

## Response to reviewer#2

Thanks for the reviewer's helpful suggestions! The comments are addressed point-by-point and responses are listed below.

**Comments:** The research on new particle formation (NPF) is of great importance considering its vital role in modulating the cloud condensation nuclei. While NPF has been widely studied, the authors primarily focus on the development of aerosol size distribution among different altitudes as well as the impact of aerosol-radiation on NPF. The analysis angle is unique and the manuscript is well written. I have a few comments prior to the acceptance of the manuscript for publication.

**Reply:** Thanks for the comments.

**Comments:** Major comments: 1. A typical NPF figure ( $dN/d\log D_p$  vs. time) at a few selected altitudes might be helpful for readers to understand the evolution of NPF along with time and altitude.

2. In the abstract, the authors hypothesized that the nucleation processing in the upper boundary layer should be stronger than that at the ground. Since the observational PNSD in the vertical direction is available, I am wondering whether the authors can calculate the formation rate directly. In this way, one can easily identify whether the nucleation processing over the upper altitude is higher than that at the ground.

**Reply:** Thanks for the comment. The reviewer gave insightful suggestions for better understanding the evolution of NPF. As shown in Fig. 2 and Fig. S3, we measured only 16 PNSD profiles on January 19, 2019. The time interval is so large that the typical NPF figure

at different altitudes is not available. Calculating the formation rate is not appropriate as the measured aerosol PNSD changed significantly (Cai and Jiang, 2017) with the development of the mixing layer.

Minor comments:

**Comments:** Line 120: Some changes were made in the source code of the TUV model so that the model can calculate the  $J(NO_2)$  and  $J(O^1D)$  profiles. A bit more information is useful. For instance, a few more words on what major changes have been made.

**Reply:** Thanks for the comment. We added a brief description of the changes of the TUV model in the manuscript.

In the TUV model, the input of the aerosol optical properties are the aerosol optical depths at the wavelength of 550 nm and the column-averaged SSA. The profiles of the  $\sigma_{sca}$  are calculated assuming that the aerosol  $\sigma_{sca}$  are proportional to those measured by Elterman et al. (1968). The  $g$  values are set to be fixed as 0.61. Some changes were made in the source code of the TUV model. In our model, the author-defined aerosol  $\sigma_{sca}$  profiles, SSA profiles and  $g$  profiles can be used as the input of the model. Therefore, the  $J(NO_2)$  and  $J(O^1D)$  profiles with different aerosol optical profiles (including aerosol  $\sigma_{sca}$ , SSA, and  $g$ ) can be estimated.

**Comments:** Line 123: Altitude, Please revise to altitudes

**Reply:** Thanks for the comment. We revised the word.

**Comments:** Line 132 (Line 193; 205;304): Transportation Please revise to transport.

**Reply:** Thanks for the comment. We revised the corresponding words.

**Comments:** Line 144 for different altitudes and a different time. Please revise to for different altitudes and time

**Reply:** Thanks for the comment. We revised this sentence.

**Comments:** Line 159 These particles were still not well mixed at the range between 0 and 240 m until 11:20. From Fig. 2, it does not seem to show the mixing at 11:20. Is it something not shown in the figure?

**Reply:** Thanks for the comment. The time should be 10:20. We revised the text in the corresponding manuscript.

**Comments:** Line 183 (Line 479;295) different times, Please revise to: different time

**Reply:** Thanks for the comment. We revised the corresponding words.

**Comments:** Line 185: The ratio on the ground surface decreased. It is not clear that the ground decreased compared to ??

**Reply:** Thanks for the comment. We want to say that the ratio at the ground decreased over time during 8:00 and 10:00 in the morning.

**Comments:** Line 196 later Should be late; if the authors only want to emphasize afternoon, the word "later" should be removed.

**Reply:** Thanks for the comment. We revised the words into “late afternoon”.

**Comments:** Line 266-270 The authors list the altitude of boundary layer height of either 1000 or 500 meters. Please clarify whether these heights are the exact boundary layer heights or approximate altitude? Or they represent a range, i.e., less than 1000 meters?

**Reply:** Thanks for the comment. The boundary layer heights of 1000 or 500 meters are the exact boundary layer heights. We made some revisions in the corresponding lines.

Cai, R., and Jiang, J.: A new balance formula to estimate new particle formation rate: reevaluating the effect of coagulation scavenging, *Atmospheric Chemistry and Physics*, 17, 12659-12675, 10.5194/acp-17-12659-2017, 2017.

Elterman, L., Wexler, R., and Chang, D.: COMPARISON OF AEROSOL MEASUREMENTS OVER NEW MEXICO WITH ATMOSPHERIC FEATURES, Journal of the Optical Society of America, 58, 741-&, 1968.