

Interactive comment on “Eight-component retrievals from ground-based MAX-DOAS observations” by H. Irie et al.

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We thank the reviewer very much for reading our paper carefully and giving us valuable comments. Detailed responses to the comments are given below.

Major comments:

Comment 1: Authors claim that they have attempted to retrieve vertical profile information for 8 components. However, the paper reports only average concentration values near the surface with crude vertical resolution of 1 km. Figure 2 shows that concentrations of trace gases except ozone are all zero > a few km height. It would be very nice if profile information with finer vertical resolution near the surface where trace gases are concentrated is given by the authors' retrieval algorithm.

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Reply: We are also interested in retrieving more vertical profile information than the average value of the 0–1 km altitude layer. However, the degree of freedom for signal for profiles retrieved here was usually only 1–2. Under these circumstances, we have decided to start with focusing on the 0–1 km layer, for which the retrieved quantities are likely to be much more reliable than at higher altitudes, as the light path in the 0–1 km layer is usually much longer. However, we have revised the introduction section to state "We show that MAX-DOAS can reasonably retrieve 8 components: ... for the layer 0–1 km, which corresponds to the lowest layer in profiles retrieved with JM1, where the highest sensitivity is usually expected owing to the longest light path," in order to assist readers' understanding. Retrieval with a finer vertical resolution is an interesting option, but for this work we retain the current approach, which has the advantage that the retrieval results are less subject to the choice of a priori, as mentioned in section 3.2.1. Currently, we think that it is unclear whether or not a finer-vertical-resolution retrieval always shows better performance.

Comment 2: Authors used CHIEIRE CTM model results, which is based on assumed emission inventory data for validating their MAX-DOAS measurements. However, it is not appropriate to use model simulation results to validate measurement results. It would be better use independent observation results measured by in-situ sensors at the tower during the CINDI campaign. Furthermore correlations between MAX-DOAS measurements and CHIMERE simulation are not so good for most of trace gases. It seems that aerosol, NO₂ and water vapor were measured at the tower during the campaign. It would be better if authors focus the discussions of the paper toward more detail investigation on the validity of their retrieval for those parameters with finer vertical resolution. Inclusion of more complete error analyses for those parameters is also need to improve the scientific quality of the paper.

Reply: We agree with the reviewer that model data should not be used for 'validation' of observations, and we have never claimed such 'validation' throughout the manuscript. The CHIMERE model data have been used to check the consistency between MAX-

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DOAS and CHIMERE data. CHIMERE was able to give us at least a first-order estimate of the variability of atmospheric concentrations above Cabauw. We believe that the use of CHIMERE SO₂ data was a good example for constituents, for which independent observation data were unavailable at Cabauw. Responding to the spirit of the reviewer's comment, however, NCEP H₂O data have been replaced with H₂O data obtained based on dew point temperature measurements at the tower. We think that the error analysis performed here is sufficient for the purpose of the present study, since we have covered well-known major error sources, including uncertainty in air mass factor determination. A more detailed error analysis would have to be performed for a more precise study, such as a validation study, as the reviewer suggests.

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