

Author's reply to Referee #2

We would like to thank the referee for helpful comments and suggestions. We will adapt all suggestions in the final version of the manuscript (amt-2018-353).

Point-to-point response to specific comments and suggestions:

Referee: P1,L6: "bug" -> (coding) error

Authors: We will replace "bug" by "coding error" throughout the manuscript.

Referee: P2,L12: It largely depends on surface albedo whether "too much aerosol" shortens or lengthens the lightpath. If surface albedo is high, multiple reflections between the surface and the aerosol layer are efficient and lengthen the path. I.e. the statement is not true in general.

Authors: We will add:

"Pathlength errors also largely depend on surface albedo. For example, if the surface albedo is high, multiple reflections between the surface and the aerosol layer are efficient and lengthen the path."

Referee: P2,L13,14: Similar to the previous comment, spectral variation of surface albedo is probably even more important than spectral variation of aerosol optical properties in changing the radiative transfer regime between the O2A and the CO2 bands. Plus, the third player is the difference in absorption optical thickness structure between the bands that induces different height sensitivities to "wrong aerosol" when retrieving gas columns.

Authors: We will add:

"The spectral variation of surface albedo and aerosol optical properties also change the radiative transfer between the A-band and CO₂ bands. For example, differences in the absorption optical thickness structure between the three bands induce band dependent height sensitivities to different types of aerosols in the retrieval."

Referee: P2,L20: I recommend mentioning that, while ACOS has surface pressure in its state vector, it is heavily constraint to the a priori (I presume).

Authors: We will mention that the surface pressure is substantially constrained by the surface pressure prior in the paragraph that discusses the elements of the ACOS state vector on P3, L15:

“The state vector includes, among other parameters, the surface pressure which is primarily derived from information retrieved from the O₂A-band (but substantially constrained by the surface pressure prior).”

Referee: P2,L31: we are hoping to achieve -> we need to achieve

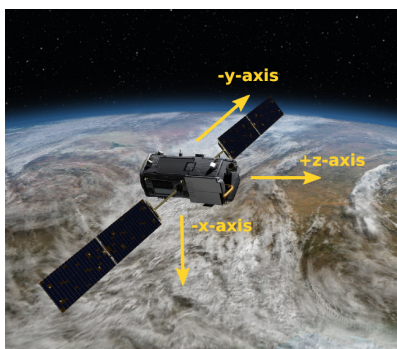
Authors: We will replace “we are hoping to achieve” by “we need to achieve”.

Referee: P4,L26: 0.7 -> 0.76

Authors: We will replace “0.7” by “0.76”.

Referee: P5,1st paragraph: A sketch would help.

Authors: We will add the following figure illustrating the orientation of the observatory:



Referee: P6,L15+: 1.8k -> 1.800, 1k -> 1.000

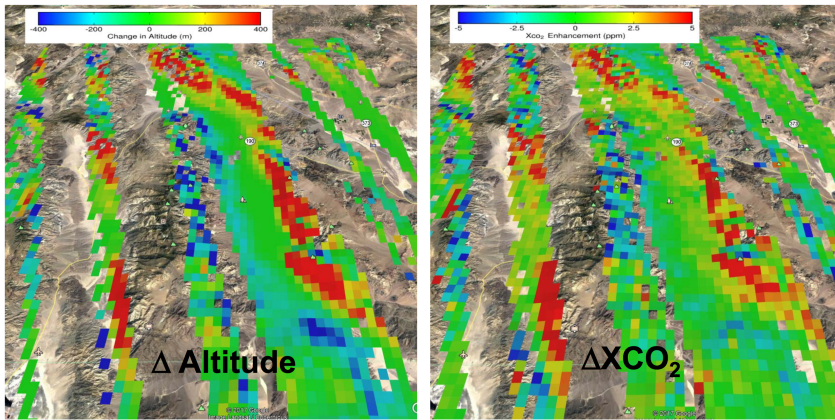
Authors: We will replace “1.8k” by “1.800” and “1k” by “1.000”.

Referee: Table 2: “K” -> “/1000” in the header or at least “k”

Authors: We will add “($\times 10^3$)” in the header of Table 2.

Referee: Figure 3: To me, the topography related bias is not really apparent in the figures. Would it make sense to plot the slopes instead of the altitudes in the left panels?

Authors: We will add figures similar to the one below that show the slopes in the analyzed areas (e.g. in the figure below for the Death Valley scene Δ altitude represents the change in altitude in northeast direction which correlates with the bias in XCO₂).



Referee: App1,L17: Taylor expansion -> Taylor expansion in c around $c=0$ (right?)

Authors: We will replace “Taylor expansion” by “Taylor expansion in c around $c=0$ ”.

Referee: App1, A7: So, strictly, the “ c ” in equ. (A7) is different from the “ c ” in equ. (A6).

Authors: Yes, we will add the following sentences and refer to Table 4 where the different bias correction coefficients are listed:

”Here, c represents the coefficient for the dP parameter in the parametric bias correction over land ... Note that the parametric bias correction coefficient c in Eq.(A6) and Eq.(A7) is different for land and ocean observations (see Tab. 4).”