

Interactive comment on “Development of a unit-based industrial emission inventory in the Beijing-Tianjin-Hebei region and resulting improvement in air quality modeling” by Haotian Zheng et al.

Anonymous Referee #1

Received and published: 5 November 2018

This study developed the unit-based industrial emission inventory in Beijing-Tianjin-Hebei region, for which configurations and locations of individual industrial emission sources were utilized. Significant differences in horizontal distributions of emissions were seen by comparing with the traditional proxy-based emission inventory. The air quality simulations using this unit-based emission inventory showed better model performance than the proxy-based emission inventory.

I think this is an important progress to get better model performance. It should contribute to developing effective emission controls against heavy air pollution in this re-

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gion. However, various critical information is missing in the current manuscript. It is necessary to revise it based on the comments described below.

As mentioned in the introduction, previous studies have already developed unit-based emission inventories while their target sectors may be limited. I suppose there should be more papers including Liu et al. (2015) for example. It is necessary to clearly describe what is new in this study. This manuscript says previous studies did not cover all industrial sectors in the BTH region. Then, does this study cover all industrial sectors? Which sectors were newly included? Is the methodology identical for the sectors which have been already included in previous studies? Significance of this study should be described more clearly.

One of difficulties in unit-based emission inventories we often face is consistency of energy consumption against energy statistics. Did this study use energy consumption reported from each emission source? If so, is the sum of the reported energy consumption consistent with that in energy statistics? Usually, it is very hard to collect detailed information of small emission sources. If this is the case, energy consumption should not be consistent, and a hybrid approach in which unit-based and proxy-based information are combined may be necessary for each sector. The unit-based and proxy-based emission inventories were compared in this study. Do energy consumptions used in both inventories match?

Although detailed descriptions for vertical distributions are missing in the current manuscript, I agree that reasons of differences in concentrations between the unit-based and proxy-based emission inventories should be horizontal distributions and vertical distributions as mentioned in the second paragraph in the page 9. According to Figures 5 and 7, concentrations simulated with the proxy-based emissions are almost entirely lower throughout the domain. If influences of horizontal distributions are dominant, it is supposed that concentrations in surrounding regions would become higher, but such influences seem to be very limited. Therefore, it might be possible that differences in concentrations between two emission inventories are mainly caused by dif-

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ferences in vertical distributions of emissions. I would strongly recommend conducting an additional simulation to separate influences of horizontal and vertical distributions of emissions by changing only each of them.

This paper shows relative improvements in the unit-based emission inventory by comparing with the proxy-based emission inventory. Therefore, relative changes depend not only on the unit-based inventory but also the proxy-based inventory. If poor proxies are used in the proxy-based inventory, relative improvements could become larger. Therefore, it is important to explicitly shows which proxies were used in the proxy-based inventory for each sector (not just “such as population . . .” at the end of the section 2.2). Use of better proxies should be also one of possible directions to get better model performance.

Specific comments are as follows.

Page 3, Line 9-10

I think that Lim et al. (2005) is not related to the description around here.

Page 3, Line 17-18

It is not clear which sectors are considered in previous studies and which sectors newly appear in this study. I would recommend adding a table listing all the industrial sectors considered and which are new in this study.

Page 4, Line 6-7

It is not clear what kind of product yields are used for estimating emissions of each sector. I would recommend showing types of products used for each sector in a table I recommended above.

Page 4, Lines 9 and 17

The equation (1) is used to estimate emissions of the pollutant i . The industrial enterprise j and the production process m appear in this equation, but they are summed up.

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Then, how about the control technology n ? It is not summed up, but it does not appear in the left-hand side. Usually fractions of control technologies are inserted, then they are summed up for all of control technologies. This is the same for the control technology k in the equation (2).

Page 4, Lines 9 and 17

I do not understand why the equations (1) and (2) are separated. It seems the first and second terms of the equation (2) represent clinker and cement production, respectively. However, isn't it possible to treat both as one of production processes m ? If not, then what are production processes considered in both equations? Please clarify them. In fact, it is not clear what production processes considered in this study are.

Page 4, Lines 12-14

EFs depend only on the pollutant i and the production process m . Is there any possibility to use emission factors specific to each industrial enterprise? Is it enough to use identical emission factors for all the industrial enterprises?

Page 4, Line 25 – Page 5, Line 1

Specific references are not listed here while a lot of specific references for proxy-based emissions are listed in a subsequent paragraph. Specific references should be also listed for unit-based emissions as much as possible.

Page 5, Lines 2-4

Do these numbers cover all the plants located in the target area?

Page 5, Line 5

Is there no information on control technologies for boilers?

Page 5, Line 9

Is the expression "emission factor method" appropriate? The unit-based approach also

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uses emission factors. I think it is usually called as “top-down method” (but sometimes confused with top-down estimates utilizing observations including satellites).

Page 5, Line 17

How about speciation of PM_{2.5} and NMVOCs for unit-based emissions?

Page 5, Line 20 – Page 6, Line 18

References for models and modules are required.

Page 6, Line 10

What are “other” configurations? Please show explicitly.

Page 6, Lines 21-23

Is CO not included in this study? Why?

Page 7 Lines 1-22

Area names are mentioned in these paragraphs. However, horizontal distributions firstly appear later in Fig. 3. Its description should appear before descriptions of areas.

Page 7, Line 6

It is impossible to see many industrial boilers in Fig. 2.

Page 8, Line 9

I think that NMB and NME are not appropriate metrics in terms of this study. The target of this study is accurate horizontal distributions. However, overestimation in one areas and underestimation in other areas could be cancelled out in these metrics. It is necessary to appropriate metrics which can properly shows improvements realized in this study.

Page 8, Lines 15-17

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What is a possible reason for the poor model performance on SO₂?

Page 9, Lines 19-20

I cannot find any descriptions on plume rise before here. How to gather stack information? How to calculate plume rise? These descriptions are required in the method section.

Page 10, Line 1

Details of “concentration gradient” are necessary. How to select urban and suburban locations? Are monthly mean concentrations used?

Page 10, Lines 24-27

I think it is not enough to explain changes of NO₃⁻ only by NO_x sensitivities. I do not think they are main reasons. SO₄²⁻ concentrations in the unit-based approach are much lower than the proxy-based approach whereas NH₄⁺ is almost constant as shown in Fig. 7. In this case, more HNO₃ is converted to NO₃⁻ with excess NH₄⁺ whereas these processes depend on abundance of HNO₃ or NH₃.

Reference

Liu, F., Zhang, Q., Tong, D., Zheng, B., Li, M., Huo, H., and He, K. B.: High-resolution inventory of technologies, activities, and emissions of coal-fired power plants in China from 1990 to 2010, *Atmos. Chem. Phys.*, 15, 13299-13317, <https://doi.org/10.5194/acp-15-13299-2015>, 2015.

Interactive comment on *Atmos. Chem. Phys. Discuss.*, <https://doi.org/10.5194/acp-2018-858>, 2018.

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