Atmospheric Measurement Techniques Discussions

Atmos. Meas. Tech. Discuss., referee comment RC2
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Comment on amt-2022-241

Anonymous Referee #2

Referee comment on "Exploring bias in the OCO-3 snapshot area mapping mode via geometry, surface, and aerosol effects" by Emily Bell et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2022-241-RC2, 2022

The paper by Bell et al. examines the causes of a scene specific bias (Swath Bias – SB) in OCO-3 measurements collected in Snapshot Area Mode (SAM), with implications for other observations such as the target modes of OCO-2 and OCO-3. Instead of resorting to statistical reasoning, the authors actually focus on a few scenes and try to understand the workings of the bias through simulations. I appreciate this approach since it requires mechanistic studies to make progress in terms of improving forward models (or at the very least bias correction schemes) which will ultimately lead to better data. The methods employed are rigorous and state-of-the-art, the paper is well written and it includes the relevant references to previous literature. Therefore, I recommend publication in AMT after considering the few, mostly minor comments below.

The ACOS retrieval uses the retrieved surface pressure to calculate XCO2. I am wondering how much trouble actually comes from the surface pressure retrieval (mostly informed by the O2A band) and how much from the actual CO2 retrieval. The large effect of the change in "dP correction" on the SB (section 7) fuels my concerns. Also, the fact that coarse aerosols (with a smooth spectral variation of optical properties between O2A and strong CO2 band) seem less problematic than fine aerosols (with a substantial spectral variation) could hint at particular difficulties in getting a "consistent scattering picture" from the O2A and CO2 bands. Would it be possible to separate the surface pressure related portion of the SB? How large is it – if it is large, why not use a priori surface pressure?

While I like the approach to concentrate on understanding individual scenes, I find the focus on one particular scene in Australia quite narrow. The scene is bright and surface reflectivity is probably spectrally smooth throughout the spectral range covered. This implies that the dominating scattering effect in all bands (somewhat depending on geometry) is light path enhancement due to (multiple) reflections between ground and aerosol layer. While the authors touch on the effect of surface albedo (Fig. 13), I would recommend examining in depth another, darker scene with substantial spectral variation in surface albedo (e.g. vegetation). For darker scenes, light path shortening due to direct

backscattering from the aerosol layer would be more important i.e. discussion of such a scene would cover an entirely different radiative transfer regime and thus, it could contribute mechanistic understanding.

L165f: I got quite a bit confused with the directions „across swath" and "along swath". I understand that a simple "across/along track" does not work because OCO-3 has a dedicated pointing system such that the scanning is not aligned with forward direction of the space station. Maybe the authors could consider to make a small sketch defining their notations or include the notation in one of the early figures.