Reply to Anonymous Referee #2

We thank the reviewer for the careful reading of the manuscript and helpful comments. We have revised the manuscript following the suggestion, as described below.

Specific comments:

Comment: Page 8, Lines 11–15 Please consider briefly showing the analysis procedures in supplementary material.

Response: We have added a paragraph in Section 2 to provide a detailed description of the subjective procedure used for the classification:

"***2.3 Classification Method***

The subjective procedure is used to categorize the synoptic situations that affect the plume transport patterns in the Guanzhong basin. The synoptic weather system is first identified according to the geopotential height and wind fields on 850 hPa. Then the detailed position of the basin to the weather system can be determined. For example, if the basin is located in the southwest of a trough, the synoptic situation is categorized as "southwest-trough"; and if a high-pressure system controls the basin, the synoptic situation is defined as "inland-high". However, since the synoptic situations are not very clear-cut at times, the FLEXPART-WRF model is further used to calculate the plume transport patterns in the basin under different synoptic situation classifications. If there exists the transition of the weather system influencing the basin for one day, the synoptic categorization is determined by the plume transport patterns in the basin. For example, on some day, the weather system influencing the basin transits from "inland-high" to "southwest-trough". The calm and stable situations induced by "inland-high" facilitate the pollutants accumulation in the basin, but the dry and cold northwest winds caused by "southwest-trough" is subject to evacuate the pollutants in the basin. If the FLEXPART-WRF model results show that the plume moves outside of the basin, the synoptic situation is categorized as "southwest-trough" for the day, otherwise it is classified as "inland-high". Additionally, the occurrence of precipitation is not considered yet in the categorization, which can efficiently wash out pollutants in the atmosphere. Therefore, it is worth noting that, on different days which are grouped into the same category, the pollutants behavior might be quite different caused by the weather system transition or precipitation occurrence."

Comment: Page 6, Lines 25–26 Page 8, Lines 19–23 It is stated that six selected days, representing six categorized typical synoptic simulations of the Guanzhong basin, were simulated by the numerical model. Please elaborate a bit about the selection process since the synoptic situations are not very clear cut at times, or even for different days which were grouped into the same category, the PM behavior could be quite different. Did the authors simulate a few cases for every category and then make the selection? Would the model give similar simulation results for most of the cases in the same category?

Response: We have selected 3 cases for every category and then made the selection. The FLEXPART-WRF and WRF-CHEM models give similar simulation results for the three cases in the same category generally. We have clarified in Section 3:

" *For discussion convenience, the following six days are selected to represent the above*

six typical synoptic situations: (1) Feb. 16, 2014 ("north-low"), (2) Jan. 19, 2014 ("southwest-trough"), (3) Dec. 26, 2013 ("southeast-high"), (4) Dec. 2, 2013 ("transition"), (5) Jan. 23, 2014 ("southeast-trough"), and (6) Dec. 23, 2013 ("inland-high"). For the selection process, three days are first chosen for every category. The FLEXPART-WRF and WRF-CHEM models are then used to simulate the pollutants transport pattern and $PM_{2.5}$ variations and distributions on the three selected days in each category. In general, the simulation results from the two models are similar in the same category, but uncertainties still exist, caused by the weather system transition or occurrence of precipitation. Finally, the most typical day for each category is selected for further analysis and model simulations. The synoptic patterns of the selected six days, shown in Figure 3, are similar to those in Figure 2."

Please also reference Section 2.3 for the classification method.

Comment: Figure 8 Seen from the figures, the model simulations tend to underestimate the PM concentrations when the concentration levels are high. What are the author's views on this? What are the major uncertainties of the model?

Response: We have clarified in Section 3: "*The WRF-CHEM model generally captures well the observed diurnal variations of the $PM_{2.5}$ mass concentrations, but the model simulations tend to underestimate the $PM_{2.5}$ concentrations when the levels are high. The model biases are mainly from the uncertainties of anthropogenic emissions and meteorological field simulations. The model often underestimates the observed $PM_{2.5}$ mass concentrations during nighttime, which perhaps is caused by illegal emissions that are not reflected in the available emission inventories. In addition, in the afternoon on Dec. 23, 2013, the model considerably underestimates the observation. According to Figure 9f, apparently, the simulated northeast winds are subject to pushing the plume to the south of the basin, causing the model underestimation compared to measurements.*"