Dear Chris,

We are very grateful for your comments and suggestions, which have helped to improve our manuscript significantly. We have revised the manuscript accordingly. In the following we respond to your two comments made on the second revision.

Sincerely,
Maximilian Rißmann and Jia Chen on behalf of all co-authors

Figure 3 Caption must describe the 0.02x0.02 degree gridding scheme that is used to present the OCO-2 data.

Thanks a lot for pointing this out. We adjusted the Figure caption accordingly.

Lines 154-158, regarding the AK Correction. "AK" in your equation (3) appears to be the 20x20 CO2 averaging kernel matrix, which is not available in the lite files. It appears you used the AK term for XCO2 (a vector, not a matrix, and which I typically call "a"), which if you did it that way is actually wrong. That this is a matrix is clearly stated in O'Dell et al. (2012) right after the equation is introduced. Rather than using the "C" profile quantities, you may wish to put the equation in XCO2 form for simplicity, and which does not require the full AK matrix. The proper AK equation in XCO2 form is as follows, and actually can be written three different ways:
XCO2_ak = Sum{i=1..nlev} h_i a_i u_mod,i + h_i (1-a_i) u_ap,i + [h_i u_mod,i – h_i, u_mod,i]
= XCO2_mod + Sum{i=1..nlev} h_i (1-a_i) (u_ap,i – u_mod,i)
= XCO2_ap + Sum{i=1..nlev} h_i a_i (u_mod,i – u_ap,i)
where "u" are profile co2 mole fractions, "ap" means the retrieve a priori, "mod" means model, "h" is the pressure weighting function vector, and "a" is the normalized averaging kernel vector for XCO2 (with values typically ranging from 0 – 1.5) . Both forms of the equation are easily derived from your equation (3), where "AK" from equation (3) is the full averaging kernel matrix (not vector!). "h" and "a" are both quantities available in the OCO-2 lite files. The middle form of the AK correction equation above shows that the correction only modifies the "pressure-weighted" XCO2 from the model if some levels have "a" significantly different than unity, and the apriori value is significantly different from the model value for those same levels. The third form of the equation was given in Connor et al. (2008, https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2006JD008336), as his equation (15).

Thanks for your comment regarding the Eq.3 and sorry for this misunderstanding. You are right, the lite file does not contain the 20 x 20 matrix, but rather the averaging kernel vector. In this study, we use the mean of these profiles over the target area around Munich to smooth the WRF modelled concentration profiles, which is shown in Fig.1 (on the next page). Next, we indeed follow the method presented in O Dell et al. (2012) to calculate the modelled AK-smoothed concentration $XCO_{2,ak}$:

$$XCO_{2,ak} = \sum_{i=1}^{n_{lev}} h_i[a_i u_{mod,i} + (1 - a_i)u_{ap,i}]$$

Here, a_i and h_i denote the AK value and pressure weight at the i^{th} model level, $u_{mod,i}$ and $u_{ap,i}$ represent the modelled and a-priori CO2 concentrations at the i^{th} model level.

We corrected Equation 3 in the manuscript to now be consistent with our method:

Eq. 3	$$XCO_{2,ak} = \sum_{i=1}^{n_{lev}} h_i[a_i u_{mod,i} + (1 - a_i)u_{ap,i}]$$

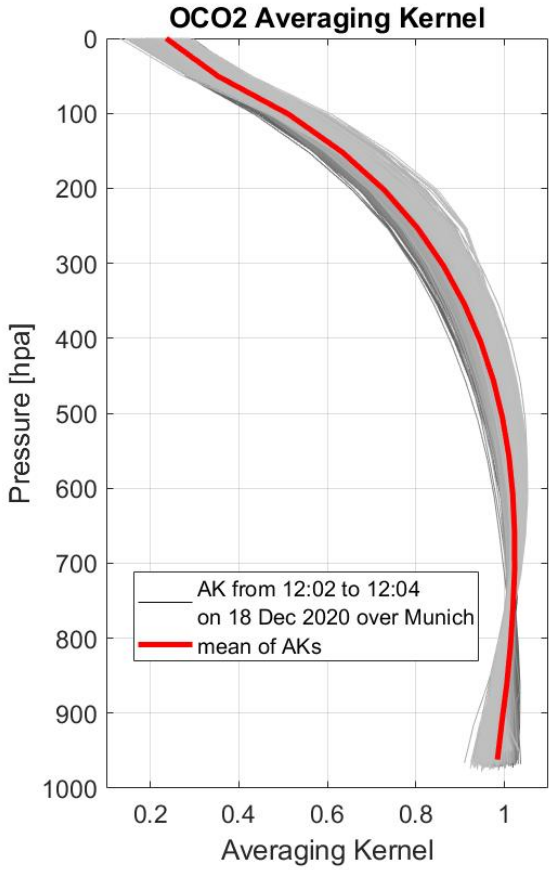

Figure 1. The AK profiles over the area of our interest around Munich (grey) and their mean used in the calculation of smoothing the modelled concentration (red).