

## ***Interactive comment on “Vertical profile of $\delta^{18}\text{O}$ from middle stratosphere to lower mesosphere derived by retrieval algorithm developed for SMILES spectra” by T. O. Sato et al.***

**Anonymous Referee #2**

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Review of: Vertical profile of  $\delta^{18}\text{O}$  from middle stratosphere to lower mesosphere derived by retrieval algorithm developed for SMILES spectra

By Sato et al. Atmos. Meas. Tech. Discuss., 6, 8889–8935, 2013

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### General comments

This paper does a nice job of describing a well-performed project involving the development, characterization and interpretation of a retrieval of geophysical information from the SMILES instrument, optimized for measurement of ozone isotopes and ozone

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isotopic ratios. The work has been performed in what appears to be a robust manner, and the results have been well characterized and likely to be robust.

I am confident this paper will merit publication in AMT, though I do have some minor comments for the authors to address/consider. The standard of English is generally good. I have pointed out a few places where better wording is possible. However a pass through by a copy editor would probably improve it further. The figures are generally very clear, though, again, I do have some minor suggestions for improvements.

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### Specific comments

— Title

Suggest "... from \*the\* middle ... derived \*using\* a retrieval ..."

— Abstract

Line 4/5: "...algorithm specific for the isotopic..." is unclear and clumsy wording. Does it mean you're retrieving the isotope ratio as a state vector element, or, more simply, that this whole retrieval system is geared towards retrievals of isotopic species?

Line 14: Add comma after "agreement"

Line 16/17: Reword to "The  $\delta^{18}\text{O}$  peak, of 18%, is located at the stratopause"

Line 20: suggest "... wide \*altitude\* range ..."

— Page 8891

Line 8: Not sure that "trend" is the right word here, as it's altitude not time we're considering. I suggest "behavior" instead.

Line 18: "Using spectroscopic techniques, asymmetric..."

— Page 8892

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Line 10: "the importance of photochemistry..." Not sure what this is trying to say, was it a surprise that photochemistry was important? Surely everyone would have expected that. Was there something specific about the photochemistry that was important?

Line 14: Suggest "...low-noise spectra, enabling observations at high altitudes with good signal to noise."

— Page 8893

Line 3: "spectrum" -> "spectral"?

Line 5: "above the middle stratosphere" -> "in the middle stratosphere and higher" (or do you really mean to exclude the middle stratosphere?)

Line 21: Consider changing "functions" to "model"?

— Page 8894

Line 5/6: Fuse two sentences to give: "...after correcting it by a bias offset estimated by comparing ..."

Line 12-14: Not sure this last sentence adds anything, consider deleting.

Line 16: suggest "As mentioned in Sect. 1, only two of the three bands can be simultaneously observed..."

Line 19: suggest adding comma after "study"

Line 20/21: "depending on the other band" - this discussion feels unclear, at least to me.

— Page 8895

Line 1-2: I actually don't understand why "retrieving the VMRs of O3 and 18000 with different weights due to the difference of the spectral line intensities" would be a problem? Why do you not want to do this. A more detailed explanation and motivation here would help.

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Line 5: suggest moving "were" to after "retrieved"

Line 6-7: suggest "the spectrum..." -> "a first-order polynomial representing a spectral baseline"

Line 13-14: suggest "spectral" rather than "spectrum"

Line 17: again "spectrum" -> "spectral"?

— Page 8896

Line 14-16: Took me a while to realize you're talking about accounting for the movement of the antenna during integrations. Consider rewording along those lines. Just calling it a "widening" doesn't make it clear where it's coming from.

— Page 8897

Equation 2: Your definition of chi-squared is unconventional, as you point out. If you'd wanted to weight the a priori more, why not simply have a tighter a priori covariance matrix? Furthermore, it's not clear that your retrieval is really minimizing this chi-squared. If it were, I would have expected to see  $1/n_x$  and  $1/n_y$  terms in equation 13. If it is truly equation 13 you're using to arrive at the solution, then I would contend that you've found the minimum in the conventional chi-squared (i.e., the one without the division by  $n_x$  and  $n_y$ ). Please clarify this discussion. If indeed there are additional  $1/n_x$   $1/n_y$  terms lurking about in the algebra, have you checked that they don't extend to things like the averaging kernels also.

— Page 8898

Line 6: Not sure what "dispersion" means in this case, would "divergence" be better?

— Page 8900

Equation 13: So, the Gamma, Marquardt-Levenberg parameter doesn't change from iteration to iteration then? That seems quite unconventional to me. Is the retrieval really

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that non linear that you have to use such an unconventional approach to reach your solution. Granted, if the chi-squares are good, then the solution is probably a perfectly good one, even if you got there a round about way.

— Page 8901

Line 27: "... conservatively estimated as being twice the size of those for the O3 line, considering..."

— Page 8902

Line 26: "for obtaining" -> "in order to obtain the isotopic ratio without recourse to any vertical..."

— Page 8903

Line 12: Suggest "This is because of" -> "This improvement derives from"

— Page 8904

Line 1: "might" is weak here, surely that would be easy enough to check and verify for sure.

Line 24: "We encourage determining" is clumsily worded. How about "We recommend that a laboratory study be undertaken to determine"

Line 28: "overcame" -> "overcome"

— Page 8905

Line 16: What do you mean by "comparable" here? Was it that roughly the same fraction of points were rejected?

Line 18: This kind of filtering can be dangerous (TOMS ozone hole etc.) Could you at least say how many points were rejected by this filter? Did they still have reasonable chi-squares?

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— Page 8906

Line 17: At 28km - what about lower altitudes, or are there no data produced lower down?

Line 18: At 57km - what about higher altitudes, or are there no data produced above that altitude?

— Page 8906

Line 18: suggest "a significant" before "temperature dependence"?

Line 24-25: The sentence "We also discuss" is clumsily worded

— Page 8911

Line 16: suggest "trends" -> "behavior" as trends is typically thought of as being time related.

— Figure 1

Caption: For last sentence suggest: "Green, red and blue shading represent the b1, b2 and c1 frequency windows, respectively."

— Figure 2

Not sure that having symbols on the lines really adds anything. Consider removing them to make the plots less cluttered. Also, I suspect the fonts are a bit small.

— Figure 3

Again, not sure the symbols add anything.

— Figure 4

The last sentence in the caption is unclear (at least to me). Do you mean divergence rather than dispersion? Also, does "which is the same" really mean "as for"?

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— Figure 5

The overlapping shadings are a little hard to distinguish, though not impossible. Might showing error bars be clearer? It would probably be more cluttered though, so what you have here may be OK.

— Figure 7

Suggest showing a larger y-range, to at least take in the error bars for the averages, if not every point. Also, consider using darker colors for the points, they're too light to see clearly on my screen.

— Figure A1

Again, symbols don't add much, fonts too small.

— Figure A2

Again, consider dropping symbols

— Figure A4

Same comment on shading as for Figure 5.

— Figure A5

Again, font size and need for symbols.

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