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Atmospheric Chemistry and Physics Discussions

Interactive comment on "2015 and 2016 winter-time air pollution in China: SO_2 emission changes derived from a WRF/Chem-EnKF coupled data assimilation system" *by* Dan Chen et al.

Anonymous Referee #1

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The paper with the title: '2015 and 2016 winter-time air pollution in China: SO2 emission changes derived from a WRF/Chem-EnKF coupled data assimilation system' analyzes the effect of data assimilation (DA) on the forecast of SO2 emissions for a Chinese domain comparing selected years. Doing this, the authors further aim to assess the impact of modified emissions (e.g. due to emission reduction strategies) from 2010 to 2015,2016 on SO2 levels for selected areas in China. The study per se is interesting and treats a relevant field also in the scope of this journal, due to its implication for a large area which is supposed to have regional to global impacts.

The partly poor language and structure however still need for significant revision before

I would recommend a publication in ACPD. Most importantly, the scope of the study has to be worked out more clearly. Starting from the abstract, which is missing from a clear description of the problem, the scope of the study and the presentation of the expected outcome. Continuing in the introduction section, it remains unclear what exactly is compared against, and what new development and improvements this study brings. In my point of view the study addresses two ways of data assimilation, correct? Is it the main task to evaluate this new development or is it rather the discussion of policy induced emission regulations. Please try to focus more clearly what are the main ideas behind this study and the intended outcome. Doing this, the introduction has to be re-structured and certain sections have to be revised due to language problems. The overall manuscript has to be double-checked for a clear presentation of firstly the purpose of the study, a clear description of the methodology and a precise presentation of the results and discussion of the outcome also in light of the presentation of the benefits of your approach for the research field.

With regard to the language, please check the entire manuscript for missing articles and filler words such as Page 4/ Line 5, Page 7/ Line2,Line 7.

According to methodology, some statements about the general WRF-Chem model setup have to be provided next to the explanation of the data assimilation framework. Is this adapted from another study? If so, please clarify. What is the difference of your approach to other DA configurations in WRF-Chem such as WRF-Chem/DART? Please discuss briefly.

In places, it is hard for the reader to distinguish between the different experiment-acronyms and one has to flip back and forth through the document. I would recommend to provide an overview table listing all the experiments used for the study with keyword/short description, purpose etc. Followed by a short description of what is aimed to be discovered in the single experiments, the scope of the study might become clearer for the reader as well. This information however is partly given at various places in the text already, but needs to be consolidated again in a revised version.

In this context it is not entirely clear what the difference between the experiments EMIS_DA and CONC_DA is and what emissions are used for the experiments. Maybe I am getting something wrong here, but to me it seems that 2010 emissions have been used for all simulations. As you are discussing emission reductions however, which dataset has been used for the years 2015, 2016? What approach did you follow to account for actual emission reductions? Besides that: Except from emissions and DA-technique, did you account for identical model configurations for all experiments? For instance, did you account for rapid urbanization in these areas in any dataset? What land use database is used and did the urban surface evolve over time? WRF offers different urban canopy models in its setup. Did you account for any of those?

Please find in the following further comments line by line:

Page 2 Line 2: this sentence is not quite correct. What you want to say something like: ambient concentration of various pollutants has been changed over the last couple of years.

L3: not clear what is meant by 'control studies' here and you how this is connected to the scope of your study. In general it is hard to follow the intention of you study within this sentence.

Please do re-write the abstract, particularly the introduction to it. This is crucial for getting the scope of your study and properly introduces the reader to the problem.

L11: unclear wording 'priori'

L17: how is this 'energy expansion strategy' manifested?

L21: unclear term: were corresponded

L22: bad sentence

Page3 Line 1: The analyzed emissions showed an improvement compared to what?

L2: BIAS and RMSE/correlation coefficients comparing what exactly? What does the

range mean?

L4: What is meant by 'limited due to a small spread'?

L9: Differences in lifetime relates to what process? Mixing, transport, boundary layer dynamics. . .?

L11: How are the emissions tracked by satellite observations?

L18: Source/citation missing for the 'national strategy'

L20: What is a power plant park?

L22: total amount has

L23: a bottom-up approach

Page4 Line2: unclear

L5: meaning unclear here: do you mean a wide spread analysis including several villages? I this context it is not clear what the Zhi (2017) paper really is about.

L8: Do the rural areas mentioned here refer to the studied villages?

L11: which models

L22: What models are you referring to here?

Page 5: Line 1: what exactly was perturbed

3-5: unclear structure and unclear meaning

7: capable of detecting

14: article missing

Page6: Line 10-21: fits better to the introduction

2: is used

Page7: Line 8: units missing

17: Peng et al: repetition

21: unclear

Page 8: Line 3,4: unclear about the details of the differences. What does the change from aerosols to SO2 infer? Why is that important?

22: unclear description of the cause for indirect relationships

Page 10: Line 18: convert

Section 2.3: Please specify the difference/benefits of your approach compared to the 'bottom up' inventories you mention here. What strategy is followed here? Please provide more details about the general methodology.

Page 11: Line2: What is the difference between priori emission year and focusing year?

L7: Source

L8: see above: unclear terminology

L19: optimal in what sense?

L21: unclear sentence

Page 12: Line 7: How often did you encounter these 650 ugm^3. Where does this threshold come from?

Page 13: Line 4: 50 member ensemble. As mentioned earlier, more information on the WRF-Chem model setup and general model configuration has to be provided here. Maybe a table is enough.

L14: Unclear meaning of 'assess the analyzed emission'. Basically you compare simulations with and without DA, correct? In general this Chapter needs more substance

in order to understand the differences and the purpose of the various experiments. As mentioned above, the different setups which have been used should be briefly summarized, e.g in a table.

Page 14: Line 13: 'Figure 13 shows' (check through the entire document)

L21: 'failure' bad wording here

L22: 'innovations exceeding' unclear

Page 15: Line10: 'The Golden Triangle'

Page 16: Line 4: What leads you to the conclusion that that meteorology is a minor factor here? Do you have proof for this, or for the other aspect respectively?

Page 18: Line 5: better: small/minor changes

Page 19: I was wondering what kind of land use dataset was used and how detailed the urban areas are represented. Did you account for an increase in urban land-cover/density from 2010 to 2016? Did you account for a urban canopy model included in WRF? As said before, a table highlighting the most important model setups will help.

Page 20: Line 7,8: unclear sentence

Page 21: Line1: Do colder temperatures in 2016 contribute to differences to 2015? Can you find different meteorological/dynamical patterns explaining this effect?

Chapter 5.1/5.2: Next to the presentation of the statistical measures (BIAS,RMSE) a more thorough discussion of their meaning and their connection to each other should be provided

General: The correct acronym should be WRF-Chem/EnKF.

Figures: Please check the legends and the axes for good readability.

Figure 13: What is the reason for the large spread in a priori SO2? Please provide more details.

Figure 6: Please provide a better discussion on the large RMSE and -spread and qualitatively explain its numbers? Is it much/less or in the range of commonly found RMSEs for these approaches/ in this area, for this configuration? How is that related to the bias?

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