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Atmospheric Measurement Techniques
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Interactive comment on "Information content of OCO-2 oxygen A-band channels for retrieving marine liquid cloud properties" *by* Mark Richardson and Graeme L. Stephens

Anonymous Referee #4

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This paper analyzed the information content in O2 A band for retrieving marine liquid cloud properties. it used the Rodgers (2000) formal optimization framework and expressed the information content in terms of degree of freedom for signal and Shannon entropy. The O2 A band on OCO-2 has 800+ channels, and this paper shows that only ~75 channels are needed to retain all information content for retrieving cloud optical depth, cloud pressure thickness, and cloud-top pressure. The method in this paper is sound, but revisions are needed to include various advances in recent studies of using O2 A and B for cloud/aerosol height retrievals, as well as more justification about assumptions and caveats in this study.

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Discussion paper

1. Abstract. what is cloud-pressure thickness? what is the unit here?

2. Introduction. Most references cited in the first paragraph are theoretic work done in the past. While they are interesting, there are renewed interests in recent years to use O2 A and B band to retrieve cloud/aerosol height, with some using real data with good validations. They should be included in this paper, and discussion should be made that recent studies with real data use only O2 A/B bands from an imager (such as EPIC or MERES), although some studies did recommend the use of spectra to retrieve aerosol height. See references below and references therein (including some work done by authors' colleagues in JPL).

Ding, S. et al., 2016, Polarimetric remote sensing in O2 A and B bands: Sensitivity study and information content analysis for vertical profile of aerosols, Atmospheric Measurement Techniques, 9, 2077-2092.

Xu, X. et al., 2017, Passive remote sensing of altitude and optical depth of dust plumes using the oxygen A and B bands: First results from EPIC/DSCOVR at Lagrange-1 point, Geophys. Res. Lett., 44, 7544-7554.

3. Section 2. It should be made clear if cloud properties are well characterized, will CO2 be retrieved accurately in cloudy-sky conditions? If so, is it column CO2 above cloud top or whole atmospheric column, including CO2 within cloud? Any references will be helpful in this regard. To what degree of accuracy of cloud properties are needed in order to retrieve CO2 with good accuracy?

4. Section 2.1. It is noted that there are often aerosol layer above marine boundary layer cloud. To be clear, no aerosol effects are treated in L2RTM, correcT? How about surface reflectance?

section 2.2. what is the state vector? optical depth, top pressure/height? be clear here. This also applies to the title of this paper. what properties to be retrieved? droplet size, top pressure/height or optical depth?

5. Page 4, Line 25. Ding et al. (2016) used similar method to select channels needed in O2 A and B band for aerosol retrievals. It is worthy to mention here.

6. Page 5, L20. How about effective variance of cloud droplet size? Does it matter?

7. Page 6, L2. "A pressure scale height of 8 km is assumed to convert the resultant ....". This sentence is hard to comprehend.

8. Page 6, L27. mean of 12.6 um? should it be 12 um to be consistent with previously stated? How about effective variance?

9. Page 6, L29. cloud top pressure of 850 hpa? but, in the 3.1, it says three different pressures.

10. Page 8, L10. what is the priori for cloud top pressure here? what is the error in OCO-2 measurement itself?

11. P10, L7. Do these 75 channels have the same wavelenghts for all test cases?

12. P11, last sentence. what is proposed here is a strong statement. What is the basis to support that "assumptions made here don't affect primary conclusion" here?

13. Finally, it is not all that clear if measurement in O2 A with such a finer spectral resolution will be needed? In other words, using 75 channels vs. using just one channel (such as from EPIC, MERES or TROPOMI) for cloud retrievals, are there huge differences? Answering this question will greatly improve the impact of this paper.

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