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Atmospheric Measurement Techniques Discussions
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Interactive comment on "High-resolution airborne imaging DOAS-measurements of NO_2 above Bucharest during AROMAT" *by* Andreas Carlos Meier et al.

Anonymous Referee #1

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The paper describes NO_2 measurements performed over Bucharest during the AROMAT campaign in September 2014. Nitrogen dioxide was observed with the Airborne imaging DOAS instrument AirMAP from the University Bremen. The focus of the paper is on the data retrieval and a short interpretation of the observed tropospheric column densities. To large parts it is interesting to read especially the albedo correction is very a nice idea. In some parts however the paper might be shortened a bit to stress out the main focus (AMF calculations with the highly varying albedo and the interpretation of the data). Therefore I suggest:

- Shifting the stratospheric correction (4.1.2) to the appendix. After half a page the authors state that the corrections discussed above were neglected here. From

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Table 1 one can easily calculate that the difference in the stratospheric AMFs is close 0.2 for flight 2 and around 0.05 for flight 1. Moreover parts of this section focus on the satellite retrieval and are not directly related to the airborne instrument, though used for the correction in general.

- Shortening the description of the aerosol profile chosen and the other AMF parameters. I am not sure whether it suitable to use an aerosol profile from August 2015 for measurements in September 2014. But if a typical profile is assumed it might be used.

For the albedo correction two reference pixels from the MOD09A1 database, which has a resolution of 0.1 degree, are chosen. Why is the reference taken over the city? According to the map the intensity varies by a factor of 2 with high small scale variations. An area with less variability might be a better choice?

Airborne measurements provide high resolution and good data that might be used for many interesting scientific questions. The comparison to satellites is from my point of view not really an interesting question; we did that too often in the past. So I thank the authors that they did resisted this temptation.

1 Detailed comments:

- P3 l24 & p4 l1: The area of the city in km^2 and the area covered by the flights are not necessary. The maps show that most of the city including some suburbs were covered.
- P4 l1: Flight 1 (2014-09-08) started in the north and ended in the south, on this day the wind blew from north east (figure 2). Is it possible that the aircrafts plume was observed? The influence might be small and can hardly be estimated or?

- P4 l2: include “around local noon” in the flight description.
- P5 l18: The grating with 600 g/mm and 500 nm blaze wavelength was used. The other gratings (the Acton 300i allows up to 3) are not important in this context. The same grating was already used in Schönhardt et al. (2014).
- P5 l25: Does the size of the ground pixel change towards the edges of the swath? Later on it is mentioned for large roll angles of the plane but under normal flight conditions?
- P6 l3: There is an updated version of the solar atlas by Chance and Kurucz (2010), you might use instead.
- P7 l4: “multi measurements in one grid cell were averaged” how good do the multi measurements agree? At least for the vertical column that might be interesting to see.
- P10 l5: Please replace “normal to the surface” by “vertical”, the local surface might differ from the horizontal e.g. mountains.
- P10 l13: The sentence beginning with ”The dSCD and the AMF. . .” is not clear, please clarify.
- P13 figures 4 and 5: The BoxAMF for 440 nm are shown here and in section 5 the wavelength of 437.5 nm is mentioned (P17 l6), please use consistent data. Even though the difference in the AMF due to this wavelength change might be small,
- Figure 5: Is it useful to add a vertical line at 0.04 and 0.1 for a better comparison to Figure 4?
- P14 Figure 6: Is the figure necessary? In this figure it looks if the VZA is mainly in flight direction.

- P18 l6 Add a point “g)” For each measurement the retrieved albedo was used for the AMF calculation.
- P19 Figure 11 and P20 Figure 12: these two figures both show a linear correlation and a histogram. It would be nice if the same scales for the two histograms were used.
- P21 Figure 13: The grey and green areas are slightly confusing, on the other hand they might be important. Does it look better or worse if you show the street lines only?
- P21 l1-5: For each measurement the individual retrieved albedo was used. This might be mentioned a bit earlier in the analysis description e.g. P18 l6 g) (above)
- P25 figure 17: The measured wind directions does not agree with the apparent distribution of the plume, in the emission estimates the later wind direction is considered. Specify in the discussion of the figure.
- P25 l10 ff: The airborne measurements are very interesting by themselves. There is no need to compare to satellite data.
- P29 Table 6: just for completeness add the background correction here.
- P30 Table 7: Why is the uncertainty in the AMF calculation comparable, while MPIC uses a simple geometric approximation and the telescopes’ elevation is 22° and the UGAL instruments points to the zenith and the AMF calculation is much more sophisticated. What is the typical resolution of these measurements for the local traffic and speed?
- P31 l10: The mismatch caused by the forward direction of the MPIC instrument’s telescope was not corrected for?

- P33 l15 ff: The presented airborne measurements provide a much higher resolution than the OMI data used by Liu et al. (2016), moreover there are some "isolated" plumes like point source 9 in figure 15. If not for now but for the future it might be worth to estimate the NOx lifetime form the airborne measurements. Even the big Bucharest plume might be used, however here the assumption of a point source is no longer valid.

- P33 l20 ff: This circular approach seems appropriate for a point source. However a city is rather an area source than a point source (p34 l13). Also emissions upwind of the centre are to be considered. In the current approach these emissions are counted at a distance of l and it is not important if the distance is upwind or downwind of the city. But in a Cartesian system with one axis along the wind direction, integrating perpendicular to the wind, this effect can be taken into account. As the authors already mentioned, in the circular approach with radii steps of 100 m the area increases between 0.06 km^2 in the centre to 12.5 km^2 between 9.9 and 10 km (p34 l13).

2 Typos and small corrections:

- P2 l3: "processes" instead of "precesses"

- P27 l2 and l5: the surface reflectance for Figure 4 is given with 5% or 0.04, one of the numbers is not correct. In the figure label it is 0.04.

- P33 l21: Is it really a Cartesian coordinate system. In a first approximation the geographical system on that small scale is Cartesian. To me the new one looks like a polar system.

3 References:

For some references the doi is not given, it is not mandatory but good practise. Constantin 2012, Heue (2005 and 2008), Lohberger 2004 and Rozanov 2014. please recheck the others as well

For the two books Burrows, Borrell and Platt (2011) and Platt and Stutz (2008) there are brackets around the doi and doi is written in capital letters while in all other references it is not.

Chance, K., and Kurucz, R. L., An improved high resolution solar reference spectrum for earth's atmosphere measurements in the ultraviolet, visible, and near infrared. J. Quant. Spect. Rad. Trans., 111, 1289–1295, doi: 10.1016/j.jqsrt.2010.01.036, 2010.

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