Dear Editor:

We are truly grateful to yours and other reviewers' comments during the open discussion of our manuscript (Evaluation of regional background particulate matter concentration based on vertical distribution characteristics. **No. acp-2015-65**). Based on these valuable comments, we have carefully addressed the referee's main concerns with this work. Please see point-by-point response to comments for details.

Thank you very much for your work concerning our paper.

Best regards

Sincerely yours

Suqin Han, Yu-fen Zhang and Yin-chang Feng

Responses to the reviewer#1

Review of "Evaluation of regional background particulate matter concentration based on vertical distribution characteristics" by Han et al. This study presents vertical structures of meteorological parameters, turbulence, and PM in a 250 meter tower. The data presented here is valuable to study the effect of PBL on the PM diffusions. Because the region is under heavy PM pollution, this study provides some useful results. The paper analyzes seasonal variations of diffusion of PM at different levels, and some statistical methods are applied in this study. However, some definitions need to be clarified. The English in the paper needs to be improved. This paper needs to be revised before it can be accepted for publication. The detailed comments are listed as below.

Response: The definitions have been illustrated and the English in the paper has been improved. Detailed responses go as follows.

Specific comments:

Comment: P6; The definitions of the stable, neutral, and unstable conditions in Fig. 2 need to be explained.

Response: The gradient Richardson number（R_i）was used for classifying the atmospheric stability conditions:

$$R_i = \frac{g}{\overline{T}}\left[\frac{\Delta T}{\sqrt{z_1 z_2}\ln\frac{z_2}{z_1}} + r_d\right] \times \left[\frac{\sqrt{z_1 z_2}\ln\frac{z_2}{z_1}}{\Delta u}\right]$$

where, $\Delta T = T_2 - T_1$, $\Delta u = u_2 - u_1$, T_2 and $T_1$are the measured temperatures at the height of $z_2$and z_1, $\overline{T}$ is the averaged temperature in the layer between level z_2 and

z_1, u_2 and u_1 are the measured wind speed at levels z_2 and z_1, g is the gravitational acceleration, r_d is dry adiabatic lapse rate. According to the values of R_i, three different conditions can be distinguished: $R_i \geq 0.1$ for stable condition, $-0.1 < R_i < 0.1$ for neutral condition, and $R_i \leq -0.1$ for unstable condition.

Comment: P7; The definition of the night PBL height (NPBL) needs to be explained.
Response: In this paper, temperature profile was observed at 15 platforms (5m, 10m, 20m, 30m, 40m, 60m, 80m, 100m, 120m, 140m, 160m, 180m, 200m, 220m and 250m) on the meteorological tower. The vertical gradient is calculated as

$$\frac{\Delta T}{\Delta Z} = \frac{T(z+1) - T(z)}{Z(z+1) - Z(z)}$$

where $T(z+1)$ and $T(z)$ represent the measured temperatures at levels $z+1$ and z, and $Z(z+1)$ and $Z(z)$ represent the altitudes at levels $z+1$ and z. The height of the nocturnal planetary boundary layer (NPBL) is determined by the bottom of positive temperature vertical gradient level, i.e. the bottom of inversion.

Comment: P8 and Fig. 5; Why the $PM_{2.5}$ concentrations are higher at noontime at 220 m than other levels? Is this due to the secondary formation?
Response: This is mainly due to strong vertical mixing at noontime. After sunrise, the PBL starts to rapidly increase. Pollutants near the ground gradually diffuse upward. At noontime, the mixing layer is fully developed with the averaged PBL height being about 1000-1200m. Among these 4 platforms (2 m, 40 m, 120 m and 220 m), $PM_{2.5}$ concentration at 220m is the highest during noon-afternoon-time.

Comment: P2; "was 40.0 ± 20.2, 63.6 ± 16.9 and 53.2 ± 11.1 μg/m^3 , respectively, in July, August and September". Should change to "was 40.0 ± 20.2, 63.6 ± 16.9 and 53.2 ± 11.1μg/m^3 , in July, August and September, respectively".
Response: The expression has been revised.

Comment: P2; Atmospheric particulate matter (PM) has drawn considerable attention because it has been associated with many urban environmental problems, such as acid precipitation, decreasing visibility and cli-mate change (Zeng and Hopke, 1989; Charlson et al., 1992; Schwartz et al., 1996;Chameides et al., 1999). PM has also been implicated in human mortality and mor-bidity (Dockery et al., 1993; Lagudu et al., 2011). The references should include Cao et al., 2013. Tie et al., 2009. Cao J.J., X. Tie, W. Dabberdt, Z.Z. Zhao, and T. Jie, On potential acid rain enhancement in eastern China, J. Geophys. Res., 118, 4834–4846,doi:10.1002/jgrd.50381, 2013.

Tie, X., D. Wu, and G. Brasseur, Lung Cancer Mortality and Exposure to Atmospheric Aerosol Particles in Guangzhou, China, Atmos. Environ, 43, 2375–2377, 2009.
Response: The references have been added in the introduction.

Comment: P3; “In addition, regional compound pollution” should be “In addition, regional air pollution” P3; “in the city cluster” should be “ a cluster of cities”.
Response: The expression has been revised.

Comment: P4; With the increase of vertical height, the influence of source emission on local air quality is weakening should be “With the increase of vertical height, the influence of source emission on local air quality decreases with altitude”
Response: The expression has been revised.