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Interactive comment on "Global satellite validation of SCIAMACHY O_3 columns with GOME WFDOAS" *by* A. Bracher et al.

A. Bracher et al.

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We thank Anonymous Referee 1 for his positive review and his comments. In our response we answer in italics to each comment raised.

1. "The conclusions should be based on the results presented and need careful reconsideration." According to the suggestions made by referee #1 and #2 we changed as pointed out the manuscript and therefore the conclusions as suggested.

2. "Additional plots, in particular global latitude-longitude maps of the SCIAMACHY-GOME differences and plots of seasonal biases as found with GOME GDP 2.4 are helpful and could easily be added." Now we present the global maps of the one-day comparisons (see Fig. 2). The seasonal biases are explained in Fig.3. We also

checked for longitudinal dependencies in the different latitude bands, but could not see any significant differences, therefore these plots we do not show but added this information now in the manuscript. Because we saw the latitudinal dependencies, we supplied these plots before, but despite only showing the mean and rms values we now show the relative deviation for each compared data bin or each comparison in Fig. 2.

3. "Because two different retrieval algorithms are applied to different satellite instruments there is an attribution problem. This can be improved by involving a third data set. There are a few options, for instance a comparison of GDP 2.4 with WFDOAS (both GOME) or a comparison with GDP v4." We were already able to adapt the WFDOAS algorithm to SCIAMACHY level-1 data and extract total ozone columns for a few days (10) in 2003. These data were now compared to the SCIAMACHY V5.01/5.04 and GOME WFDOAS results in order to elucidate which differences can be attributed to the instruments and which to the algorithm. The results are now included in Figs. 1,2,4,5 and discussed. They clearly show that the largest contribution to the differences are due to algorithm issues rather than of instrumental nature.

4. "The introduction and list of references should give credit to retrieval and validation activities by other groups." We added more references on non-Bremen total ozone retrievals and validation activities from satellite instruments and also gave a summary over validation activities concerning SCIAMACHY total ozone operational product.

5. "After reading the paper it is not clear to me what I have learned about SCIAMACHY. One important reason for this is the fact that two quite different algorithms are applied to two instruments. Are differences detected related to details of the retrieval algorithms, or to level-1 issues in SCIAMACHY? In particular, because the paper is submitted to the SCIAMACHY validation special issue, I would especially like to learn how level-1 calibration issues influence the ozone column retrieval. This can be studied by applying one algorithm with fixed settings to both SCIAMACHY and GOME. Indeed, the reprocessing of SCIAMACHY with the WFDOAS algorithm (mentioned by the authors) would serve this purpose, and may result in much clearer answers concerning the quality of

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ozone retrievals that are achievable with SCIAMACHY. Another possibility would be the comparison between WFDOAS and the old GOME GDP processing version 2.4 (if the data is still available). Comparisons with such an additional product would provide a means to distinguish instrument aspects from retrieval aspects." See answer to point 3.

6. "Looking at the results without prior knowledge about the retrieval methods one first of all would draw the conclusion that both SCIAMACHY and GOME are in surprisingly good agreement, to within a few percent. With this level of agreement, and based on figures 1 to 5, it is not so easy to judge which of the two is actually better. However, the authors claim that the differences should be attributed to SCIAMACHY. This conclusion is based on WFDOAS validation results with ground-based observations, which are mentioned to agree within typically 1%. I find these very good agreements between WFDOAS and WOUDC quite surprising: Dobson (and Brewer) instruments are normally quoted to have uncertainties and seasonal dependencies of a few percent (inter-calibration; temperature and profile dependence of the derived columns) with larger uncertainties under extreme conditions (e.g. ozone hole). The authors also mention WFDOAS vs. WOUDC differences of 5-8 % for large solar zenith angles. This is also where the larger GOME-SCIAMACHY differences are observed. Can the authors be sure that differences at high SZA can be attributed to SCIAMACHY (instead of WFDOAS-GOME)? With all this in mind I would not be able to draw the conclusion that the SCIAMACHY retrieval is of lower quality." As point out in 3., we can now conclude from including the SCIAMACHY WFDOAS data set in the comparisons, that the instrumental effects play a minor role and that the algorithm type is more strongly impacting the data quality. The differences at high SZA are also attributed to (as stated in section 5): "The much larger negative bias between SCIAMACHY V5.01 and GOME WFDOAS during polar winters compared to other regions and seasons might be explained that generally at high SZA and in polar regions satellite and ground based UV-VIS measurements have larger errors due to lower signal to noise ratio at low light conditions. Because the two instruments are flying in the same orbit 30 min. apart from each other

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the SCIAMACHY measurements at high northern latitudes during sunrise are taken at higher solar zenith angles than GOME measurements and therefore may probably show a larger error than collocated GOME data. The situation is reversed at high solar zenith angle in the southern latitudes. This also explains why the scatter increases at high latitudes (this is also true for SCIAMACHY WFDOAS to GOME WFDOAS comparisons)."

7. "Unfortunately the period of overlap between GOME and SCIAMACHY is less than 6 months. After studying the figures (figure 3) I would claim that evidence for a seasonal bias is rather weak. The authors quote seasonal biases that were identified in the GOME-GDP 2.4 product (Lambert, 2000). It would be very instructive if the authors could include the result found by Lambert as additional curve in figure 3 (if possible). This could add more credibility to the claim that seasonal biases are observed." Unfortunately we were not able to include the Lambert et al. (2000) data in our Fig.3, but we now clarified in the discussion that this seasonality has been also detected by Bramstedt et al. 2003 in GOME GDP 2.7 data set validated with groundbased sensors. We also included now that still the SCIAMACHY v5.01/5.04 results seem to show a weaker seasonality then the previous GOME data products.

8. "The authors mention that "A reprocessing with an algorithm equivalent to GOME GDP version 4.0 and/or GOME WFDOAS V1.0 will improve significantly the quality of the SCIAMACHY ozone product" (abstract). How can the authors be sure? The quality seems to be quite good at the moment. Is this a conclusion which is drawn based on the results of the present study or is it just a belief? For instance, there are serious problems with the radiometric calibration and polarisation of SCIAMACHY, and I would argue it can not be excluded that this will give unexpected results when WFDOAS is applied to SCIAMACHY measurements. The statement should either be justified or be removed." We show now in the revised version that comparing for some days in 2003 SCIA WFDOAS to GOME WFDOAS the latitudinal/SZA/total ozone dependencies disappear. In addition we still expect a similar improvement from introducing GDP 4.0 and

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TOGOMI to SCIAMACHY total ozone processing since all three algorithms, GOME 4.0 and GOME WFDOAS, have shown similar data quality in validations (Weber et al. 2004, Lambert et al. 2004a, Eskes et al. 2005).

9. "The paper mentions on p 799 and in the conclusion that the current GOME version is GDP v3.0. GDP 4 has now become available (December 2004). In fact it would be quite interesting to see results for both the WFDOAS and GDP 4 algorithms." We changed that GDP 4 has become available (after we submitted the paper to ACP) and now we show additional comparisons of GOME WFDOAS to SCIAMACHY WFDOAS and of SCIAMACHY 5.04 to SCIAMACHY WFDOAS (see above).

10. "The list of references is very Bremen oriented. The reader would benefit from a more balanced introduction, which gives credit to recent ozone column retrieval developments for GOME, SCIAMACHY, but also TOMS (version 8). Also a short summary of past SCIAMACHY ozone validation activities and main conclusions (the paper by Lambert etc.) would be very helpful to understand and judge the additional value of the presented work." See answer to point 4.

11. "In the conclusion the authors should indicate what new results are obtained with respect to existing validation papers, like the paper by Lambert et al. (the small negative bias of 1% was already reported). The comparison approach consists of a gridding on a 2.5-degree latitude-longitude grid. Subsequently the results are discussed as function of latitude alone. Because of the possible dependence of the retrieval on the surface albedo (LER), surface altitude, snow cover, it is very interesting to see the difference between the two products as a global map. I would encourage the authors to include such a map (maps) in an updated version of the paper. It is strange that the authors put so much emphasis on the gridding approach and computational speed issues, even mentioning this in the abstract. I regard the gridding as a rather straightforward approach and even extended comparisons with some added search criteria should not be a problem for the relatively modest satellite data sets considered (compared to modern day computer power). I suggest to remove this remark from the abstract." Most of

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this comment we answered already above (see points 1,2). According to the referees suggestion we removed the remark on computing time from the abstract.

12. "On page 806: "In summary, the current operational SCIAMACHY total ozone data Version 5.01/5.04 shows an insufficient data quality with a clear dependence on season, latitudes and total ozone." As mentioned above, to me it is not clear that this follows from the inter-comparison presented." According to our results presented now and the changed discussion we altered this sentence to "In summary, the current operational SCIAMACHY total ozone data Version 5.01/5.04 shows a dependence on latitudes, solar zenith angle and total ozone that reduces the data quality to an overall negative bias around 1% with an RMS of 2 to 3%. We could show that a reprocessing of SCIAMACHY total ozone data with an equivalent of GOME WFDOAS improves the accuracy within to 1%. A similar improved data quality we expect from SCIAMACHY total ozone reprocessed with equivalents to GOME V4.0 or TOSOMI."

13. "p 806, before acknowledgements: "An adaptation of WFDOAS algorithm to SCIAMACHY is currently planned and it will ensure a better consistency between GOME and SCIAMACHY. " Such a conclusion can not be justified and should be removed." This sentence was removed as suggested and since we are now showing results of comparing SCIAMACHY WFDOAS with SCIAMACHY V5.04 and GOME WFDOAS.

14. "Figures 2, 4, 5 seem to suggest a common reason for the differences. Could all plots be explained with for instance only an ozone column dependent bias?" We now extended in the manuscript the discussion on why differences observed in Figs. 2, 4, 5 also bear a common reason: "The similar characteristic behaviour of the differences between SCIAMACHY V5.01/5.04, SCIAMACHY WFDOAS and GOME WFDOAS as function of SZA and total ozone is not a real surprise since the total ozone is also somewhat dependent on the solar zenith angle during the SCIAMACHY (and GOME) measurement, with higher total ozone observed at mid latitudes with an intermediate SZA. The much larger negative bias between the SCIAMACHY and GOME algorithms in the polar winters of our study compared to other regions might be explained that

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generally at high SZA and in polar regions satellite and ground based UV-VIS measurements have larger errors due to lower signal to noise ratio at low light conditions. Because the two instruments are flying in the same orbit 30 min. apart from each other the SCIAMACHY measurements at high northern latitudes during sunrise are taken at higher solar zenith angles than GOME measurements and therefore may probably show a larger error than collocated GOME data. The situation is reversed at high solar zenith angle in the southern latitudes. This also explains why the scatter increases at high latitudes (this is also true for SCIAMACHY WFDOAS to GOME WFDOAS comparisons)."

15. "The authors mention: "Both figures show a clear tendency in the difference to GOME as a function of the SCIAMACHY SZA" (Fig.4) the figure shows changes in the order of 1-2 %, which I suggest may also be classified as good agreement!" We now agree that the dependency is not as strong as claimed before and reformulated this sentence to "All three figures showing the validation of the operational SCIAMACHY product show a tendency in the differences to GOME and SCIAMACHY WFDOAS as a function of SCIAMACHY SZA", but are still obvious as we can not see it in the SCIAMACHY WFDOAS to GOME WFDOAS comparisons.

Interactive comment on Atmos. Chem. Phys. Discuss., 5, 795, 2005.