

Atmos. Chem. Phys. Discuss., referee comment RC1  
<https://doi.org/10.5194/acp-2022-301-RC1>, 2022  
© Author(s) 2022. This work is distributed under  
the Creative Commons Attribution 4.0 License.

## Comment on acp-2022-301

Anonymous Referee #3

---

Referee comment on "Four-dimensional variational assimilation for SO<sub>2</sub> emission and its application around the COVID-19 lockdown in the spring 2020 over China" by Yiwen Hu et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2022-301-RC1>, 2022

---

This manuscript describes the development and application of a 4DVAR system to optimize SO<sub>2</sub> emissions in China. An OSSE test shows improved consistency with the true emissions after optimizing emissions using this system. The framework has also been applied to estimate SO<sub>2</sub> emissions during the COVID19 shutdown and shows a reduction of 18% compared to 2019. The topic fits the readership of ACP. I recommend publication after addressing the following comments:

L18, please specify the studied region in the abstract.

L64 – 77, I would expect literature reviews on the application of 4D-Var to SO<sub>2</sub> emission estimates in this paragraph. There are several of such studies. How are these 4D-Var estimates compared with previous EnKF SO<sub>2</sub> estimates and your results?

Eqn1, it was not clear to me whether H is an operator or a matrix from my first glance. I suggest using a different font for H.

Eqn3, the use of  $H \delta(c)$  here implies that the operator is linear, but I doubt that for SO<sub>2</sub>. Could you discuss the impact of this assumption on the results?

L239, it is not clear to me what is the objective of these experiments just based on what is described here. Please clarify.

Fig 7 & 8, how are these emission changes compared with previous studies?

Fig 11, the observation is significantly smaller than the simulations, even after DA. Could you address this a bit more and discuss the implications of this? How is this compared to other studies?