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**Title: "Measurement report: Chemical characteristics of PM2.5 during typical biomass burning season at an agricultural site of the North China Plain"**

**Anonymous Referee #1**

Received and published: 10 November 2020

## General Comments:

In this manuscript, the authors report chemical characteristics of $PM_{2.5}$ under the impact of biomass burning (BB) in the North China Plain. A unique episode with extreme biomass burning impact, with daily concentrations of levoglucosan as high as 4.37 μg $m^{-3}$ was captured. The formation process and chemical characteristics of this severe biomass burning pollution episode were also reported. This field measurement was interesting and the data in this study was valuable. This study matches the definition of Measurement Report quite well, presenting substantial new results from field measurements of atmospheric properties and processes. The manuscript is well organized and concisely written, and minor revisions indicated below are needed before publication.

**Our reply:** We thank the reviewer for the pertinent comments. We have prepared the point-by-point responses to address the reviewer's comments as shown below. The blue color text shows the amended sections in the manuscript. The line numbers correspond to those in the revised version of the manuscript.

## Major comments:

**(1) LOD (limit of detection) of the water-soluble inorganic ion analysis also suggested described in the experimental section.**

**Our reply:** According to the referee's comment, LOD (limit of detection) of the water-soluble inorganic ion analysis is described in the experimental section.

"The quartz filter samples were also analyzed for water-soluble inorganic ions by a Dionex

ICS-5000+ ion chromatograph, including $SO_4^{2-}$, $NO_3^-$, $NH_4^+$, $Cl^-$, $Ca^{2+}$, $Na^+$, $K^+$ and $Mg^{2+}$. The method detection limits for the individual ionic species were 0.18 μg $L^{-1}$, 0.15 μg $L^{-1}$, 0.03 μg $L^{-1}$, 0.048 μg $L^{-1}$, 0.08 μg $L^{-1}$, 0.01 μg $L^{-1}$, 0.01 μg $L^{-1}$, 0.008 μg $L^{-1}$, respectively." (See Lines 115-118)

**(2) Experimental section should include more detailed information regarding statistical analysis conducted.**

**Our reply:** According to the referee's comment, we added the description of statistical methods applied to our data in the revised manuscript.

"Statistical analysis of data, i.e., the correlation analysis between the concentrations of levoglucosan, mannosan and $K^+$ at Gucheng site during the sampling period were conducted with the linear fitting method." (See Lines 151-154)

**(3) "Concentration" in table 1 should be changed to "Average concentration".**

**Our reply:** According to the referee's comment, we changed "Concentration" to "Average concentration" in Table 1 in the revised paper.

**(4) The meteorological factors (temperature (T), relative humidity (RH), wind speed (WS) and rainfall) in Figure 1 were together expressed in one figure, difficult to distinguish. It is suggested to separate these meteorological factors to two figures and add the time-series variation of PBL as well.**

**Our reply:** We thank the anonymous referee for this valuable comment. We added the time-series variation of PBL and separated the meteorological factors into two figures, i.e., Figure 1f and Figure 1g.

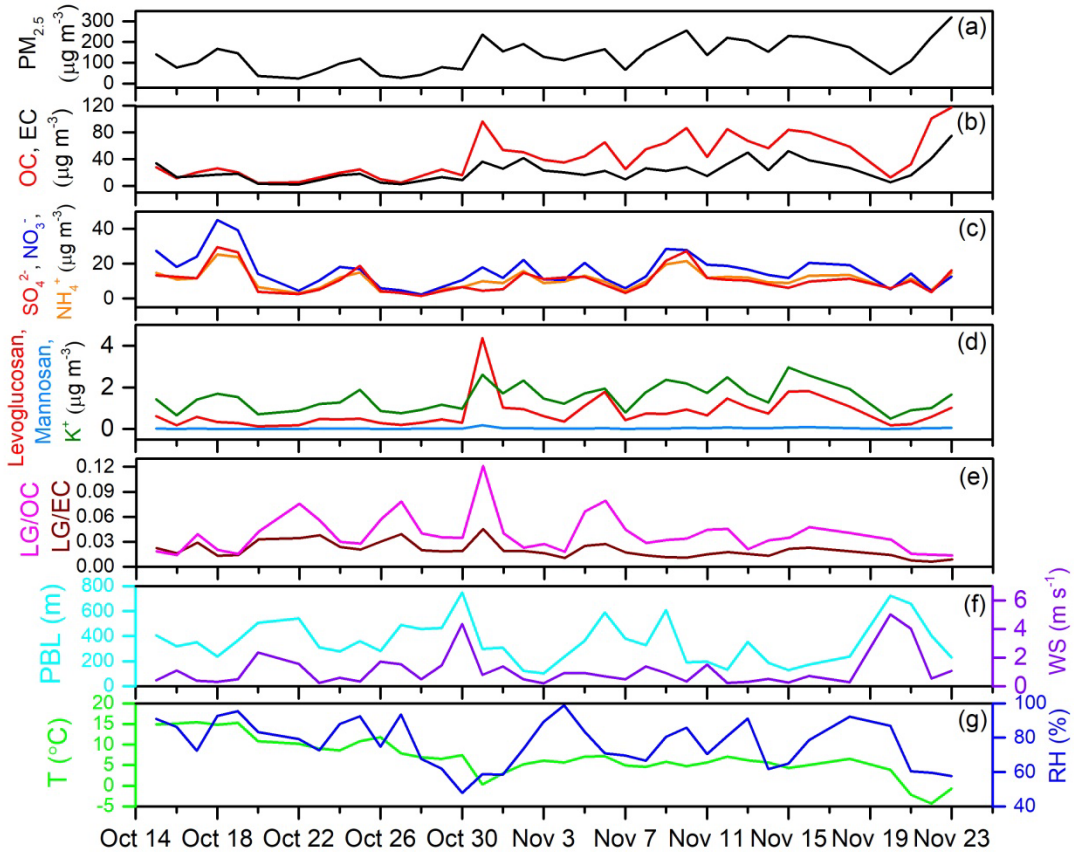


**Figure 1.** Time-series variation obtained for $PM_{2.5\text{-cal}}$ and its major components, biomass burning tracers as well as meteorological factors at the GC site during the sampling period from 15 Oct to 23 Nov 2016 (a) $PM_{2.5\text{-cal}}$, (b) OC and EC, (c) secondary inorganic aerosols, i.e., $SO_4^{2-}$, $NO_3^-$ and $NH_4^+$, (d) levoglucosan, mannosan and $K^+$, (e) ratios of levoglucosan to OC (LG/OC) and levoglucosan to EC (LG/EC), (f) PBL and wind speed (WS), (g) temperature (T) and relative humidity (RH).

**(5) The English grammar and usage should be polished by some English native speakers.**

**Our reply:** According to the referee's comment, we have improved the English writing in the revised paper.

**(6) The abbreviation such as LG and MN is not generally used in literatures. These abbreviations are not easy to be remembered and make the manuscript difficult to understand. I suggest that the authors using the origin names or abbreviations more easily to be remembered.**

**Our reply:** According to reviewer's suggestion, the abbreviations of LG and MN were changed to

the original names, i.e., levoglucosan and mannosan in the revised manuscript.

**(7) Discussion of the possible degradation of levoglucosan should be included in the Day and night distributions.**

**Our reply:** According to the referee's comment, we added a remark that the chemical degradation of levoglucosan may occur due to photochemical reaction in the ambient aerosols during daytime in the revised paper, extending the discussion of day-night distribution results.

"Moreover, besides the influence from variations of the PBL height, the chemical degradation of levoglucosan may occur due to photochemical reaction in the ambient aerosols during daytime, further enlarging the gap of levoglucosan levels between daytime and nighttime (Sang et al., 2016; Gensch et al., 2018). Consequently, the contribution of levoglucosan to $PM_{2.5\text{-cal}}$ during nighttime (0.64%) was observed to be higher than that during daytime (0.37%) (Figure 3)." (See Lines 201-206)

**(8) More time series of diagnostic ratio such as levoglucosan to OC ratios should be presented to illustrate the impact of BB**

**Our reply:** We thank the referee for this valuable comment. We added the time series of levoglucosan to OC ratios as Figure 1e, illustrating the impact of biomass burning. Meanwhile, the discussion of the influence of biomass burning emission on organic aerosol was also updated in the revised paper.

"The levoglucosan/OC ratio was utilized to estimate the effect of biomass burning on ambient organic aerosols. Accordingly, levoglucosan/OC ratios sharply increased to 0.045 during period II, which was noticeably higher than during other periods in this study. Moreover, this level is also higher than most of the published field observations, i.e., at urban sites (Zhang et al., 2008; Cheng et al., 2013; Zhang et al., 2014), rural sites (Sang et al., 2013; Ho et al., 2014; Pietrogrande et al., 2015; Mkoma et al., 2013) and agricultural sites (Ho et al., 2014; Jung et al., 2014), yet lower than at an urban site in northern Italy during wintertime (in the range of 0.01 to 0.13) (Pietrogrande et al., 2015). This illustrates that biomass combustion played an important role in organic aerosol pollution during the intensive BB episode II. However, due to other emissions of OC enhanced during the major BB episode (period III)

and heating season (period IV), i.e., combustion of coal and biofuel for heating, OC increased to an even higher level (55.2 ± 17.1 μgC $m^{-3}$ and 69.4 ± 24.6 μgC $m^{-3}$, respectively). Due to the abundance of organic aerosols, the contribution from biomass burning emission was thereby reduced and the levoglucosan/OC ratios during periods III and IV decreased to 0.016 ± 0.005 and 0.014 ± 0.006, respectively, even lower than those observed in the minor BB period I (0.025 ± 0.008).” (See Lines 254-268)