

Interactive comment on “Tomographic retrievals of ozone with the OMPS Limb Profiler: algorithm description and preliminary results” by Daniel J. Zawada et al.

Anonymous Referee #2

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Authors introduce 2D tomographic retrieval algorithm for ozone retrieval from scattered light limb measurements of OMPS. Although scattered light tomography for limb measurements has been demonstrated earlier, the concept is for the first time applied for ozone retrieval for real measurements of OMPS. I encourage publishing the manuscript once the following points are sufficiently addressed.

General comments:

- in the first algorithm description sections authors provide rather theoretical description of the inversion method without stating what physical quantities are used as measurement and what exactly are going to be retrieved. Only very late and in different places

C1

it is said that state vector may consist of various quantities in a sequence, e.g. logarithm of number density (stated only on page 13 of the manuscript), perhaps aerosol number density (but it is not clearly stated in Sect. 2.7.2). This makes it hardly possible to follow the arguments about practical considerations provided along the theoretical descriptions. I would strongly encourage the authors to restructure the manuscript to make its understanding straight forward.

- I have a feeling that more should be done with respect to the verification/validation, especially under strong gradient conditions. There is only one such orbit provided. Please add a study for a northern winter day with strong northern polar ozone depletion. For this case the Sun's geometry is opposite to that of the gradient in the SH. Also gradient at high SZAs (see below) must be investigated to sustain statements in the manuscript. Additionally middle and high latitudes where much stronger ozone variations might take place as at equator must be covered in a more systematic way. One could at least provide comparisons for one orbit per season thus covering typical seasonal variations in ozone distribution.

-there is a constant signal to noise ratio 100 assumed for the whole scan profile for the error estimation as given in conclusions of Jaross et al., 2014. Some sceptics is there due the natural illumination changes of several magnitudes along the tangent altitude and even despite the applied dynamical considerations, stray light and possible degradation of the instrument might be an issue.

Detailed comments:

P1L6: Add some words that MLS measurements used for the comparison are as well 2D, tomographic.

P1L24 add “and OCIO” after “of NO₂” since Pukite et al., 2008 did 2D retrieval for this gas as well.

P2L3 “relatively fast along orbital track sampling”: fast relates to speed or time, perhaps

C2

say “relatively fine resolved”. Sect.2. As said in general comments; it would help a lot to state at the beginning what physical quantities you are operating with.

P3L7 “Between grid points bi-linear interpolation is applied to create a continuous representation of the atmosphere.” It must be explained in detail how the interpolation is implemented. I.e. this could mean some subgridding or analytic constraints in model.

P3L15, F1 Figure must be improved. Please use different colors as “white grey” and other grey since it is really impossible to distinguish in the figure.

P3L17 “A common approach to minimize” Citations needed

P4L1-2 “Under this approach we have not noticed unphysical effects at the edges of the retrieval.” A prove for this statement is necessary. Given your verification and validation evidence (just one orbit with gradient at lower SZA) this has not been verified: Can this been tested with an example with a gradient condition at the orbit parts with SZA 88 deg and above? In such cases Pukite et al. 2008 reported problems for the first profile of the orbit. Please provide evidence.

P4L10 Related to general comments. Still on the 4th page of the manuscript there is no idea what is to be state vector and measurement vector.

P4L18 A more concrete and exact description is needed. How the transformation is practically performed? What assumptions used? What has to be understood under “atmosphere specification ... is transformed”, i.e. What is this atmosphere consisting from and characterized by? What and how it is changed due to transformation? How the Jacobian matrix is transformed?

P4L21 “These transformations are typically quite small in effect” Can you provide a number?

P5L6 And how much time resource do you need for one orbit?

P6L16 “Most atmospheric retrieval methods fall into two classes” Again, it is of course

C3

good to give some review about the background of inverse methods but it is difficult for a reader to follow your considerations and choices if it is still not stated what you are going to retrieve from what.

P6L17 “the resolution of the retrieved profile is determined by ... the resolution of the retrieval grid.” This statement is generally wrong: The resolution is an ability to resolve some features. If there is not enough information one is not able to resolve the features even on fine grid. I think you wanted to say something else; perhaps one should skip the part of the sentence after “i.e.” Eq.3 shouldn't all zeros be bold?

P7L16 “ozone number density, stratospheric aerosol number density, and surface reflectance assuming a Lambertian surface” Later you state that the state vector for ozone retrieval is logarithm of number density. This is again the confusion here between the long theory description and rather imprecise and misplaced description of the practical stuff.

P7L19 Does it mean solving 3 different separate inverse problems (Eq. 2)?

P8L20-21, Eq4 In text you mention k to be used for both indexing tangent altitude and triplet, though in Eq. (4) indexing for triplets is missing.

P8L22 What is meant by ozone sensitivity is minimal? Or perhaps effect of ozone absorption on spectra is minimal?

P13L8 “signal to noise ratio of 100”; “an upper bound on the error estimate taken from Jaross et al. (2014).” As said at the beginning this assumption might be much too optimistic.

P13L9 “state vector is the logarithm of number density”. Only on page 13 there is finally mentioned the physical quantity all about the theory was. What about other quantities?

P14 Have you studied the effect different settings of the horizontal regularization. Is it not possible to do retrieval without any horizontal regularization because you also match the horizontal retrieval grid to that of the measurements?

C4

P15L28 "orbit 27695" mention here day and time of the Eq. crossing.

P17L7 "Figure 10 shows the result of these comparisons in the tropical 5° S to 5° N latitude bin." What is about systematic study for other latitudes where far more gradients appear?

P19L10 day, time for orbit?

P23L4 "for the entire orbit" The retrieval is limited to SZA 88 deg. This should be stated.

P23L13 "one orbit" You compared two orbits.

P23L18 "tradiational"-> "traditional"

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