Atmos. Chem. Phys. Discuss., 5, S1402–S1405, 2005
www.atmos-chem-phys.org/acpd/5/S1402/
European Geosciences Union

Atmospheric Chemistry and Physics Discussions

Interactive comment on "The direct radiative effect of biomass burning aerosols over southern Africa" *by* S. J. Abel et al.

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Received and published: 28 June 2005

We thank the anonymous reviewer for his/her constructive comments.

Specific comments

1) sec. 2.2.2, paragraph 3; sec. 2.3, paragraph 1: The radiative transfer model used in this study assumes internally well-mixed particles which are characterised by one refractive index for all particles. This transfers into an implicit assumption on the wavelength dependence of the particle optical properties. An even stronger assumption is contained in the MODIS retrieval of aerosol optical depth, which apparently uses a wavelength independent single scattering albedo. Although absorbing and non-absorbing components are unlikely to be externally mixed in biomass burning aerosol, *it is certainly possible that the coated sphere particle approximates reality better than internally well mixed particles. Consequently, it would be a useful addition to the article to also quantify the sensitivity of the radiative forcing to the assumption on the aerosol state of mixture and the simplifications made concerning the wavelength dependence of the aerosol optical properties. While this addition might go beyond the scope of the article, it should be mentioned that the assumptions made on the state of the mixture introduce another, potentially systematic uncertainty for the calculated radiative forcings.*

Kaufman et al. (1997) describe the MODIS aerosol retrieval over land. The optical properties of the biomass smoke in the retrieval scheme are modeled using a log-normal distribution, resulting in a single scattering albedo (ω_0) of 0.90 at 670 nm. We have not been able to model the optical properties used in the retrieval as it is not made clear in Kaufman et al. (1997) as to what refractive index is used. However, even if the imaginary part of the refractive index (absorption) is constant we would expect the ω_0 to vary with wavelength due to variations in scattering efficiency with particle size. It is now made clear in the revised version that the ω_0 of 0.90 is at 670 nm.

The optical properties used to model the radiative effect of fresh and aged biomass burning aerosol in this article are calculated from log-normal size distributions fitted to in-situ measurements (Haywood et al., 2003a) combined with appropriate refractive indices to simulate the measured ω_0 at 550 nm. The resultant wavelength dependence in ω_0 (see Table 2 in this article) is very similar to that derived from AERONET almucantar measurements (figure 14, Eck et al., (2003)). Including the optical properties of biomass burning aerosol modeled in this manner into a radiative transfer code has also been shown to give excellent agreement with independent measurements of the sky radiance (Haywood et al., 2003b). Further, the modeled fresh and aged aerosol ω_0 used in this article spans the range in ω_0 shown in figure 14 of Eck et al., 2003. Therefore, although the coated sphere approximation is not used in this study, changing the amount of fresh and aged aerosol included in the radiative transfer model in this article

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(section 3.2) explores the uncertainty in the radiative forcing resulting from observed differences in both the magnitude and spectral dependence of ω_0. The discussion of aerosol optical properties included in the model (section 2.3) has been expanded to include the above point.

2) p. 1174, 11. 12-13: It should be mentioned which particle density was assumed to calculate the specific extinction coefficient in Table 2.

The following text is added to p.1174, line 12: "A particle density of 1.35 gcm^{-3} is assumed for both the fresh and aged aerosol (Haywood et al., 2003a)."

3) p. 1175, 11. 26-27: It is simply stated that the MODIS retrieved effective cloud droplet radius is higher than the one measured in situ. An explanation should be given for this phenomenon, especially since it is stated in section 3.3 that the MODIS retrieved effective cloud droplet radius is low biased.

The MODIS retrieved effective radius off the western coast of southern Africa (September 2000-2003 average) is typically 12 - 14 μm, whereas that measured in-situ from three individual flights during the SAFARI 2000 campaign are approximately 7-8 $\pm$ 3 μm. This apparent discrepancy highlights the difficulty in comparing monthly averaged fields from satellite data with point measurements made in situ at a single instant in time. This explanation has been added to the relevant text.

4) p. 1176, 1. 3: Replaced with stratocumulus.

5) p. 1179, 1. 29: Mathematical symbol in text replaced.

6) p. 1183, 11. 21-25; Tables 3 and 4: It is not apparent how the "range" referred to in the captions of Tables 3 and 4 as well as quoted in the text is obtained. This should be briefly explained.

This refers to the range in the grid box values of radiative forcing over the model domain. This has been explained in the text and the captions in tables 3 and 4.

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7) p. 1184, 1. 19: Sentence rephrased and now reads "The sensitivity of the direct effect to the threshold value of satellite fire counts used to assign fresh aerosol properties to a grid box is tested by reducing the threshold from 500 (base case) to 300."

8) Fig. 11: It will be made sure that the figure is readable in the revised version.

References

Eck, T. F., Holben, B. N., Ward, D. E., Mukelabai, M. M., Dubovik, O., Smirnov, A., Schafer, J. S., Hsu, N. C., Piketh, S. J., Queface, A., Le Roux, J., Swap, R. J., and Slutsker, I.: Variability of biomass burning aerosol optical characteristics in southern Africa during the SAFARI 2000 dry season campaign and a comparison of single scattering albedo estimates from radiometric measurements, J. Geophys. Res., 108, 8477, doi:10.1029/2002JD002321, 2003.

Haywood, J. M., Osborne, S. R., Francis, P. N., Keil, A., Formenti, P., Andreae, M. O., and Kaye, P. H.: The mean physical and optical properties of regional haze dominated by biomass burning aerosol measured from the C-130 aircraft during SAFARI 2000, J. Geophys. Res., 108, 8473, doi:10.1029/2002JD002226, 2003a.

Haywood, J. M., Francis, P., Dubovik, O., Glew, M., and Holben, B.: Comparison of aerosol size distributions, radiative properties, and optical depths determined by aircraft observations and Sun photometers during SAFARI 2000, J. Geophys. Res., 108, 8471, doi:10.1029/2002JD002250, 2003b.

Kaufman, Y. J., Tanré, D., Remer, L. A., Vermote, E. F., Chu, A., and Holben, B. N.: Operational remote sensing of tropospheric aerosol over land from EOS moderate resolution imaging spectroradiometer, J. Geophys. Res., 102, 17 051–17 067, 1997.

Interactive comment on Atmos. Chem. Phys. Discuss., 5, 1165, 2005.