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www.atmos-meas-tech-discuss.net/3/C41/2010/

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.

Anonymous Referee #2

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General comments:

The article reports a simulation work that aims to quantify the impact of the variability of the surface reflectance on the atmospheric CO2 retrieval error for a total column differential absorption lidar operating from space. Although the topic is highly relevant to operation of a TC-DIAL from space, the article presents major shortcomings which prevent it from being published.

It is agreed that a relevant parameter contributing to the retrieval error is the difference of the surface reflectances observed between two successive laser measurements. The presented analysis is based on surface reflectance variability obtained

from MODIS data at 500 m resolution, while the laser beam footprint parameter used in the simulation is 150 m.

As described in the article Amediek et al. quoted by the author, a careful analysis of the statistical properties of the surface reflectance can allow to upscale measurements performed at a smaller spatial resolution, to get knowledge about the variability for a specific geometry at a scale relevant to the operation of a TC-DIAL. However it is not understood how reflectance data averaged over 500mx500m areas can allow to access to information about the reflectance variability at a resolution smaller than 150 m, essential to model small spatial shifts of the order to 10 m between an on-line and an off-line laser footprints. There is no convincing discussion addressing this crucial issue to support the presented approach.

Detailed comments:

As understood from the article, a representation of the geometry is given in Figure 1, where the square area represents the MODIS pixel of 500 m resolution, the colour code represents values of the surface reflectance, the green spots represent the two consecutive lidar footprints of 160 m separated by the distance of 12 m. Each pair of pulses is separated by 700 m corresponding to the 10 Hz pulse repetition frequency and the typical velocity of low Earth orbit satellites.

The effect studied in the paper is the error produced by the change in the lidar reflectivity between two consecutive pulses separated by 12 m. It is obvious from the schematic representation that the MODIS resolution of 500 m does not provide the information required to study the effect of the overlap mismatch. By the very principle of a Differential Absorption Lidar measurement, the effect of the lack of overlap occurs only within one pair of pulses. The fact that the surface reflectance varies from one pair to the other pair does not play any role.

The authors claim that "These retrieval errors are defined as lower bound estimates owing to the likely resolution difference between the surface reflectance data and the

expected surface heterogeneity observed by a DIAL instrument." The relevance of the lower bound errors that the study aims to provide is not understood. While studying errors, the concern should rather be on upper bounds. Furthermore, due to the resolution difference between MODIS and a DIAL instrument, the calculated errors will not provide any insight into the real errors, and are expected to be clearly not representative, by a large and unknown amount.

The authors further claim that "On the scale of individual pulses, the lower resolution of the MODIS datasets will reduce variations owing to smaller scale objects, however the integration distance will aid in reducing the statistical impact of this effect". The fact that the overlap error is random, and is reduced by averaging, is well known. The overlap error is already underestimated by the method, the averaging will underestimate the effect of the overlap error even more, but this does not improve the method.

Finally, several other errors or inconsistencies were pointed out in previous comments that have not been answered in the new version. Among these comments, one important is the fact that the paper still suffer from a lack of definition of key parameters (e.g. the surface reflectance variability, the averaging strategy, the treatment of the surface reflectance variability of water from MODIS data).

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

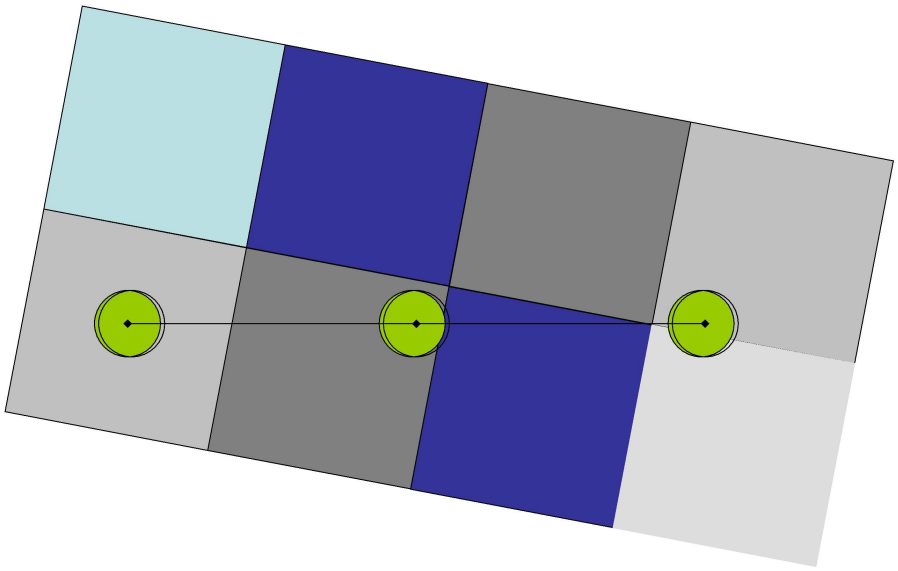

Fig. 1. Geometry on scale