Review of the paper "Estimating bias errors in the OCO-2 retrieval algorithm caused by 3D radiation scattering from unresolved boundary layer clouds" by Merrelli et al.

General comments

This paper uses the SHDOM 3D radiative transfer code to model the radiative effects of low altitude unresolved clouds upon the operational retrieval. The calculations determine that the existing cloud screening has difficulty identifying unresolved clouds that fill less than one half of the field of view. XCO2 biases (i.e. retrieved XCO2 – known values) are less than 1 ppmv when the albedo at 2.1 microns is high (e.g. over land surfaces), and up to 5 ppmv when the observations are for low albedos (e.g. over snow).

This study is very useful because it indicates how 3D cloud effects can unduly influence the operational retrieval, and also points to directions to which the cloud screening processes can be improved.

The paper is generally well written, concise, and should be published. Specific comments and Technical comments are suggested below to improve the readability of the paper.

Specific comments

Page 2, 1st paragraph section 2.1, line 124. It is now known that the OCO-2 polarizer is rotated parallel to the principal plane (i.e. 90° to the pre-launch design orientation) due to a fabrication error. It would be good to state the operational orientation, and note that this was a fabrication error. One page 9, line 883, change the I and Q math to reflect the post-launch reality.

Page 3, line 200. In regard to Figure 1, were SHDOM calculations carried out at all of the OCO-2 wavelengths (at high spectral resolution) or for a subset, followed by a mapping technique to assemble the 1016 point / band spectra? It is not clear that SHDOM is the individual radiative transfer model used at the 0.01 cm^{-1} resolution.

Page 4, line 287. Does the 30 second compute time refer to the operational OCO-2 computer at JPL, Colorado State University, or the University of Wisconsin? The compute time (if on a slower machine) could give a false impression of the operational setting. Please clarify (e.g. state that the runs were on the JPLOCO-2 operational computer).

Page 4, line 366. What is meant by "reduced" χ^2?

Page 5, line 418. Can SHDOM be run using an open boundary condition to avoid the wrap-around problem? If this is not the case, tell the reader that the periodic boundary condition is a specific feature of SHDOM.

Page 5, lines 435 - 436 and Figure 4. There is confusion between x-positions in Figure 4 and the SRF positions 0, 5,10, 15, and 20. A rephrasing "A total of 25 SRF centered positions are used. Positions 0, 5, 10, 15, and 20 (i.e. SRF centered positions at 0, .5, 1, 1.5 and 2.0 km for 100 m

grid cells) are shown in Figure 4" is suggested. In Figure 4, "SRF at positions 0, 5, 10, 15, and 20 (panels from left to right)" could also help avoid ambiguity.

Page 6, line 536-538. The sentence "so by comparing the clear sky bias at the same time, the 3D radiative transfer effect can be isolated" is not clear. The clear sky bias is compared to what? Which bias is referred to? Too much is said in too little words. Please expand the sentence and clarify.

Page 6, line 552. There are missing numbers in the phrase "The gap in observations around SRF position is due to the ABP" after the word "position".

Technical corrections

Line 159. Clarify "and the values" to "and the fluorescence variable values".

Table 1. The text on page 4 (line 277) states that prior and variances are listed in the Table, but I only see prior values. A rephrasing to "The assumed prior values (i.e. optical depths, pressure heights and thickness values) are listed in Table 1" is suggested.

Page 5, line 425. Typo "little extinction of the solar radiation".

Page 6, line 564. Change to "to compute an accurate X_{CO2} value for all cases in this scenario".

Page 7, line 662. There are missing words after "for" in the phrase "posterior covariance for the from the"

Figure 7 caption, last line. Change to "each boxplot is indicated at the bottom"

Figure 14 caption, third line. Typo. Change to "the soil surface albedo."