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## ***Interactive comment on “Characterization of merged AIRS and MLS water vapor sensitivity through integration of averaging kernels and retrievals” by C. K. Liang et al.***

C. K. Liang et al.

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Comment 01: "P2839, Line 4: "...with a quality flag of "PGood." The total verticality (TV) and also possibly the local verticality (LV) will include layers above and below both PGood and PBEST. Can you comment on how your inclusion of layers for pressures greater than PGood or PBEST might affect the weighting of profiles as described in Section 3.2? Have you performed an analysis similar to the ones shown in Figures 2 and 3 where PgOOD is required to be greater than some threshold (e.g., MIN(750hPa,PsurfStd))?"

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## Response 01:

We appreciate the reviewer's comment, and realize that there could be some confusion for readers who are not very familiar with the AIRS quality flags. For this analysis, I only selected profiles where PGood = PSurf, so, the merging technique should not be affected. This is something I neglected to mention in the section 3.1, but have corrected by replacing "...with quality flag of "Pgood" to "...with quality flag of "Pgood=Psurf" where Psurf is the surface pressure". Also, in analysis not reported in the paper, I did the analysis with the quality flag PBest=PSurf and that yielded basically the same results because the differences between profiles with PGood=Psurf and PBest=Psurf really only impacts profiles down in the lower free troposphere or boundary layer. But, the overall yield is lower, thus we chose to use PGood=PSurf.

Comment 02: "P2858, Figure 6: As indicated in the manuscript text, AIRS sensitivity to water vapor falls off rapidly above  $\sim 250\text{hPa}$ . In Figure 6, there appears to be large a mismatch between the mode of the gray distributions (AIRS) and the mode of the black distributions (MLS) between 147hPa and 215hPa. This seems to indicate that there is a bias between AIRS and MLS profiles most probable values and in the joint distribution of the difference between the "joined" profile and the MLS profile. On P2847, the authors state that the differences between "joined" profiles and retrievals from either instrument are generally within expected uncertainties; however some more discussion regarding differences between raw retrievals would be appreciated. Can you comment on the magnitude of the biases between MLS and AIRS and how biases in profiles from either instrument may compromise the merging of profiles using the instrument dependent verticality? Also, the addition of curves showing the cumulative distribution functions might be better to gauge outlier rates."

## Response02:

The MLS has been shown to be drier ( $\sim 8\%$ ) than many other water vapor measurements (see Read et. al, JGR, 2007). The AIRS bias compared to other measurements

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is less well characterized, as the validation work, to date, had involved a very sparse set of radiosonde data. Divakarla et.al JGR, 2006 seems to indicate that AIRS is wetter (~10%) than RAOB measurements in the upper-troposphere (though this RAOB data only goes up to about 250 hPa). Given the averaging kernel characteristics, however, I would argue that AIRS would still continue to be wet between 147 hPa and 215 hPa since the kernels tend to peak below these pressure levels (where it's more moist) for these retrieval levels. AIRS is typically wetter than MLS at these levels as well; this is also indicated by the MLS mode (black) being consistently greater than the AIRS mode (grey) (Figure 6). The JOINED profiles, in effect, incorporates the biases from both instruments. At levels above 147 hPa the joined profile really just takes on the bias characteristics of MLS since the AIRS averaging kernels do not contribute much at these levels. So, if AIRS and MLS are typically wetter and drier respectively, then the JOINED profiles will effectively reduce the biases from both profiles from 147-215 hPa since the local verticality from MLS will serve to pull the JOINED profile away from AIRS (a drying effect) and the AIRS local verticality will serve to pull the JOINED profile away from MLS (a moistening effect). If there were sufficient high quality radiosondes within the vicinity of these joined profiles, one could contemplate future analysis to perform detailed characterization of the joined profile data with RAOBs measurements.

NOTE: the quoted "bias" values are statistical values that cannot be necessarily linked to any known systematic bias, so it is difficult to remove on a profile by profile basis. With regard to Figure 6—I have attached a cumulative distribution version of my initial figure. I believe I will change my Figure 6 to this one. Thank you very for the suggestion!

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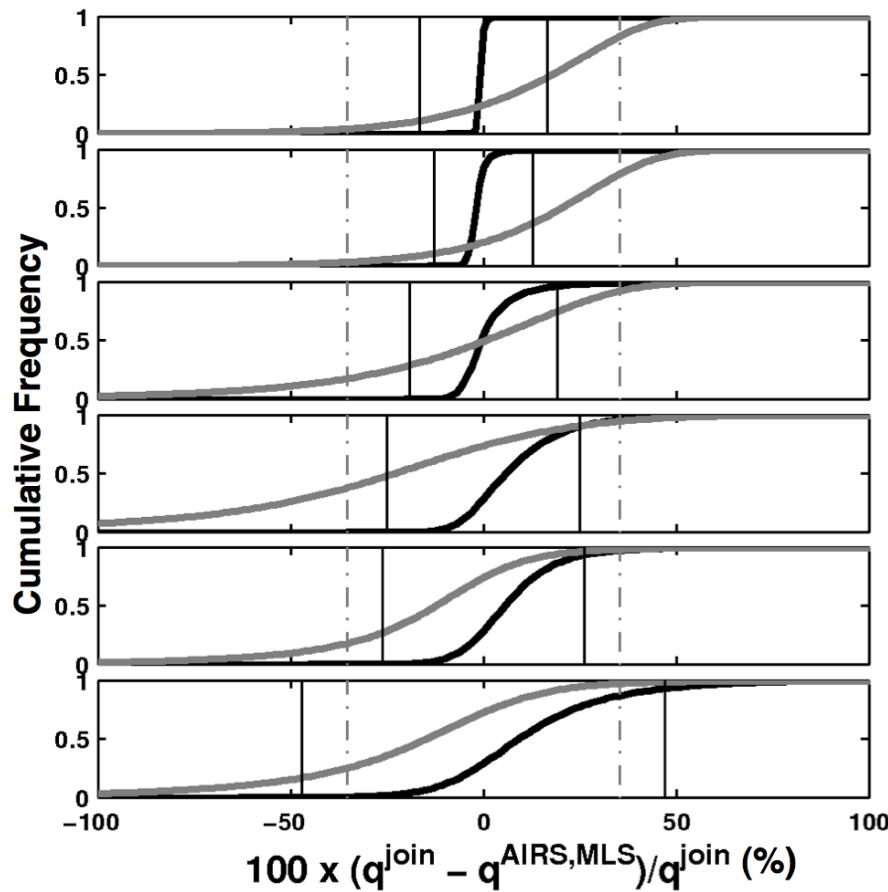
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**Fig. 1.** Cumulative distribution version of Figure 06