

Interactive comment on “Improving the Retrieval of XCO₂ from Total Carbon Column Network Solar Spectra” by Joseph Mendonca et al.

Anonymous Referee #2

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This is a very nice and important paper. It should be published in AMT, I have only a few minor comments.

1. The paper is very theoretical. Line 92 starts with: to take speed dependence into account ... Here it would be nice to explain what is meant by speed dependence. It should be mentioned that the assumed basis for the Lorentz portion of the Voigt profile is, that for all collisions between the molecules the statistical average velocity is taken. However, in reality this is not true, the molecules have a distribution of speeds, which requires the qSDV.
2. The same holds for the Dicke narrowing, mentioned in line 59. What is the Dicke narrowing? It should be mentioned that when the mean free path of an atom is much smaller than the wavelength of the radiative transition, the atom changes velocity and

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direction many times during the emission or absorption of a photon. This causes an averaging over different Doppler states and results in an atomic linewidth that is narrower than the Doppler width (I have taken this from Wikipedia).

3. The O₂ concentration in the atmosphere is very stable and well known. I would be interested to see the difference between the known O₂ concentration and the O₂ from the TCCON spectra as a function of the SZA. These results are somehow hidden in the paper (Figure 6), but since the qSDV is applied to CO₂ and O₂ it would be good to see where the differences mentioned (0.004) are coming from, from CO₂ or O₂.

4. I found it a bit disappointing that the airmass dependence is now + 0.004 instead of - 0.013. This is a large reduction, but the results show that still something is wrong in the measurements/retrieval. The authors might discuss this in more detail. See above at 3.

5. For me the fact that the airmass dependence is nearly gone when applying qSDV (Figure 8) very important. This should be more highlighted as main result. Figure 8 c and d look very similar. For me an airmass correction is not necessary, or is this a mistake in the panels?

6. May be a Figure showing XCO₂/O₂ as a function of SZA for i) XCO₂/O₂, ii) XCO₂(sQDV)/O₂ ii) XCO₂/O₂(sQDV), iii) XCO₂ (qSDV)/O₂(qSDV) would be interesting to see where the improvement is coming from. For me a few other Figures of 1-5 could be deleted or put in the supplement.

7. The main part of the paper deals with the speed-dependent Voigt line shape. I would suggest to include this in the title, may by: Improving the Retrieval of XCO₂ from Total Carbon Column Network Solar Spectra by inclusion of the speed-dependent Voigt line shape.

6. In the conclusions the authors write: Using cavity ring-down spectra measured in the lab, we have shown that the Voigt line shape is insufficient to 290 model the line

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shape of O₂ for the 1.27 μm band, ... As far as I see, the improvement might also results because the qSDV is applied also the CO₂.

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