

Interactive comment on “Tropospheric NO₂ vertical column densities over Beijing: results of the first three-years of ground-based MAX-DOAS measurements (2008–2011) and satellite validation” by J. Z. Ma et al.

Reply to Anonymous Referee #2

Referee comments

This paper report the tropospheric NO₂ vertical column densities (VCDs) over Beijing based on ground-based Multi Axis Differential Optical Absorption Spectroscopy (MAX-DOAS), and analysis the results with satellite data. this work is helpful to know the trace gas over North China, and even their effect on climate. But major revised is needed before it is published, including:

Author Responses

We thank the anonymous referee for his/her constructive comments on the manuscript and have revised manuscript accordingly.

Referee comments

1. The manuscript need to be refined further, including writing and photos;

Author Responses

We have tried to refine our manuscript, including both text and figures. Specific revisions are described in our responses to the comments from the two referees.

Referee comments

2. How to define the tropospheric NO₂ VCD in this paper? by altitude or something else;

Author Responses

Tropospheric NO₂ VCDs retrieved from MAX-DOAS observations at high elevation angles (30° and 45°) are sensitive for the lowest few kilometers (below about 5km) of the troposphere; the exact altitude range depends on aerosol and cloud conditions. We added this information to the revised version of the manuscript (page 9, line 10-14). In any case, the derived tropospheric VCD includes the NO₂ concentrations in the boundary layer.

Referee comments

3.The variation of tropospheric NO₂ VCD is owing to variability of PBL(e.g. Fig.7 and 10). It is might be not reasonable, first there are no data of PBL in this manuscript; second the variation of PBL will not affect the NO₂ VCD, it can affect the ground NO₂ concentration. Therefore, further analysis is needed to explain the variation of NO₂ VCD;

Author Responses

Our explanation on the effect of PBL was wrong. We appreciate the referee's insightful comment on this point and have revised our manuscript accordingly. For instance, please see page 13, line 7-13: *“Although the diurnal variation patterns of NO_x emissions in Beijing appear to be the same in different seasons, the diurnal variation patterns of tropospheric NO_2 are rather different from one season to another, owing to the differences in its emission strength and atmospheric lifetime. In addition, the dynamic processes associated with the PBL structure might influence the accumulation and dispersion of NO_2 . Note that in contrast to the NO_2 volume mixing at the surface, the NO_2 VCD should not change directly with a variation in the PBL height”*. Quantifying the effects of emissions, chemistry and PBL processes is beyond the scope of this paper and will be dedicated in the future study.

Referee comments

4. About the aerosol shielding effect (part 3.6.2), the authors just make case study with AOD values, including 0, 0.1, 0.3, 0.5, 1.0, 2.0 and 3.0, why not use true values since it can be calculated based on satellite data?

Author Responses

Here we merely performed a model sensitivity study to investigate the effects of aerosols on the NO_2 retrieval in general instead of specific days. These selected AOD values should cover a typical range of AOD in the real atmosphere. We did not select more data points, e.g. between 2.0 and 3.0, because the results (Figure 17) will change almost linearly within this range.