

Author responses (denoted by asterisks) to second review below of Referee #2:

This is my second review of the manuscript, the first of which was related to the original version of the manuscript. I am satisfied with all replies and actions in response to my first review, except for one issue. This refers again to the temperature bias due to neglected horizontal temperature gradients:

The logic behind the applied approach towards assessment of temperature biases due to horizontal gradients is still not clear to me. I understand from Remsberg et al., 2004 (their table 2 and related text), that the random and systematic errors of V6 T(p) has been assessed. A number of uncertainties (also called error sources) go into this assessment, however, the systematic error due to horizontal temperature gradients is not one of those. Instead, systematic errors due to calibration, line intensity, forward model etc. are summed up (RSS) to the total accuracy, and total precision (estimated from other error sources, again without temperature gradients) and total accuracy are summed up (RSS) for the total error. This one is presented in line g of the Table 2 of Remsberg et al., 2004, These errors (Remsberg et al., 2004, Table 2, row g) are now, in the current manuscript, used as assessment of the error due to disregarded temperature gradients. There might be arguments to justify this approach, e.g. that these errors can be taken as upper estimates, for example, however I think these arguments need to be presented in the current manuscript.

*You are correct that error estimates for T(p) in Table 1 (from Table 2 of Remsberg et al., 2004) assume that there are no significant temperature gradients along the view path or that accurate corrections for gradients have been applied. Table 1 merely shows sensitivities of the retrieved species to those estimated temperature biases. We have revised the text to make that clear.

Further, the authors refer to a first-order correction of LIMS temperature biases due to horizontal gradients by Gille and Russell, 1984. Unfortunately, I do not have free access to this paper, neither personal nor institutional, due to the restrictive publication policy of AGU/Wiley, therefore I cannot judge if an appropriate description of the first order correction has been provided by Gille and Russell, 1984, and if they quantify the residual temperature biases. I assume that AGU's/Wiley's restrictive publication policy will affect many other readers as well, and therefore I recommend to provide a short description of the method and results in the current manuscript. On the other hand, Roewe et al. 1982 seem to provide a quantitative assessment of temperature biases due to horizontal gradients (and the access to this paper seems to be free). It would be helpful for the reader to know if the temperatures have been corrected by the numbers provided in the latter paper, and which residual effects remained.

*The LIMS overview paper of Gille and Russell (1984) has a copyright restriction, but Gille et al. (1984) and their description of corrections for temperature gradients does not. However, both papers require that you have institutional access to JGR, at least, to download it freely. We realize that easier access is desirable for early JGR papers. We rely mostly on the Gille et al. (1984) reference and you can access a .pdf of it through ResearchGate. Roewe et al. (1982) considered view path corrections based on horizontal radiance gradients, while the archived V5 and V6 data sets are corrected for horizontal temperature gradients (as in Gille et al. (1984) and in Kiefer et al. (2010)). Residual, ascending/descending T(p) biases are still present following both correction methods. We refer to the findings on the T(p) gradient corrections of Gille et al. (1984) in our revised text.

After reading this submitted manuscript and the cited papers (those that are accessible to me) several times I have got the impression that the "first order correction scheme" might be a 2D-retrieval along one orbit. This, indeed, would correct horizontal temperature variations at first order (i.e. the gradients). In this case, remaining A-D differences could come from other effects than horizontal temperature variations, like slightly different gain calibrations between the two observations, in which case the application of the error assessment of Remsberg et al., 2004 Table 2, row g would make sense. If my assumption is correct, the fact that a 2D-retrieval has been applied which corrects for the first order horizontal temperature gradient effects needs to be stated clearly and at the beginning of the paper. It is of utmost importance for understanding of all what follows. And the A-D biases of trace gases should not primarily be related to unresolved horizontal temperature gradients but to the other differences related to the accuracy assessment in Remsberg et al., 2004.

*If Roewe et al. (1982) is the only LIMS gradient analysis paper that you read, it is likely that you were misled somewhat because they considered along-orbit corrections based on horizontal radiance gradients. Since the relation between temperature and radiance is very nonlinear, the V5 and V6 T(p) and species profiles have corrections for the horizontal, view-path T(p) gradients, in the following manner. Daily, near-global temperature fields were obtained from a 4-zonal wavenumber mapping of the T(p) profiles from a V5 first-pass retrieval. The mapped fields are at 18 separate pressure levels (spaced vertically by 2.3 to 4.3 km, depending on level). Temperature gradients for each profile were determined from the maps, according to the LIMS tangent-path viewing direction in longitude and latitude (a 2D approach, perhaps?), and new, second-pass T(p) retrievals were performed taking account of those gradients. V5 gradient estimates from the similar V5 Level 3 map product were used for the processing of the V6 profiles, even though the along-orbit spacing between the V6 profiles is twice as close as those from V5 and resolves gradients better. The T(p) gradient values for each profile are on the archived V6 Level 2 files and used for retrievals of the species. While both the V5 and V6 temperature profile biases become smaller after gradient correction, one must remember that our analyzed temperature gradient information is approximate. Any residual T(p) biases will affect the V6 species with a sensitivity similar to that in Table 1. In particular, the zonally-averaged, ascending and descending orbital species values at a latitude will differ slightly, as diagnosed also by Kiefer et al. (2010). We have revised the text to make these points clearer.

Finally, I would like to express my point of view that the importance of the LIMS data record, as an early data set with near-global coverage, can hardly be overestimated. For this reason, the description of the data and their quality assessment should be done as complete and careful as possible. I appreciate very much Dr. Remsberg's initiative towards this goal.

*Thank you for your interest in this study and for your constructive comments.