Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2019-204-RC1, 2019

Atmospheric Measurement Techniques Discussions

Interactive comment on "A MAX-DOAS aerosol profile retrieval algorithm for high altitude measurements: application to measurements at Schneefernerhaus (UFS), Germany" *by* Zhuoru Wang et al.

Anonymous Referee #1

Received and published: 4 September 2019

The manuscript entitled "A MAX-DOAS aerosol profile retrieval algorithm for high altitude measurements: application to measurements at Schneefernerhaus (UFS), Germany" by Wang et al. presented a new look-up table based aerosol extinction profile retrieval algorithm for MAX-DOAS observations at Schneefernerhaus (UFS), Germany. Details of the parameterization of the look-up table, retrieval procedure and error analysis are presented. In addition, the authors also investigated the sensitivity of different input parameters to the retrieval results. The new retrieval technique is applied to synthetic data for validation. The long term observations of aerosol optical depth are also

Printer-friendly version

Discussion paper

validated by comparing to sun-photometer measurements. The validated MAX-DOAS measurements are then used to investigate the temporal variation of aerosol at UFS. The manuscript is in general well organized and scientifically interesting for the community. Therefore, I recommend publishing the manuscript after addressed the following comments.

Sect.1 para 2: the authors summarize the main methodologies for aerosol monitoring, however, these mentioned AERONET, Lidar and MAX-DOAS are very different in the measured parameters, detection range, etc. I suggest the authors could introduce a little bit about the measured aerosol parameters of these methods, and their advantages and disadvantages for aerosol monitoring.

Sect. 2.2: the sun-photometer measured AOD were interpolated to obtain the AOD at 360 nm and 477 nm. Which kind of the interpolate method? Linear or non-linear? Any large difference due to different interpolate method? Why only time period between 10:00-14:00 UTC and stable aerosol abundance were considered? What does the intensity means in P.5 L.2? The aerosol optical properties required for MAX-DOAS inversion were collected from the AERONET site at Hohenpeißenberg. It is located at an altitude of 980 m and approximately 43 km north of the UFS. As the authors introduced, the aerosol vary strongly with time and location. How to estimate the uncertainties on the retrieved results due to the difference of aerosol optical properties between Hohenpeißenberg and UFS site?

Sect. 3.1: How the DOAS fit windows were determined? Are they based on sensitivity analysis? Please clarify. How about the performance of spectral analysis? The levels of RMS and SCD errors? Any filtering for O4 DSCDs was applied before being introduced to the retrieval scheme? Please add a reference to QDOAS: http://uv-vis.aeronomie.be/software/QDOAS/

Sect. 3.3: How did the authors obtain the topography? And how did the authors distinguish snow or rock and vegetation? Is it taken from a digital elevation map (DEM)

and albedo map? Please clarify. How to define the pseudo-reality topography using TRACY-2? What's kind of the parameters were included in the pseudo-reality topography? It would be useful to compare radiative transfer simulation results from the two radiative transfer models with the same setting to quantify the differences between the two models.

Sect. 3.5: It is difficult to understand the parameterization of aerosol extinction coefficient in Table 3. Please clarify. I also think the vertical resolution of retrieval is very coarse in the design of the look-up table, in particularly compared with other ground-based MAX-DOAS studies. Btw, there only one sub-section of 3.5, I do not suggest to use the title of 3.5.1.

Sect. 3.6: What's the DOAS fitting error? How to evaluate it? There are so many sub-titles. In my opinion, 3.6.1 and 3.6.2 can be grouped as the errors on measured O4 DSCDs, while 3.6.3-3.6.6 can be regarded as the errors on simulated O4 DSCDs. So I suggest to re-organized this part.

Sect. 4.4, p. 26, l. 5-6: Any explanation about the seasonal pattern of AOD that higher in summer and lower in winter? Also the systematic underestimation of MAX-DOAS AOD? Could the authors can present the co-located ceilometer observations or lidar measurements nearby to certificate the vertical structure of aerosol extinction? Please also discuss the possible reason for the high ratio of aerosol extinction coefficient between 360 and 477 nm in summer than in the other seasons.

Sect. 5: The conclusion is mostly repeating the results, please consider shorten the entire summary and conclusion section.

Minor comments: p. 6, l. 2-3: Did the authors observe any seasonal pattern of cloud cover? It might be important for the later analysis of aerosol temporal variation.

p. 7, l. 6: Which radiative transfer model the authors are referring to? Please clarify.

p. 9, l. 11: Please define all the terms in the equation.

p. 13, l. 10: I don't understand why should the surface albedo error dependent on aerosol profile?

p. 14, l. 9-13: If the authors already consider the error caused by aerosol above the retrieval height, then why the error bar of Fig. 9 still do not overlap with the sun-photometer observations most of the time?

p. 17, l. 4-10: Radiative transfer model error also play a role in the discrepancy between measurement and simulation. Please revise the statement. The elevation dependent O4 scaling factor also introduced in other studies, e.g. Irie et al., 2015; Zhang et al., 2019. Please review and cite.

p. 25, fig. 9: The error bars do not overlap with the sun-photometer measurements most of the time indicated that there are some significant error sources are not consider in the error analysis. Please clarify.

p. 27, fig. 11: As mentioned before, cloud screening also play a role in the analysis, it is important to indicate the number of valid measurement used in the calculation.

Reference: Irie, H., Nakayama, T., Shimizu, A., Yamazaki, A., Nagai, T., Uchiyama, A., Zaizen, Y., Kagamitani, S., Matsumi, Y., 2015. Evaluation of MAX-DOAS aerosol retrievals by coincident observations using crds, lidar, and sky radiometer intsukuba, Japan. Atmospheric Measurement Techniques 8, 1013–1054.

Zhang, J., Wang, S., Guo, Y., Zhang, R., Qin, X., Huang, K., Wang, D., Fu, Q., Wang, J., and Zhou, B.: Aerosol vertical profile retrieved from ground-based MAX-DOAS observation and characteristic distribution during wintertime in Shanghai, China, Atmos. Environ., 192, 193–205, 2018.

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2019-204, 2019.