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Atmospheric Measurement Techniques Discussions

Interactive comment on "Potential and limitations of the MAX-DOAS method to retrieve the vertical distribution of tropospheric nitrogen dioxide" *by* T. Vlemmix et al.

Anonymous Referee #4

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General comments:

In general, the paper "Potential and limitations of the MAX-DOAS method to retrieve the vertical distribution of tropospheric nitrogen dioxide" by Vlemmix et al., is well written with the appropriate presentation of scientific goals, methods and results. It addresses an important topic of NO2 profile retrieval from the MAX-DOAS technique. Theoretical sensitivity studies are shown along with the application to actual measurements during CINDI NO2 campaign in 2009. MAX-DOAS NO2 retrievals are compared to point measurements, LIDAR and radiosonde results. I believe the paper meets the scope of

AMT and should be published with some modifications. In my opinion, the title of the paper does not reflect the study presented. The authors do not investigate the MAX-DOAS method potential and limitations for profile retrieval in general but rather the 2 and 1 layer profile parameterized inversion technique.

Specific comments:

p. 4018 / 16: not clear what “extended model version” is.

p. 4020 / 1: polynomial orders used 2 – 5.

p. 4020 / 5: please specify instrument spectral resolution and sampling.

p. 4020 / 6: replace the reference to QDOAS manual with the updated manual info: http://uv-vis.aeronomie.be/software/QDOAS/.

p. 4020 / 9: please specify which version and temperature of Hermans abs. cross section you used.

p. 4020 / 26: I agree with the authors that the DOAS fit error does not represent the true measurement accuracy. However, I do not think that RMS of the measurements relative to one hour average is appropriate either. As authors point out NO2 volume mixing ratios (vmr) can change on a small time scale (minutes) depending on the emission rates, transport etc. In case of changing NO2 vmr the main source of this variability is not DOAS measurement accuracy. I would recommend, in addition to DOAS fit errors, to account for abs. cross section accuracy and uncertainty due temperature dependence of the NO2 cross section used in DOAS fit.

p. 4022 / 12: please specify the initial guess values for each parameter retrieved by the inversion.

p. 4022 / 9, 10: choice of the upper layer height (3.5 km) and extent (0.5 km) seems rather random and unrealistic.

p. 4023 /3: this paragraph states that there is no height sensitivity above 2 km (for

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low AOD), logically it is not clear why you proceed with the inversion algorithm that considers the second layer above 2 km. I would recommend re-parameterizing your inversion model to include 2 layers, where height, extent and abundance of both layers are retrieved (or derived from the retrieval) to make the model more realistic.

p. 4024 / 8: Please give more details about DAK. Please specify what layer height grid is used in the forward model, which NO2 and O3, aerosol stratospheric profiles are used. Do you consider NO2 and O3 cross section temperature dependence (with altitude) in the forward model calculations?

p. 4025 / 21 please include standard deviation for SSA and asymmetry parameter from AERONET (2007 - 2009). Is there a seasonal dependence of these properties?

p. 4026 / 1: Temperature correction coefficients derived in this section scientifically make sense, however, it is not clear if they are improving the retrieval or not. The effective temperature is calculated for the two layers only based on the "scaled" US standard atmosphere profile by the surface T measurements. The actual atmosphere might be "off" by a few degrees. In addition, the elevated (even erroneously retrieved) NO2 layer will decrease Teff. Error in the AMF in aerosol retrieval step is also non-zero. Differential NO2 abs cross section has temperature dependence as a function of wavelength. This will produce slightly different results depending on which (several) local minima and maxima are used for diff. cross section calculation.

p. 4034 / 25: please explain why an elevated layer of 0.1 km extent and 0.2 AOD was chosen.

p. 4038 / 10: please list the selected days and criteria used for selection.

p. 4039 / 8: why AERONET level 1.5 instead of 2 is used? Cloud screening is important for both AERONET and MAX-DOAS measurements.

p. 4039 / 19: In addition to uncertainties due to aerosol forward scattering, external stray light at small relative azimuth angles might contribute to large differences between

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the AERONET and MAX-DOAS AODs.

p. 4040 / 7: please rephrase. The effect of clouds on radiance depends on the cloud optical depth.

p. 4040 / 29: please rephrase “strong confirmation”. NO2 radiosonde method presented in Sluis et al. (2010) is not an established technique.

Figures 8, 9 11 and 12 are too small.

Interactive comment on Atmos. Meas. Tech. Discuss., 4, 4013, 2011.