The authors thank the editor and the reviews for their encourage and the constructive and up to point comments. Our detailed replies to the referee comments are given below.

1 Reply to Referee #1

We thank the referee share his time to give the constructive suggestions. Our detailed replies are given below.

1.1 Comment from Anonymous Referee 1

Received and published: 5 June 2014

Suggestions were given below, 1) Section 3.3: why have you added more point source emissions in the surrounding areas of Beijing? Just for the improvement of your simulations? 2) Section 3.3: More point source emissions were added and the area emissions were updated in the original domain D4 or in the expanded Domain D4? 3) Please add the simulations in Figs. 7, 8, and 9 only when domain D4 was expanded, more point source emissions were added, and the area emissions were updated, respectively? 4) Please add the simulations when more point source emissions were added and the area emissions were updated but domain D4 was NOT expanded. 5) If possible, please add the WRF-Chem model simulations when more point source emissions were added and the area emissions were updated but domain D4 was NOT expanded. 6) Please add the implications of your research. 7) English still needs improving.

1.2 Respond

Comment: 1) Section 3.3: why have you added more point source emissions in the surrounding areas of Beijing? Just for the improvement of your simulations?

Reply: Yes, the added more point source emissions in the surrounding areas of Beijing is used for the improvement of the simulation. Besides that, the area emissions in Baoding and Tangshan has been also increased for the model improvement, and the total emissions in two cities are according to the emission report in (Compilation Committee of China Pollution Source Census, 2011)[1].

As described in the fouth paragraph of section 2.4.2 in the manuscripts, there are only 418 point source emissions in Hebei province in the forecast system, only including the main industrial emissions. In this study, we have collectted more point source emissions in Baoding, Tangshan and Langfang Municipality, a total of 4405 point source emissions, and shown in section 3.3 and Fig. 4 in the manuscripts. Those added point source emissions includes industrial, commercial and other catalogs. As we known, the point source has more accurate location, and the more point source emissions would give more accurate on the emissions distribution, which is important in the simulation of air quality.

Figure 1: The location of Baoding, Tangshan and Xianghe stations are shown as "green tringle". They are all in the Beijing's surrounding areas, where more point sources have been added in this paper.

With the model sensitivity test, we found that the updated emissions can improve our model performance, including the model performance in the surrounding areas. Here we present the model improvement in Baoding, Tangshan and Xianghe stations, which are located at Baoding, Tangshan Langfang Municipality, and the station map is shown in Figure 1. The observation is from the Beijing-Tianjin-Hebei Atmospheric Environment Monitoring Network operated by the Institute of Atmospheric Physics, Chinese Academy of Sciences[2], and coveres the air pollution episode menioned in the manuscript. As described in the left figure of Fig.2 in the manuscript, the original domain D4 just covers Beijing Municipality, that Baoding, Tangshan and Xianghe station is either outside or nearby the domain boundary, thus, we design a group model sensitivity test in the "New" expanded Domain D4, to check if the added point and area sources emissions would improve the model performance on the surrounding areas. The model results driven by the forecast emission have been compared to the model results presented in the manuscript, which is driven by the updated point and area sources emssions in the same New expand domain D4. With this set of comparison, we can get the model performance on Beijings surrounding areas, and get the model improvement due to the emissions updated.

The scatter plot and quantile–quantile (Q–Q) plots are used to illustrate the model performance. The Q–Q plots are introduced by Chang et al.(2004) [3], and used to compare the concentration distributions between the simulations and observations, with the Q–Q plots, biases at low or high concentrations are quickly revealed. As shown in Figure 2, the CMAQ model has obviously better

Table 1: Statistical measures for PM10 hourly concentration in Baoding, Tangshan and Xianghe stations, which is located at Beijing's surrounding areas. The "rEmis" is mark that the model results driven by the forecast emission and the "New" is mark the model results driven by the updated emissions.

	Baoding		Tangshan		Xianghe	
	rEmis	New	rEmis	New	rEmis	New
MB	-208.22	-182.95	-121.69	-111.52	-141.73	-103.68
ME	209.53	187.42	133.07	130.25	143.00	117.07
FAC2	16%	33%	38%	35%	23%	48%
NMSE	4.258	2.702	2.549	2.036	3.064	1.367

model performance in Baoding and Xianghe station, and a little model improvement in Tangshan station: the pink simulated–observed points in Baoding and Xianghe stations are much closed to the red line "y=x" than the blue ones according the left scatter plots. With the Q–Q plots in Figure 2, we also can found that the CMAQ model has better performance in both the high and low concentration range, and get better distribution on PM10 hourly concentration. The mean bias(MB), mean error(ME), FAC2 and normalized mean square error(NMSE) are calculated and shown in Table. 2. Consistent with the scatter plots and Q–Q plots, the statististical measures indicate the model performance improved obviously in Baoding and Xianghe stations, that their FAC2 increases from 16% and 23% to 33% and 48% respectively while the NMSE decreases from 4.258 and 3.064 to 2.702 and 1.367.

As shown in the plots and statistical parameters, after the point and area sources emissions updated, the model performance improved obviously, especially in Baoding and Xianghe stations. But we also can found that the model performance of PM10 hourly concentration in Beijing's surrounding areas, is poorer than that in the Beijing, which the FAC2 of the hourly concentration reach to 74% and NMSE decreases to 0.190, which is mentioned in section 3.4.2 in the manuscript. There may be two reasons: first, the emissions in the surrounding area maybe still underestimated, that the Q–Q plots show that the model underestimates the PM10 concentration in both high and low concentration range in the three surrounding stations. Second, the model domain may need to be expanded much bigger if we want to get much better model performance in the surrounding area, for example, if we want to get much better model performance in Baoding Municipality, may we need to expand the model domain to cover Baoding's surrounding areas, e.g. Shijiangzhuang Municipality. Both of the two reasons need to be more in-depth analysis in the future study.

In the end, because this manuscript is focus on the simulation in Beijing, the model performance in the surrounding areas mentioned above will be present in the supplement materials to support this manuscript.

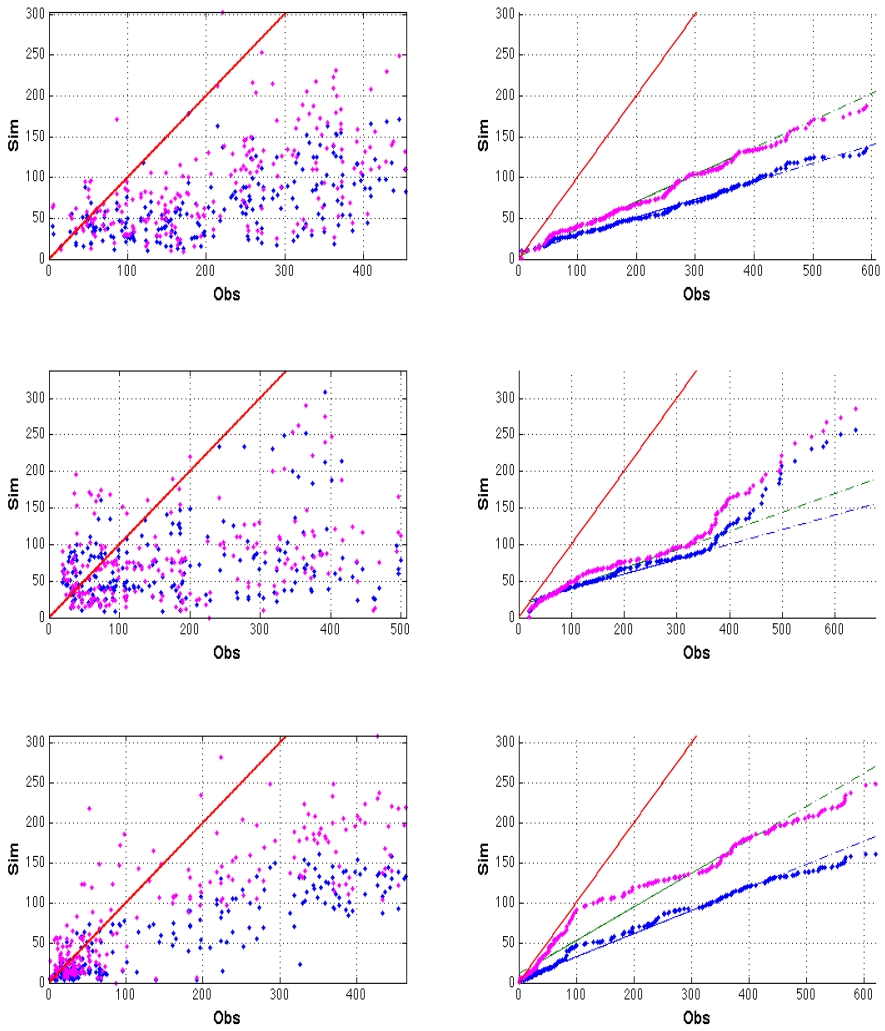

Figure 2: The scatter plot and quantile–quantile (Q–Q) plots of the observed and simulated PM10 hourly concentration in Baoding, Tangshan and Xianghe stations. The upper is Baoding stations, the middle is Tangshan station, the lower is Xianghe station. The "blue" points are driven by the forecast emission in the "New" domain, the "pink" points are driven by the updated emission in "New" domain, while the "Red" line is the model perfect line "y=x".

Comment: 2) Section 3.3: More point source emissions were added and the area emissions were updated in the original domain D4 or in the expanded Domain D4?

Reply: As memtioned aboved, "more point source emissions" and the area emissions were updated in the expanded domain D4.

Comment: 3) Please add the simulations in Figs. 7, 8, and 9 only when domain D4 was expanded, more point source emissions were added, and the area emissions were updated, respectively?

Reply: Thank you for your comment. The work of adding more point sources emission and updating the area source emissions are both to update the emission to improve the model performance. And we mark the emissions before updating as "Forecast Emissions" and the emission after updating as " New Emissions", according this comment from the referee, we try to add two simulations in Figs 7, 8 and 9 only when domain D4 was expanded, and only when the emissions updated, and present in the followed.

Base on the time series plot "Fig. 7" in the manuscript, we add two simulation: 1) the "added" blue dashed line is the model results driven by the updated emission without expanding the model domain, which is only updating the emissions, including point and area source emissions; 2) the "added" green solid line is the model results driven by the forecast emission in the "New" expanded model domain, which is only expanding the model domain.

As shown in Figure 3, the "blue dashed" line is similar to the "green dashed" line, which is the model results in the forecast system. The peak of the PM10–API in the "blue dashed" line is about 105, just a little improved than the forecast system results("green dashed"). Compared the "blue" and "green" dashed lines, they used the same model domain but different emissions, the "blue dashed" used the updated emission. It illustrates that the emission updated only can improve the model performance a little without expanding the model domain.

But, compared the "green solid" line and the "blue solid" line, the two model results also used the same model doman but different emissions, the "blue solid" used updated emission while the "green solid" used the original forecast emission in the same "New" expanding model domain, we can found that the "blue solid" line has obviously better model performance than the "green solid" line, and the peak of the "blue solid" reaches to 180, much closer to the observed "red solid" line than the "green solid" line, which peak is about 140 as shown in Figure 3. It illustrates that the same emission updated can improve the model performance obviously than the original forecast emissions in the expanded model domain.

With the two group comparison("dashed" and "solid") mentioned aboved, we can found that effect of emission updated will be obvious in the suitable model domain, as the expanded model domain in our manuscript.

We also add the two simulation into Figs. 8 and 9 according to the comment, and show in Figure 4 and Figure 5. The similar to the discussion aboved, the model performance is better in the expaned domain, no matter the original

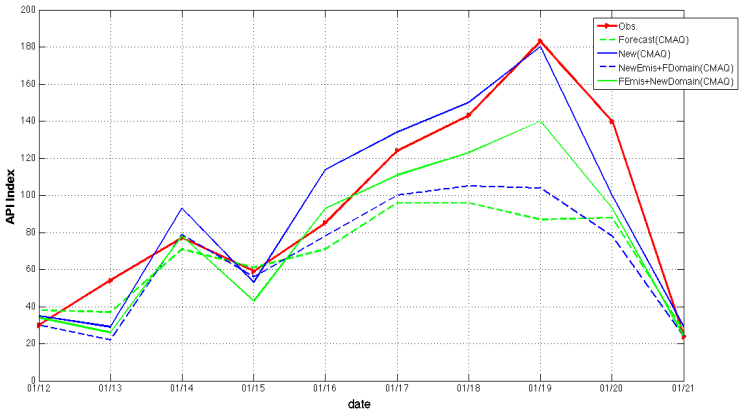

Figure 3: The time series of the averaged PM10-API in the NSAQ stations in Beijing urban area. The red solid line is the observation, the green dashed line is in the forecast system and the blue solid line is in the "New" simulation(the hindcast). The "added" blue dashed line is the model results driven by the updated emission without expanding the model domain, the "added" green solid line is the model results driven by the forecast emission in the "New" expanded model domain.

forecast emissions and the new updated emissions, and the effect of emission updated wil be obvious in the expaned domain for the CMAQ model.

The added model results will be presented in the manuscript.

Comment: 4) Please add the simulations when more point source emissions were added and the area emissions were updated but domain D4 was NOT expanded.

Reply: Thanks for the comment, the simulation, when the more point source emission added and area emissions updated but domain D4 was NOT expanded, is mark as "NewEmis+FDomain(CMAQ)" in Figure 3, Figure 4 and Figure 5 and discussed aboved.

Comment: 5) If possible, please add the WRF-Chem model simulations when more point source emissions were added and the area emissions were updated but domain D4 was NOT expanded.

Reply: That is a good suggestion, we thanks the referee for this comment, this comment help us to make clearly about why the model underestimated the PM10 concentration during this typical episode.

Because, we have no enough experince on the WRF-Chem model, but in the air quality Ensemble Air Quality Forecast System for Beijing (EMS-Beijing), there are another air quality model CAMx, which is developed by ENVIRON International Corporation[4]. In the past month, we collected the forecast model results of CAMx model during the air pollutant episode in January 2010, as the blue dashed line shown in Figure 6. The CAMx model also underestimated the

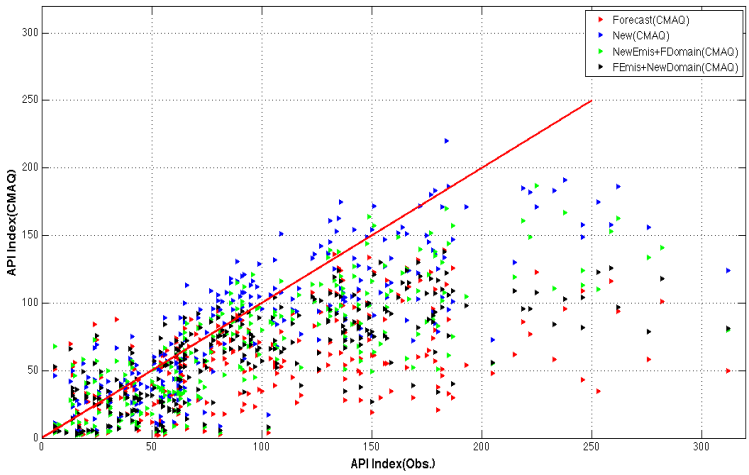

Figure 4: The scatter diagram of the observed and simulated PM10-API in all stations in Beijing. The red is in the forecast system, and the blue is in the new simulation (the hindcast). The "added" green triangle is the model results driven by the updated emission without expanding the model domain, the "added" black triangle is the model results driven by the forecast emission in the "New" expanded model domain.

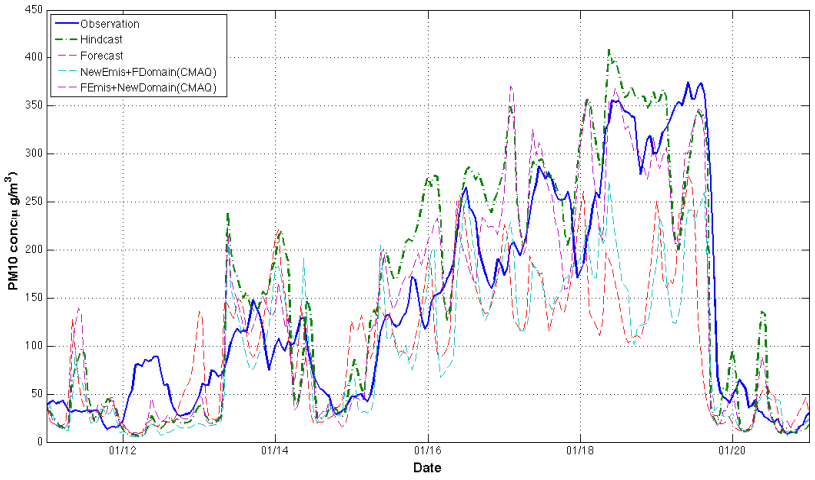

Figure 5: The time series of the PM10 hourly concentration during the air pollution episode in January 2010. The blue solid line is the observation, which is the averaged PM hourly centration observed in the ten NSAQ stations in Beijing MEMC monitoring network. The red dashed line is the PM10 hourly concentration in the forecast system, and the green dashed line is PM10 hourly concentration in the hindcast. The "added" cyan dashed line is the model results driven by the updated emission without expanding the model domain, the "added" magenta dashed line is the model results driven by the forecast emission in the "New" expanded model domain.

PM10 concentration when the episode occure, and the peak of PM10-API forecast by CAMx model is 113, better than CMAQ model but also underestimated much.

We also added one simulation using CAMx model, which is driven by the "New" updated emissions, including more point source emission added and area source emissions updated, but in the forecast domain, whose domain D4 was NOT expanded, as the comment from the referee. The model results are also shown in Figure 6 as "the blue points-line with trianle", we can found that the model performance improve obviously, and the peak of PM10-API reaches to 170, much better than "Forecast(CAMx)", and also much better than its brother model, CMAQ, with the same emissions and model setup. The most possible reason is that the CMAQ v4.4 model use one-way nested technology while the CAMx v4.4 model use two-way nested, and the added surrounding emissions can effect the Beijing's stations more effectively. To make sure this reason, more in-depth analysis will be taken in the future study.

Further more, we added another CAMx model simulation, drive the model with the updated emission in the "New" expand domain. As shown in Figure 6, the peak of PM10-API in the blue solid line with "New" emission and "New" domain would reach to 181, closer to the observation, that is better than the blue points-line, which driven by the "New" emission in the original forecast domain.

Because this manuscript focus on the PM10 forecast with CMAQ model, but the CAMx model results mentioned aboved will point out a possible reason why the CMAQ model underestimate the peak during the episode, the CAMx model results will present as supplement materials to support this manuscript.

Comment: 6) Please add the implications of your research.

Reply: Thanks for this comment, we will try our best to add the implications in the revision according to the comments from the reviewers and referee.

Comment: 7) English still needs improving.

Reply: Thank you for this comment. The English copy-editing is required to help us to improve the English presentation, before that, we will try our best to improve the English presentation, and check the grammatical and syntactic errors as we can.

2 Reply to Referee #2

We thank the referee for the precious and constructive comments. Our detailed replies are given below.

2.1 Comment from Anonymous Referee 2

Received and published: 7 June 2014

This is a useful paper, attempting to improve MM5-SMOKE-CMAQ model performance in the forecast by using some numerical methods such as enhance the inner domain and update regional point and area source emission. This

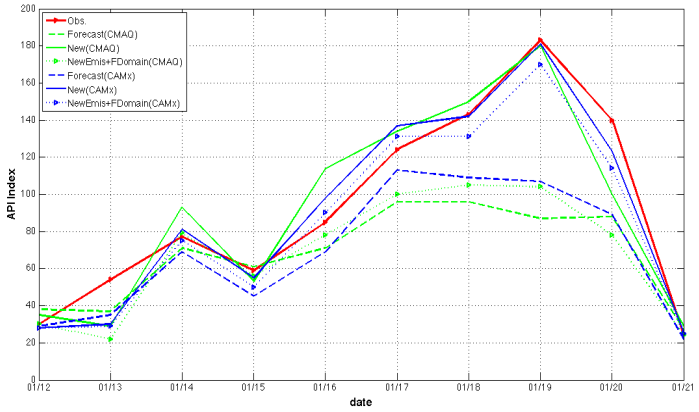

Figure 6: The time series of the averaged PM10-API in the NSAQ stations in Beijing urban area. The red solid line is the observation, the green lines is the CMAQ model results and the blue line is the CAMx model results. The green dashed line is the CMAQ model results in the forecast system, and the green solid line is the CMAQ model results in the "New" simulation with updated emission and expanded domain. The "added" green points-line with triangle is the CMAQ model results driven by the "New" updated emission in the original forecast domain. The "added" blue dashed line is the CAMx model results in the forecast system, the "added" blue solid line is the CAMx model results in "New" simulation with updated emissions and the "New" expanded model domain, and the "added" blue points-line with triangle is the CAMx model results driven by the "New" updated emission in the original forecast domain.

study could contribute to the model performance improvement but some concerns need to be noted, and I recommend some revision before publication. 1. Could the authors provide the model evaluation on the surrounding cities, eg. Tangshan, Baoding or Landfang, where more point sources have been added to improve the simulation. Actually, I know it is hard work to collect the observation in China, but that will help us to know the model performance in the surrounding areas. 2. Please add some comparisons before and after improving the source emission without expanding the domain to make sure the model performance due to the emissions updated. 3. The paper is well structured and in reasonable English. However, I suggest it is edited carefully for various grammatical and syntactic errors prior to publication.

2.2 Respond

Comment: This is a useful paper, attempting to improve MM5-SMOKE-CMAQ model performance in the forecast by using some numerical methods such as enhance the inner domain and update regional point and area source emission. This study could contribute to the model performance improvement but some concerns need to be noted, and I recommend some revision before publication.

Reply: The authors thank the referee for the encourage and comments, the manuscripts has been revised as followed according the comments.

Comment: 1. Could the authors provide the model evaluation on the surrounding cities, eg. Tangshan, Baoding or Landfang, where more point sources have been added to improve the simulation. Actually, I know it is hard work to collect the observation in China, but that will help us to know the model performance in the surrounding areas.

Reply: In the past month, the hourly concentration of PM10 in Baoding, Tangshan and Xianghe stations are collected to illustrate the model performance in Beijing's surrounding areas. The observation is from the Beijing-Tianjin-Hebei Atmospheric Environment Monitoring Network operated by the Institute of Atmospheric Physics, Chinese Academy of Sciences[2], and coveres the air pollution episode menioned in this paper. The location of the three stations are shown in Figure 7, Baoding and Tangshan stations are locate at the urban of Baoding and Tangshan Municipality, and Xianghe station is located at one county of Langfang Municipality.

As described in the left figure of Fig.2 in the manuscript, the fouth domain(D4) in the forecast system just covers Beijing Municipality, that Baoding, Tangshan and Langfang station, is either outside or nearby the domain boundary. Therefore, the "New" domain is used to check if the "added" point and area sources emissions would improve the model performance on the surrounding areas. The model results driven by the forecast emission in the "New" domain have been compared to the model results presented in the manuscript, which is driven by the updated point and area sources emssions in the "New"

Figure 7: The location of Baoding, Tangshan and Xianghe stations are shown as "green tringle". They are all in the Beijing's surrounding areas, where more point sources have been added in this paper.

domain. With this set of comparison, we can get the model performance on Beijing's surrounding areas, and get the model improvement due to the emissions updated.

The scatter plot and quantile–quantile (Q–Q) plots are used to illustrate the model performance. The Q–Q plots are introduced by Chang et al.(2004) [3], and used to compare the concentration distributions between the simulations and observations, with the Q–Q plots, biases at low or high concentrations are quickly revealed, which is used in Wu et al.(2012)[5] for model evaluation.

As shown in Figure 8, the CMAQ model has obviously better model performance in Baoding and Xianghe station, and a little model improvement in Tangshan station: the pink simulated–observed points in Baoding and Xianghe stations are much closed to the red line "y=x" than the blue ones according the left scatter plots. With the Q–Q plots in Figure 8, we also can found that the CMAQ model has better performance in both the high and low concentration range, and get better distribution on PM10 hourly concentration.

The mean bias(MB), mean error(ME), FAC2 and normalized mean square error(NMSE) are calculated and shown in Table. 2. Consistent with the scatter plots and Q–Q plots, the statististical measures indicate the model performance improved obviously in Baoding and Xianghe stations, that their FAC2 increases from 16% and 23% to 33% and 48% respectively while the NMSE decreases from 4.258 and 3.064 to 2.702 and 1.367.

As shown in the plots and statistical parameters, after the point and area sources emissions updated, the model performance improved obviously, espe-

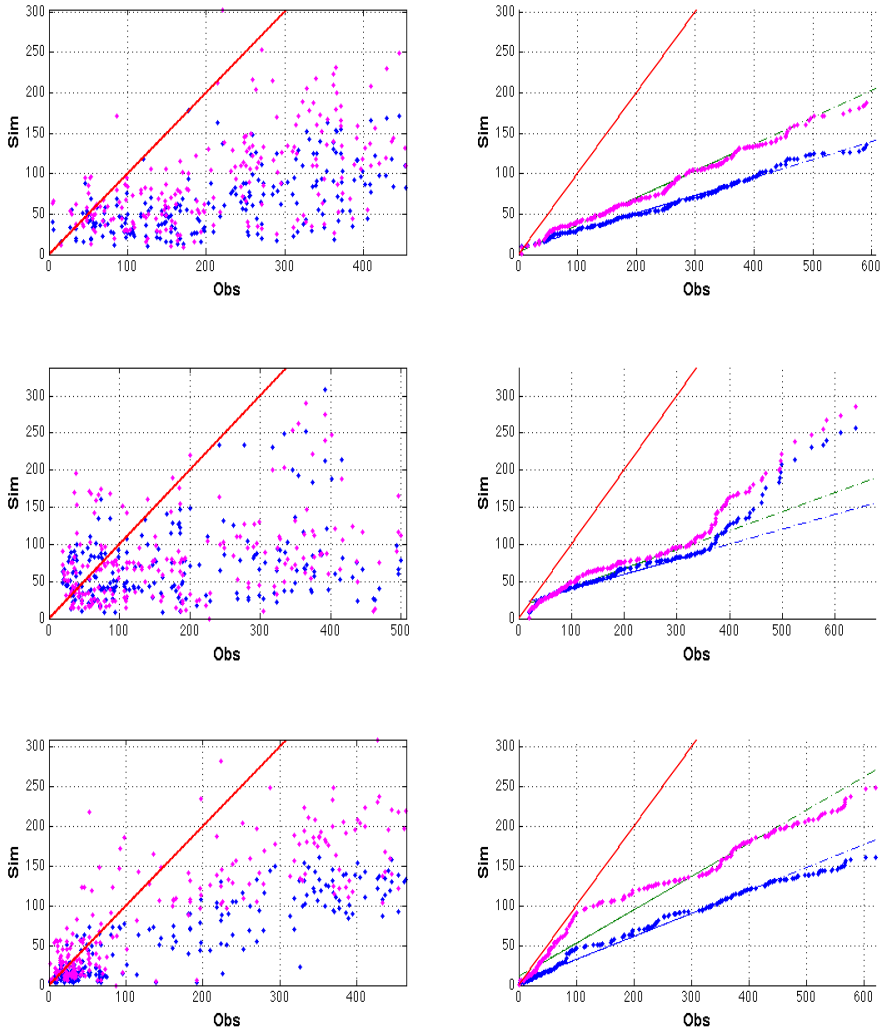

Figure 8: The scatter plot and quantile–quantile (Q–Q) plots of the observed and simulated PM10 hourly concentration in Baoding, Tangshan and Xianghe stations. The upper is Baoding stations, the middle is Tangshan station, the lower is Xianghe station. The "blue" points are driven by the forecast emission in the "New" domain, the "pink" points are driven by the updated emission in "New" domain, while the "Red" line is the model perfect line "y=x".

Table 2: Statistical measures for PM10 hourly concentration in Baoding, Tangshan and Xianghe stations, which is located at Beijing's surrounding areas. The "rEmis" is mark that the model results driven by the forecast emission and the "New" is mark the model results driven by the updated emissions.

	Baoding		Tangshan		Xianghe	
	rEmis	New	rEmis	New	rEmis	New
MB	-208.22	-182.95	-121.69	-111.52	-141.73	-103.68
ME	209.53	187.42	133.07	130.25	143.00	117.07
FAC2	16%	33%	38%	35%	23%	48%
NMSE	4.258	2.702	2.549	2.036	3.064	1.367

cially in Baoding and Xianghe stations. But we also can found that even the model performance improved obviously in Beijing's surrounding areas, their model performance of PM10 hourly concentration is poorer than the Beijing's, which the FAC2 of the hourly concentration reach to 74% driven by the updated emissions in the "New" domain. There may be two reasons that need more in-depth analysis First, the emissions in the surrounding area maybe still underestimated, that the Q–Q plot shows that the model underestimates in both high and low concentration range in the three surrounding stations. Second, the model domain may need to be expanded much bigger if we want to get much better model performance in the surrounding area, for example, if we want to get much better model performance in Baoding Municipality, may we need to expand the model domain to cover Baoding's surrounding areas, e.g. Shijiangzhuang Municipality.

In the end, because this manuscript is focus on the PM10 simulation in Beijing, the model performance in the surrounding areas mentioned above, including the station map, scatter plots, Q–Q plots and statistical parameter will be present in the supplement materials to support this manuscripts.

Comment: 2. Please add some comparisons before and after improving the source emission without expanding the domain to make sure the model performance due to the emissions updated.

Reply: Thank you for your comment. Based on the time series plot "'Fig. 7' in the manuscript, we have added one model result and present in Figure 9 as marked "NewEmis+FDomain(CMAQ)", which result is driven by the updated emissions without expanding the model domain, used the model domain in the forecast system.

As shown in Figure 9, the "blue dashed" line is the similar to the green dashed line, which is the model results in the forecast system, the peak of the PM10–API in the "blue dashed" line is about 105, just a little improved than the forecast system results("green dashed"). Compared the "blue" and "green" dashed lines, they used the same model domain but different emissions, the "blue

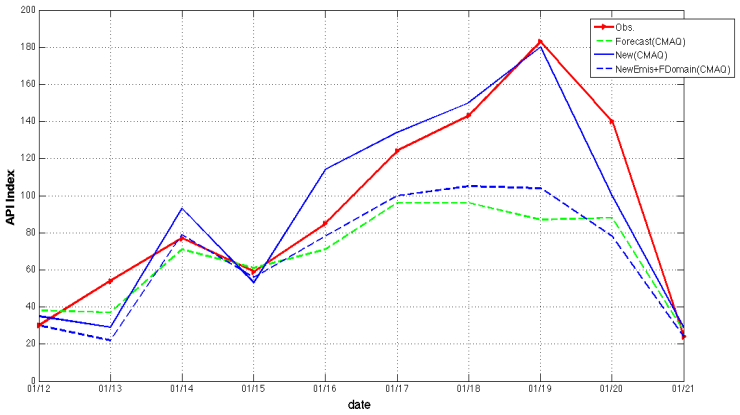

Figure 9: The time series of the averaged PM10-API in the NSAQ stations in Beijing urban area. The red solid line is the observation, the green dashed line is in the forecast system and the blue solid line is in the "New" simulation(the hindcast). The "added" blue dashed line is the model results driven by the updated emission without expanding the model domain.

dashed" used the updated emission. It illustrates that the emission updated just only can improve the model performance a little without expanding the model domain.

More, based on Figure 9, we have added another model result and present in Figure 10 as marked "FEmis+NewDomain(CMAQ)", which result is driven by the forecast emission but in the "New" model domain, shown as "green solid" line in Figure 10. Compared the "green solid" line and the "blue solid" line, the two model results also used the same model doman but different emissions, the "blue solid" used updated emission while the "green solid" used the original forecast emission in the same "New" expanding model domain, we can found that the "blue solid" line has obviously better model performance than the "green solid" line, and the peak of the "blue solid" reaches to 180, much closer to the observed "red solid" line than the "green solid" line, which peak is about 140 as shown in Figure 10. It illustrates that the same emission updated can improve the model performance obviously than the original forecast emissions in the expanded model domain.

With the two group comparison("dashed" and "solid") mentioned aboved, we can found that effect of emission updated will be obvious in the suitable model domain, as the expanded model domain in our manuscript.

Figure 10 and the discussion will be presented in the manuscript to make sure the model performance due to the model domain expanded and emission updated.

Comment: 3. The paper is well structured and in reasonable En-

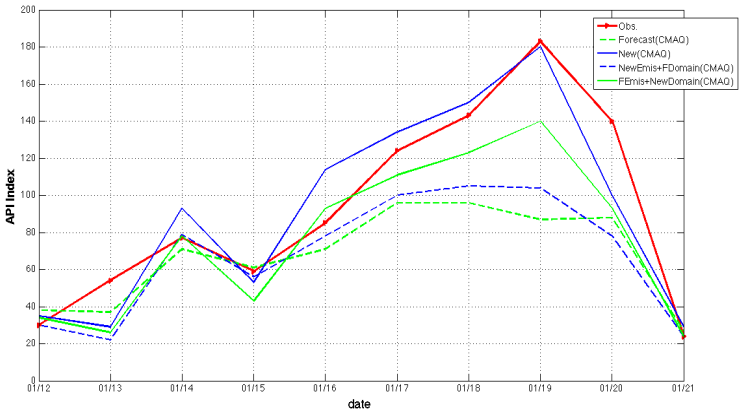

Figure 10: Same as Figure 9, the added green solid line is the model results driven by the forecast emission in the "New" expanded model domain.

glish. However, I suggest it is edited carefully for various grammatical and syntactic errors prior to publication.

Reply: Thank you for your comment. We will try our best to improve the English presentation, and check the grammatical and syntactic errors as we can. More, the English copy-editing is required to help us to improve the English presentation.

3 Correction to the menuscripts

According to the comments from the reviews, the menuscript has been corrected as followed:

3.1 Typo in abstract

"According to the daily forecast results for the entire duration of 2010, the model shows good model performances in the PM_{10} forecast on most days but clearly underestimates some air pollution episodes."

updated to

"According to the daily forecast results for the entire duration of 2010, the model shows good model **performance** in the PM_{10} forecast on most days but clearly underestimates some air pollution episodes."

3.2 Abstract

The discussion of the model sensitivity testing has been added into the abstract: "...third, update the area source emissions, which in- cludes the regional area source emissions in Baoding and Tangshan and the local villagetown level area source emissions in Beijing. As a result, the hindcast shows a much better model performance ..."

updated to:

"...third, update the area source emissions, which includes the regional area source emissions in Baoding and Tangshan and the local villagetown level area source emissions in Beijing, **The last two methods are combined as the emissions updated method. According to the model sensitivity testing results by the CMAQ model, the emissions updated method and expanding model domain method can both improve the model performance separately. But the expanding model domain method has better ability on capturing the peak values of PM_{10} than the emission updated method due to better produce the pollution transport process in this episode. As a result, the hindcast results("New(CMAQ)"), which is driven by the updated emissions in the expanded model domain**, shows a much better model performance..."

The discussion on the PM_{10} hourly concentration " The hindcast also has better model performance in PM_{10} hourly concentrations during the typical air pollution episode, the correlation coefficient increases from 0.77 in the forecast to 0.88, the FAC increases from 62% to 74%, and the NMSE decreases to 0.190."

updated to:

"The hindcast also has better model performance in PM10 hourly concentrations during the typical air pollution episode. "

The last sentence in the astract: " All of this illustrates that the hindcast gives much better model performance than the forecast in PM_{10} prediction in Beijing stations."

updated to:

" The updated emissions companied with suitable domain in this study improved the model performance significantly in Beijing area."

3.3 The last paragraph in the introduction section

"...and the model evaluation and discussion about PM_{10} in the new simulation (hindcast) is in Sect. 3.4."

updated to

"and the model evaluation and discussion about PM_{10} in the model sensitivity testings only when the model domain expanded, the emissions updated, and the hindcast simulation (included the all improvement methods) is in Sect. 3.4."

3.4 The last paragraph in the section 3.1

According to the comment from Referee 1 and 2, we present the model performance in Beijing's surrounding stations in the supplement material, and mentioned it in the section 3.1 in the manuscript.

"And the PM_{10} hourly concentration in Beijing's surrounding areas are also collected to evalute the model performance in the surrounding areas and be presented in the supplement material, due to this manuscript focus on the model performance in Beijing."

3.5 Figure 7, 8 and 9 has been updated

According to the comment from Referee 1, the two simulation has been added in the Figure 7, 8 and 9 only when domain D4 was expanded and emissions have been updated, respectively. And their captions have also been updated.

3.6 In the second paragraph of section 3.2

Because Figure 7, 8 and 9 has been updated, the mentioned to the figure has been updated as followed:

"The green **solid** line in Fig. 7 presents the averaged PM10-API prediction in the ten NSAQ stations in Beijing, which is predicted by CMAQ model in the forecast system, and compared with the observed red **solid** line to show its model performance."

3.7 In the third paragraph of section 3.3

According the first suggestion of Referee 1, the first sentence has been changed as followed:

"Second, we add more point source emissions into SMOKE model, especially in the surrounding cities on the south and east of Beijing."

updated to:

"Second, we add more point source emissions into SMOKE model, especially in the surrounding cities on the south and east of Beijing, to improve the model simulation."

3.8 The discussion of model performance has been re-writed in section 3.4

The subsection for the discussion of the model performance has been re-writed, due to the two simulation has been added in Figure 7, 8 and 9, and makes clearly about the effect of the emission updated and model domain expanded to the model performance.

3.9 The second paragraph in the conclusion section

"In final, three numerical methods are effect on the model improvement and present in the hindcast."

updated to:

"In final, three numerical methods are adapted to the model improvement and presented in the this study"

Delete the last sentence in this paragraph, "The methods are about the model setup and emissions."

3.10 The first sentence in the third paragraph in the conclusion section

"Compared the model evaluation about particle matter in the forecast and hindcast during the typical air pollution episode, we have found that the hindcast shows a much better model performance, one obvious evidence that the hindcast's averaged PM_{10}-API in NSAQ stations can reach to 180, and much closer to the observed "183" **than the forecast's "96"**, while its hourly concentration can reach to $350\mu g/m^3$, which the "observed" concentration the forecast can not reach.

updated to:

"Compared the model evaluation about particle matter in **different model sensitivity testings** during the typical air pollution episode, we have found that the hindcast **, includes the domain expanded and emissions updated,** shows a much better model performance. One obvious evidence that the hindcast's averaged PM_{10}-API in NSAQ stations can reach to 180, and much closer to the observed "183", while its hourly concentration can reach to $350\mu g/m^3$, which the "observed" concentration **but** the forecast can not reach."

3.11 The second sentence in the third paragraph in the conclusion section

"In the simulation of the averaged PM_{10}-API in Beijing NSAQ stations, **the hindcast shows a better model performance, where the mean bias** decreases to -0.2, the normal mean error to 15.9%, and the correlation coefficient increases to 0.93."

updated

"In the simulation of the averaged PM_{10}-API in Beijing NSAQ stations, **the mean bias of the hindcast** decreases to -0.2, the normal mean error to 15.9%, and the correlation coefficient increases to 0.93."

3.12 The fouth paragraph in the conclusion section

According to the comment from Referee 1, the fouth paragraph has been rewrited to add the implications of our research.

"The improvement of the model setup and emissions will clearly help to improve the model performance, thus, the emissions updated is essential in the future forecast, not only the emission inventory but also its temporal profile and so on. In the future, more observed data sets of the model evaluation will be collected, and try to inverse the temporal profile of emissions, e.g. collect the observed and forecast's SO_2 concentration in the past years, and inverse the temporal profile of SO_2 emissions, which is predominated by power plant and heating emissions, or collect the CO concentration to evaluate the mobile sources emissions in Beijing."

updated to:

"The improvement methods we conducted in this study will be helpful to enhance the model performance in forecasting the air quality in Beijing and surrounding area. Especially the expanding model domain test indicated that the suitable domain setting is very important for the regional transport process, which is a key point in air quality forecasting not only in Beijing but also other similar regions. The modified emission inventory can also be used in the future forecasting and modeling works."

3.13 Thebibliography

One citation has been added in thebibliography

Zhao, X. J., Zhao, P. S., Xu, J., Meng,, W., Pu, W. W., Dong, F., He, D., and Shi, Q. F.: Analysis of a winter regional haze event and its formation mechanism in the North China Plain, Atmos. Chem. Phys., 13, 5685-5696, doi:10.5194/acp-13-5685-2013, 2013.

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