We thank the referee for a very thoughtful review and detailed suggestions to our manuscript. Incorporation of these suggestions helps to improve the quality of our manuscript significantly. Following are the responses to the reviewer's comments, and related revises have been incorporated into the updated manuscript.

(1). **Comment**: The simulation period need to be clarified in the method section 2.4.
Response: The CMAQ model simulation period covers March and April from 2006 to 2010. This period is selected to represent the spring dust episode of East Asia. We have added this introduction into section 2.4 in the revised manuscript (see first paragraph of section 2.4).

(2). **Comment**: As the analysis is mainly focused on the spring time from 2006 to 2010, it would be better to explain how to initialize the model for each year.
Response: The regional model CMAQ uses daily initial concentrations and boundary conditions provided by a global model simulation with GEOS-Chem. The downscaling method is described in Lam and Fu (2009). GEOS-Chem simulation was conducted for 5 years from 2006 to 2010. We have added this information into section 2.4 in the revised manuscript (see second paragraph of section 2.4).

(3). **Comment**: Temporal coverage of observation data with screening criteria is also suggested to add in Table 4.
Response: Table 4 gives a brief introduction of the observations used in this study, and more details of these data are added into the revised manuscript in section 2.5. All the observations are collected to cover the simulation period March and April from 2006 to 2010, except for the data from Fudan Univ. network due to limited measurement efforts. The local data from Fudan Univ. has daily measurements only for 2007. We didn't apply additional screening criteria to the observations in this study because the data has already been examined before being officially release. The MODIS level2 AOD is filtered by GSFC before release. The API data is organized by China MEP and it has been screened before being published. The AERONET level 2.0 data used in this study is screened and quality assured mainly by the local agencies that organized the observational sites. The EANET data is screened and quality assured by Dr. Keiichi Sato (ksato@acap.asia) and Dr. Ayako Aoyagi (eanetdata@acap.asia) from the Asia Center for Air Pollution Research. The TAQMN data is screened and quality assured by Taiwan EPA before release.

(4). **Comment**: P35598 L17, I found difficulties to understand the function (6). Should that only apply to the case when Sm is > Wmax as stated in L11?
Response: The reviewer is right. W_{max} represents the maximum water holding capacity for each soil type. The soil moisture adjustment factor f_{soilm} is applied only when soil moisture S_m exceeds W_{max}. In addition, S_m shall not exceed the saturation soil moisture limit S_l, and the soil moisture adjustment factor f_{soilm} is set as 999.9 in the code only to avoid computational abnormal values. So we have revised the function (6) as:

$$f_{soilm,i,j} = \begin{cases} 1.0, & for\ S_m \le W_{max} \\ (1.0 + 1.21 \times (S_m - W_{max})^{0.68})^{0.5}, & for\ W_{max} < S_m \le S_l \end{cases} \quad (6)$$

(5). **Comment**: P35602 L21, "the ACM2 PBL scheme" should be introduced at WRF part
Response: The reviewer is right, the WRF simulation uses ACM2 PBL scheme. The CMAQ model can define its own PBL scheme for vertical diffusion, so the vertical diffusion is configured by CMAQ again while running the. But usually the PBL schemes used by WRF and CMAQ will be the same to retain consistency. As the detailed description of the WRF configuration is described in Dong and Fu (2015a, b), we removed the description of CMAQ ACM2 PBL scheme in the revised manuscript.

(6). **Comment**: P35603 L20, I would suggest to clarify that Dust_profile, Dust_Chem and Dust_Chem_High were performed based on Dust_Revised.
Response: Yes the reviewer is right, the scenario Dust_Profile, Dust_Chem, and Dust_ChemHigh are all performed based on Dust_Revised. We have added this in the revised manuscript (see last sentence of section 2.4).

(7). **Comment**: P35605 L27, the sentence of "with relatively larger discrepancy in cities close to the Gobi Desert." is confusing, please revise it.
Response: We intended to demonstrate that among all the cities which has API data, model evaluation results indicate relatively larger bias for those that are closer to the Gobi Desert. We realize that the original description is confusing and we have revised this sentence in the updated manuscript (see last sentence of the first paragraph in section 3.1)

(8). **Comment**: P35606 L1-2, is that based on daily records of all API sites from spring in 2006-2010?
Response: Yes, the evaluation statistics are calculated based on daily data pairs. We have added this information in the revised manuscript (see second paragraph in section 3.1).

(9). **Comment**: P35607 L1-2, "The two cities are close to the Gobi Desert, as shown by Fig. 1.", Such information cannot be found in Figure 1
Response: The locations of the two cities (Duolun and Yulin) are shown in Figure 2. We have revised the description and Figure 2 in the updated manuscript.

(10). **Comment**: P35607 L19-20, need to clarify that these two observations (API and Huang et al. (2010)) cover the same time period?
Response: Huang et al. (2010) covers the period from March 20 to April 20 2007. In this study the same observation data are used to examine the simulated concentrations of trace metals and $PM_{2.5}$ from CMAQ. The spatial distribution of modeling bias shown in Figure 3(d) is averages of March and April from 2006 to 2010. The main objective of this part is to demonstrate that CMAQ underestimates trace metals and $PM_{2.5}$ at near desert sites (Duolun and Yulin), and meanwhile it also overestimates PM_{10} at the near desert area. The time period of observations is described in the updated manuscript (see last sentence of section 2.5).

(11). **Comment**: P35608 L4-5, "O_3 (1st row), SO_2 (2nd row), SO_4^{2-} (3rd row), HNO_3 (4th row), NOx (5th row), and NO_3^- (6th row)", that doesn't match with the layout of Figure 6

Response: In the original manuscript we submitted, Figure 6 contains 6 rows of plots in portrait direction. The edited version, after being converted into PDF format, somehow distorted the figure to cause this problem. We are contacting the office to have this issue resolved. Thanks for the reviewer's comment.

(12). **Comment**: P35609 L10-12, "The elevation of NOx concentration should be attributed to the conversion of gas-phase HNO_3 back to NOx (Yarwood et al., 2005)" Since O_3 and OH is reduced, that might also account for the change in NOx and NO_3
Response: The reviewer is right, we have add this in the discussion (see first paragraph of section 3.3).

(13). **Comment**: P35635 Figure 2, the orange rectangles are hardly to find. It would be helpful to add the location of the Gobi and Taklamakan desert as well.
Response: The approximate area of Gobi and Taklamkan desert is marked in the revised figure. The location of orange rectangles are also revised to make them easier to be found (see Figure 2 in the updated manuscript).

(14). **Comment**: P35596 L3, "simulation" to "simulations"
Response: This is revised according to the reviewer's comment in the updated manuscript.

(15). **Comment**: P35597 L20, "elsewhere" to "in"
Response: This is revised according to the reviewer's comment in the updated manuscript.

(16). **Comment**: P35599 L23, "emission" to "emissions"
Response: This is revised according to the reviewer's comment in the updated manuscript.

(17). **Comment**: P35606 L4, "simulation without dust emission" to "no dust emissions"
Response: This is revised according to the reviewer's comment in the updated manuscript.

(18). **Comment**: P35607 L15, "one set of data pairs" to "Dust_Profile"
Response: This is revised according to the reviewer's comment in the updated manuscript.

(19). **Comment**: P35614 L28, "al" to "all"
Response: This has been revised according to the reviewer's comment in the updated manuscript.

(20). **Comment**: P35615 L19, "comapred" to "compared"
Response: This has been revised according to the reviewer's comment in the updated manuscript.

(21). **Comment**: P35617 L7, "Model development" to "Dust model"
Response: This has been revised according to the reviewer's comment in the updated manuscript.

(22). **Comment**: P35617 L16, "bye" to "by"
Response: This has been revised according to the reviewer's comment in the updated manuscript.

(23). **Comment**: P35628 Table 1, “in next section” to “in this study”
Response: This has been revised according to the reviewer’s comment in the updated manuscript.

(24). **Comment**: P35630 Table 3, “intial” to “initial”
Response: This has been corrected.

(25). **Comment**: P35631 Table 4, please check the title
Response: The title of Table 4 has been changed to “Observations used in this study”.