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Interactive Comment

Interactive comment on "A subsiding regional forest fire aerosol layer at Whistler, BC: implications for interpretation of mountaintop chemistry observations" *by* I. G. Mc Kendry et al.

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Following is a detailed point-by-point response to the reviewer's comments. The changes made in the revised manuscript that accompany this response are given by page and line numbers in the bolded text. Of particular note, the strong emphasis on "subsidence" has been removed (including from the title). Extensive revisions have been made to figures including the addition of an AOD panel to Figure 5. Discussion of the issues related to the interpretation of sloping time series (raised by Mike Fromm and the reviewers) has been incorporated as dis-

cussion in the text.

Response to Anonymous Referee #1:

We appreciate the careful review of our discussion paper by Referee #1 and feel that we are able to address most of the specific comments in our revised paper. Following are some details of how we took these comments into consideration.

The suggested reference concerning the altered absorbing properties of aged smoke particles has been included. **(Page 2, lines 19-20)** Additional references regarding specifics of the CORALNet lidar system are not available at this time, but for the purposes of this paper we wish to keep brief our descriptions of the various observational components for this case study.

The station elevation is made explicit. **(Page 5, line 12)** Plotting of the datasets in heights above sea level was considered, although data of this kind are more commonly shown in units above instrument level, and changing the height units to a.s.l. would still not make the images directly comparable due to differing vertical scales and ranges that cannot be easily adjusted. Horizontal lines indicating the mountaintop elevation on Figures 5a and 5b orient the reader to the level of greatest interest. As for the overlap function for the CORALNet lidar, while this is clearly an important input to the data extraction and processing algorithms for the lidar, we do not feel it is necessary to discuss these algorithms explicitly in this paper. This is partially due to the fact that the overlap function only comes into play for the first $<$1km of altitude, while our focus is on the area near Whistler peak; and partially because the importance of the backscatter ratios reported from the lidar lies in dynamic changes revealed through relative variations, rather than from absolute values. Therefore the overlap function – as a constant factor throughout the measurements – is essentially irrelevant for this application.

We have clarified the optical properties being presented and have labelled the units in Figure 5. **(Fig. 5, figure and caption)** Mention of the ceilometer's limitations as compared to a higher-power instrument such as the CORALNet lidar is added. **(Page 9, lines 19-22)**

Including the AERONET AOD time series from Saturna Island is a good idea and we have added it to Figure 5. **(Fig. 5d and page 9, lines 22-26)**

It was also suggested that we correlate optical property data from the lidar and ceilometer to particle concentrations on the mountain to bolster claims that both instruments are showing the same smoke plume feature at the elevation of Whistler Mountain. We believe that such analysis would be interesting, but the Whistler ceilometer does not have a long enough data record, particularly for episodes of high PM concentration, to derive a sound relation between backscatter and PM concentration. We have done such comparisons for another CL31 ceilometer (see van der Kamp, D. and McKendry, I.G., Comparison of tethered balloon vertical profiles of particulate matter size distributions with lidar ceilometer backscatter in the nocturnal urban boundary layer, International J. Environment and Pollution, Vol 41, Nos1/2, 155-165, 2010.) and feel comfortable that the backscatter generally correlates well with PM concentration. Additionally, comparisons between the CORALNet lidar and a co-located CL31 have indicated that elevated aerosol layers manifest themselves similarly in the two datasets (McKendry, I.G., van der Kamp, D., Strawbridge, K.B., Christen, A., Crawford, B., Simultaneous observations of boundary-layer aerosol layers with CL31 ceilometer and 1064/532 nm lidar, Atmospheric Environment, 43 (36), 5847-5852, 2009). In this case, chemistry data from the SPMS are the primary means of verifying the nature of the elevated aerosol layer.

Response to Anonymous Referee #2:

We agree with this reviewer that the importance of placing individual measurements into context using other available datasets and analysis methods is an important point of this paper and should be highlighted. Similar to comments made previously by Michael Fromm, this reviewer suggests that our interpretation of the lidar and ceilometer data may be overreaching a bit, specifically in regards to our assertion that dynamic subsidence likely caused the observed lowering with time of the smoke plume. In light of these comments, we have changed the wording of the paper in places (and the paper's title as well) so that other possible causes of the plume orientation are acknowledged and to recognize that, despite the variety of observations available in this case study, a full, unambiguous 4-D picture of the relevant processes is not attainable. **(Page 10, lines 1-13**) We also agree that more emphasis can be placed on vertical mixing, which is evident in both the lidar and ceilometers plots. In this context, a bit more detail is added to the discussion of PM data from the valley station. **(Page 10, lines 17-29 and Page 11, lines 15-16)**

The CL31 data represent two-way attenuated backscatter in units of $10^{-5}sr^{-1}km^{-1}$. The units are now labeled in Figure 5b. **(Fig. 5b)** Due to technical limitations in this case, we are not able to convert the CL31 and lidar data into the same units for a direct comparison, but we do not feel this is necessary to the inferences being made from the time series.

All of the technical corrections suggested are incorporated in the revised manuscript. As with Referee #1, we appreciate this reviewer's attention to detail in reading our discussion paper.

Technical corrections:

In Abstract line 1 and P 20306 line 3, spell out the first use of British Columbia (BC) for those not familiar with the continent. **(Page 1, line 13 and Page 3, line 12)**

No need for lidar to be in italics. **(fixed throughout document)**

P 20307 line 7. Error in citation for Räsänen, Lönnqvist and Piironen (2000). The problem with some letters which should have diacritical marks not being displayed is probably a formatting issue as this occurs elsewhere in the manuscript (References -P 20317 line 27, P 20319 line 10 and line 22). **(Page 4, lines 3&15 and bibliography)**

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P 20310 line 4, almucanter should be almucantar. **(Page 7, line 8)**

P 20321 Table 1, use either Angstrom or Ångström. **(Table 1)**

Figure 5 (A) There are no units for the color scale. I assume, therefore, that this is a plot of backscatter ratio. This should be stated in the caption. **(Fig. 5, figure and caption)**

Figure 5 (B) Again there are no units for the color scale. Since this is from a ceilometer, I suspect that the measurement is of attenuated backscatter coefficient. **(Fig. 5, figure and caption)**

The suggestion to bring the depolarization data from the CORALNet lidar into this paper in order to help distinguish between smoke and other aerosols – possibly even in the absence of corresponding colour ratios – is an excellent one. In fact, the focus of some of our research is the development of just such an algorithm, similar to that used by the CALIPSO lidar team to produce their ***Vertical Feature*** and ***Aerosol Subtype*** masks. However, the level of precision and accuracy required to differentiate between depol. ratios of 3-4% in the boundary layer and those of 5-8% aloft is something we are not comfortable or confident in at the present. This is true for a number of reasons, the most important of which is that, unlike the CALIOPE lidar, which undergoes a very thorough and rigorous process of calibration and validation on a regular basis, the data collected by the CORALNet lidars undergoes only minimal processing prior to being posted. Consequently, CORALNet lidar data in its present form is most useful for relative measurements, such as backscatter ratios, but currently we cannot be completely confident in the accuracy of derived products such as AOD, AOT, and depolarization ratios.

In addition to this, the main purpose of bringing the CORALNet lidar data into this paper is that it "…highlights the importance of lidar remote sensing methods in the interpretation of mountaintop chemistry measurements." We feel that the plots of backscatter ratios used in Figure 5 show amply that the CORALNet lidars have played a valuable

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role in validating and enriching our understanding of the mountaintop chemistry measurements; and to delve further into the lidar data would take focus away from the primary goal of this particular paper. In short, we would prefer to give these issues (depol. ratios, etc.) a full investigation in a separate paper rather than including them as a subsection of this one.

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