Comment on essd-2022-59
Anonymous Referee #3


This manuscript describes a method to apply the CO2 Sounder Lidar for measuring XCO2 to cloud and aerosol observations, focusing on data processing algorithms and data quality evaluation methods. The main research findings of this manuscript will be particularly important for understanding the relation between XCO2 and aerosols. The method of data processing is well described and will likely become a cited example of how to undertake such tasks. I have commented on the manuscript with several minor corrections, which I believe will improve the readability of the manuscript.

1. The authors use "attenuated backscatter cross section" for the same meaning as "attenuated backscatter coefficient." Since the unit of $\beta_T^2$ is m$^{-1}$ sr$^{-1}$ (Equation 5), "cross section" may be misleading. In addition, some "attenuated" is omitted. In that case, it would also be misleading as it means the atmospheric backscatter coefficient $\beta$.

2. Lines 149-150. The authors are discussing the off-line signal using seven wavelengths except for the No.1 wavelength. You have to clarify why you did not use the No.1 with quite a weak absorption.

3. Figures 5 and 6. I do not understand the relationship between the XCO2 and attenuated backscatter coefficient profiles and the flight path. I suggest you add latitude and longitude to the x-axis of Figure 5.

5. Lines 307-309. If layers of clouds and aerosols are also broadened to 15 to 20 range bins for the same
reason, the effective range resolution of the lidar may not be 10 bins obtained with the data processing. Please include enough information such that an independent investigator would be able to repeat the experiments.

I suggest you add a line showing the boundary layer altitude in Figures 7 and 8 to help focus the reader for discussing this effect.

7. SNR evaluation of observation results
You have shown observation results of attenuated backscatter coefficients, XCO2 and surface reflectances. These results are sufficient evidence of the usefulness of the CO2 Sounder Lidar. Unfortunately, the discussion of the SNR is only based on assumptions but remains unconvincing. I suggest you discuss the SNR of clouds and/or smoke plumes using observation data.

8. Line 393.
No data about the detection of smoke plumes are presented in the manuscript hence there is no backing for this conclusion.