ANSWERS TO REFEREE 1:

We thank the reviewer for her/his valuable comments which helped to considerably improve the quality of the manuscript.
We adressed all the comments of the referee. The detailed answers follow

Referee 1 (Ref 1):

27174 line 15 cloud can be written as clouds or cloud coverage.

Authors response (AR):

Change will be performed

Ref 1:
27174 lines 8-10 and 23-24 refer to the same thing so 8-10 can be probably deleted.

AR:
Lines 8 to 10 will be deleted

Ref 1:
27175 line 8. Day to day variability may or can result in changes of UV. . .
27175 Lines 5-9. This is not very essential. There are several papers referring in their introduction such numbers. It is informative and needed but of course day to day variability including dust events and or smoke events can be seen also in:
e.g. Balis D.S, V. Amiridis, C. Zerefos, A. Kazantzidis, S. Kazadzis, A. F. Bais, C. Meleti, A. Papayannis, V. Matthias, and H. Dier, Study of the effect of different type of aerosols on UV-B radiation from measurements during EARLINET , Atmos. Chem. Phys.,4, 307-321, (2004)
and
Arola, A., Lindfors, A., Natunen, A., and Lehtinen, K. E. J.: A case study on biomass burning aerosols: effects on aerosol optical properties and surface radiation levels, Atmos. Chem. Phys., 7, 4257-4266, doi:10.5194/acp-7-4257-2007, 2007
In addition, certain locations e.g. high aerosol load AERONET AOD stations (e.g. China), could provide AOD data that could lead to much more UV decrease from day to day or daily. So it is more correct to say that you get these numbers from measurement experiments or monitoring such as Krzyscin and Puchalski, 1998, Reuder and Schwander, 1999 and the two references above. Theoretical and modeled UV attenuations using AOD from other stations worldwide could provide higher numbers.
27177 line 8-9.

AR

The section will be changed to:

"Simultaneous measurements of AOD and ground UV performed by Krzyscin and Puchalski (1998) and Balis et al. (2004) showed that changes in AOD during a day may lead to changes in atmospheric transmission in the UV range of up to 20-30% . Other measurements of the day to day variability showed that changes in AOD may result in changes of UV radiation of the order of 20% to 45% (e.g. Reuder and Schwander, 1999; Arola et al., 2007)."

Ref 1:
Please define more clearly what radius of importance is. Something like: the minimum radius around a measuring station that outside its limits surface albedo contributes less than the measurement uncertainty ? Here you mention -significant contribution- which is unclear.

AR
The section will be changed to

Exact knowledge of large-scale surface albedo is a crucial factor for accurate model calculations as areas around the measurement station might still contribute significantly – that means with a contribution larger than the measurement uncertainty - to the measured UV. So far there are few studies dealing with this problem and the results for the "radius of importance" differ quite strongly. Degünther et al. (1998) state that contributions from outside a radius of 40 km around a measurement station can reach up to 3%, while Smolskaia et al. (1999) refer to a radius of importance of only 2.5 km and Wagner et al (2011) estimated, for the case studies in the Innsbruck area, the radius of importance for actinic flux at 5 km.

Ref 1:

27180 line 20 delete sza or put it in a parenthesis.

AR

This will be made

Ref 1:

Model set up.
I still have a difficulty to understand how the albedo of a neighboring shaded area has been taken into account for the simulations of a certain pixel. Maybe this has to be clarified.

AR:
A shaded pixel still reflects the diffuse irradiance, (the photons that have already undergone one scattering event). For the simulations of the incident irradiance/actinic flux on one pixel the simulation is performed in the same way than for the irradiance/actinic flux map simulations: we have the same number of pixels, the same domain box, and the same digital elevation map. The pixel of interest is however in horizontal position in order to be compared with the measured irradiance. The uncertainties which may arise due to an eventual pixel discontinuity are corrected by our model (see model description).

Ref 1:

Discussion of figures 9 and 10.
Figures 9 and 10 summarize the results shown in figures 5 to 8. It is interesting to discuss on the fact that overall actinic flux is more sensitive when changing from 50m to 800m DEM probably due to the fact that photons from angles close to the horizon are much more sensed in the case of actinic flux that the ones for the irradiance?

AR

Yes we also think that this is the explanation.

Ref 1:
Also to explain why at higher altitude pixels irradiance ratios are double than the ones of the actinic flux.

AR
Concerning this point see also the remarks of reviewer 2: We had to recheck the calculations that were used for this figure. They were done using an older version of the programm which does not include the pixel discontinuity correction.
The results shown in fig. 5 (50m) are at some pixels slightly too high and at other pixels slightly too low because of the missing pixel discontinuity correction.
In fig 7 (irradiance at 800m resolution) there was an error in the calculations (that is the reason for the ratio of 800m to 50m calculation that is much too high). The reason lies in

an error in the number of the photons used for the calculation of the absolute unit which does not correspond to the number of photons really used for the calculation. We apologize for this mistake. The ratio of 800 m irradiance to 50 m irradiance is now not larger than 2, which may easily be explained by changes to the horizon (also because of the inclination of the pixel) and by shading.. The other results (fig.6,8 and 10-16) were obtained using the methods shown in appendix A or in Wagner et al. 2011 and are correct.

Ref 1:

I was wondering what would be the correlation of the pixels presented in the ratios (figures 9 and10) with the mean altitude of each pixel. Patterns should match ? Sections 3.2.2 and 3.2.3.

AR:
Please see the last comment. The ratio are maximum when the corresponding pixel in the 50 m DEM is in the shade and when the coverage of the horizon is high. Usually the largest ratios are behind the summit of the mountains because of a very high inclination of the pixels and because of the pixels that are in the shade.

Ref 1:

I miss some comments on the absolute differences of model runs and measurements. Relative differences to the DEM are justified.

AR

Following sections will be included in 3.2.2:
"Fig. 11 to 13 show the 3-D model simulations represented by the shapes with the corresponding error bar calculation uncertainty (see section 2.2.2) and the measurements with the corresponding measurement uncertainties indicated by the coloured areas. If there is an intersection between 3-D model error bar and the measurement uncertainty area we can state that there is an agreement between measurement and model. This is achieved at the three stations for all three case studies except for the 50 m resolution calculation for Kolm.
We also can only affirm that there is a statistical significant difference between two calculations performed with two different DEM pixel size if there is no overlap of their error bars. Here we will assume that the 50 m pixel size calculation is the most accurate and it will be taken as a reference."

And in 3.2.3:
"A good agreement between model and measurements is only obtained for Innsbruck 1230 UTC (Fig. 14). For Innsbruck 0820 UTC model calculations underestimate actinic flux for Hafelekar and partly for Innsbruck and Lans. For the simulation for Sonnblick and surroundings there is a strong underestimation of the calculated actinic flux for Kolm. The explanation lies probably in the fact that local factors (reflections from surrounding objects and from the topography) have a strong influence on the measured actinic flux."

Ref 1:

A case of a shaded pixel and measurement could be very interesting to be evaluated.

AR:

Unfortunately we have only measurements at Innsbruck, Lans, Hafelekar, Kolm, Bodenhaus and Sonnblick. All stations were in direct sun.

Ref 1:
Also, a sky radiance map could reveal directional features that can be captured or not from model runs. It would be interesting to add some discussion on the above in the case that such data do exist.

AR:

Forward 3-D modelling is unfortunately not suited for the calculation of the sky radiance distribution at one pixel since there are not enough photons. For that purpose Backward modelling Ray Tracing would be much better. It is however then only a calculation for one pixel and for that you need a different model.