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Atmospheric Measurement Techniques Discussions

Interactive comment on "Estimating bias in the OCO-2 retrieval algorithm caused by 3-D radiation scattering from unresolved boundary layer clouds" *by* A. Merrelli et al.

Anonymous Referee #1

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The paper by Merrelli et al. investigates how the assumption of a horizontally homogeneous atmosphere impacts retrievals of the column-average mole fraction of carbon dioxide (XCO2) from simulated observations of the Orbiting Carbon Observatory (OCO-2). A 3D radiative transfer model generates expected OCO-2 soundings assuming a small spherical cloud in the lower atmosphere that fills a fraction of the OCO-2 ground-pixel i.e. simulating a horizontally inhomogeneous scene. Then, the OCO-2 cloud-clearing and retrieval procedures are carried out relying on the horizontally homogeneous assumption. Various retrieval exercises examine the sensitivity of the OCO-2 retrievals on the position and geometric extent of the cloud.

Given that XCO2 soundings from OCO-2 are about to be delivered to the public, the paper is timely and relevant to the atmospheric gas retrieval and data user community.

The only concern I have is that the study is limited to (more or less) a single low-level cloud that fills a fraction of the OCO-2 footprint. To what extent are the conclusions of general value for XCO2 errors induced by 3D radiative transfer effects? How relevant are the error estimates for a global ensemble of OCO-2 soundings? I acknowledge that it would require a lot of effort to extend the study to a realistic ensemble of cloud optical and geometric properties, surface properties, and solar-viewing geometries. This is probably beyond the scope of the paper. Despite this limitation, the employed methods are robust and might prove a starting point for further investigations.

Therefore, I recommend publication after considering the mostly minor comments below.

Specific comments

Overall: In the view of my concern above, I recommend that the discussion covers some words on how relevant the findings presented are for the OCO mission. Biases found here are on the order of 0.5 ppm to 5 ppm which is in the significant range that could be detrimental to OCO's goals if the errors occurred regionally correlated.

p11548,l4 (and several other places): "plane parallel" While plane parallel is certainly a standard term describing the type of employed radiative transfer model, it is actually not really the plane-parallel assumption that is tested. It is rather the assumption of a horizontally homogeneous atmosphere. This should be mentioned at least once in manuscript.

p11554,l7: were > where

p11558,l22: There is also clouds with thicknesses 0.8 and 1.2km.

p11562,l13: "0.8 km" Is this the thickness of the cloud?

p11564,l9 and onward: In my opinion it would be better to not discuss both, albedo and relative errors in %. One is meant percentage points, the other real percentage. How about using fractions for albedo (throughout the paper)?

p11565,l22: remove "and"

p11565,section 5.2.4: Discussion should focus on the correlation of actually observed XCO2 and pressure biases, not on the calculated statistical covarince. The latter largely depends on what the state vector variables are. If these are really XCO2 and pressure (and not partial columns or similar) I wonder why the calculated covariance is small.

p11566, Fig.14: It would be interesting to see the a priori scattering parameters and to discuss how the retrievals deviate from the prior.

p11566,l22: ABO2 > ABP ?

Table 1: Pressure units missing.

Fig.3: What does reflectance mean exactly here? It does not seem to be the ratio of backscattered continuum radiance to solar irradiance.

Fig.4: Is the SZA=35 deg case illuminated from the opposite azimuth than the SZA=60 deg case or why is the shadowing to opposite sides?

Fig.14: soid > soil

Interactive comment on Atmos. Meas. Tech. Discuss., 7, 11547, 2014.