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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Aerosol number fluxes over the Amazon rain forest during the wet season" *by* L. Ahlm et al.

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We thank Anonymous Referee #1 for comments and suggestions for improvement of our manuscript. The comments from the reviewer followed by our responses to the comments can be seen below.

Referee comment 1:

Most importantly, the argument that anthropogenic particles are not responsible for deposition, and that secondary organic aerosol is likely responsible, relies on Figure 14, which doesn't have any error bars attached. This makes the figure potentially misleading, and throws the authors' argument into doubt. A more robust way to present the data would be a box and whisker plot showing the mean, median and percentiles.

Inclusion of uncertainties is essential to the figure and this key argument.

Response:

We tried to make a box plot but the resulting figure did not look clear enough. There will always be a large amount of outliers when box-plotting results from eddy covariance measurements. In the box plot we made, it was harder to see the medians which we consider as the most important factor in Fig. 14, since the medians show what happens most frequently. More details obscured the key information. However, we agree with the reviewer that Fig. 14 needs percentiles and we have added 25 and 75 percentiles to the figure.

Referee comment 2:

I am wary of nighttime fluxes of CO2 over the Amazon. In particular, drainage is known to occur at this site due to the topography, and there is a large body of literature describing these effects and their potential corrections (see papers by Baldocchi et al., Goulden et al.). The authors should further comment on the potential for drainage to occur in particle fluxes before interpreting nighttime measurements

Response:

We have added a discussion of drainage flows in the CO2 flux section. The main points are that the nighttime CO2 flux is often underestimated by the eddy correlation method and there is growing evidence that nighttime advection caused by drainage flows is the root cause of the failure to capture the respiration flux in stable conditions at night (Finnigan, 2008). Araújo et al. (2008) investigated nighttime CO2 fluxes at this same site and found that CO2 was drained from the plateau, where the tower is located, during the night and accumulated in the valleys. Drainage flows have been observed to be most important during clear night with very stable stratification (Goulden et al., 2006). This means that the underestimation of the CO2 respiration flux is largest in the dry season when the nocturnal stratification is much more stable than in the wet

season when our measurements were made. Nights are often clear in the dry season but much cloudier in the wet season. We are currently working on a new manuscript where we observe nighttime CO2 fluxes close to zero in the dry season but a peak in upward flux in the morning associated with enhanced turbulence and release of the CO2 that has been stored in the canopy throughout the night. In the wet season, however, we observe more continuous upward CO2 fluxes throughout the night and no peak in the upward flux in the morning. Similar observations were made by Malhi et al., (1998). This further confirms that the loss in nocturnal CO2 respiration flux is larger in the dry season. The main impact from drainage flows on CO2 exchange is that CO2 is transported downslope at night which results in horizontal variations in CO2 concentration caused by topographical variations, which in turn results in horizontal variations in nocturnal CO2 respiration flux. For aerosol particle fluxes, we think that drainage flows should be a much less important factor than for CO2. The reason is that particle fluxes are pointing downward at nighttime (Fig. 9 in the manuscript) and the particle flux is measured above the forest canopy. Intuitively, we think that drainage flows should be much more important when there is a source within the canopy but of less importance if there is no source within the canopy and only deposition is studied. Still, nighttime particle fluxes are of course associated with larger uncertainties than daytime fluxes and this is why we included a u*-filtered diurnal cycle of the particle flux (Fig. 9d). We now have added more discussion of nighttime fluxes in both section 3.4 and 3.5 including both CO2 and particles.

Referee comment 3:

p.17352/3, the authors comment on the relative size of the errors for particle fluxes versus CO2 fluxes. The fact that these errors are larger for particles does not necessarily mean that the 'processes are more complex', and I suggest removing that statement. As alluded to further in the paragraph, the particle flux methods are associated with larger uncertainties.

Response:

The words "more complex" have been removed from the manuscript. Even though the aerosol number concentration in the Amazon boundary layer is relatively stable in the wet season (compared to the aerosol in most other regions), it is much less stable than the CO2 concentration (Fig. 9 in the manuscript). The higher day to day variability in aerosol concentration compared to the day to day variability in CO2 concentration is likely the most important factor for the larger variability in aerosol flux compared to the CO2 flux. Also, the fact that entrainment may produce upward fluxes on days when entrainment has a lowering impact on the aerosol number concentration within the boundary layer of course increases the day to day flux variability. Larger uncertainties in the aerosol flux measurements compared to the CO2 flux measurements may play a role as well.

Referee comment 4:

Error bars should be included in most of the figures: Figure 7 shows particle concentration as a function of Black carbon concentration. Both these numbers should have uncertainties associated with them, and a bar chart seems inappropriate, without at least an indication of the uncertainties, and number of points that go into each bin.

Response:

Error bars representing 25 and 75 percentiles have been included in Fig. 6, Fig. 7 and Fig. 14. The information of minimum number of values per bin has been added to the figure text of Fig. 7.

Referee comment 5:

Technical corrections. p. 17533, line 8 should read "Care" p.

Response: We have changed to "Care needs to be taken".

Referee comment 6:

p. 17360, l23, should read "..data that do not fulfill"

Response: Has been changed.

References not found in the manuscript:

Finnigan, J.: An introduction to flux measurements in difficult conditions, Ecological Applications, 18, 1340-1350, 2008.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 17335, 2009.