Atmospheric Measurement Techniques Discussions

Atmos. Meas. Tech. Discuss., referee comment RC1
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Comment on amt-2021-122

Anonymous Referee #1

Referee comment on "A minimum curvature algorithm for tomographic reconstruction of atmospheric chemicals based on optical remote sensing" by Sheng Li and Ke Du, Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2021-122-RC1, 2021

General comments

The paper faces the problem to introduce the "smoothness" a priori information in the tomographic reconstruction of atmospheric chemicals based on optical remote sensing. In particular, a new minimum curvature (MC) algorithm is proposed and applied to multiple test maps. The performance of the new algorithm is compared with that of other existing algorithms. The MC algorithm shows almost the same performance as the low third derivative (LTD) algorithm but with significantly less computation time.

I think that the subject is correctly presented in the introduction and sufficiently put in the context of the existing literature on the argument; instead, I find that the description of the method is not given in all needed details. I suggest to improve the description of the method and below I give some suggestions.

I think that the paper deserves the publication on AMT after that the following issues are considered.

Specific comments:

- In the Tikhonov approach, an important issue is the choice of the value that is given to the regularization parameter, because this value determines how much a priori

information goes into the results. In the paper, it is specified only "the regularization parameter is set to be inversely proportional to the grid length". I suggest describing the criterion that it has been followed for the choice of this parameter.

- It would be interesting to know if the algorithm is able also to produce a diagnostics of the results. Generally, a procedure that solves an inverse problem provides also an estimation of the errors (more in general of the covariance matrix) of the products. Furthermore, it would be useful to have quantities (such as the averaging kernel matrices obtained in the case of retrieval of atmospheric vertical profiles) that provide the sensitivity of the result to the true state, which are useful also to estimate the spatial resolution of the result.

- Line 43: I suggest to put a reference for the Radon transformation.

- Line 141-149: In the description of the LTD algorithm it is not clear which are the equations of the system that has to be solved. I understand that for each cell we have two equations obtained setting to zero the third derivatives (in both direction x and y, I suppose, but it is not specified). Then, which are the other equations? Those obtained to look for the minimum of Eq. (3)? Please explain in detail which are the equations of the system that has to be solved.

- Line 159-160: From Eq. (7) I understand that the seminorm is a number relative to the whole field, therefore, I do not understand the meaning that "the seminorm can be calculated at each pixel". Then, which is the summation mentioned in the text? I think that a more clear explanation is needed.

Technical corrections:

The authors introduce many acronyms, but not all of them are then used. I suggest introducing only the acronyms that are used several times in the paper.

Line 26: equality ---> quality

Line 85: necessary ---> need

Line 136: what is the superscript 21 after “problem”?

Line: 174: well-posted ---> well-posed.

Line 212: It ---> it

Line 242: increase ---> increases

Line 286: equality ---> quality