

Interactive
Comment

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.

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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?

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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 covariance. 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: soild > soil

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

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