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Atmospheric Chemistry and Physics Discussions

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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I am reading with interest the recent ACP-D paper "A subsiding regional forest fire aerosol layer at Whistler, B.C.: implications for interpretation of mountaintop chemistry observations." It is a very interesting and provocative analysis of several distinct data sets. However, I have some fundamental questions/concerns. My main concern is the possible incorrect attribution of a downward sloping aerosol-layer feature in a lidar height/time curtain to the meteorological process of subsidence. I have seen other cases involving similar lidar height/time curtains wherein similarly sloping layers are attributed to either subsidence or gravitational settling of particles. However it is not self evident that the existence of aerosol-layer sloping in such curtains is the result of either of those processes. The lidar data themselves do not provide enough information to draw such conclusions. Below is a list of questions/comments that I'd like to offer for the authors' consideration.

* Presumably in Figure 5 is the information from which the authors derived a descent rate of the smoke. But I see many features before, during, and after the apparent subsidence period (the morning of 30 August according to the paper) making it difficult to identify the feature of focus (time and altitude-wise). I see a downward sloping red feature below 2200 m in Figure 5a between 00 and 12 LST. Is this it? But I also see a near mirror image between 12 and 00 (31 Aug). Above and below these sloping reds and yellows are lots of other scattering particles. Might it be a good idea to mark on the figure the feature for which the slope is calculated? In my opinion the absence of a clear identification of the focus feature makes the premise of the paper difficult to assess.

Making the assumption that the paper is keying on a negatively sloping (i.e. high smoke early, low smoke late) aerosol feature, I present some comments and alternate explanations.

* Fire emissions are a 4-dimensional problem. The 2009 British Columbia fires had been burning for weeks, and continued burning (as did some others in BC) after the paper's period of focus. Smoke emissions from them were quasi-continuous, but with varying intensity, altitude, and wind direction consistent with fire behavior and ambient weather forces. Just how all that looked in x, y, z leading up to the paper's observations is a big unknown. And then how that blob got reshaped under the prevailing winds is also a big unknown.

* The paper makes clear that "subsidence" is an atmospheric process associated with synoptic-scale vertical velocities. Yet the "subsidence" as applied to the aerosol mea-

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surements is a time-change of altitude of a feature measured at a fixed location. There can be (and usually are) a host of reasons for such a sloping aerosol feature. It seems to me that without any knowledge of the aerosol profile upwind of a certain measurement location, ascribing a slope (in either direction) in such a time series to any single atmospheric process is not possible. The best that could be said about a particular sloping aerosol feature in a lidar time series is that subsidence may be one of several explanations for the slope.

* It's not clear to me that synoptic-scale subsidence would even necessarily lead to a feature like a negative slope in a lidar's time series. If the forcing is synoptic in scale (thus so too the geographical extent of the downward vertical velocity), conceivably a regional aerosol feature imbedded in–and blowing through–that synoptic environment could take on any slope in a lidar time series. It would all depend on the pre-lidar-observation dimensions of that layer's volume and its time-varying location w.r.t. the position and evolution the synoptic-scale dynamics. In short, it seems there is no single solution for this type of problem.

* It seems plausible to me that the thermal wind is as good an explanation for a negatively sloped aerosol feature in a lidar time series as any other. If one envisions a simple smoke injection at a particular place and time forming a sort of vertical cylinder of smoke, then letting that cylinder evolve under thermal wind forcing would lead to a tilt that when captured in the lidar beam would appear as high smoke early, low smoke late. I.e. a negative slope. See the cartoon included in this comment. It seems to me that for a young plume injected into the free troposphere, the shear of wind speed and direction almost certainly dominate the plume evolution. A quick check of nearby radiosondes in this case revealed that both speed and directional shear were strong in the lowest altitudes of the free troposphere.

*For what it's worth, the CALIPSO daytime data on 29 Aug is quite strategic. One orbit passes just a few km from Whistler and UBC, and shows the smoke well. These data might offer a valuable and different context to the groundbased lidar analysis, so

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perhaps they should be looked at.

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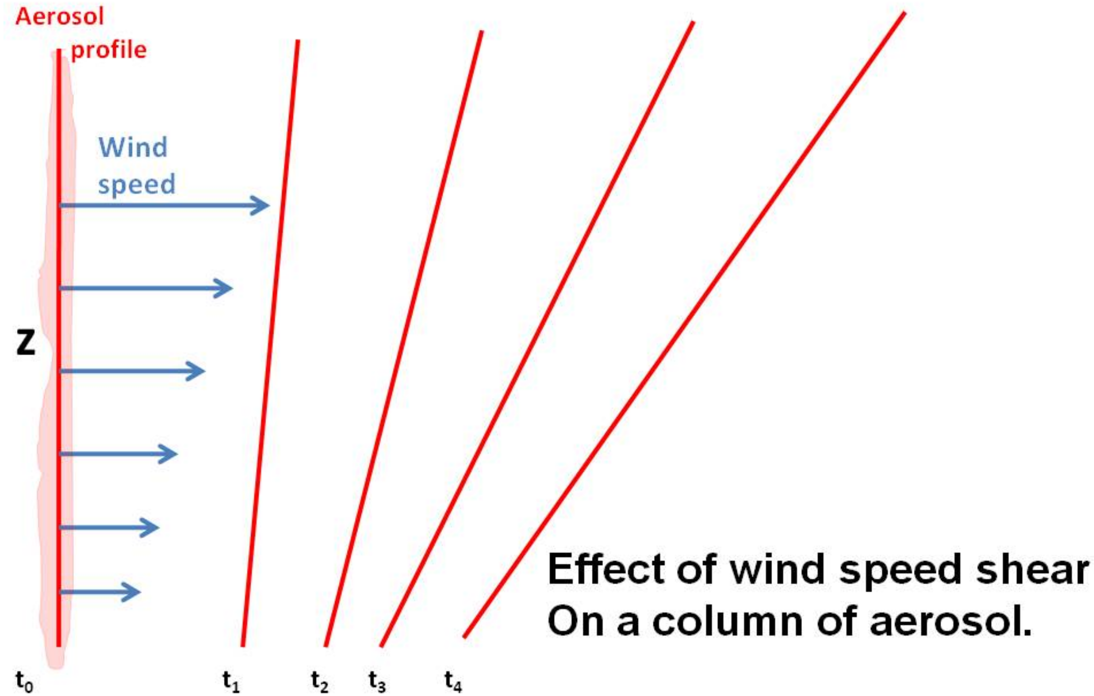

Fig. 1. Layer Tilt Cartoon p1

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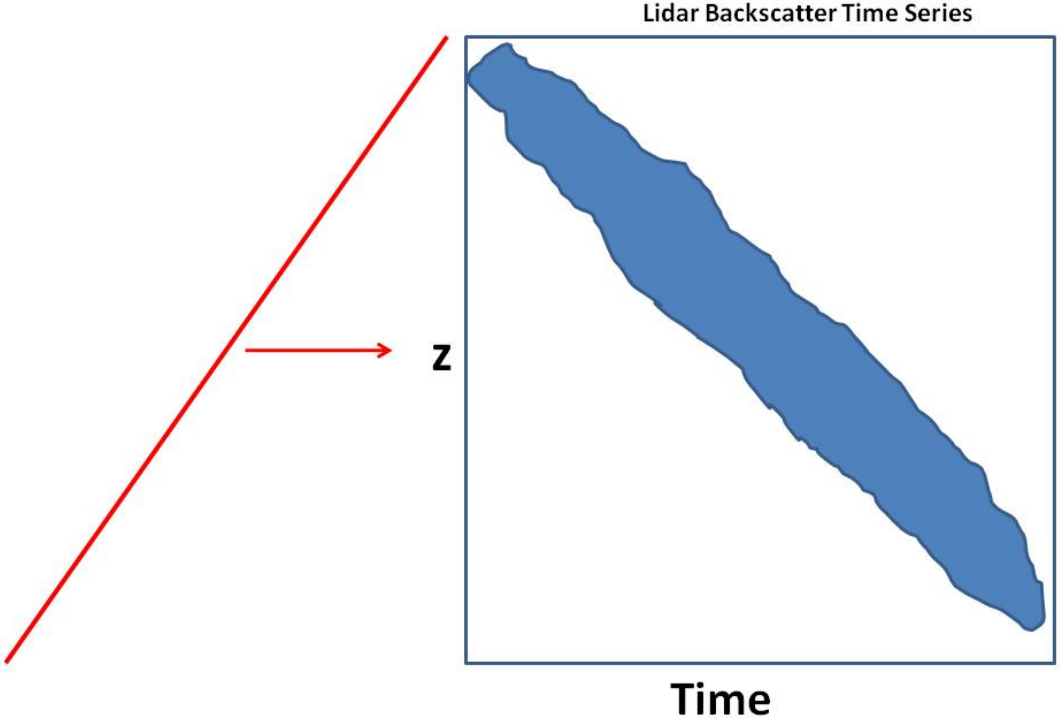

Fig. 2. Layer Tilt Cartoon p2

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