

This paper presents a cloud retrieval algorithm utilizing a broader O₂-O₂ absorption bands between 435-495 nm, along with correction methods including de-stripping, offset correction for slant column density, and temperature corrections. It also incorporates auxiliary data, such as meteorological data and surface albedo climatology, in the retrievals. The effect of each improvement (except for the wider fitting spectral range) is analyzed using real measurements from TROPOMI and OMI, comparing the results with those from the classic OMCLDO2 algorithm. The TROPOMI and OMI retrievals align better using the proposed algorithm. NO₂ retrievals are also corrected using the proposed cloud results, OMCLDO2 cloud results, and cloud results from the FRESCO algorithm. The corrected NO₂ retrievals are then compared with one another. The theory is sound, and the analysis is thorough. I recommend the paper be accepted after minor revisions.

We thank Referee #1 for the comprehensive review. Responses to specific comments:

1. Section 3.3: Does the correction for across-track variability (de-stripping correction) affect the retrievals of cloud fraction? This seems not to be demonstrated in the section.

We have added a sentence in the revised manuscript:

“Additionally, this impact on cloud fraction retrieval is negligible.”

2. Section 3.4 introduces the offset correction for slant column density. However, much of the content describing the temperature correction seems to belong in Section 3.5.3. This overlap may cause confusion for the readers. Additionally, why is an offset of $-0.08 \times 10^{43} \text{ molec}^2 \text{ cm}^{-5}$ applied to the TROPOMI SCDs? This offset appears to be the corrected value intended for this section, but how this value is derived is not explained.

In section 3.4, we removed the sentence “Since the O₂-O₂ SCD retrieval uses an absorption cross-section at a fixed temperature, this factor aligns the retrieved and modeled O₂-O₂ absorption, compensating for the variation of O₂-O₂ absorption due to temperature changes.” As it is repeated in section 3.5.3

Additionally, we have added:

”This offset corresponds to the difference in the mean O₂-O₂ SCD values between OMI and TROPOMI for scenes with cloud fractions between 0 and 0.05 over the two study regions.”

3. Is radiometric cloud fraction the same as effective cloud fraction? The two terms are used interchangeably, but the relationship between them is not clarified in the paper.

Yes, the radiometric cloud fraction and effective cloud fraction refer to the same quantity in this study. To avoid confusion, we have revised the manuscript to use the term effective cloud fraction consistently throughout

4. 545 “We”-> “we”

Corrected.