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Atmospheric Measurement Techniques Discussions

Interactive comment on "Effects of clouds on the UV Absorbing Aerosol Index from TROPOMI" *by* Maurits L. Kooreman et al.

Anonymous Referee #2

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General Comments:

This study investigates the cloud effects on the AAI with three models: the traditional Lambertian Scene Model (LSM), and two cloud models (i.e., Lambertian Cloud Model (LCM) and Scattering Cloud Model (SCM)) of IPA assumption, primarily at large scales by aggregating TROPOMI data over the Pacific Ocean where absorbing aerosol effect is essentially negligible. Sensitivity studies of the cloud height and surface albedo with a series of scenarios are also conducted through RT simulations.

Strength: this paper presents the first systematic investigations of the cloud effects on the AAI using TROPOMI data of unprecedented high spatial footprints in UV by making comparison of the performance from three models (LCM, SCM, and LSM).

Weakness: results are inconclusive due primarily to the instrumental degradation and calibration issue in current L-1b data. It is difficult to evaluate the performance of the three models with measured radiances of a calibration problem. This limit of the study will be repeatedly pointed out in specific comments below, even though it is beyond the scope of this study. As stated in conclusions, extra future works still remain for improving the operational TROPOMI AAI product including the surface effects.

Overall, this paper is well written and provides useful information of the cloud effects on the AAI for aerosol community. It is appropriate for publication with minor revisions.

Specific Comments:

1. Page 1, lines 18 -19: I have not seen any comparison result of the performance of AAI in terms of footprints sizes (e.g., fine TROPOMI vs. coarse Suomi NPP/OMPS) in this paper. The authors need to discuss such topics in discussion or future plan before stating in abstract.

2. Page 3. Line 77: describe "qa_value" scheme how to derive this quantity.

3. Page 4, Figures 1 and 2: provide regional information of the maps (both longitudes and latitudes ranges) and TROPOMI orbital number.

4. Page 5, lines 120 -125: mostly negative AAI values imply that instrumental effects (not only time dependent degradation but also absolute calibration at 340 and 380nm) appear to be far larger than cloud effects.

5. Page 10-11. Section 3.2 describes the physical principles and interpretation of the Lambertian surface model-based AAI in terms of BRDF concept. In reality, surface BRDF behavior and its effect on the AAI can be far more complex than a simple interpretation of the diffuse to direct light ratio and difficult to say the signs of AAI. Reconsider the change of the title of section 3.2 since it did not show any real surface BRDF effect on the AAI.

6. Page 21, line 410: sun glint features are due to the Fresnel reflection over the ocean

surface under clear sky condition.

7. Page 21, all plots in Figure 12 show large negative AAI values (except sun glints) and a strong cross-track dependence regardless of regions and models, which is not consistent with the results in Torres et al (2018). As stated in many places of this paper (page 2, lines 33-34; page 5, lines 117-119; page 26, lines 477-479), an optimal AAI retrieval would mean that clouds give a neutral AAI, i.e., close to or equal to zero, especially from the statistics of averaging many orbits in this study. The results here indicate that the instrumental effect appears to be far larger than the improvements to forward modeling with cloud models.

8. Page 23, Figure 14, difficult to read legends and labels. Other figures also need to be improved with increased font size and legends.

9. Page 24, Figure 15 shows mostly negative AAI values due to a calibration problem.

10. Page 26, line 463: never shown any real BRDF results.

11. Page 26, lines 473-474: difficult to conclude it because of the instrumental degradation and calibration issue.

12. Page 28, lines 528-536: I disagree. This is not a “subjective” or “preferential” choice issue but a scientific issue. The current TROPOMI AAI product should be further investigated and improved with more effective physical models for absorbing aerosol studies by minimizing other effects such as clouds, surface, and instrument.

13. Page 28, line 540. Other sensors (e.g., Suomi NPP/OMPS-NM AAI and DSCOVR-EPIC AAI) are also capable of detecting such huge smoke plumes at large scales. Clarify an unprecedented “sensitivity” of TROPOMI.

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