Atmos. Chem. Phys. Discuss., 15, C8852–C8856, 2015
www.atmos-chem-phys-discuss.net/15/C8852/2015/

Atmospheric Chemistry and Physics Discussions

Open Access

ACPD

15, C8852–C8856, 2015

Interactive Comment

Interactive comment on "Contributions of dust and biomass-burning to aerosols at a Colorado mountain-top site" *by* A. G. Hallar et al.

A. G. Hallar et al.

gannet.hallar@dri.edu

Received and published: 2 November 2015

The authors greatly appreciate the feedback and positive response from this reviewer. We are pleased that the reviewer found the research worthy of publication after revision and thank the reviewer for the critical and professional feedback. Please find our response to each of the comment from the reviewer below.

Reviewer 1: Overall, the paper is well written and the observations are carefully handled. I think this is a useful summary of a large collection of observations that emphasizes the important contributions to aerosol direct radiative forcing from dust and fire events, which may increase in significance in the future.

We greatly appreciate this positive feedback on this extensive effort to characterize these observations.

I have the following minor comments:

1. Page 21310, lines 13-17 – The Leaitch et al reference discusses measurements made at Whistler Peak and from a smaller aircraft (Cessna 207) in the vicinity of Whistler Peak. There was a Hi-Res ToF AMS at Whistler Peak, and there was a quadrapole AMS on the Cessna 207. Leaitch et al discusses the measurements from the Cessna and some of the Whistler Peak observations. The HRToFAMS data at Whistler Peak are discussed by Sun et al. (ACP, 9, 3095-3111, 2009). The C-130 conducted only a couple of flights near Whistler, and the overall C-130 results are discussed by Dunlea et al (ACP). This should be corrected.

Thank you for the correction. The paper has been modified and both the Sun et al. (2009) and Dunlea et al. (2009) references have been added.

This section now reads:

From the comprehensive INTEX-B dataset, which included a Quadrapole Aerosol Mass Spectrometer aboard the C-130 (Dunlea et al., 2009) with a High- Resolution Time-of-Flight Aerosol Mass Spectrometer (Sun et al., 2009) and an off-line ion chromatography on the ground, Leaitch et al. (2009) concluded that coarse particles of dust accumulated sulfate, nitrate and organic material, which diminished the role of these compounds in indirect radiative forcing, but potentially enhanced their roles in direct radiative forcing.

2. Page 21312, lines 18-19 – Do you mean NPF in general or NPF during the dust and fire events? Please clarify.

We were indicating NPF in general and the sentence has been modified to read:

Newly formed particles dominate the number concentration in general at SPL, but are too small to be optically active.

ACPD

15, C8852–C8856, 2015

3. Page 21312, lines 24-25 – Please explain the uncertainty values on these two lines. On page 21307, there is reference to an AOD uncertainty of 0.01, which is significantly higher than the values here, and from Figure 3 it looks as if the standard deviations are also higher.

The sentence referenced stated: "The average AOD for the spring is 0.069 $\pm$ 0.0002 (median = 0.061), and for the summer is 0.099 $\pm$ 0.0004 (median = 0.074)"

The mean for the spring and summer over the entire dataset is presented with the standard deviation around the mean for the entire dataset. This was not intended to indicate the uncertainty. In Figure 3, the standard deviation of the running hourly averages is presented.

We have corrected the sentence to read: "The average and standard deviation of the AOD for the spring is 0.069 $\pm$ 0.0002 (median = 0.061), and for the summer is 0.099 $\pm$ 0.0004 (median = 0.074)"

We also added the statement: As indicated by the low standard deviation the year-to-year season average variation in AOD is very small.

4. Page 21313, line 6 – What do you mean by "further"?

Thank you for the correction. We were attempting to indicate that there is a period within the spring season where the Ångström exponent reaches a minimum. The word further was replaced by "more significant".

5. Page 21313, lines 22-24 – You might add that here the point that neph is an in-situ measurement whereas the MFRSR is an integration of the column above.

Good point! This has been added. The following sentence was added: Additionally, the nephelometer is an in-situ measurement made at low RH whereas the MFRSR is an integration of the ambient aerosol in the vertical atmospheric column.

6. Page 21314, lines 3-7 – The month offset in the decline in the Angstrom exponent

between the two measurements is interesting. Any suggestions as to why? Could it be that transport is lower earlier?

The authors agree with your hypothesis that the transport of dust may be vertically inhomogeneous and vary by seasons. At this point, we do not have enough overlapping data between the MFRSR and nephelometer at the surface to make this conclusion. We hope to revisit this hypothesis after collecting a longer co-located dataset.

7. Page 21316, lines 5-6 – Before this, you mention that the measured regional dust episodes have a mean size of about 1 um. Asian dust may have larger mean diameters (e.g. Lee, Y.-G. and Cho, C. H.: Characteristics of aerosol size distribution for a severe Asian dust event observed at Anmyeon, Korea in April 2006, J. Korean Meteor. Soc., 43, 87–96, 2007 – also, Fig. 11 of Leaitch et al.).

The authors agree with this statement and greatly appreciate this comment. We have now included the references above. We also want to mention another reference from Storm Peak Laboratory. During an Asian transport event (as identified by Gaseous Elemental Mercury and Carbon Monoxide ratio) at Storm Peak Laboratory the persistence of larger (2-4μm) aerosols particles were consistently aloft from April 3rd to 7th, 2007. (Obrist et al., 2008).

The paper now states: "As mentioned previously, regional dust events observed at SPL between 2009-2011 had a mean dust particle size by number of approximately 1 μm. As reported by Lee and Cho (2006) and Leaitch et al. (2009), Asian dust may have larger than1 μm mean diameter. These finding are consistent with the smaller αMFRSR observed during Asian dust events in comparison to the regional dust storms found in this study (e.g., Figure 4a)."

8. Page 21316, lines 17-18 and Figure 4 - The differences seem to be mostly at lower AODs and scattering values. Does the nephelometer measurement have greater sensitivity to smaller particles than the MFRSR? Any idea how to interpret the gray dots in Fig. 4a?

ACPD
15, C8852–C8856, 2015

We believe the reviewer is referring primarily to the "summer" data points (red dots) and comparing these data points in Figure 4a and Figure 4b.

(1) It should be noted that these summer data points are not necessarily representative of fire data, they are just measurements made in the summer which is when the fires are more likely to occur. (2) The nephelometer can measure 24/7 regardless of cloudy skies or lack of sun and thus can make measurements at times when the MFRSR is unable to do so. Therefore, those points might be representative of clean free tropospheric nighttime air, which the MFRSR cannot observe. We expect this nighttime air to be cleaner (scattering less than 10 Mm-1), and thus may slightly flatten the curve in the nephelometer data (at the low range) in comparison with the MFRSR. (3) As the instruments were adjusted to report the similar wavelengths, we do not expect that the nephelometer is significantly more sensitive to smaller particles. Measurement differences between the MFRSR and nephelometer might lead to the nephelometer sampling a size distribution shifted towards smaller particles than observed by the MFRSR (e.g., particle losses in the aerosol manifold (50% cut off at $\sim$8 μm; and lower RH than ambient). The in-situ aerosol system at SPL measures switches between sub-10 μm and sub-1 μm every 30 min providing an estimate of fine mode scattering fraction. In the summer the median fine mode scattering fraction is greater than 0.9, i.e., more than 90% of the observed scattering is due to submicron aerosol

The grey points represent data primarily in the winter and fall seasons. Overall, the winter is very clean (as indicated by primarily low AOD and low scattering observed). We do observe pollution events at SPL during all seasons, which may explain the occasional higher AOD and higher Ångström data points. In general, outside of coarse particle events (dust events found in the Spring), the grey points follow a pattern of increasing AOD with decreasing size. This indicates occasional anthropogenic influence of SPL.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 21299, 2015.