

Atmos. Chem. Phys. Discuss., referee comment RC2  
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## Comment on acp-2021-294

Neil Harris (Referee)

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Referee comment on "A sulfur dioxide Covariance-Based Retrieval Algorithm (COBRA): application to TROPOMI reveals new emission sources" by Nicolas Theys et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-294-RC2>, 2021

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This manuscript describes a new optimal estimation algorithm for UV SO<sub>2</sub> which puts all the variability in the covariance matrix. It has been developed for use with TROPOMI data and shows reduced variability in the residuals as well as lower limits of detection. These improvements enable changes in source strength to be more readily observed and for weaker sources to be monitored. It is good work which should be published after minor corrections.

I agree with all Referee 1's comments and think they should be made.

It would be good if you can address the comment about ACP vs AMT. One way of making it more 'ACP' is to add a bit more on the interpretation of the new estimates of SO<sub>2</sub> emissions and what the implications are for model studies using existing inventories. I was surprised to see that lower detection limits did not lead to more SO<sub>2</sub> emissions being estimated overall. Does that mean even smaller sources are unimportant? Such a discussion would also strengthen the broader conclusions.

Two other comments:

- How does the type of land surface, and particularly its spectral signature, affect the retrieval? You mention particular land surfaces in respect to a couple of examples of less good agreement. Is that related to a retrieval issue or to possible emissions from that land surface? Similarly for aerosol loading.

- Could the potential error sources / limiting factors be mentioned as well as the advantages? Is this the perfect algorithm which is limited by measurement characteristics?

Minor comments

Page 29, line 19 – delete 'actually'

Page 30, line 11 – 'spatial distributions: the emissions'