Atmospheric
Chemistry
and Physics
Discussions

ACPD

Interactive
comment

Interactive comment on "Retrieval of total column and surface NO$_2$ from Pandora zenith-sky measurements" *by* Xiaoyi Zhao et al.

Anonymous Referee #1

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General comments

This paper describes the process to obtain the surface NO2 mixing ratio using the NO2 column from the ground-based Pandora observation. Some validations are performed by the comparison to the model outputs and in-situ measurement. The approaches look logical and the final products seem reasonable. Considering the rising importance of Pandora data for the air quality monitoring, publication of this work is useful to the research community and potential readers. But some more discussions should be included to improve this manuscript. Please refer to the comments below for the revision process.

Specific comments

Printer-friendly version

Discussion paper

P1, L27: Traffic is one of the important NO2 sources. Please include.

P2 L1-L12: Why is the total vertical column NO2 significantly treated first instead of in-situ measurement. For air quality monitoring, in-situ measurement has been performed basically. Before the importance of Pandora observation is addressed, the necessity of ground-based remote sensing of trace gases should be stated first, in spite of the well-structured ground-based in-situ networks.

P2 L8-9: The reason to use zenith-sky observations under the cloudy condition is not clear. Why zenith-sky mode has more reliable than direct-sun mode under the cloudy condition?

P4 L20-21: Why do we need O4 retrieval? Still, some potential readers do not have any idea about the meaning of O4 retrieval.

P7 L1-2: In other Pandora paper (usually including Dr. Jay Herman in the author list), diurnal variation of stratospheric NO2 is not much considered. It will be more interesting (and even useful) to add some arguments compared with their approaches.

P8 L10-24: Notation is not clear. There are VCD_DS and VCE_ZS. Also, there are VCD_EMP and VCD_NDACC. VCD_EMP (and VCD_NDACC) is related to VCD_DS or VCD_ZS? Better notation or more description of these notations look required.

P10 L10-12: V_ftrop is from the GEOS-chem simulations. How does GEOS-Chem consider the lightning NOx in the free-troposphere? In other words, GEOS-Chem can catch the free-tropospheric lightening NOx reasonably? It seems better to include some discussions about the estimation of lightning NOx in the free troposphere and even stratosphere, which is related to the final quality of C_pan from the Pandora observation.

P10 L22-24: How about the year-to-year variation of conversion ratio? Is it larger or smaller than the diurnal variation of conversion ratio? If there is, it seems to include some discussion for how to treat or consider the year-to-year variation.

P11 L21-28: How to connect the results and discussions here to those in Fig. 4? The lesson from Fig. 4 seems that the ZS Pandora NO2 has better quality than the direct-sun Pandora NO2, right? But here both ZS and direct-sun Pandora NO2 shows consistent quality. Then what do we really learn from Fig. 4 in this work?

P12 L3-18 and Fig. 8: In this study, the validation is performed for the 2015-2017 period. Why only a month (APR 2017) is considered in this analysis? The better quality of ZS NO2 than direct-sun NO2 can be justified with this figure but whether the ZS NO2 always provide the reliable NO2 under the heavy clouds cannot be determined based on only 1-month situation. It seems necessary to deal with additional cloudy cases (at least in the supplements).

P13 L3-L20 and Figs. 9 and 10: In addition to the GEM-MACH model results, Pandora ZS and direct-sun NO2 products also show the higher standard deviation after sunrise compared to the time close to sunset. Considering the radiative extinction is more disturbed during the time close to sunrise and sunset, the higher standard deviation in the morning is not well understood. Why NO2 product in the morning has higher biases? This is also due to the propagation of GEM-MACH PBL uncertainty? (But authors mentioned that the surface NO2 from ZS Pandora observation is less dependent on the PBL height in P13 L29-30).

Technical corrections

P6 L2: two times -> twice

P7 L30-32: The meaning of this statement is not clear to me. Please more clarify the explanation.

P8 L10-12: This statement looks redundant, just a repetition of statements above.

P11 L10: This result (slightly lower correlation) -> This slightly lower correlation

Figs. 4, 7, and A2: If a slope value is the only significant value, then 'slope = ***' looks better expression. If authors would show the information with the format of 'y = slope

x', it seems better to add intercept values together, to have the original regression equation (the equation looks not completed without intercept values)

Figure captions: It seems that all figure captions can be more clarified to better describe the figures. Please check and correct once more before the submission of revised manuscript (Now they are somewhat confused. Fig. 6 and 7 are examples. What really figure b and c imply? Direct description of figure a, b, c looks better to read).

Time period: Please clearly suggest the time period of each analysis (at least in each figure caption). I think each analysis has a different time period of analysis, which is a little complex to me. While I can accept this difference, the clear time information should be provided to help the readers' understanding.

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