

Interactive comment on “A case study on biomass burning aerosols: effects on solar UV irradiance, retrieval of aerosol single scattering albedo” by A. Bagheri et al.

A. Bagheri et al.

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We would like to thank Referee 2 for the positive remarks and constructive comments and suggestions, which are highly appreciated and will be taken into account upon manuscript revision. Responses to individual comments are given below.

General comment 1:

The title mentions a case study. This could be an argument for the one day biomass burning measurements, because they are seldom. However, to get typical Trondheim aerosol data, measurements averaged from some more clear days would be an advantage.

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General comment 2:

For atmospheric physics the change in the aerosol properties for clear and turbid conditions is of much more interest. They are the basics for the ratio of the irradiances. Thus instead of Fig. 1, AOD values should be shown.

General comment 3:

To model (the ratio of) global and diffuse irradiances (Fig.1) already assumptions on the single scattering albedo (SSA) are necessary, besides that on surface albedo and asymmetry factor. Thus these results are of minor relevance, even if they are fitted in a way to agree with the measurements. It is mentioned that the measurements of the direct Sun have been used to determine the spectral aerosol optical depth (AOD). However, this procedure does not need any radiative modeling, with assumptions on alpha. In contrary, alpha would be one of the results. The changes in AOD for the different conditions should be shown as a result. It directly could explain the effects for the direct irradiances, including variable Ozone. Moreover, the values of alpha could be used to test the assumptions on the aerosol type.

General comment 4:

Global irradiance and direct irradiance have been measured with different instruments, with different calibration. Is this the reason why not direct measurements have been shown, but only ratios?

Response to general comment 1, 2, 3, and 4:

We consider the above comment to be very close and would provide a common response to them. Generally we would refer to the AC to referee 1, there, we have provided a detailed overview. We assumed that the effects from different aerosol type would be best shown in the irradiance ratios with minimum relative errors.

General comment 5:

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Taking into account the width of the filters, the data should be made comparable and used to determine the diffuse irradiance directly from the measurements. Based on these data, and individually for each wavelength with measurements, the SSA should be determined with the DDR method, as mentioned. If this is done independently for the wavelengths with global irradiance measurements, no assumptions for alpha are necessary and the actual ozone could be taken into account directly.

Response: We do not understand what the question is? One of the main parameter into the model for retrieving SSA is alpha or complete optical depth file. Please refer to eq. 2 in Kudo et al. 2008 and King et al. 1997.

General comment 6:

Is there an explanation for the low SSA values for the background aerosol (Fig.3)?

Response: With awareness of this issue, we will provide a more detail explanation in the revised version. We assume that the most significant information about retrieved SSA's are not in their absolute values but rather in their relative changes. The information (which will be discussed in more detail in the revised version) extracted from changes in SSA's for biomass episode relative to a typical day in Trondheim would be interesting.

General comment 7:

Why has urban aerosol been used for the lower level? What about sea salt or clean continental?

Response: We will consider this question in the revised version. The model produced a better match to measured irradiance with the urban aerosols. We assume that the real atmosphere in Trondheim is a mixture of urban and sea salt with an unknown mixing ratio. Probably the mixing ratio in the model for the urban aerosols have better representativity than marine type.

General comment 8:

In the uncertainty analysis for SSA no uncertainty for the irradiance measurements has been taken into account. Response: Yes, thanks for pointing out this error, this will be corrected in the revised version. A complete analysis of uncertainties have been given in the AC as response to RC from referee 1.

General comment 9:

The data for AOD and SSA for the two aerosol types should be combined in a table.

Response: We will consider this suggestion and provide a table for SSA's and AOD's in the revised version.

Minor comment 1:

Referee: page 17988 lines 20+21, What is the reason for the sentence on effects of long-term and short-term changes on?

Response: The sentence : "Moreover, the effects of long-term and short-term changes in atmospheric aerosols should be separated." will be removed.

Minor comment 2:

Referee: page 17989 lines 14-16, Is the effect of aerosol vertical height really responsible for a 25% effect in the irradiance at the surface? I can not imaging, but if so, it should be taken into account in the analysis.

Response: The statement is based on modeling study conducted by (Diaz et al., 2000). In order to take into account the aerosol vertical profile, one have to perform lidar measurement. Since there are no lidar at the measurement site, it would be impossible to account for the aerosol vertical profile.

Minor comment 3:

page 17989 line 20, If the quantity beta is shown, it should be explained.

Response: The statement is ment to be an introductory for the rest of the paragraph.

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Therefore, not explained in detail, we mean that it is not part of the scope of the manuscript. However, the statement is connected to another work about the aerosol climatology in Trondheim which has not been published yet. If we manage to submit the other work, we will refer and connect the statement into the climatology work.

Minor comment 4:

Referee: page17990 line 18 + 21, No different words for the same instrument should be used: monochromator = spectroradiometer.

Response: The sentences from line 15 to 20 will be changed to: "The solar platform consists of several instruments for the purpose of remote sensing, including one spectroradiometer and one multichannel moderate-bandwidth ground-based ultraviolet (GUV) filter radiometer belonging to the Norwegian UV network. The spectroradiometer measures direct UV irradiance in the range from 290 to 550nm in steps of one nm. The spectroradiometer has a spectral response function of 1.0nm nominal full width at half maximum (FWHM)."

Minor comment 5:

Referee: page17990 line17+26, GUV should not be mentioned before it is explained.

Response: The sentence on line 16-17 (one multichannel moderate bandwidth filter radiometer (GUV)) will be changed to: "one multichannel moderate-bandwidth ground-based ultraviolet (GUV) filter radiometer"

Minor comment 6:

Referee: page17990 line 26, The filter radiometer was not "also" used to measure global irradiance , it was only used to measure global irradiance.

Response: The sentence will be changed into: "A multichannel, moderate-bandwidth, filter radiometer, GUV, was used to measure global irradiance in parallel with the spectral direct measurement."

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References

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[Kudo et al. 2008] Rei Kudo, Akihiro Uchiyama, Akihiro Yamazaki, Eriko Kobayashi, and Tomoaki Nishizawa Retrieval of aerosol single-scattering properties from diffuse and direct irradiances: Numerical studies *JOURNAL OF GEOPHYSICAL RESEARCH*, VOL. 113, D09204, doi:10.1029/2007JD009239, 2008

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