

Interactive comment on “MAX-DOAS measurements of formaldehyde in the Po-Valley” by A. Heckel et al.

Anonymous Referee #2

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This manuscript presents first results of HCHO measurements made during the FORMAT campaign in summer 2002 near Milan, Italy and concentrates on discussing the details of the measurement and retrieval technique. The reader gets the impression that the authors have done a very thorough job and the work presented in this paper is a solid base for the scientific investigation of these measurements. The technique, presented here, is in principle very promising for comparisons with satellite observations and for the investigation of pollution events.

General comments:

However, in my mind the manuscript also raises a couple of questions: First, if the technique is so strongly depended on cloud-free days, how useful is the whole data set and how many days (e.g. out of the 30 days of measurements) can in reality be

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used for the data analysis as presented in this paper - maybe not many more than the 3 days discussed in this publication?

Second, to retrieve more reliable profile values and, in turn, boundary layer mixing ratios, a proper inversion technique such as optimal estimation is most likely necessary for the proper interpretation of the multi-axis measurements. This addition would clearly improve the data analysis presented in this study and allow a more quantitative interpretation of the results.

Third, how realistic is the assumption of horizontal homogeneity in this study and if this assumption doesn't hold, what potential impact has that on the results (VCDs, profiles and boundary layer mixing ratios)? The authors themselves raise the issue and point out that horizontal inhomogeneities can have a large impact and lead to incorrect vertical profile retrievals. How sure can we then be, that the presented results are reasonable given that the assumption of a horizontally homogeneous distribution of HCHO over 40 km has to be made when the sources are only about 50 km from the measurement location?

Detailed comments and suggestions:

Abstract, line 7: 'four week period'

Abstract, line 10: 'oxygen dimer'

Abstract: Some of the text in the abstract (e.g. the 2. sentence) is somewhat misleading and leads the reader to believe that the paper presents the results (vertical columns) for the whole campaign while in reality only 3 days of that four week period are presented.

The authors should adjust the text and make it clear that although the campaign covers 4 weeks, in this paper only measurements from the 3 day period (12-14 August) are presented.

Abstract: the authors should also include the errors when presenting the observed

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values in the abstract.

Page 1, column 2, line 34: 'ground-based' (should be hyphenated as in the abstract)

Page 2, column 1, line 8: 'second part of the paper ...' could use rather something like 'in section 4 and 5'; there is not really a second part of the paper

Page 2, column 1, line 24: 'measurements in the zenith'

Page 2, column 1, line 28: 'complications due to changes'

Page 2, column 1, line 36/37: could swap 'increasing' with 'decreasing' to connect better to the following sentence: 'for decreasing elevations the path length in the lower troposphere is increasing.'

Page 2, column 1, line 41/42: strictly speaking, 'in each direction' is potentially a bit misleading, actually should be something like 'at each elevation angle'. This comment applies also to several other parts of the manuscript.

Page 2, column 2, line 7/8: 'one horizon viewing direction' means probably at one elevation angle?

Page 2, column 2, line 10: 'off-axis measurements'

Page 2, column 2, line 11: delete one 'profile'

Page 2, column 2, line 17: 'the viewing geometry'

Page 2, column 2, line 20: 'a radiative transfer model': would be good to provide some brief information here on which model is used

Page 2, column 2, 3rd line from the bottom: 'at a small zenith angle'

Page 2, column 2, last sentence: as discussed later, this is only true for horizontally homogeneous fields and should probably be mentioned here, too.

Page 3, column 1, line 28/29: 'computing the enhancement'

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Page 3, column 2, line 1 : I think I do understand what the authors want to say with 'single zenith measurements known from the past', but this could be worded somewhat clearer.

Page 3, column 2, line 21-24: Is it at all realistic to assume a horizontally homogeneous distribution of HCHO when the main source are only about 50 km from the measurement location; how uniform is the emission from this source?

Page 3, column 2, line 35-38: 'In order to obtain ...' what iteration process was used to find the optimal trace gas profile?

Page 4, column 2, line 1-2: How can you be certain that there were no clouds during these 3 days (maybe there were hardly visible clouds) that could have disturb the analysis?

Page 4, column 2, line 10: '... during the 3 days without cloud influence (Figure 6).' As far as I can see, a reference to Figure 6 is missing in the text.

Page 4, column 2, line 20: could enclose 'and therefore the slant column' in commas

Page 5, column 1, line 14: rather: 'emissions from a local source'

Page 5, column 1, line 41: '... in the boundary layer (Figure 7).'

Page 5, column 1, line 43: add something like: '...and again around 16:30 UTC' (highlighted in yellow, Figure 7)

Page 5, column 2, line 2: 'Figure 7'(no brackets)

Page 5, column 2, line 14: 'HCHO loading'

Page 5, column 2, line 33: what does 'SLPM' stand for?

Page 6, column 1, line 31: 500 m seems to me to be very high resolution given the technique. And since no optimal estimation technique was used, how can you be sure that your resolution was around 500 m and e.g. not rather 3 or 5 km?

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Page 6, column 1, line 38: 'dataset' should be two words (as in line 1)

Page 6, column 1, section 5: Although this paper does not discuss the scientific results of the FORMAT campaign, but rather concentrates on introducing a technique to measure HCHO, it would be interesting for the reader to learn a bit about how to interpret the results presented in Figure 9 (and mentioned in the abstract). Just a brief discussion of the presented subset would be in my opinion a valuable (or at least interesting) addition to the paper. Some of this discussion is a little hidden presented in section 4.1 when discussing the slant columns and could maybe either be partly shifted to the later section or briefly be repeated either there or under the conclusions.

Page 6, column 2, line 14: 'molec/cm2'

Page 6, column 2, line 16: 'photon shot noise', shouldn't that be 'photon noise'?

Page 6, column 2, line 36-38: The uncertainties for the VCDs due to errors in the radiative transfer calculations is estimated to be 15

Page 6, column 2, line 48: 'first results'

Page 7, column 1, line 8-10: better to use something like this: 'The measurements were analysed for HCHO, and results for three selected days are presented ...'

Figure 9: What causes the discontinuities in the MAX-DOAS data set when the actual resolution of the measurements is around 5 minutes? Is it cloud conditions? Also, you could indicate representative error bars for a couple of data points for the different data sets.

Interactive comment on Atmos. Chem. Phys. Discuss., 4, 1151, 2004.

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