However, some important issues must be corrected or clarified. In brief (see below the detailed comments):

* I think there is confusion about what a higher resolution (or pixel size) means.
* I found difficult to correlate the main conclusions with figures 11-16.
* Some formulae and units must be corrected.

After addressing these points, I think the paper will be appropriate for being published in ACP.

Specific comments

Abstract

1. Introduction

* Page 27174, lines 12-13: The reference Rieder et al. (2008) is duplicated both here and in the reference list.
* Line 15: …to changes in cloudiness…
* Lines 17-18: I think that in the way the sentence is written it is incorrect. The text "solar zenith angle (SZA)" written between parentheses may be understood as a synonymous of the elevation angle when it is not (zenith angle is the complementary angle of the elevation angle). Then, the definition given in lines 18-19 corresponds to SZA, and not to the elevation angle. In any case, I think this basic definition is not necessary.
* Page 27175, line 28: in the reference Madronich (1987), the author does no deal with experimental measurements of actinic flux.
* Line 20: Do the authors mean: "these factors are not fully taken into account…"?
* Page 27176, line 27: McKenzie et al.
* Page 27177, lines 23-24: Please delete "previous" or "previously".

* Line 28: "…three case studies…"

2. Methods and data

2.1 Locations and measurement data

* Page 27178, line 27: "…were used:…"
* Page 27178-9, lines 27-1: How or why these specific days and times were selected? Have the authors run more calculations at other times? Do these days and times represent typical cases? Did the authors any statistics?

2.2 Model setup

2.2.1 1-D radiative transfer model

2.2.2 3-D radiative transfer model

Geometrical problems arising in 3-D model calculations: pixel discontinuity

* Page 27180, lines 20-22: at large SZA (i.e. close to 90º) the expression 1/cos(SZA) tends toward infinity (not to zero). At the end of the sentence please delete "sza".

Uncertainty estimations of 3-D model calculations

* Page 27181, lines 11-12: "…uncertainties in the model input parameters…"

3-D Model validation

* Page 27182, lines 8-9: did the author mean: "…showed UNCERTAINTIES … less than 13% for irradiance and less than 25% for actinic flux in the UVB?" or maybe they meant an agreement WITHIN 13% and 25%, respectively. If this is the case, does this uncertainty represent an average or a maximum value? In no case 25% is a small difference, but if this is an average value it would imply much larger differences between the 3-D model used in this work and the experimental measurements. How do these differences affect the conclusions of this work?

3. Methods and data

* Sections 2 and 3 have the same name

3.1 Effect on Parameters of digital elevation map resolution

3.1.1 Altitude

* Page 27182, lines 20-25: First, I consider that 50 m is a better resolution than 800 m. This is to say that when we go from 800 m to 50 m we are increasing the resolution and decreasing the pixel size. From this point of view, these sentences are confusing. For example, I understand that if the altitude goes from 1594 m at 50 m resolution to 2146 m at 800 m resolution, it is overestimated when the resolution decreases. Please check this point.

* Page 27183, lines 1-2: I guess the altitude input parameter is the surface elevation. I think the last term maybe a clearer one.

* Page 27183, line 5: "The decrease in altitude at higher DEM resolution,…". Please, see the comment about Page 27182, lines 20-25.

3.1.2 Changes to the horizon

* Page 27183, lines 11-12 and 15-16: In these lines, the concept of resolution and pixel size is properly used (according to my previous comments). Consequently, it is not consistent with what the authors stated before.

* Lines 16-18: When the authors state "the decrease" they are giving the sign or direction of the change, so that the minus sign is redundant (or even confusing). I would say a decrease of 3% or a change of –3%.

* Lines 21-22: Here the authors mention that the equation A11 is used to correct the irradiance values while in the figure caption equation A12 is mentioned. Please check and correct this point.

* Lines 23-28: Is the direct beam present at this solar zenith angle (57º)? Or are these effects only for the diffuse component? If the change in the horizon led to block the direct beam I would expect a much larger difference.

3.2 Influence of digital elevation map resolution on accuracy of UV irradiance and actinic flux calculations

3.2.1 Influence on geographical distribution of UV

* Page 27185, line 4: "… as the increase in…". Did the authors mean: "as the differences in…"? In any case I was surprised by increases (or differences) larger than 100% in irradiance and actinic flux only because the shading effect. Thus, could the authors please mention or explain the conditions which may lead to increases (or differences) larger than 100% in irradiance and actinic flux?

* Page 27185, line 7: "… to be between 0.3 and 2." I guess these are the results for actinic flux. Please add also the range for irradiance.

3.2.2 Influence on UV irradiance incident on horizontal planes at the selected stations

***** Page 27185, line 22-23: "…increasing DEM resolution…" or increasing DEM pixel size?

3.2.3 Influence of digital elevation map resolution on accuracy of UV actinic flux calculations

***** Page 27185, line 25-27: "The Sonnblick… valley station." I do not understand the sentence. Is it about Sonnblick or Kolm?

4. Conclusions

Among the main conclusions of this work authors state that:

* "the uncertainties increased with increasing DEM pixel size leading to calculated actinic flux values that were too high by up to 20%" (Page 27187, lines 25-26).

and also that

* "The DEM resolution required to obtain small uncertainties in 3-D radiative transfer modeling needs to be high enough to represent the local topography adequately" (Page 27188, lines 11-12).

These conclusions are saying that a better resolution does lead to a better agreement between model and measurements (using the latter as a reference). However, it is hard to me to see this fact from figures 11 to 16, where the results of the model calculations using different DEM resolutions are compared against measurements. Looking at these figures I can see neither a trend nor a better result (considering the differences between the experimental and the modeled values using different DEM resolutions). Even more, I cannot see any biases (systematic overestimations or underestimations) and, in many cases (e.g. Figs 13, 14, 15, 16), calculations using the 50 m resolution show the largest differences respect to the experimental values. Thus, I think this point should be clarified.

Appendix A

Calculation of irradiance in the 3-D model

* In half of the equations, the slash (which is used as the division sign) appears as a subscript. Also, in some equations the product is designated with a dot, while in others is not. In equation A11 the dot before the sin function has no sense. Please rewrite the equations in a consistent way.

* Page 27189, line 2 and 10: it should be "…the following equation"
* Page 27189, line 5 and 17: Units should be W m^{-2} nm^{-1}.
* Page 27189, line 9: I guess authors meant: direct irradiance
* Page 27189, line 22: I would use a period after "…box is reduced,…"
* Page 27190, line 4: calculation.
* Page 27190, line 6: Units should be W m^{-2} nm^{-1}.
* Page 27190, line 15: $N_{rea,\ diff.}$
* Page 27190, line 16: Please delete de colon.
* Page 27191, line 21-22: I would say: We simulated diffuse… (and not: We may…)
* Page 27192, line 11-12: I would say: If the angle subtended by the obstruction is larger…
* Page 27192, line 12: I would use a period after "…equal 0". Also, *f* is equal to 1 or *f* equals to 1. Also, I do not understand the result when *f* equals 0. In this case, H is also zero (Eq. A11). Thus, ε_{dif} is zero (Eq. A12) and, consequently, D_{rea} is equal to zero (Eq. A2), which means that the diffuse irradiance incident at a pixel (the final result

of the model simulation) is zero. Is that correct? I think it could be useful to clarify this point.

* Page 27192, line 20: Units should be W m^{-2} nm^{-1}.
* Page 27192, equation A13: According to Eq. A4 N_{tot} should be replaced by P_{tot}.
* Page 27193, line 3: Units should be W m^{-2} nm^{-1}.
* Page 27193, equation A15: N_{tot} should be replaced by P_{tot}.

References

* Page 27193, Line 15-19: I did not find the reference to Arola et al. (2002) in the text. Please include it in the text or delete it from the reference list.
* Page 27194, line 33: It should be Degünther instead of Deguenther.
* Page 27195, lines 21-26: I did not find the reference to Koepke et al. (2006) in the text. Please include it in the text or delete it from the reference list.
* Page 27196, lines 3-4: I did not find the reference to Kylling and Mayer (2001) in the text. Please include it in the text or delete it from the reference list.
* Page 27197, lines 9-12: the reference is duplicated.

Figures

* Units in all the figures should be written as mW m^{-2} nm^{-1}.
* Why in Figures 11-13 the measurement uncertainty is ±5% but in Figures 14-16 it is ±10% even though the same place, day and instrument were used?