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Atmospheric Chemistry and Physics Discussions

Interactive comment on "A modeling study of the nonlinear response of fine particles to air pollutant emissions in the Beijing-Tianjin-Hebei region" *by* Bin Zhao et al.

Anonymous Referee #2

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General comments

ERSM has been developed by extending the capabilities of the conventional RSM. Its performance was evaluated. Then, sensitivities of emissions of various primary pollutants and precursors, sectors, and regions on seasonal concentrations of PM2.5 and their components in BTH region were discussed.

The advantage of the ERSM technique is that it can represent complex non-linear relationships between ambient pollutant concentrations and their precursor emissions. On the other hand, it requires over 1000 simulations. If changes in ambient concentrations in several future scenarios, only several simulations with the brute force method

are required. I feel the advantage of the ERSM which overcome tremendous efforts to run simulations over 1000 times is not fully emphasized in this manuscript. In addition, descriptions of limitations of the ERSM technique are scarce. Please add more descriptions on the advantage and disadvantage of the ERSM technique.

ERSM could provide valuable information to develop effective strategies based on complex non-linear relationships. It means non-linear responses should represent the actual situation in the real atmosphere. I think validation of the responses obtained by ERSM is not enough whereas comparisons of observed concentrations have been made.

Especially, nonlinear responses of NOX emissions are critical for policy making. How much NOX reduction is necessary to realize positive effects to reduce PM2.5 concentrations? ERSM could give the answer. However, if the answer is not correct in the real atmosphere, policies may fail to realize PM2.5 reductions.

Which components are included in inorganic PM2.5? Is EC included? How about other components like metals? It looks strange that primary organic aerosol (POA) is included as a precursor probably due to treatment in VBS. Please give precise definitions of these words.

What do "discrepant temporary control strategies" mean? How are they possible? I understand major sources are different in each heavy air pollution episode. However, it could be possible to implement different temporary control strategies for each episode only if it could be forecasted. Can ERSM be used to forecast major sources in coming heavy air pollution episodes? I think differences of major sources in each episode suggest to implement strategies which control emissions of all the sources which could be major in various episodes.

Specific comments

Page 3, Line 8 How much are 2012 levels?

Page 3, Line 22 The sentence here says “CTMs are the only feasible tools for evaluating the response of PM2.5 concentrations to emission changes”. However, the sentences around the line 14 describe that embedding chemical tracers in chemical transport models (CTMs) cannot represent non-linear response. They may confuse some readers who are not familiar to CTMs.

Page 3, Line 26 “Sensitivities” are more appropriate than “contributions” in the context here.

Page 4, Line 5 How inadequate?

Page 5, Line 7 How were emissions of IVOC provided?

Page 5, Line 8 OA and SOA are listed parallelly, but SOA is included in OA.

Page 5, Line 30 I think NCEP final analysis data is not reanalysis data. Is it not used for grid nudging?

Page 6, Line 4 I think terrain data is not from MODIS.

Page 6, Line 25 How about open biomass burning emissions?

Page 9, Line 21 How about the performance of SO42-, NO3-, and OA?

Page 10, Line 8 Why are only NMEs shown? How about R and MNEs? I suppose it is more important for RSM to see responses than to reproduce concentrations.

Page 10, Line 15 I do not understand meaning of comparisons between ERSM and conventional RSM. Why these two model could produce different results? Which should be correct? The sentence in the line 31 says that the ERSM predictions are definitely subject to numerical errors, but I do not know why “definitely”. Although there are descriptions of ERSM in the first paragraph of the section 2.2, the advantages and disadvantages of ERSM against conventional RSM should be clearly explained.

Page 11, Line 5 What is the advantage of ERSM against conventional RSM in the

results shown in Figure 4? I think the sector-wise results shown in the right figure cannot be obtained by conventional RSM. Is that correct? Please described what is newly obtained by using ERSM.

Page 11, Line 16 It looks strange to represent primary inorganic PM2.5 as “single pollutant” because it is a mixture of various components in fact.

Page 11, Line 29 What is the reasons of small sensitivities of SO2 emissions on PM2.5?

Page 11, Line 31 Nonlinear sensitivities of NOX emissions and their changes from negative to positive are described from here. I also agree that this is very important phenomena to consider effective emission controls. However, on the other hand, the descriptions in the page 10 treat such a nonlinear change in sensitivities and differences with conventional RSM as just a rare case involving large unrealistic reduction of NOx emissions. I do not agree that. Even if large NOx reduction is required, the performance of ERSM to represent such a nonlinear change should be carefully evaluated.

Page 12, Line 2 Indeed, the regimes are very important for negative and positive sensitivities of NOX emissions. Therefore, it is quite important to see if ERSM could accurately represent regimes in the real atmosphere. I suppose such validations are scarce.

Page 12, Line 20 Are there any discussions on differences between sensitivities of all pollutants and sectors and sum of sensitivities of individual pollutants and sectors?

Page 12, Line 31 What is a reason of higher sensitivities of residential and commercial sources in winter? Heating?

Page 13, Line 8 Are there any specific results indicating the importance of NOx emissions outside the BTH region?

Page 14, Line 6 How does seasonal variations of NH3 emissions look like?

Page 14, Line 25 Is it confirmed that NOX competes with SO2 for NH3 in a thermodynamic pathway? I think SO42- is much more predominantly in aerosol phase than NO3-.

Page 15, Line 1 Does this POA include semivolatile components which could condensate only under lower temperature in winter?

Page 17, Line 10 I agree more model simulations of more episodes are necessary, but a model can always give results. I believe what is important is to confirm model results are consistent with actual situations in the real atmosphere. That is quite important to consider effective strategies for heavy air pollutions.

Page 18, Line 18 I am wondering if NMVOC and IVOC should be discussed together to implement any strategies because their sources and their effects on PM2.5 and ozone could be different.

Page 18, Line 24 I agree NOx reduction is necessary in the long run. However, it could increase PM2.5 emissions in the near term with slight reduction. How should such adverse effects be considered? Any messages on this issue?

Page 18, Line 26 I feel the importance of Southern Hebei is not so discussed in the main text.

Technical corrections

Page 6, Line 17 origninally -> originally

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