

Interactive comment on “2015 and 2016 winter-time air pollution in China: SO₂ emission changes derived from a WRF/Chem-EnKF coupled data assimilation system” by Dan Chen et al.

Anonymous Referee #2

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Chen et al. applied a data assimilation system based on the WRF/Chem model and SO₂ surface measurements to constrain hourly SO₂ emissions over China for the January months 2015 and 2016. The two months were analyzed in order to (1) evaluate the Chinese SO₂ emission reduction in recent years due to strict control strategies, and (2) test the ability of the WRF/Chem data assimilation to improve the emission estimates. The study is neatly conducted. An ensemble of model simulations with or without assimilation of the SO₂ measurements are applied to quantify the emission changes in 2015 and 2016 relative to the prior emission estimates for the year 2010. This presents a good application of the data assimilation method to assess the Chinese emission and its changes that fits the journal scope well. I think the

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authors shall address the following comments before publishing on ACP.

Specific Comments:

(1) Page 2, Line 7:

What does “larger spread” mean? Please explain “spread” here and in the text (Page 5, Line 1).

(2) Page 7, Line 20:

The study used the proxy of absolute emission values instead of emission scaling factors in the data assimilation system, as the authors explained that it allow the detection of new emission source. How is “new emission source” represented in the model? For a grid with zero emissions in the prior? If so, it is not clear in the text how this could be estimated and whether the system would generate negative emission estimates. If not, would the use of scaling factors in logarithm also work? This needs to be better described.

(3) Page 9, Section 2,2,2:

The section is difficult to understand for readers that did not read some papers in the reference list. What is the mathematical meaning of inflation factor? How to interpret the pointer symbol in Equations (2) and (3)? Please add more explanation.

(4) Page 12, Section 2.4:

Here the authors define SO₂ measurements larger than 650 ug/m³ to be unrealistic, however, are these “unrealistic” measurements still used in the following comparisons (for example in Figure 3 and Figure 11). Please justify.

(5) Page 12, Line 11:

The phrase “changing trend” is not proper here and throughout the text. The emission changes from 2015 to 2016 do not define a “trend”, and the “trend” is not changing. I

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suggest replace it by “emission changes“.

(6) Page 13, Line 14:

Is there any difference between the experiments “NO_DA” and “NO_DA_forecast”? Generally, it is not very clear how many experiments were conducted and compared in this study. It would be helpful to add a table to summarize their information.

(7) Page 15, Line 15:

For “fixed hourly factors in the priori emissions”, are the prior hourly factors provided by the MEIC inventory or defined by the model?

(8) Page 17, Section 4.2: A recent paper on ACP has analyzed the changes in Chinese anthropogenic emissions since 2010 based on the MEIC emission inventory. I suggest the authors compare their conclusions with the bottom-up estimates for additional evaluation.

Reference: Zheng, B., Tong, D., Li, M., Liu, F., Hong, C., Geng, G., Li, H., Li, X., Peng, L., Qi, J., Yan, L., Zhang, Y., Zhao, H., Zheng, Y., He, K., and Zhang, Q.: Trends in China's anthropogenic emissions since 2010 as the consequence of clean air actions, *Atmos. Chem. Phys.*, 18, 14095-14111, <https://doi.org/10.5194/acp-18-14095-2018>, 2018.

(9) Page 21, Section 4.4: The study has presented monthly and hourly emission estimates. How about daily emission estimates? Are there significant daily variations in the constrained SO₂ emissions? Please clarify.

(10) Page 22, Line 6: Regarding the statement “the response time from emission to ambient concentration are simplified in the assimilation system”, shouldn't the assimilation system consider physical and chemical transformations of SO₂ in the atmosphere? please explain why this is the case.

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(11) Other corrections:

Page 7, Line 9 - “determined form” should be “determined from”

Page 7, Line 10 - defined the abbreviation “BECs”

Page 15, Line 4 - “emission decreasing” should be “emission decreases”.

Page 17, Line 17 - “that from 2015 to 2016” should be “those from 2015 to 2016”.

Interactive comment on *Atmos. Chem. Phys. Discuss.*, <https://doi.org/10.5194/acp-2018-1152>, 2019.

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