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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Radiative budget in the presence of multi-layered aerosol structures in the framework of AMMA SOP-0" *by* J.-C. Raut and P. Chazette

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The authors appreciated the comments of reviewer 1 that help to improve our manuscript. Please find a point-by-point discussion and answer of the issues raised by reviewer 1. To facilitate the work for the reviewers and readers, the reviewer s comments and suggestions are preceding each reply in bold face.

In paragraph 3.1 the authors highlight the coherence and the differences in the vertical profiles of the aerosol extinction profiles derived from ULA and FAAM instrumentation : while the agreement in the biomass burning layers is good, large differences are detected in the desert dust cloud. This is possibly

caused by the limit in the aerosol size distribution derived from the PCASP, with a maximum radius of 1.5μm, while the contribution of larger particles, especially over the desert, is clearly significant. This has also implications in the determination of the aerosol complex refractive index, and may explain why approaches A1 and A2, as also stated by the authors.

Yes, the authors underlined that the differences mainly occur in the sampling of large mineral dust particles. Two reasons have been mentioned: the limit of detection of the Rosemount head at 1.5 μm used for nephelometer and PSAP inlets and the error caused in correcting irregular scattering phase functions. This latter uncertainty is indeed due to the limit in the sampling efficiency of the aerosol size distribution derived from the PCASP, as indicated by the reviewer. This point will be clarified in the revised paper.

In the simulation of the UV and visible fluxes by means of the TUV radiative transfer model did the authors account for NO2 and SO2 column? Are there any measurements accounting for NO2 and SO2 columnar amount or surface concentrations?

TUV radiative transfer model enables to take into account the absorption of solar radiation by NO2 and SO2 molecules. However, there was not any available measurement of integrated NO2 and SO2 concentrations during our study. According to coarse satellite measurements, e.g. SCIMACHY imaging spectrometer, the columnar amounts are of order 0.1 DU. Notwithstanding those parameters have a very limited impact on the results. On the one hand, the absorption of NO2 and SO2 molecules is low. On the second hand, our study focuses on the additional radiative forcing the aerosol, where NO2 and SO2 concentrations belong to the background amount and have a moderate influence on the results. A sensitivity study on the NO2 and SO2

ACPD

8, S6212–S6216, 2008

Interactive Comment

concentrations was performed. A factor of 10 on the corresponding columnar amounts leads to a discrepancy lower than 0.1 W/m2 on the aerosol radiative forcings.

In the model simulations the 2-stream Delta-Eddington approximation and the 4-stream discrete ordinate method are used (paragraph 2.2.2). While the 4-stream DOM may be appropriate to simulate the irradiances, usually 4 streams are not sufficient for the calculation of photolysis rates, which requires a larger number of streams (16). This may explain the differences found by the authors between measured and modelled J(NO2) photolysis rates (paragraph 6.1). In my opinion the comparison of the radiative fluxes calculated with the two methods may be eliminated, and only the 4-stream DOM may be used. Moreover, I would suggest to use 16 streams to model the J(NO2) and to verify whether differences arise.

The authors have followed the suggestions of reviewer1. J(NO2) photolysis rates have been recalculated using a 16-streams discrete ordinate method. Taking properly account for the multiple scattering, the 16-streams discrete ordinate method performs better in calculations of the propagation of the solar radiation. Multiple scattering plays a role in attenuating the descending solar flux and in increasing the light scattered. In case of A1 approach, the modelled J(NO2) photolysis rates superimpose on the measured one within 1 percent. However, the differences observed in comparison with the 4-streams method are not clearly significant. This is linked to a compensation effect between the higher number of photons backscattered by dust in the upward direction and their absorption into the biomass-burning layer. In the new manuscript, only 4-stream method will be used to simulate the irradiances, and the 16-stream method will enable to compute the J(NO2) photolysis rate.

In paragraph 6.2.1 it may be useful to compare the radiative forcing efficiency

ACPD

8, S6212–S6216, 2008

Interactive Comment

(radiative forcing for unit aerosol optical depth in the visible, i.e. 500 nm) instead of the radiative forcing calculated in previous studies, which strongly depends on the aerosol amount. The radiative forcing efficiency, on the contrary, depends on the aerosol optical properties.

It is indeed difficult to compare the radiative forcings computed in this paper with previous studies when different burdens are distributed vertically. The results of other studies presented in the manuscript have been chosen because they present almost similar optical depths. The authors agree with the referee s comment in highlighting the relevance of the radiative forcing efficiency, instead of the radiative forcing itself. Nevertheless, most of the results are mentioned in the paper in terms of heating rates rather than in aerosol radiative forcings (Sect. 6.2.1). As a consequence, the authors prefer adding the respective optical depths along with the radiative forcings or heating rates than quoting radiative forcing efficiencies. Radiative forcing efficiencies of our study are moreover presented in Table 3 in normalizing the forcings at the wavelength of 355 nm, which is more appropriate to the spectral domain used in our measurements and calculations.

I would recommend to shorten some paragraphs, for example 6.2.4, 6.2.5, 6.3.

Section 6.2.4 has been slightly shortened. Since the 2-stream Delta-Eddington approximation is insufficient to determine photolysis rates and is less efficient than the 4-streams discrete ordinate method, the comparison of the radiative fluxes calculated with the two methods will be eliminated in the revised paper. Thus, Section 6.2.5 will be removed. It will contribute to shorten the manuscript.

The technical corrections have been done.

ACPD

8, S6212–S6216, 2008

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8, S6212–S6216, 2008