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Interactive comment on “Interpreting SBUV smoothing errors: an example using the Quasi-Biennial Oscillation” by N. A. Kramarova et al.

Anonymous Referee #2

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The manuscript “Interpreting SBUV Smoothing Errors: an example using the Quasi-Biennial Oscillation” by Kramarova et al. describes the uncertainties connected to the SBUV ozone layer data, and how these uncertainties can be reduced. The suggested method is the combination of several layers, which can reduce the smoothing error for the combined layer significantly, and correctly capture natural ozone variability, e.g. from the Quasi-Biennial Oscillation.

The language of the manuscript is mostly clear, and the grammar is very good. However, I feel (as somebody who does not have to deal with retrievals on a daily basis) that in most manuscript parts, descriptions, discussion of results and implications of

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the results need some clarification, and sometimes more information. I would therefore recommend the manuscript for publication after some rephrasing has been done, and the listed comments/remarks have been addressed:

General remarks:

- Some descriptions in the text are vague, and it is not clear if they refer to a specific figure or to something that is not shown in a figure. Some of these unclear references/descriptions are pointed out below in the “Specific comments” section. But I would also recommend that you check the rest of the manuscript to clear up other possible short or vague descriptions.

- The SBUV ozone data set is one of the longest continuous records available, and is therefore used often for trend analyses. However, the vertical resolution of the measurements is coarse, and the lower levels have high uncertainties connected to the values. With combining several different layers, as suggested in the manuscript, it is possible to reduce the uncertainty on the ozone values, but this also clearly decreases the number of layers in the upper troposphere and stratosphere significantly. I am not sure if I understand correctly what the main message of this manuscript is: It is possible to decrease the uncertainty (and get the ozone variability right) on the SBUV layer data by combining the layers to be able to describe trends with less uncertainty? Or: It is possible to decrease the uncertainty on the SBUV layer data by combining the layers, but now layers are too broad to be of use to distinguish the differences in trends in specific atmospheric regions? I think it would be helpful if you would state more clearly what you think the data could be used for (maybe add some examples) after combining the layers and therefore reducing the smoothing errors.

- p.6, lines 14-26: The Aura MLS climatological profiles calculated from measurement from January 2005 to December 2010, are merged with ozone sonde climatologies that are calculated from January 2000 to December 2005. So far there is no discussion about the possible problems for the total covariance calculation due to the different

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covered time periods. Do you expect that to have an impact? If no, why not?

Specific comments:

- p.4, line 17/18: Why is the top layer not included?
- p.4, line 19/20/21: What does the sign “/” stand for?
- p.4, line 22: “AK” is already defined as “SBUV averaging kernel matrix”. It would be better to use different abbreviations for the “averaging kernel matrix” and the “averaging kernels”
- p.4, line 30: the lower boundary for the sharp SBUV AK is given as 25 hPa, but later (p.5 line 2) it is mentioned as 10 hPa. Are these the boundaries for different things? If yes, please explain this in more detail, if no, then please be consistent in mentioning the hPa value for the lower boundary.
- p.5, line 2: “. . . shifted upward (downward),. . .” with respect to what?
- p.5, line 11/12: I am not sure what is meant here by “fraction ozone changes”.
- p.5, line 16: “. . . i and j are layer indexes.” Are these indexes of neighboring layers, or just any layers?
- p.5, line 27: How is the total DFS calculated?
- p.5, line 29: “. . . higher SZAs and resulting increased vertical resolution in the upper layers.” It is not clear why the higher SZA should result in an increased vertical resolution. It is explained on p.6, lines 4-7, so maybe just a rearrangement of the text would be helpful to clarify this.
- p.5, line 30/31: The sentence “The layer DFS. . .” is somehow vague. Could you be more specific about which upper layers you mean? In Figure 3 the uppermost layers (above 1 hPa) show smaller DFS than the layers directly below (between 10 hPa and 1 hPa).

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- p.6, line 3: Why does the DFS of the tropical profile below 40 hPa decrease abruptly?
- p.6, line 13/21: Could you be more specific about the definition of the ozone sonde latitude bins?
- p.6, line 25: What does it mean if you convert “MLS and sonde profiles preliminary...”?
- p.6, line 25/26: Did you have to use any auxiliary data to convert the MLS and sonde data to partial columns? If yes, could you please mention them?
- p.6, line 27-29: Could you explain in more detail how the merging was done exactly? It is not clear to me what “. . .proportional 75/50/25% weighting for lower/mid/upper parts of the range.” means.
- p.7, line 6: What do you mean with a priori here? Is this the a priori profile used in the SBUV retrieval? And does that change with different latitude? Please be more specific in your description.
- p.7, line 6/7: the range given in the sentence “Standard deviations vary between 2-15
- p.7, line 8/9: There is a reference to a high latitude standard deviation profile, but no high latitude profile is shown in Figure 4.
- p.7, line 22/23: Where does the total column ozone come from that is mentioned here? Is this just the integration over the different SBUV layers? Be more specific.
- p.7, line 30: “. . . (as large as 15-20%). . .” These numbers cannot be seen in Figure 5. Do you refer to a different figure here?
- p.7, line 30/31: it is not clear to which profile (latitude band and/or season) the sentence “Errors also increase up to 5%...” refers. Please be more specific.
- p.8, line 2/3: It was not totally clear to me at this stage in the manuscript that the TC matrices are only functions of latitude. Does that the sonde data was averaged over

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the whole period (Jan 2000 to Dec 2005) within the different latitude bins? And the same was done for MLS? Could you explain this with a little more detail somewhere?

- p.8, line 4: “correspondence” might not be the best possible word choice here (made me stumble over the meaning of the sentence).

- p.8, line 10/11: Where does the QBO signal come from? The averaging of MLS and sonde data should average the QBO data out, so the signal should not be present in the TC. Does the signal come from the AK?

- p.8, line 17/18: Could you explain (again?) why there is an increased sensitivity in the upper layers?

- p.9, line 3: What does Xa stand for? Still the a-priori profile?

- p.9, line 25/26: Could you explain in a little more detail why the physical interpretation would be a challenge?

- p.9, line 27-30: How exactly are the different SBUV layers combined? And does the method of combining them affect the resulting reduction in smoothing errors?

- p.10, line 3: You state here that the “AK are significantly reduced below 250 hPa”, but on page 5 you state that the AK are significantly reduced below 60 hPa (in the tropics). Is there a threshold you apply to decide where the AK is significantly reduced? And why didn't you test combining the layers from 60 hPa to 16 hPa in the tropics (since the AK is reduced below 60 hPa in the tropics already)?

- p.10, line 14: “The smoothing errors are larger. . .”, larger than what?

- p.11, line 1-15: I assume the MLS data was also combined to make a comparison between the combined SBUV layers possible. Could you make that clearer in the text? As well as the method of combining the MLS layers?

- p.11, line 29: You mention two parameters on which the smoothing error depends on. However, on page 2 line 29-31 you mention three things on which the smoothing error

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depends on: the vertical resolution of the observing system, the accuracy of the a priori data, and the magnitude of the natural ozone variability. Is it two or three parameters? And if it is three, then please discuss the third parameter somewhere in the manuscript as well.

- p.15: Add somewhere the time period for which the ozone profiles are used.
- p.16: Why are there no columns for the latitude bands 90S-80S and 80N-90N?
- p.19, line 2: Do the mid-latitude profiles represent a specific hemisphere? If yes, please specify in the figure caption.
- p.20: What do the vertical profiles of the square roots of the diagonal elements of the TC for latitude bins in the SH look like? Does the fact that there are clearly less ozone sonde measurements available in the SH have an effect on the profiles? It would also be helpful to see a high-latitude profile here.
- p.21, line 2: Do the mid-latitude profiles represent a specific hemisphere? If yes, please specify in the figure caption.
- p.22: Why are the smoothing errors so small for Nimbus 4 and Nimbus 7 (both figures)? And could you add “a)” and “b)” to the respective figures?
- p.23: Would it be possible to have the same y-axis range for all four plots? That would show the differences of the smoothing errors for the different layer combination clearer.

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