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Atmospheric Chemistry and Physics Discussions

Interactive comment on "On the quality of the Nimbus 7 LIMS Version 6 water vapor profiles and distributions" *by* E. E. Remsberg et al.

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Response to Reviewer 1

Onion peeling vs. optimal estimation: An onion-peeling approach is appropriate for the LIMS experiment because of the good vertical resolution of the measurement via a limb-viewing geometry. The addition of an optimal estimation formulation would have been helpful for those altitude regions where the measured signals had a low signal-to-noise (S/N) in the tangent layer; the optimal estimation formulation can also provide estimates of error for each individual retrieved profile. However, it is worth remembering that the LIMS experiment was designed to generate stratospheric H2O distributions at a time when its "climatology distribution" and "a priori profile" were really not known. Also, the retrieval of water vapor from infrared measurements at 6 to 7 micrometers

is a very non-linear problem and, therefore, very sensitive to small bias errors in the radiances and in their registration with pressure. These factors become particularly problematic in the lower stratosphere in polar winter, when temperatures are cold and H2O mixing ratios are relatively low, i.e., at times of low S/N. The onion-peeling approach exposed those occurrences in the retrieved profiles and pointed us to further diagnoses of their cause.

HITRAN 1996 data: Further improvements in the line parameters for H2O, such as widths and positions, have no effect for the forward model of the LIMS broad-band radiometer measurements at 6 to 7 micrometers. More importantly, the strengths of the relevant H2O bands are essentially unchanged for the later versions of HITRAN.

Temperatures in the lower mesosphere and near the stratopause are slightly warmer for V6 versus V5 because of (1) improvements in knowledge of the attitude of the Nimbus 7 spacecraft and its effects on the registration of the LIMS radiance profiles with pressure-altitude, and of (2) a greater accuracy with pressure and temperature in the development of the CO2 and the (interfering) ozone emissivity tables for the LIMS forward model for T(p) (see Remsberg et al., [JQSRT, 2004]). A slightly warmer atmospheric temperature for the tangent layer means that more of the observed radiance in the H2O channel is explained by the Planck Blackbody function as opposed to the infrared transmittance along the view path, which depends on the amount of H2O itself (see Eqs. (1) and (2) in Gille and Russell, JGR, 1984).

MLS is showing dryer H2O values than LIMS in the lower stratosphere near 60S in mid-November. Figure 4.2 of WMO [2007] shows a time series of the average NCEP/NCAR reanalysis temperatures for 60-90S at 100 hPa for successive Octobers. The average temperature was about -61C in 1979 compared with -65C in 2004. At the very least, the colder temperatures of 2004 are in the right direction to explain the dryer air recorded by MLS in November 2004.

Response to your questions about the tropical H2O "tape recorder" signal. It is realized that an anomaly plot might be of value at certain pressure levels. For example, at 20 hPa the maximum and minimum H2O values seem to occur within the 7-mo time period of the LIMS dataset; however, the annual extremes would be underestimated at many of the other pressure levels. Nevertheless, the relative changes with time of the LIMS H2O values should be fairly accurate, at least above the 30-hPa level for the 10S to 10N latitude band. We estimate a maximum change from 4.4 ppmv in November to 4.0 in April at 20 hPa. We have looked further about the possibility that there was encroachment of subtropical air (with its higher average H2O values) across the 10N boundary in winter (for example, see plots of the effects of the zonal wave variance on LIMS HNO3 for each month in Remsberg and Bhatt (JGR, 1996)). But, we found only a minor change in the max minus min H2O at 20 hPa, when we focused on the latitude range of 10S to 6N. We have seen rather large changes for the interannual variability of the amplitude of the tape recorder signals from both the HALOE and the MLS data, but do not know what those variations might have been during the time period of LIMS. Other LIMS issues include the fact that we have only made a first order correction for the interfering radiances from CH4, which makes a significant contribution in the tropical lower stratosphere. The CH4 distribution was varied only seasonally for the V6 algorithm. There are smaller interfering radiances from the aerosol layer for the H2O channel, as defined from a March/May aerosol extinction distribution that was held the same for the other seasons. Therefore, the amplitude of the LIMS H2O tape recorder signal is qualitative, at best. We are not as familiar with the accuracy of the amplitudes of the MLS signals, especially near 26 hPa where there is a discontinuity in its retrieved H2O profiles. Still, it is expected that both MLS and LIMS should be able to resolve a given profile of H2O equally well because they have similar vertical resolutions. Finally, differences for the MLS and LIMS tape recorder phases are likely not significant, if they vary by just 0.5 month.

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