

Interactive comment on “Improvements in the profiles and distributions of nitric acid and nitrogen dioxide with the LIMS version 6 dataset” by E. Remsberg et al.

Anonymous Referee #1

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General comments: The LIMS HNO₃ and NO₂ data sets have been re-processed with an updated retrieval algorithm (version 6). This paper describes the algorithm improvements and evaluates the results. The main improvement to HNO₃ is better treatment of interference by CO₂ in the upper stratosphere, reducing the high bias in HNO₃ that had been seen in the version 5 retrievals. The main improvements to NO₂ are in the middle and upper stratosphere. These primarily result from improved spectroscopic parameters, particularly inclusion of spin-rotation effects. Minor improvements also resulted from better retrievals of temperature and water vapor, biases in which previously led to errors in the NO₂ retrievals. There still appears to be a high bias in LIMS NO₂ above 1 hPa, due to not accounting for non-LTE emissions from H₂O that contaminate the NO₂

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signal. The results are used for several different scientific investigations. The authors confirm that the V6 retrievals result in HNO₃/NO₂ ratios in the upper stratosphere that are consistent with theory, in contrast to the V5 results. They show that day/night ratios of NO₂ now agree better with models. They also re-evaluate the descent of NO_x into the stratosphere from the mesosphere (having been produced by energetic particles) during the 1979 winter; they show that the results agree with more recent observations showing significant descent of NO_x in the absence of strong geomagnetic activity.

This is a very well written paper. It is well organized and easy to follow, and contains important results for investigators using the LIMS data. I recommend publication after consideration of the following minor comments.

Specific Comments: Lines 53-56: References to the work mentioned here would be helpful.

Figure 1 (and all figures): Please give an explanation for black regions on the plots (presumably missing data?).

Lines 166-167: Please explicitly state the pressure levels and latitudes where the “spurious, upward extension” of NO₂ distributions is observed.

Figure 3: This figure shows black areas, most of which presumably signify missing data. However, there is a black region near 40-50 S and 5 hPa – if this is offscale, either the color scale should change, or the text should note the maximum values in this region.

Lines 170-171: The paper states that Figure 3 is similar to Figure 2a, but that “One exception is the occurrence of relatively large values of NO₂ near 50°S compared with those at equatorial latitudes.” This statement needs some clarification; at the very least, the pressure range to which it applies should be stated. As far as I can discern, at most pressure levels below about 3 hPa both figures show larger values at 50S than near the equator (and both figures show only a small, or even reversed,

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gradient at higher altitudes). This is a minor point, in that the main difference in Figure 3 compared to Figure 2a is, as noted by the authors, the very large NO₂ mixing ratios at high northern latitudes in the upper stratosphere and mesosphere.

Lines 289-295 and Figure 4: I am confused by Figure 4 and the accompanying text. I read the explanation to mean that Figure 4 should show both theoretical and empirical estimates of precision. I believe that the figure shows the empirical estimates, which are given by standard deviations for sets of descending and ascending profiles from 25-35 deg S latitude on 1 Feb 1979, but I do not see a profile that would indicate the theoretical precision calculation. My confusion stems from the sentences that state, "The calculated precisions shown in Figure 4 vary from 0.15 ppbv....Those calculated values [which I think refers to the calculated precisions]....compare well with empirical estimates....in Figure 4."

Lines 412-413: Referring to the HNO₃/NO₂ ratios in Figure 6, the paper states that "both the model and LIMS show a steady decline with decreasing pressure..." This should be qualified to note that this is not the case for the LIMS data poleward of about 40 deg N latitude. An explanation for the increase in the ratio near 1 hPa should be given.

Lines 448-462 (description of Figure 7 (top) & Figure 8): I believe that the authors are discussing the inability of a 2D model to simulate zonal inhomogeneities in order to explain why the observed and modeled HNO₃ in Figure 7 do not agree particularly well in the top panel of Figure 7 (except near the equator). However, this is never stated. If I am correct, it would be helpful to include a statement summarizing this. If I am not correct, more explanation of the implications of figures 7 and 8 is warranted.

Lines 464-473 (description of Figure 7 (bottom)): Here, the LIMS HNO₃ + NO₂ data should represent a lower bound to total NO_y, yet the model calculates an even lower value. The error bar on the LIMS data is quite large, though, and indicates that the differences are not really significant. Still, the authors essentially explain away the

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differences as being possibly caused by incorrect specification of NO_y sources in the model, and transport formulations in the model. Thus the case overall seems very weak (agreement within very large uncertainties), and I wonder if this is really worth including in the paper. If I am misunderstanding the significance of these results, more explanation would be helpful.

Figure 9. The variation with latitude in this figure, which is the main point of including it, would be more easily visualized if the color scale were compressed to a smaller range.

Technical suggestions / Typos: Line 71: Write out FOV the first time it's used.

Line 138: I believe that the "moderately high" here refers to the mixing ratios around 2-3 ppbv. Since the range plotted extends from 0 to something greater than 12 ppbv, a more accurate description is perhaps "slightly elevated".

Line 141: The text says "May 15", but Figure 1b says "May 16".

Line 192: Change "...levels and encompassing..." to "...levels encompassing..."

Line 340: Change "...from that of..." to "...from those of..."

Line 472: Change "...and to the transport...." to "...and on the transport...."

Line 589: Change "degrading" to "degrade".

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 2769, 2010.

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