Response to comments by referee 1

We would like to thank Prof. McKendry for your comments and helpful suggestions. We revised our paper according to these comments and suggestions.

Specific comments:

Question 1. The title should be modified - I suggest something like: Impact of emission controls on air quality in Beijing during APEC 2014: lidar ceilometer observations.
Response 1: Thank you for your suggestion. We agree with you and revise the title to "Impact of emission controls on air quality in Beijing during APEC 2014: lidar ceilometer observations".

Question 2. The manuscript badly needs a map in which the regions in which emission controls were implemented are shown. Some discussion of the types of emission controls (where and what?).
Response 2: Thank you for your suggestion. We illustrate our measurement site and to describe the regions with emission controls.

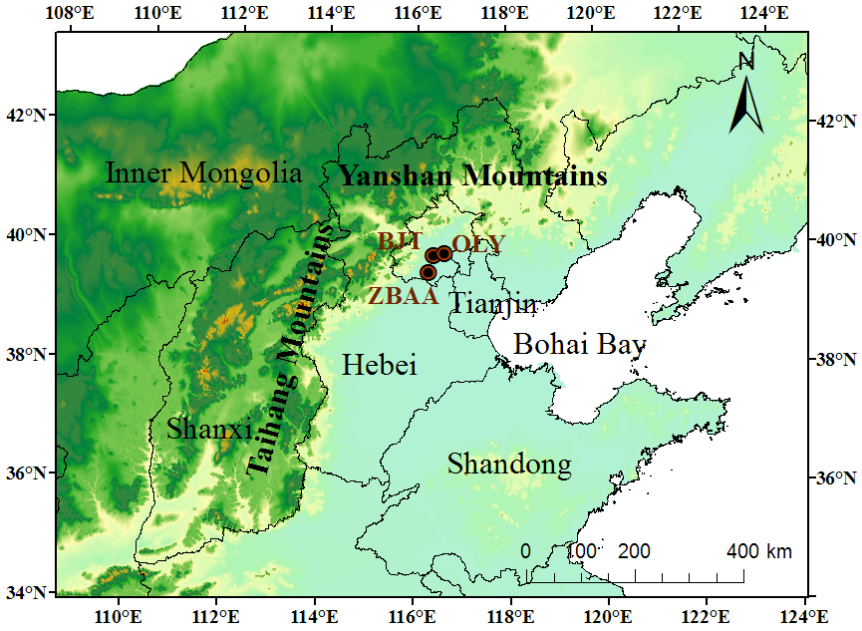

Figure 1 Observation sites and topography

Besides, we also added some description in the section of introduction to explain the emission controls. Please see the revision as follows.
Consequently, more than 460 businesses with high emissions in Beijing were required to stop or limit their production during 3–12 November, 2014. The number of private vehicles in operation during the same period was reduced by 50% through an odd/even number plate rule. Further, 9298 enterprises were suspended, 3900 enterprises were ordered to limit production, and more than 40,000 construction sites were shut down in all six provinces, cities and autonomous region.

Question 3. There is a terminology problem where "process" is used to describe "degraded air quality episodes". The various places where this occurs is highlighted in the marked up PDF.

Response 3: In section 3.2.3, visibility was used to indicate the degree of atmospheric pollution. With the decreasing of the visibility, the evolution of the air pollution was illustrated statistically. It was not the same with the actual episode. Therefore, we revised the manuscript thoroughly. For the actual air pollution, we used episode. For the statistical evolution of the air pollution using visibility, we used different air pollution degrees. Besides, to avoid the misunderstandings, the initial accumulation stage was revised to the transition period because of the significant changes of the air pollution and the peak pollution stage was revised to the polluted period.

Question 4. Similarly, the term "High Layer atmosphere" I think refers to upper boundary layer?

Response 4: Please see the responses of the technical comments.

Technical comments in the paper:

Question 1: Page 3, line 1. By comparing the PM2.5 concentrations before, during and after APEC (BAPEC, DAPEC and AAPEC, respectively), we found that the concentration of fine particles decreased by 60% and visibility improved by 60% during APEC.

Response 1: We are sorry for the misunderstanding. We compare the period of DAPEC to BAPEC and AAPEC, and the rates of change are not the same for BAPEC and AAPEC. To avoid the misunderstandings, we revised this sentence to "By comparing the $PM_{2.5}$ concentrations and visibility before, during and after APEC (BAPEC, DAPEC and AAPEC, respectively), we found that the concentration of fine particles decreased by 59.2 and 58.9% and visibility improved by 70.2 and 56.0% during APEC compared to DAPEC and AAPEC, respectively."

Question 2: Page 3, line 22.

Response 2: Thank you for your suggestion. We have fixed this mistake.

Question 3: Page 4, line 1.

Response 3: Thank you for your suggestion. We have fixed this mistake.

Question 4: Page 4, line 11. Not quite sure what is meant here. Do you mean that in the absence of measurements, model output must be used?

Response 4: We are sorry for the misunderstanding. Because the vertical variations of aerosols are lacking, we don't know how to do the coordinated regional prevention and control. Some people want to do this work using air quality model. However, lacking the validation of the observations, the results

from the air quality model are not reliable. To avoid the misunderstanding, we revised this paragraph into "Although coordinated regional prevention and control has been proposed for many years, it is difficult to obtain evidence and quantify the intensity of regional transport solely based on ground observations. Thus, reductions in regional emissions have not been implemented. Previous studies attempted to use air quality model to quantify the intensity and height of regional transport (Wu et al., 2011). However, the vertical gradient of air pollutants was not measured to test the model; therefore, the results are not reliable. Thus, it is of great importance to measure the vertical gradient of air pollutants to quantify the intensity and height of the regional transport."

Question 5: Page 4, line 21.
Response 5: Thank you for your suggestion. We have revised it to "sand storms".

Question 6: Page 4, line 27.
Response 6: Thank you for your suggestion. We have revised it to "sand storms".

Question 7: Page 5, line 6.
Response 7: Thank you for your suggestion. We have revised it to "aforementioned".

Question 8: Page 5, line 7.
Response 8: Thank you for your suggestion. We have deleted "a".

Question 9: Page 5, line 10.
Response 9: Thank you for your suggestion. We have deleted "the".

Question 10: Page 5, line 11.
Response 10: Thank you for your suggestion. We have deleted "the".

Question 11: Page 5, line 12.
Response 11: Thank you for your suggestion. We have deleted "the".

Question 12: Page 6, line 4.
Response 12: Thank you for your suggestion. We have revised it to "episodes".

Question 13: Page 9, line 1.
Response 13: Thank you for your suggestion. We have revised it to "different atmospheric pollution degrees".

Question 14: Page 9, line 12.

Response 14: Thank you for your suggestion. We have revised it to "nine poor air quality episodes were observed".

Question 15: Page 9, line 13-17.
Response 15: Thank you for your suggestion. We have revised them to "episode".

Question 16: Page 10, line 2.
Response 16: Thank you for your suggestion. We have revised it to "episode".

Question 17: Page 10, line 8.
Response 17: Thank you for your suggestion. We have added "(Fig. 2)" in the end of this sentence.

Question 18: Page 10, line 16.
Response 18: Thank you for your suggestion. We have revised it from "evaluation" to "evolution".

Question 19: Page 10, line 23.
Response 19: Thank you for your suggestion. We have revised it to "Therefore, the attenuated….".

Question 20: Page 11, line 5.
Response 20: Thank you for your suggestion. We have revised it to "The presented results showed….".

Question 21: Page 11, line 13-21.
Response 21: Thank you for your suggestion. We have revised it to "According to the average vertical gradient of the attenuated backscattering coefficients during the period of observation, we found clear differences between ….".

Question 22: Page 12, line 5-7.
Response 22: Thank you for your suggestion. We have revised from "fine particles may originate from different locations in the different degrees of air pollution of each pollution episode"

Question 23: Page 12, line 9.
Response 23: Thank you for your suggestion. We measured visibility using the Belfort Model 6000 Visibility Sensor in our institute. I have added some sentence to give some introduction about the measurement in section 2.4.

Question 24: Page 13, line 1.
Response 24: Thank you for your suggestion. We added "the" before atmosphere.

Question 25: Page 13, line 2.

Response 25: Thank you for your suggestion. We revised the sentence to "…results in decreased concentrations between the space from 300 to 900 m".

Question 26: Page 13, line 7.

Response 26: Thank you for your suggestion. We revised it to "pollution episode intensity".

Question 27: Page 14, line 3.

Response 27: Thank you for your suggestion. We revised this sentence to "…in $PM_{2.5}$ concentration because of the similar meteorological conditions during these three periods".

Question 28: Page 17, line 6.

Response 28: Thank you for your suggestion. We revised this sentence to "When cold, dry air masses go through Beijing, the attenuated ….".

Question 29: Page 17, line 9.

Response 29: Thank you for your suggestion. We revised this sentence to "Subsequently, the evolution of a pollutant episode was completed.".

Question 30: Page 17, line 13.

Response 30: Thank you for your suggestion. We revised it to "episode".

Question 31: Page 17, line 18.

Response 31: Thank you for your suggestion. We revised it to "in the space from 0 to 900m".

Question 32: Page 18, line 5.

Response 32: Thank you for your suggestion. We revised it to "upper boundary layer".

Question 33: Page 18, line 9.

Response 33: Thank you for your suggestion. We revised it to "by convective mixing".

Question 34: Page 18, line 10.

Response 34: Thank you for your suggestion. We revised it to "upper boundary layer".

Question 35: Page 18, line 13.

Response 35: Thank you for your suggestion. We revised it to "led".

Question 36: Page 18, line 15.
Response 36: Thank you for your suggestion. We revised it to "southerly flow was not significant, and it was replaced by near-surface static winds….".

Question 37: Page 18, line 18.
Response 37: Thank you for your suggestion. We revised it to "upper boundary layer".

Question 38: Page 18, line 20.
Response 38: Thank you for your suggestion. We revised it to "upper boundary layer".

Question 39: Page 19, line 1.
Response 39: Thank you for your suggestion. We have deleted "the".

Question 40: Page 19, line 3.
Response 40: Thank you for your suggestion. We have deleted "the".

Question 41: Page 19, line 7.
Response 41: Thank you for your suggestion. We revised it to "upper boundary layer".

Question 42: Page 19, line 9.
Response 42: Thank you for your suggestion. We revised it to "of different pollution degrees".

Question 43: Page 19, line 13.
Response 43: Thank you for your suggestion. We revised it to "upper boundary layer".

Question 44: Page 19, line 16-17.
Response 44: Thank you for your suggestion. We added ~ before the percent.

Question 45: Page 19, line 24.
Response 45: Thank you for your suggestion. We revised it to "coal burning for heating".

Question 46: Page 20, line 4.
Response 46: Thank you for your suggestion. We have deleted "the".

Question 47: Page 33.
Response 47: Thank you for your suggestion. We have deleted "the".

Question 48: Page 35.

Response 48: Thank you for your suggestion. We revised it to “episode”.