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Atmospheric Measurement Techniques
Discussions

Interactive comment on "Retrieval and evaluation of tropospheric aerosol extinction profiles using MAX-DOAS measurements over Athens, Greece" *by* Myrto Gratsea et al.

Anonymous Referee #2

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The study "Retrieval and evaluation of tropospheric aerosol extinction profiles using MAX-DOAS measurements over Athens, Greece" presents aerosol profiles resulting from an inversion of MAX-DOAS measurements with the BOREAS algorithm. It generally matches the scope of AMT. However, there are major shortcomings in the methodology which require major clarifications, additional RTM calculations, and extended discussions. The manuscript should thus not be accepted for AMT unless major extensions and revisions are made. Thus, the current review only focusses on the retrieval part, as the presented results are likely going to change.

Retrieval shortcomings

1. Observation geometry

MAX-DOAS profile retrievals have been developed and refined in the last years and have been shown to yield valuable information on trace gas and aerosol profiles. However, the assumptions made in BOREAS (as well as other inversion schemes) put a MAX-DOAS instrument at the ground within flat terrain.

The situation in Athens seems to be quite different: the instrument is located at a hillside at ∼500m altitude. SCDs at negative and zero elevation angles have been measured, but are not included in the analysis. So I wonder how the near-surface extinction in Athens could be derived from an instrument on a hill looking upwards!? This aspect is not really explained and discussed quantitatively in the current manuscript.

I am not aware of a MAX-DOAS publication with similar viewing geometry. As the current study seems to be the first, it could be pioneering in this aspect. But it has to provide far more details, discussion and RTM calculations in order to interprete the resulting BOREAS profiles:

- what is the exact setup for the BOREAS retrieval? I assume the instrument was set to station altitude. But where is the surface in RTM calculations? At station level as well? At sea level? I assume that simulating 3D terrain is not easily possible, but the potential impact of terrain should at least be discussed.

- how large is the MAX-DOAS sensitivity for aerosols below station height? Fig. 5 indicates high sensitivity to altitudes below station level, but I really wonder where this should be coming from as the instrument is only looking upwards.

- what is the meaning of the aerosol contour plots down to sea level, and where is the information coming from?

- how has the AOD derived by BOAS to be interpreted? Is it really the full AOD for the city of Athens (where the MAX-DOAS is pointing at), or just the fractional AOD from station altitude upwards?

- from the contour plot, I would conclude that the largest fraction of the extinction profile is below 500 m. This could also be expected for urban pollution accumulating in a valley. But in order to interprete these results and the contour plots, it is essential to give evidence (by RTM calculations) that aerosol profiles can be actually derived down to the ground from an elevated intrument looking upwards. If the extinction below station altitude cannot be trusted, however, it should be discarded from Fig. 4. In this case, the comparisons should also only consider the fractional AOD from station altitude upwards. The case studies would than have to be revised completely.

2. Standard atmosphere

The profiles used for T and p affect the O4 VCD, which affects the aerosol profile inversion. Using a standard atmosphere is thus not appropriate. I recommend to repeat the analysis with more realistic T/p profiles for Athens. At least, the authors have to quantify the effect of using a standard atmosphere for winter vs. summer.

Minor comments:

Eq. 1: It might be worth mentioning that SCD_alpha is actually rather SCD_alpha-SCD_90 as well, as the zenith SCD has been used as reference in the DOAS analysis.

Page 8, line 234 and line 237: This information should already be given in section 2.2.1.

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