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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Lidar observations of pyrocumulonimbus smoke plumes in the UTLS over Tomsk (Western Siberia, Russia) from 2000 to 2017" *by* Vladimir V. Zuev et al.

Fromm (Referee)

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Reviewer: Mike Fromm

Note: Throughout this review I will refer to the author team as "auth."

This paper is a broad survey of a single aerosol lidar data set covering 18 years. The instrument's data record has been examined by this team in prior papers, focused solely on the lower stratosphere (LS) and volcanic aerosols. In this work auth nudge their reportable lower data bound down to 11 km, i.e. into the upper troposphere (UT). Their aim is to expand their scope from volcanic plumes to include pyrocumulonimbus

smoke plumes.

Auth are to be commended for their rigorous accounting for pyroCb events. They use published works and a pyroCb blog to identify a large number of pyroCb events, from which plumes might have crossed over the Tomsk lidar. Considering that the Tomsk aerosol lidar is positioned in a region otherwise poorly instrumented for aerosol profiling, and has been operated for years before space-based lidar data became available, this is a strategic data set. And considering that auth have methodically undertaken an accounting for UTLS pyroCb smoke, this stands as a first to my knowledge. Hence this paper merits consideration in ACP.

Auth make many convincing connections between Tomsk UTLS aerosol layers and specific pyroCb events. However, there are also a few unconvincing cases reported here. Auth also attempt to attribute a weak UT aerosol layer with Bogoslof volcano over a very long trajectory path. I found this to be unconvincing. It may be possible to bolster each one of the less than convincing cases but substantial work is needed to do so. For instance, during the CALIPSO era, the space-based lidar data can be used to corroborate the Tomsk observations and infer particle type (based on depolarization). Auth cite an example of a work (Vaughan et al.) that performed such an analysis. Perhaps auth might follow that example in testing their connections.

My recommendation is for auth to make the substantial changes needed to make all the cases convincing or remove those that are not improvable.

One general concern is the use of both "above ground level" and "above mean sea level" altitude reference frames. I strongly recommend that auth use just ASL. AGL can be confusing in the HYSPLIT plots because altitude variations of a UTLS air parcel often have nothing to do with the ground, yet the AGL plots make it look like big excursions are occurring when in many cases it's just because of topographic changes. HYSPLIT does allow one to plot the time series in the ASL reference frame, so this valuable improvement would come with little effort.

It is a good idea to consider UT aerosol instead of the high LS cutoff used in prior papers. Auth now have chosen a fixed altitude (11 km) that is sometimes in the UT and sometimes in the LS. They need to defend the choice of this fixed altitude.

Another general concern is that auth regularly refer to “weak” and “strong” aerosol layers but they do not define the terms. I would suggest that if they want to continue using those qualifiers, to establish a quantifiable distinction up front.

It is surprising that auth do not find any UTLS aerosol layers attributable to pyroCbs in the 9-year period 2004-2012, given their tabulation of strong pyroCb events and the fact that a number of convincing connections were made before and since. In addition to the table provided we know that the frequency of pyroCbs was roughly the same in this period as in others. In fact the pyroCb community has been able to discern pyroCb smoke and volcanic sulfates in the UTLS at the same time (e.g. in July 2011, CALIPSO showed Grimsvotn, Nabro sulfates and pyroCb smoke from the Las Conchas pyroCb (New Mexico) over Europe). It may be beyond the scope of this paper to revisit this period, but I would ask auth to provide an accounting of the dates of lidar measurements deemed to be cirrus free. Such a table in an appendix or supporting information section would be of great value to researchers assessing the lidar data coverage through the years.

The manuscript, marked with comment bubbles containing minor and technical suggestions, is included with this review.

Please also note the supplement to this comment:
https://www.atmos-chem-phys-discuss.net/acp-2018-1153/acp-2018-1153-RC2-supplement.pdf

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