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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Direct measurements of the effect of biomass burning over the Amazon on the atmospheric temperature profile" *by* A. Davidi et al.

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We thank the reviewer for his fruitful comments. The comments helped in making the paper clearer.

Reply to Comments

1. Why not use MISR AOD, which many people consider to be more accurate than MODIS over land?
   Answer: There are three reasons why we did not use MISR AOD:
   1. MISR is on Terra, which has an overpass time of 10:30, while AIRS is on

Aqua, 1:30 overpass time. We wanted the temperature, AOD and cloudiness to be measured simultaneously. For the same reason, we cannot use radiosondes, which are launched at 8am and 8pm, local time (correspond to 12:00 and 00:00 UTC).
2. MISR's narrower swath produces insufficient statistics to sort and divide the data in the manner needed for this study. We would have needed to combine multiple years of data, and still the number of collocations would have been smaller than the number presented here.
3. The MODIS second generation AOD retrieval over land (Levy et al., 2007) is a much better product than earlier versions. The AOD at 550 nm, in the range used in this study, compares very well with AERONET stations in the Amazon during the season of interest, especially for AOD at 550 nm below a value of 0.6, which is the range used in this study.

2. The authors are mixing aerosol absorption with extinction. The heating is by absorption rather than extinction, and the effect of aerosol on transmission to the surface depends on more than extinction. At the very least the authors should acknowledge that their analysis depends on the assumption that the aerosol optical properties vary much less than the mass concentrations, and provide some support for such an assumption.
   Answer: We tried to clarify this point. Cooling below the aerosol layer can be due to extinction (both scattering and absorption) and due to increase in cloudiness induced by the aerosols. We agree that the heating at 850 hPa is due to absorption (page 12014, lines 16-17).
   The reviewer is correct in stating that we are assuming that aerosol optical properties vary less than aerosol loading. We can provide support to this assumption as can be seen this in AERONET retrievals beginning with the SCAR-B experiment (Dubovik et al., 1998) and subsequent years (Dubovik et al., 2002). We added the following to the discussion section (page 12016, between lines 6 and

7):
“We note that an implicit assumption to the above discussion is that aerosol optical properties vary less than aerosol loading. However, this can be seen in AERONET retrievals beginning with the SCAR-B experiment (Dubovik et al., 1998) and subsequent years (Dubovik et al., 2002).”

3. Page 12014, line 18. What are the expectations based on? There are no measurements of absorption, so how can you estimate an expected warming?
Answer: We thank the reviewer for drawing our attention to this vague statement. The expected increase in temperature at 850 hPa due to an increase in AOD is about 1-2℃, based on several radiative transfer modeling studies (Yu et al., 2002; Koren et al., 2004). We changed the sentence (page 12014 lines 17-18) to:
“The magnitude of increase of 1-2℃ is consistent from expectations formed from radiative transfer modeling (Yu et al., 2002; Koren et al., 2004) and there is a steady rise in temperature as AOD increases.”

4. Page 12015, lines 4-8. I am not convinced that the increase in cloud cover with AOD is purely a micro-physical effect. Have you estimated the amount of water vapor emitted by the fires, and how that might contribute to the increased cloud cover? How do the vertical profiles of water vapor correlate with AOD? The saturation effect could be point where the reduced supply due to surface cooling overcomes the increased supply by combustion. If AIRS can’t be used to address these questions, what can radiosondes tell us?
Answer: We rely on the work done by Koren et al. (2008) that showed a clear correlation between cloud cover and AOD over the Amazon basin. Koren et al. (2008) offered this plausible explanation, which fitted very well with the observation. These observational results were foreshadowed by a modeling study that identified the cause of increased cloudiness with AOD for low aerosol loading to be microphysical in origin (Jiang and Feingold, 2006), and followed by sub-

sequent work with the same explanation (Rosenfeld et al., 2008). We added the above discussion to the revised manuscript in the discussion section (page 12015, between lines 17 and 18):
“The fact there is a transition in clouds properties at a certain AOD level was shown previously by both observation (Breon et al., 2002) and modeling (Wang, 2005). Jiang and Feingold (2006), another modeling study showed that this transition point occurs when both microphysical and radiative processes are included in the model, but not when the radiative processes are shut off. Koren et al. (2008) developed an analytical model that describes this transition point at AOD~0.25, and supported this model by observations over the Amazon. Another work of interest on this topic is Rosenfeld et al., (2008). A full discussion of this transition is outside the scope of this paper, and will be addressed in the future.”
We would have liked to know the humidity vertical profile, however the AIRS humidity product is not reliable enough, and radiosondes are not suitable either (see item 1). In addition, an explanation that involves input of water vapor from fires would be difficult to demonstrate because of the high background humidity already available in the lower troposphere originating from evapotranspiration of the plant canopy and advection of water vapor from the eastern coastline due to the prevailing anticyclonic flow (Nobre et al., 1998).

5. Table 1 is unclear. Delta T cannot represent the temperature difference between 850 and 1000 hPa because it is listed for both levels. So what is it?
Answer: We thank the reviewer for drawing our attention to this, and apologize for the unclear table. We changed the caption of Table 1 to:
"A summary for the years 2005-2008. Temperature difference between hazy and clean conditions (i.e. from AOD values of almost 0.6 to nearly zero) within the pressure levels 1000 and 850 hPa. Positive numbers correspond to heating, negative to cooling. The standard deviation in all years is similar to those presented here for 2007."

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