Atmospheric
Chemistry
and Physics
Discussions

Interactive comment on "Investigations of Temporal and Spatial Distribution of Precursors SO$_2$ and NO$_2$ Vertical Columns in North China Plain by Mobile DOAS" *by* Fengcheng Wu et al.

Anonymous Referee #2

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This paper gives an overview on mobile DOAS measurements of NO$_2$ and SO$_2$ which were performed in the North China Plain (NCP) in summer 2013. The spatial distributions of the trace gases as well as spatial and temporal variations in these distributions are examined by combining them with wind and in-situ data. Hereby, the effect of pollution transport on the air quality of Beijing is investigated and a transport route for pollution from south to north towards Beijing is identified. Further, a specific emission hot spot is characterised in more detail. Finally, the DOAS dataset is compared to OMI data, where a reasonable agreement is found considering the different measurement strategies. Since the topic air pollution in China (especially in the major cities such as Beijing) is of high importance and reasonable results and conclusions are obtained the

paper is suited for publication in ACP. Nevertheless, some points need to be clarified and commented by the authors before final publication.

General Comments: The English language is in general good and fluent. However, the use of articles and prepositions has to be improved as well as the use of plural/singular forms. Additionally, some sentences are really hard to understand (for more details see specific comments).

Further, I personally don't like the term "point measurements/instrument" (e.g. page 4, line 11 or 15 / Page 5, line 25) which is used throughout the paper. Since you are referring to in-situ instruments here, I would suggest to use the term "in-situ measurements/instrument" in the paper.

Major Comments:

Section 2.4: Since the DOAS principle is the major measurement method of this paper I have several comments on this section:

Page 6 starting from line 20: Here several sentences are really hard to understand (since they are very long). I suggest that you rephrase the whole part.

Page 7, line 1-8: Here, I suggest to summarise all the fit settings in a table (one for NO$_2$ and one for SO$_2$) and to also give all the references for all used cross-section spectra. Is there a specific reason why the Greenblatt et al. cross-section is used (and not the newer Thalman et al.)? I would suggest to test if there is a significant effect on the trace gas results when using the newer Thalman et al. cross-section. Further, which high-resolution solar spectrum was used?

Perhaps you could give a reference for equation (1) and I think it should be DSCD$_{trop}$ in the last part of the equation.

The estimations of the errors is quite optimistic, but reasonable. However, I wonder how clouds are treaded in calculation of the AMFs.

So in general I ask you to revise the whole section 2.4. considering my comments.

Page 8, line 13-16: I agree that atmospheric chemistry is much too complex to discuss everything in detail here. Further, I agree that the wind direction has the main influence here. However, it would be interesting if you could comment also on the other parameters: temperature, humidity and pressure. For temperature you already did this quickly in section 2.1. Perhaps similar statements could be given for the other parameters, At least in your comment.

Section 3.1.3: In general I agree that your measurements indicate that the air quality in Beijing is negatively affected under southerly wind. However, I wonder were exactly the emission sources are located (and I think this is one of the main questions you are trying to answer in this section and the paper). At the end of section 3.1.1 you state that the high SO_2 VCDs under southerly wind along the Taihang Mountain are caused by emission in the south/southwest of the measurement region which sounds reasonable here and I agree to that. But on the other side you state (in section 3.1.3, e.g. line 30, 31) that the large emission sources (of SO_2) are located along the southwest route/region. The latter might explain the higher SO_2 VCDs along the southeastern route under westerly wind (such as on the 21st of June). This would mean that the emission sources of SO2 are located along the southwest route which would first contradict to the fact that there is a certain dependence of the VCDs in the southwest on the wind direction (north vs. south). Second, I would then expect that along the southwest route we should always see high SO_2 independent from the wind direction. I think it is quite obvious that the main emission sources are outside the cycles. Could you clarify this or comment on this? In general I think it would help to understand everything in more detail if you would show plots as in figure 4 for all cycles (perhaps as appendix).

Page 13, line 8-10 + Figure 13 e and f: First, I suggest to split up this figure (Figure 13) and give an own number for Figure 13 e and f together. Further, I wonder why you are only showing a correlation analysis for two specific days. I think you measured this

route (SJZ to DZ) four times. So you should bin your four data sets with respect to wind direction and then do a correlation analysis for the complete dataset which would be more robust.

Minor/Specific Comments:

Page 3, line 5-9: perhaps give a rough (relative) number for the "large proportions in particulate matter" and the "significant reduction"

Page 3, line 9, 10: I think the term "NO_x" should be introduced and specified first, since beforehand only NO_2 is mentioned

Page 3, line 22, 23: I would rephrase as follows: "...based on measurements using a mobile laboratory, ..."

Page 3, line 25: I would rephrase as follows: "Model simulations, another method, can obtain distributions, ... and major transport channels of ..."

Page 3, line 29: Since there have been several publications dealing with mobile (MAX-) DOAS measurements I would skip "novel" here.

Page 4, line 4, 5: Shaiganfar et al. published a paper in 2015 (*New concepts for the comparison of tropospheric NO_2 column densities derived from car-MAX-DOAS observations, OMI satellite observations and the regional model CHIMERE during two MEGAPOLI campaigns in Paris 2009/10, AMT, 2015*) I think it should be additionally mentioned here.

Page 4 , line 22: add "column" to "...vertical *column* densities..."

Page 5, line 21, 22: Here I think it is not of large importance which car is used and which dimensions it has. So I would just state that the instrument is mounted on a car/ mobile laboratory.

Page 6, line 6: Please add the year to the citation.

Section 2.3: Here I wonder how representative the 500 m simulated trajectories are for the ground-based wind data. As already discussed by you the wind data has some contradictions as for example for cycle 4. Could you briefly comment on this?

Page 8, line 9: Some words are missing in this sentence.

Page 9, line 5: Perhaps the "city effect" should be mentioned as "...affected by local emissions within the cities..." or something like that

Section 3.1.1: In general this section refers to Figure 4. Two comments on this figure: first, the dates in the left corners of the subplots are really hard to read. Second, I would suggest to use different colour scales for NO2 and SO2. This would more pronounced the elevated VCDs around the cities.

Further the city of Ji'nan is written in three different ways throughout the paper perhaps this should be harmonised.

Page 11, line 26: I would say "...they are less pronounced...", since the hot spots are still visible (see figure 4c).

Page 12, line 16: Is there any hint which kind of source this might be? Or is it the city itself?

Page 12, line 18: Please add which day is shown in figure 12 since it somehow contradicts to figure 4 where the hot spots are still visible but less pronounced.

Page 13, line 16: please change to something like "...to measure spectra of scattered sunlight...".

Page 13, line 18: "The data *analysis* consisted of three steps ... tropospheric NO_2 VCD*s*"

Page 13, line 25: here the word "grid" is missing.

Section 3.3: Especially in this section the English language needs improvement. Fur-

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ther, which error is exactly represented by the error bars in the correlation plot? Are the errors taken into account when performing the linear regression? This should be added to the text.