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Atmospheric Measurement Techniques Discussions

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.

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The paper describes a method for merging AIRS and MLS H2O profiles on a level-by-level basis using the 'sharpness' of the averaging kernel peaks to establish the relative weights assigned to the two measurements.

On a qualitative level, this sets the weights in a reasonable manner: at (tropospheric) pressure levels where the H2O content is higher, MLS is less sensitive and therefore has less well-defined AK peaks, while AIRS is more sensitive (assuming sufficient background temperature gradient) and therefore has better defined AK peaks.

However the problem with this method is the dependence of the AKs on the a priori

covariance in the two retrievals. If, for example, the AIRS data were retrieved with an a priori uncertainty considerably larger than that actually used, the averaging kernels would have sharper peaks and consequently more weight assigned to the AIRS measurement in the merge. However, the random error in the AIRS retrieval would then be increased and so the weight, compared to a constant MLS contribution, should in fact be lower. So while this AK method might describe the vertical structure of the weights reasonably well, it is not really based on using the correct diagnostic of the retrieval.

The correct method for setting the weights is to use the covariances of the two data sets or, in a level-by-level approach, just the variances. However it also has to be remembered that both AIRS and MLS measurements are themselves a weighted average of the satellite measurements and their assumed a priori estimates (both weighted, presumably correctly, by their respective covariancs, which is the principle of 'optimal estimation') and any robust method of merging the two datasets should also allow for these a priori influences. There is no mention in this paper of the covariance matrices of either the retrievals or their a priori estimates.

There is also the question of whether it is useful simply to merge AIRS and MLS profiles (a) on a relative error basis and (b) level-by-level.

Regarding (a) the AIRS data, having higher spatial resolution, would contain more accurate representation of the H2O fields in the troposphere even if less precisely retrieved than MLS.

As for (b) ideally, the weighting would be performed using the full covariance matrices rather than on a level-by-level basis. This would then allow the MLS data at high altitudes to resolve some of the vertical structure invisible to AIRS and should, in theory, lead to improved AIRS vertical resolution at altitudes below those seen by MLS.

Theoretical basis apart, a significant omission in this paper is does not explain the (non-trivial) process of how averaging kernels are remapped from the AIRS pressure grid to the MLS grid. At one point (L7, P2843) it says that AIRS profiles are simply

interpolated but there is also reference (L22, P2837) to the Maddy & Barnet paper where a more robust method is used (to convert radiosonde data to the AIRS grid).

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