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Atmospheric Measurement Techniques Discussions

Interactive comment on "BOREAS – a new MAX-DOAS profile retrieval algorithm for aerosols and trace gases" *by* Tim Bösch et al.

Anonymous Referee #3

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General comments In this paper, Tim Bösch et al. presented a new MAX-DOAS profile inversion algorithm, named as BOREAS. As the author noted, the algorithm could be the first one which retrieve profiles based on optical depths of absorbers. The algorithm is well verified through sensitivity tests with synthetic data and comparisons with various collocated independent data during the CINDI-2 campaign. In general the scientific topic is meaningful. However I think the authors should clarify two major points before publication: 1) The unique feature of the BOREAS algorithm is doing inversion based on optical depths of absorbers. The approach allows including DSOT at different wavelengths in a profile inversion. However the authors do not discuss the improvement of doing inversion with optical depths compared to with slant column densities. If there is no a considerable improvement, innovativeness of the algorithm

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Discussion paper

is doubtable. 2) In section 4, the author demonstrates that profile inversion can be improved if a priori shape is used to scale a pre-calculated AOT and VCD. However the improvement only works when a priori profile is similar with the true atmospheric profile. How do we know whether or not the a-priori shape is close to the real atmospheric profile for real measurements? If a wrong priori shape is assumed, does the method even cause larger deviations of retrieved profiles and AOT from the truth?

Specific Comments: 1) In section 3, the authors do not clarify that how the algorithm deals with negative values which could be retrieved. 2) Line 10 on page 11: aerosols can impact the sensitivities of MAX-DOAS measurements to trace gas profiles, especially at high altitudes. The optimal settings of inversion parameters could depend on aerosols. Therefore sensitivity tests should also be done under typical aerosol conditions, especially a heavy aerosol load. 3) Figure 4 (left): It is hard to identify which color curves are corresponding to individual true profiles. Please try to mark them. 4) Section 4.2: The author claim that total error of aerosol and trace gas profile inversion contains the three parts. However the level of converge, namely differences of modelled and measured SOT, could also contribute some errors. The converge level also depends on the maximum number of iterations. 5) Why is the smoothing error smaller at altitudes > 2km than that near the surface? We can expect higher uncertainties at high altitudes because MAX-DOAS profile inversion is not sensitive to high latitudes well. 6) Line 5 on page 22: The definition of a-priori variance actually increase constraint of a-priori in the inversion at high altitudes. Do you follow the same definition in the synthetic test? The definition could impact the conclusions of discussions on the optimal settings of Tikhonov, a-priori shape scaling. In addition the definition could also cause that the inversion can not retrieve lifted layers of aerosols and trace gases well. Actually the problem can be seen in Fig. 16 and Fig. 19.

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