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Atmospheric Measurement Techniques Discussions



# *Interactive comment on* "The impact of surface reflectance variability on total column differential absorption LiDAR measurements of atmospheric $CO_2$" *by* J. P. Lawrence et al.

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We are grateful to both referees for their comments. In order to address the comments raised by both referee's a substantial and substantive overhaul of the paper has been undertaken. The data has been completely reworked.

The main flaw identified in the original version of this paper by the referees' was the deficiency of the 500 m MODIS resolution data to represent the SWIR surface reflectance variability across the appropriating scaling of DIAL footprints.

In order to address this concern, new surface reflectance scaling factors for each sur-

face region have been instigated. The factors derived are the relative difference between the surface reflectance variability from the model perspective using MODIS data, and the variability from a spaceborne DIAL perspective using 30 m resolution Landsat data with overlapping footprint viewing geometry. During the orbit simulations these scaling factors are used on the MODIS variability calculations to obtain the correct surface reflectance variability across the footprint pairs. This approach provides the correct magnitude of the surface reflectance for a nadir pointing DIAL system owing to the use of the MODIS BRDF data, as well as the correct reflectance variability observed by the overlapping DIAL footprints through the application of the derived scaling factors.

A further approximation is applied to simulate the reduction of the surface footprint overlap from the Landsat resolution limit of 30 m to 10 m. This is done using two alternative methods. Firstly, a linear interpolation approach is used on the 30 m surface reflectance data to allow the simulated surface footprints to overlap by a third of a pixel (10 m) as opposed to a whole pixel (30 m) during the process of deriving the scaling factors. Secondly, a resolution reduction factor derived using data from a DIAL surface reflectance variability aircraft study by Amediek et al. (2009) is applied to the variability calculated from the MODIS data. Both approaches are in very good agreement creating scaling factors which vary by less than 5% between methods.

The reflectance variability study is now limited to areas of agriculture only. This limitation is set to avoid surfaces which contain significant amounts of shadowing in the Landsat data that could bias the derived surface reflectance data. The agricultural biome was chosen primarily because of its flat nature, but also because of its importance in the carbon cycle.

As compared to the initial submission the whole of the results and conclusion sections, as well as some additions to the methodology to incorporate the methods used to attain the scaling factors have been changed.



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Various aspects of the original paper have been removed owing to a referee noting that those particular pieces of information were not directly relevant to the study. The DIAL retrieval equation has also been corrected and the table of parameters has been simplified to contain only those which are relevant to the study.

The averaging procedure on the DIAL retrievals was noted by a referee as being important in any quantification of a retrieval bias and was not properly discussed in the original paper. The averaging approach adopted in the revised version of the paper is the calculation of the mean of the retrievals from the individual soundings and has now been mentioned in the paper with justification. An alternative approach of averaging using the received photons instead has also been considered and the consequences of this method on the retrievals and biases are discussed.

Please also note the supplement to this comment:
http://www.atmos-meas-tech-discuss.net/3/C1077/2010/amtd-3-C1077-2010-supplement.pdf

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Interactive comment on Atmos. Meas. Tech. Discuss., 3, 147, 2010.