

## ***Interactive comment on “Retrieval of tropospheric column densities of NO<sub>2</sub> from combined SCIAMACHY nadir/limb measurements” by S. Beirle et al.***

### **Anonymous Referee #3**

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#### General Comments

This study describes three stratospheric estimation schemes (SES) that can be used in retrievals of stratospheric (and tropospheric) NO<sub>2</sub> from SCIAMACHY. By examining the statistics and sign (positive or negative) of tropospheric slant columns retrieved by this method, the authors make a good case for their Relative Limb Correction (RLC) as an improvement over traditional Reference Sector Methods (RSM), which assume a zonally invariant stratosphere. Furthermore, this method does not depend on external model input and is not affected by artifacts associated with other retrievals that do allow

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zonal variability (e.g. image processing or Fourier wave analysis techniques). Thus, where applicable, it should be the method of choice for satellite retrievals that require separation of stratosphere and troposphere. However, since it relies on simultaneous independent stratospheric measurements as provided by SCIAMACHY, it cannot be used directly with nadir-only instruments like GOME or OMI. However the approach described for testing the accuracy of the various SES schemes could and should be applied to other satellite retrieval algorithms.

I believe the authors have done a thorough job in demonstrating the effectiveness of their approach with the results shown in the paper and supplemental material. Overall, I think much of the writing could be more concise and clearer, mainly with respect to English grammar. A careful edit is recommended. If this is done, I think the paper should be published after the authors also address a few additional questions (mostly minor) about some of the statements and assumptions in the paper, as detailed below.

### Specific Comments

1. For given latitude, the RLC scheme basically takes the differences between limb-measured stratospheric columns around the world and limb-measured columns in the RS and adds those differences to nadir-measured stratospheric columns in the RS. This introduces longitudinal variation into the RSM while eliminating any additive biases between the nadir- and limb-type measurements. Using only limb-measured columns (the ALC method) would not eliminate biases, as the authors show. However, they have not shown why these biases are necessarily additive (the effect of an error in tropopause height on limb columns – an additive bias – is negligible). For a multiplicative bias (e.g. limb columns at a given latitude might be systematically 20% larger than nadir columns), the ratios (not differences) of limb-measured columns should be multiplied by (not added to) nadir columns in the RS.

The assumption of multiplicative rather additive errors might not make much difference in the final results, but I think the authors should explore this possibility, or at least be

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explicit about their assumptions and why they chose to make them.

2. On p. 3004, it is stated that no correlation was found between clouds and TSCDs over the reference sector. Is this based only on an average over all latitudes in January? For example, I have seen statistical evidence presented of enhanced total slant column NO<sub>2</sub> near convective clouds in the tropics.

3. Referring to the TRSM and TRLC tropospheres as “relative” and the TALC troposphere as “absolute” is somewhat confusing, for example on page 2997 lines 12-14 just before Sec. 2.6. Actually all three are relative to some assumed stratosphere. It’s just that in the TRSM and TRLC cases, you believe the assumed stratosphere might contain a small amount of tropospheric contamination (as explained on page 3006, lines 11-17). If that is what you mean, maybe this should be clarified.

#### Technical Corrections

The list below contains a few suggestions for improving grammar, etc. I think the paper would benefit from a thorough overview by a copy editor (although it is certainly understandable as is).

1. In the Abstract: Line 2: “As the only instrument of its kind, . . .” Line 13-14: “Thus a relative limb correction scheme was also defined, . . .”
2. Page 2985: Line 10: “. . .numerous scientific applications in recent years. . .”
3. Page 2986: Line 17: “. . .CDs are not independent. . .”
4. Page 2987: Line 17: “The viewing geometry alternates between nadir and limb. . .”
5. Page 2989: Line 2: “. . .as well as systematic errors. . .” Line 17-18: “. . .geometries, including nadir, limb and solar/lunar occultation”
6. Page 2990: Line 21-22: “. . .related to this study in that large parts of the chosen. . .” Line 26: “. . .measurements from the descending part of the orbit. . .”

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7. Page 2991: Line 22: "...due to the viewing geometry and narrow vertical resolution..."(?) Line 25-26: "...retrieval are on the order of several percent in the upper ..."
8. Page 2992: Line 12: Please define "LZA" (look zenith angle?)
9. Page 2996: Line 12: "With any of these estimates of W (i.e. WRSM, WALC, WRLC) ..."
10. Page 2998: Line 8-9: "...can be derived, mainly in cases of strong temporal..."  
Line 18-19: "...where the shortcomings of RSM become particularly evident."
11. Page 3000: Line 25-26: "...in contrast to..."
12. Page 3001: Line 19: "...sometimes reduced, rather than completely eliminated the..."
13. Page 3007: Line 2: "This also affects studies on relative..." Line 24: "...and suggest using this scheme..."

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Interactive comment on Atmos. Meas. Tech. Discuss., 2, 2983, 2009.

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