Atmospheric Measurement Techniques Discussions

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Comment on amt-2020-492

Anonymous Referee #1

Referee comment on "Evaluation of UV–visible MAX-DOAS aerosol profiling products by comparison with ceilometer, sun photometer, and in situ observations in Vienna, Austria" by Stefan F. Schreier et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2020-492-RC1, 2021

GENERAL COMMENTS

The authors have applied the BOREAS retrieval algorithm to obtain vertical profiles of aerosol extinction for a substantial data set of two different MAX-DOAS instruments in the Vienna area. They assessed the quality of these retrievals by comparing the profiles, the integrated AOD and the near-surface values with extinction profiles derived from a ceilometer, AERONET measurements and PM10 measurements respectively. The data set was large enough to be able to differentiate between the seasons. In addition they demonstrate that the two MAXDOAS instruments can be used to study the spatial variability of NO2 and aerosol over Vienna.

The paper is very well structured and clearly written. This is the first assessment of the BOREAS aerosol retrieval method with a large dataset (two instruments, and almost two years of data), and with multiple colocated comparison instruments, making it an important study.

What is missing is a discussion of the issues of this particular retrieval method found in earlier studies (Boesch et al, 2018, Tirpitz et al, 2021, Friess et al, 2019): are these issues solved, can they be confirmed or disproven?

I am disappointed about the sole use of linear correlation coefficients to determine the quality of the retrievals, see specific comments below.

SPECIFIC COMMENTS

The use of a linear correlation coefficient to compare vertical profiles is not obvious to me. Correlation coefficients are typically used to assess a possible linear relationship between two datasets. Do we expect a linear relationship? And if so, between what and what? It is unclear how the corellation coefficient for vertical profiles is defined in this paper. Is it defined with respect to the average profile? And are relative or absolute differences used? Do all altitudes have equal weight in this definition? Please clarify how to interpret the correlation coefficient for vertical profiles.

A more common, and more informative way to compare profiles is to look at the absolute and relative difference profiles, and quantify the differences for certain altitude ranges. Please add this to your study.

Please clarify the differences in sensitivity and averaging kernels between the BOREAS retrievals on one hand and the ceilometer retrievals on the other hand, and whether these differences are expected to influence the comparison.

It is interesting to see that the observed average profiles often show an increase towards the lowest point, both for MAXDOAS and for Ceilometer (e.g. Fig. 2, fall, 10-16UTC, spring 8-14 UTC, and even summer 8-16 UTC). Please check if there is not an intrinsic different treatment for the lowest altitude (e.g. other vertical extent, or different interpolation). If not, can you elaborate on the possible reason why this is so often seen?

Several average MAXDOAS profiles in Figure 3 (visible) show elevated aerosol between approximately 2 and 3 km altitude, while this is not seen in the ceilometer profiles. In Figure 2 (UV) this is much less pronounced. Please give an explanation, and also how this effects the observed differences.

The regression coefficients printed in Figures 2-6 have the wrong number of significant digits. The offsets have too many, and the slopes too few. Please use the number of significant digits that is justified by the uncertainty of the coefficients. Also do not print '+-', but rather '-'.

Figures 7 and 8 are very difficult to assess. I recommend adding a more map-like display. For example a figure with four subpanels for NO2, AOD, and the near-surface values, where each subpanel represents the spatial area considered and the values from fig 7 and 8 can be shown as colored bars (or parts of a circle) in the respective viewing directions, where the length of the stripe is somewhat representative for the area observed by the MAXDOAS.The use of

p2, l19: "widely documented": please give references here

p6, l11: An elevation of 0 degree with a FOV of more than 0 will result in a vegetation signal. Is this measurement used in the retrieval?

section 2.2.1:
- second step to 'pre-select': what are the pre-selection criteria?
- third step: this is very complex; please add a figure illustrating the procedure.
- please explain what you mean by 'second-order difference'

p10, l8: How large is the effect of using measured p,T-profiles instead of US standard profiles?

Section 2.2.3: the profiles are scaled by the AOD: do you mean that the profiles are scaled so that the AOD derived from the profile matches the AERONET AOD at a specific wavelength? It is not clear to me why you need the intermediate step at 910nm

Section 3.1 Only sucessful retrievals are evaluated here, which makes sense. However, it is also interesting to know how often the retrieval does not succeed (does not match the criteria). Please give numbers.

p13, l15: I don't fully agree with this assessment. It seems that the visible retrieval tends to result in higher aerosol levels at higher altitudes, which might be the reason for the worse correlation.

TECHNICAL CORRECTIONS

p2, l1: "Hile high correlation" should probably be "High correlation"?

p8, l11: "sza is taken from retrieved maxdoas data" is better changed to " sza is taken at the time of the maxdoas measurement"

p9, l29: is SCRIATRAN implemented in BOREAS or BOREAS in SCIATRAN?

p12,l27: intervalls -> intervals

p14, l12-17: this sentence is too long, please split in two or three sentences.