

Dear Authors,

Below you'll find many comments on this article. I want to make one thing clear, all comments are aimed strictly at the writing and the science and not at any of the authors. With that, if any comment feels like a personal attack I wish to extend my sincere apologies as that was not the intention. My research focus is on turbulence and droplets in the surface layer so some of my comments about aerosols may be due to a lack of knowledge in that specific area but should still be addressed.

This article needs significant work to be accepted. I think the work is interesting so I will recommend major revisions. The revisions that are necessary will make the article look like a completely new submission.

General Comments

The English writing in this article is a bit subpar. I understand that English is not everyone's first language but there are many instances where the language used detracts from the science. I have made several comments about the language under the "Minor Issues" section but it is not an exhaustive list. I highly recommend the authors have the article proof-read by a person proficient in English grammar to improve readability.

The introduction need significant rewriting for clarity. Most of the issues are English grammar related, but there are some issues of flow. It is unclear what the hypotheses are and what questions the authors are trying to answer. Black and brown carbon are brought up but the $UVPM_{sec}$ that are mentioned in the abstract are not mentioned.

The Data and Methods section also needs significant rewriting. I have outlined some specific comments below but it is hard to follow. Consider splitting this section up in to something like:

1. Experimental setup and Data Collection
 - 1.1. Instrument specific quality control
2. Methods
 - 2.1. Specific methods used get a subsection

There are significant deficiencies in the turbulence section of this article (Section 2.5). Terms are used that I have not seen in the atmospheric literature and no references are given to the way the terms are defined. Since aerosols and turbulence are so interlinked, I strongly encourage the authors to look at how turbulence statistics are used in similar articles.

Due to the poor English writing my comments on the Results section focus mainly on the figures.

Things to consider (in no particular order):

- Better description of experimental setup

- How are tethered balloon profiles taken? Is it up and down at each timestamp (Line 140)? Or is the balloon constantly up with an array of radiosondes along the tether length.
 - If up-down are the profiles shown an average of the up and down sounding?
 - How long was each up and down sounding?
 - Did the conditions change significantly within a sounding?
 - Are the lines of Fig. 2 averages of all 40 days? Or is it a single day?
- Getting to the end of the paper I still do not understand the difference between the variety of UVPM particle types mentioned.
- Supplemental information, at least to me, should be standalone and not referenced significantly in the actual article. Currently the figures in the supplemental information are talked about as if the reader has them on the page in front of them.
- Figures are hard to interpret, especially the supplemental ones.
- Make very clear what data are used and where.
- Define the three groups (clusters???) early on in the article
- Keep figure style consistent throughout to make comparisons easy
- The flow of the article is nonexistent. I do not have a good recommendation at the moment but the authors need to sit down and outline the article first and make sure the discussion and results come in both a logical and aesthetic way. The article is rather lengthy and I feel like another pass at an outline will help the authors remove unnecessary information.
- The results don't really show me how turbulence has any impact on the vertical profile of aerosols.

Major Issues

Figures (in general): The authors talk about daytime vs nighttime and impact of altitude on concentrations. However, all of the figures are very hard to interpret since there is no clear separation between day vs night and altitudes. Fig. S3 has some altitude information but it is nigh on impossible to understand. I strongly recommend the authors organize their figures such that differences due to day, night, and altitude are very clear. Along with any other key parts the authors wish to highlight

Line 146-149: “*The performances of the...within PBL.*” – this sentence is rather unclear. What sensors were validated? What were the reference instruments? A little bit more information here would be very helpful, yes there is a reference but checking a reference to understand the meaning of a sentence creates very poor readability.

Figure 1: - This figure is not very helpful to understand the experimental setup. A table describing the instrumentation might be more helpful. Further it is unclear from Fig. 1 if there are multiple aerosol samplers at different elevations along the Tibetan Plateau. I would recommend a 2-D map showing location of all sites and then a table describing the equipment at each site. Further since the authors are talking about gradients some information on the measurement heights is crucial.

Line 194-195: “...Hybrid Single-Particle Lagrangian Integrated Trajectory...” – what is this model? Did you make it or did it already exist? If it exists a reference would be needed. If you created it then more detail is necessary

Line 203: “...combining BC and UVPM...” – I’m still not entirely sure what UVPM is as it was poorly described in the preceding sections.

Section 2.3 – A more thorough description here would be very helpful, perhaps with a figure. You say you used cluster analysis to divide the UVPM profiles in to three groups– this would be a great section in which to introduce those three groups with a table so that the reader knows what to expect in the latter sections.

Section 2.4: - This section seems like it needs to be higher up – see my note about organizing this entire section under “General Comments”

Line 237: - UVPM Ratio is undefined

Line 236: “...the fraction of $UVPM_{sec}$ in $UVPM$.” – UVPM is very poorly defined, I thought all UVPM was ‘secondary’? More care needs to be taken to describe these particle types in the introduction and data collection sections.

Equation 1 & 2: It is now very unclear to me now what aerosol types you are measuring and which types you are estimating through relationships. Further now there is a $UVPM_{pri}$ designation which is not defined (first shows up on Line 237).

Equation 3: Is “mechanical turbulence index” a term the authors came up with? This is the square root of the turbulent kinetic energy (TKE) which is like some root mean square velocity. Further TKE encompasses all turbulence and not just shear which is what the authors are trying to isolate. I strongly recommend the authors look at the TKE budget equation and go from there.

Equation 4: This notation is very unclear. Shear is a derivative so should look something like $\frac{du}{dz}$ where u is the streamwise wind speed.

Equation 5: I do not understand what this equation gives. How are you defining your streamwise (u) and spanwise (v) velocities? Traditionally $\bar{v} = 0$ since the coordinates are rotated such that the mean wind speed $U = \bar{u}$ and $\bar{v} = \bar{w} = 0$ where \bar{u} is the streamwise wind velocity, \bar{v} is the spanwise wind velocity, and \bar{w} is the vertical wind velocity.

Figure 2: Text is very small and colors are random. In an earlier section the authors mentioned a difference in profiles between day and night. It would make sense to separate these figures based on day and night. Having the colors be a gradient from start time to end time would greatly improve readability. The authors could also consider a height time concentration plot. See example below except instead of particle size on the y-axis you will have your elevation above ground. It is also unclear how these profiles were taken, was the tethered balloon raised to 2.5 km above ground level and back down at each time stamp? There are no labels on the panels of this figure, and the caption does a poor job of

describing what the reader is looking at. I've also included a caption below the example figure so the authors can understand what a caption should include

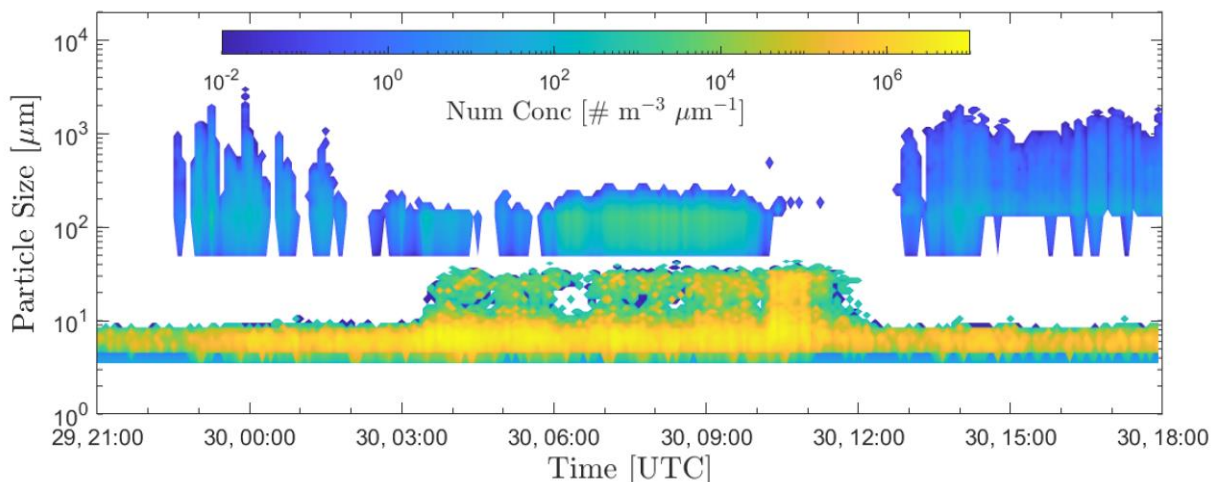


Figure X: Time series of bin-wise droplet concentration from the FM120 and FD70. During the periods of fog (0300 – 1200) we see significantly fewer larger particles from the FD70 and towards the end of the period (1100) we see the evaporation of all larger particles which result in the broadening of the peak of small particles.

Lines 298-305: “The vertical distribution of...discussed in details in the following sections.” –
 Nearly everything that was written in these lines is impossible to read from Fig. 2.

Figure S1 & Figure 3: S1 seems like it would be more useful in the paper instead of in supplemental information. Further, the way both Figure 3 and S1 are presented makes it hard to see any trend. S1 is easier since BC and UVPM_{pri} basically follow each for all time periods but then in Fig. 3 it is unclear if ever the two aerosol types follow each other. Again it would be helpful to separate these plots by day and night since that is what the paper talks about.

Figure 4: It is unclear what I am looking at here. No labels are present. It is also unclear how these calculations were done. I'm sure it was a mix of the model from earlier and whatever “CWT” is. It is not clear at all how the differences between BC and UVPM source areas is calculated.

Figure 5: UVPM and BC concentrations are flipped with respect to the previous plot making it hard to make inter-plot comparisons. Labels are very hard to read from a comfortable reading distance. It is not clear where the data for this plot comes from.

Line 395-396: “...three groups...” – These groups are not defined at all. Because they are not defined it is very hard to follow the remainder of this section.

Figure 6: Because the turbulence terms are defined in a way that I do not understand I do not know how to interpret this plot. Why are error bars all of the sudden included here and not on previous plots? I also don't see significant differences in the three clusters except in UVPM_{sec} concentrations.

Figure 8: See point for Figure 2.

Conclusion: This section is way too vague. “novel findings” may be appropriate for a conference abstract but not so much for an article. The conclusion does a poor job in tying together the entire paper.

Minor Issues

Abstract: - I’ve rewritten the abstract to give the authors some guidelines on what kind of grammar mistakes need correcting. Please note that I have simply rewritten the abstract as it stands and the authors should not just use my example directly. I do not think this is a good abstract for an article, this seems more like a vague abstract you would see for a conference presentation. I strongly recommend the authors incorporate their actual results in to the abstract in a more direct way.

Field experiments that are focused on the interactions between aerosols and the planetary boundary layer (PBL) in complex terrain are few and far between. In this article we use data from the First Planetary Boundary-Layer Meteorology and Pollution at the western SiChuan Basin (1st BLMP-SCP) campaign from Dec. 2018 to Jan. 2019. The focus of the campaign is to provide data on the impact of PBL turbulence on the profiles of air pollutants. We focus on two pollutant types: primary particulate matter (PM_{pri}) and secondary ultraviolet PM (UVPM_{sec}). Both PM_{pri} and UVPM_{sec} show similar regional and long-range transport throughout the campaign. However, the concentration of PM_{pri} rapidly declines with increasing altitude while the concentration of UVPM_{sec} has a peak at 1.5 – 2 km above ground level. We show that the concentration of UVPM_{sec} is more uniform at night and during the daytime UVPM_{sec} gets mixed down into the PBL through mechanical turbulence. This study emphasizes the importance of turbulence on the vertical profiles of air pollutants in complex terrain. Specifically, the results are helpful for understanding the formation mechanism of heavy air pollution within these complex topographic environments.

Line 32: “...fild campaign...” – should be “field.” There are also several other places where “field” is misspelled and general spelling and grammar issues.

Line 61: “Aerosol-planetary boundary layer (PBL)...” – While I understand what the authors are saying here it can be a bit confusing. For clarity, I recommend the authors write something along the lines of:

“The interactions between aerosols and the planetary boundary layer (PBL).”

Line 68: “BC can also...” – typically starting a sentence with an acronym is to be avoided for readability purposes. This comment applies to many places in the article.

Line 79: “...within PBL are...” – “...within the PBL are...” – this comment applies to all cases where PBL is used, “the” is necessary for readability purposes. Also applies to other cases like “Tibetan Plateau”.

Line 166-174: “A portable GPS...given by the manufacturer” – Very hard to follow section of text. It just all over the place.

Line 184: “0.2 and 0.05 Hz” – earlier in the paragraph temporal resolutions were given in seconds and not hertz. For improved readability it would be good to stick to one or the other.