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Atmospheric Measurement Techniques Discussions

Interactive comment on "Intercomparison of four airborne imaging DOAS systems for tropospheric NO_2 mapping – The AROMAPEX campaign" *by* Frederik Tack et al.

Anonymous Referee #1

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General Comments

This paper presents NO2 retrievals from four airborne remote sensing instruments deployed during the AROMAPEX campaign over Berlin on two flights on 21 April 2016. Details on three of the instruments have appeared in other publications; this was the first deployment of the SBI instrument which is designed to fly on a Cubesat. As all four instruments are likely to become validation instruments for the new generation of air quality satellites (Sentinel 5P, 5, 4), this paper provides a useful intercomparison of analysis approaches, results intercomparisons, error sources, and measurement differences and similarities that will be useful down the road.

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Discussion paper

The paper is very clearly written, logical and easy to read. I have only a few minor comments to address before I think it can be published in AMT.

Specific Comments

P2, Line 9: Remove brackets around “tropospheric”

P2, Line 10: Remove brackets around “-2” and list GOME and GOME-2 separately. GOME-2 is EUMETSAT also.

P2, Line 11: OMI is Ozone Monitoring Instrument

P2, Line 13: Give rough numbers for resolution for context (ie, tens to hundreds of km)

P2, Line 15: Remove brackets for “higher”

P2, Line 23: “integrate spectroscopy” is a vague expression. Be more specific.

P2, Line 34: Add Zoogman et al., 2017, JQSRT for up-to-date TEMPO reference

P7, Line 14: What temperature cross sections are used? List here or in Table 3. Is there any correction applied to the AMF to account for the temperature dependencies of NO2? Also, this is an additional error term to mention in the error section.

P7, Line 23: Is there a different reference used for each cross track position for each spectrometer? Do you average several spectra together to create each reference? What is effective SNR on the references?What is SZA of reference (close to other measurements?)? What do you use for a VCD_ref value in Equation 3? Is it taken from a model? This also feeds into the error discussion later on. The error says 100% on the reference slant column but I didn’t see what that value is or where it came from.

P8, Line 9: I think it would be helpful here to mention fitting noise values (instead of saving only for later error discussion) when discussing different noise levels – helps to interpret the plot.

P8, Line 28: Is the AMF here calculated from the surface to the aircraft or from the

surface to the top of the atmosphere? The high altitude contributions are ignored in Equation 3 but are plotted in later box AMF plots so it's not clear to me.

P 9, Line 23: I think a short description on what route the car drove (or on the map if easy to do) would help the reader interpret this figure. Right now it's not clear where the car was, other than driving through Berlin.

P 10, Line 21: Skipped to Figure 10 from Figure 6, maybe would help to reorder figures to avoid confusion.

P11, Line 18: I have a slightly hard time interpreting this figure or what it means for overall results. I can see you might use it to estimate uncertainty for surface reflectance, but later on you give a flat 20% for AMF uncertainty. You say they agree "well" but not sure what that means (there seems to be quite a large difference in peak location with Landsat, also is 1.47 agreeing well?) What are the sources of near zero values? Are they shadows? Why are there so many APEX values near zero for the shorter wavelengths?

P14, Line 6: Not sure I understand why there are empty grid cells from aircraft attitude changes.

P 14, Line 10 and onwards: Would like to see here and in corresponding table a clear mention of what is systematic/bias causing error and what is random error.

P 15, Line 25: I would like to see original maps, not smoothed just for visualization (could also include that smoothed figure, but smoothing without showing the original data makes me suspicious!)

P 15, Line 30: Skipped discussion back to Fig 11. Maybe move this figure after Fig 12 and 13.

P 17, Line 5: Can you give a number on how far the plume moved based on wind speed and time between flight lines to confirm this could be the source of the difference?

Figure 4: Purple on top of red line is very hard to see.

Figure 10. I am a bit surprised that there are no molecular features visible in the wavelength dependent AMF. (I haven't done the calculation myself – maybe the ozone features would only be visible at shorter wavelengths on this y-axis scale? Just wanted to mention this, to confirm that ozone was properly included in the AMF calculation – if so, ignore this comment.)

Figure 12, 13, 14: Black symbols, grey road are very hard to see. Consider making larger and thicker. Maybe change road color to white if still hard to see. Wind direction is almost impossible to read in plot, but that is okay as is giving in caption.

Technical Corrections

P2, Line 10: SCIAMACHY acronym definition is incorrect

P 12, Line 21: Change "origin" to "originate"

Table 5: Change to "across-track spatial resolution"

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