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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Chemical characterization of submicron aerosol and particle growth events at a national background site (3295 m a.s.l.) in the Tibetan Plateau" *by* W. Du et al.

Anonymous Referee #1

Received and published: 9 June 2015

The manuscript entitled, "Chemical characterization of submicron aerosol and particle growth events at a National Background Site (3295 m a. s. l.) in the Tibetan Plateau" by W. Du et al., presents non-refractory plus black carbon (BC) aerosol chemical composition and particle size distribution data from a remote location on the northeastern region of the Tibetan Plateau. The observations reported here fill a gap of data from this part of the world. The location is very interesting for readers of Atmospheric Chemistry and Physics.

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Interactive Discussion
Discussion Paper

The manuscript is generally well-written, yet needs clarification in some areas and additional analysis. Overall, the data were presented well, but much of the interpretation was left to the reader, which makes it difficult to understand the broader picture of the important findings from this study. I recommend publication after addressing these issues.

The overriding issue is that while the data are from a remote, "background" site, there needs to be some analysis as to where the episodes with high mass concentrations and new particle formation events are coming from. An analysis of the various wind directions and back trajectories would also be helpful in putting these observations in the context of other nearby measurements (in particular, Bird Island at Qinghai Lake and Mt. Waliguan). Throughout the text, there is mention of regional transport being important to the observations. From where? I was surprised to find that there are many urban (prefecture) areas within 200 km of the site with populations greater than 500,000 that may be contributing to the background aerosol. This information was not provided in the manuscript. Also, the infrastructure (railroads, agriculture, power plants, etc.) for supporting these people needs to be considered as potential sources.

It was a bit confusing seeing several comparisons in the text and figures with the other sites that are listed in the Supporting Information (SI) Table S1. Those sites are very far away from the sampling location and this paper is probably not intended to be a review of all aerosol composition measurements in China. It was also misleading that the Aerosol Chemical Speciation Monitor (ACSM) instrument is not sensitive to refractory material, which previously was shown to comprise over 60% of the PM2.5 composition for a summertime study at the Bird Island site (Li et al., Tellus B, 2013). The Bird Island results are probably the most relevant published data for comparison, yet they were barely mentioned in the paper. It may be more appropriate to limit the other comparisons to a short, stand-alone section.

Section 3.1: As mentioned above, it would be useful to have a series of back trajectories for the site – wind-rose plots for the higher wind speed data. It was not clear

ACPD
15, C3385–C3390, 2015

where the winds were coming from at the various wind speeds. From the back trajectories presented in Figure S1, Clean1 appeared to be near Xining in the past 12 hours whereas Clean2 appeared to be only from the desert. Why does the data with the back trajectory from near Xining appear "clean"? The back trajectories for Episodes (Ep) 1, 2, and 3 of high mass concentrations were not presented. It would be helpful to see where the potential large sources are – desert, saline lakes, forest, populated areas (density map?), power plants, railroads, etc.

Section 3.2: The diurnal plots are difficult to interpret because all the data are combined and there was no common air mass history selected for this analysis. If biomass burning was a large local source, it should be removed from these plots. An indicator of time since emission could be determined from the fraction of total sulfur as sulfate or (sulfur from sulfate)/(sulfur from sulfur dioxide + sulfur from sulfate). This would only be relevant for sulfur sources and it is unclear that sulfur sources are coincident with other pollutants (for example, carbon monoxide or CO and BC) in the region.

Section 3.3: It appears that biomass burning was a large local source of PM1 during the study, however, this point was not made clear in this section.

Section 3.4: It would be helpful to know a bit more about the meteorology, wind speed and direction as a function of the time of day. Back trajectories would also be useful to interpret the data, especially since particle nucleation was previously observed at Mt. Waliguan for air masses originating from the western sector of that site. There is no physical basis for changes in the smallest particle diameter (Equation 2) to be correlated to bulk particle composition (Figure 9), especially since the size of particles measured by the ACSM is much larger than detected by the Scanning Mobility Particle Sizer (SMPS) during new particle events. Suggest converting the growth rates from a diameter to volume unit for comparison and seeing if the volume increases match the mass increases.

Other comments:

ACPD
15, C3385–C3390, 2015

Title: change “in” to “on”

Line 142: change “plotentilla” to “potentilla”

Line 144: It seems that there were no other urban areas nearby. How big is Menyuan? Datong? Also mention the population of Xining. Are there railroads or power plants impacting the site? Note that the comparisons of city size and population need to be more quantitative, to be put into context with other locations around the world.

Line 146: define “few”

Section 2.2: How high were the sampling inlets? How was black carbon measured?

Lines 205-207: Need to mention the particle size range that is transmitted into the ACSM.

Lines 273-279: These sentences imply that air is transported from Lanzhou to the site. Is that what was intended here? Perhaps it needs to be reworded.

Section 3.2: This is the first place where the gas phase measurements are discussed. It would be helpful to have a time series of them in the SI.

Line 369: change “rationale” to “rational”

Line 403: change “bio-modal” to “bi-modal”

Line 448-449: How long would it take for urban air to get to the site?

Line 485: delete the word “ubiquitously”

Many of the figures do not include the units of measurements. Since the sampling site is at a high altitude, the units of everything should be converted to standard conditions (273.15 K temperature and 1013 hPa pressure). Units for gas phase data should be in mixing ratio (ppbv or pptv) instead of micrograms per cubic meter.

Figure 1: It should be noted that the pie-charts do not include dust and salts, which could be important for the total PM1 at the National Background Site. Suggest making

ACPD

15, C3385–C3390, 2015

the inset satellite image larger than the pie-chart map (moving the pie chart map to SI). There should be a scale on the image, along with markers for other locations such as Bird Island, Mt. Waliguan, Xining, and Wuwei (another potentially significant "nearby" urban source). Consider making it a slightly larger scale to show the location of Lanzhou, too.

Figure 2: The correlation seems to change with time, where the SMPS is lower in the later part of the study by a larger amount than in the beginning. Is there a reason for this?

Figure 3: It is difficult to see several traces on the figure, especially the wind direction, black carbon, and PM1. Why are there gaps in the data? There is a clear diurnal pattern in wind speed. Is there a diurnal pattern in wind direction too?

Figure 4: It would be helpful in the caption to point out local sunrise and sunset. Note the legend should indicate that lines with symbols in Part (a) correspond to PM1.

Figure 5: There should be tick marks on the top x-axis of Part (a) or perhaps a marker indicating where m/z 60 is located. It is difficult to distinguish the different colors in these plots.

Figure 6: Should define in the caption what "post-processed OOA" means.

Figure 7: For Part (b), need to label the y-axis and include text about the dotted lines in the caption. Should also note when it rained in Part (a) and the time of local sunrise in Part (d).

Figure 8: Remove irrelevant plots (top mass concentration, mass fraction) or put into the SI. Units for CO and PM1/CO are missing. Again, note the time of local sunrise in the caption.

Figure 9: The bottom plot in Part (a) is probably not relevant and could be removed. Suggest creating a new plot for Part (b) with growth rate in units of volume change per unit time and aerosol mass change (the difference in mass normalized to CO) per unit

ACPD
15, C3385–C3390, 2015

time. Still may not be correlated if the size ranges are not overlapping.

Table S1: Make headers match the site location names on the map from Figure 1.

Figure S2: Add the outline of Qinghai Lake and the locations of Qilian Shan Station, Bird Island, Mt. Waliguan, and Xining, maybe Wuwei. Is the black curve on the bottom plot indicating the ground level? Please note that in the caption. Also add the time difference between UTC and the sampling site.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 13515, 2015.