

Interactive comment on “On the distribution of formaldehyde in the western Po-Valley, Italy, during FORMAT 2002/2003” by W. Junkermann

W. Junkermann

wolfgang.junkermann@imk.fzk.de

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Many thanks to the reviewer for helpful comments to improve the paper. The manuscript now contains more data and a more detailed discussion and revised figures. See supplement. The specific comments of the reviewer are commented below.

Anonymous Referee #2 Received and published: 28 August 2009 This paper presents measurements of gas-phase formaldehyde from the Po-valley in Italy during summer 2002 and autumn 2003 FORMAT campaigns. Data from in-situ Hantzsch instruments are presented from three ground sites around Milan and also from an ultra-light aircraft. Aspects of the data set have been published earlier in the instrument intercomparison and modeling papers (e.g. Hak et al., Liu et al.). This paper focuses on differences in overall formaldehyde mixing ratios and diurnal variations among the various sites.

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Further insights into the differences among the three sites would be an interesting addition. The paper also presents vertical profile measurements both under cloud free conditions and also in the presence of convection. Presentation of more of these vertical profiles would enhance the paper. Through the previous instrument intercomparison, the dataset has been shown to be of good quality but the biggest problem with the paper is its lack of detail. Possibly because many details have been included in previous publications they are not included within the body of this paper. There are many results stated in the text that are not backed up by figures or details. If they are included elsewhere, then they should be referenced and not described again as a new finding. If they haven't been included, then please add figures. This paper is missing too many details to stand on its own.

Author reply: Most paragraphs of the paper were improved and details added. As well results already published in previous papers and used here again are additionally referenced.

The modeling section (Section 4) should be expanded. None of the model output is presented and it is not clear why the modeling section is included at all. Again, the text describes model/measurement comparisons yet nothing is shown. The presentation of the diurnal variations at the three sites is interesting and in particular, the morning rise in formaldehyde. How does this compare with the model output, and are the differences in the slopes of these morning increases reflected in the models? The data from the three areas with the aircraft addition are interesting and should be published but only after substantial revision.

Author reply: The model comparison was expanded. As the full model data set is already published elsewhere the diurnal variations from the models were produced the same way as from the experimental data sets and these model data that are discussed in the comparison were included into the figures. This makes comparisons clearer and more easy to follow. Its also mentioned in the introduction that the model papers by Liu et al do not go into details in the comparisons of formaldehyde data and that this is

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done in the current manuscript.

Specific comments for consideration: The addition of many commas throughout the paper will also contribute to its readability. I have not included these specific corrections in the following list. p 14001 The paper will read more clearly if the two campaigns are introduced early in the text. Author reply: A short description is included now in the experimental section p 14001, line 11, Wisthaler et al. reference is missing >Corrected p 14001, line 23 Junkerman und Burger >Corrected p 14002 line 6, “theses” >Corrected p 14002, line 19, simpler logistics and easier access >Corrected p 14002 – How did the Hantzsch technique perform during the intercomparison phase of the experiment? what measures were used to increase the instrument temperature stability? Author reply: Corrected, included in the experimental description p 14003 – Include the description of additional aircraft instrumentation and reference to table 1 after line 7, before the description of airspace >modified p 14003 – include some details about the number of flights and of these, from which flights will data be presented in this paper, Author reply: included in the experimental section p 14003, line 24 “Only one flight led . . . Corrected p 14003, can you include a typical flight track on Figure 1? Author reply: Two representative flight tracks for the campaigns 2002 and 2003 are included in Fig. 1 p 14003, lines 24-29, this is unclear, do you mean specifically, not respectively? Author reply: Corrected reformulated in the text p 14005, line 6, comma after harvesting, and delete “from” <Corrected p 14005, briefly mention the meteorology of a Fohn event Author reply: A short description was added p 14006, line 4-5, how do we know that weather patterns and local emissions are reflected in the HCHO variability? Can you show us? Author reply: This is obvious from the whole data set and from the diurnal variations in the individual sites. A sentence was added to the text. p14006, lines 6-20, does this description all refer to fig 3? When specifically, are these mixing ratios observed? Add specific dates for all three periods when diurnal variations are calculated. Author reply: Included in the text, also the reference to fig.3 p14006, line 11, omit “in the morning” >Corrected p14006, lines 25-28, were the slopes of the HCHO increases at each site consistent

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across all types of conditions? Can you give more details on the slopes? Do you have diurnal variation in other measurements to further elaborate on these rise rates? Were these modeled in Liu et al? and if so, did they agree? Author reply: Commented for CH₂O in the modelling section. NO₂ and O₃ diurnal variations agree by far better with the experiment as stated in the text. Other data on chemical compounds are available in the FORMAT data base. Within this work no new model calculations were done. p14006, line 28-29, Do you mean that the amplitude of the diurnal variation increases? >Yes, amplitude, corrected p14007, line 5-6, Are you referring to Fig 4f? >Yes, ref. included p14007, lines 15-17, were there any measurements of biogenic precursors from FORMAT? Author reply: Yes, Included and cited (Steinbacher et al, 2004/5), but not used for discussions in this paper. p14007, line 18-20, Again, where are the wind directions? Have the Bresso data been discussed in another paper?, Author reply: Yes they have been discussed in Hak et al, citation added p14008, line 1, Do you mean that the slope of the morning rise is steeper than the afternoon rise? Why? What was the wind direction during the polluted week? Author reply: NO, The morning rise is faster in the City than in the remote sites, corrected in the text. Wind direction in the polluted week was variable with a diurnal mountain flow pattern in Alzate not pronounced in Bresso, included in the text. p14008 line 25-27, Can you include the aircraft and ground-site comparisons? What do you mean by “generally in agreement”? Author reply: Included in the text, differences between airborne and ground based measurements are < 6% during flyby's. p14009, line 4, can you show the CN in addition to the HCHO? Author reply: Yes, included in the figures p14009, line 7, Do you mean the diurnal cycle in the fire emissions or in the PBL? Author reply: In the fire emissions, changed accordingly in the text p14009, line 14, mixing within the PBL is really within a few minutes?? Author reply: Modified to ~ 30 minutes, with low thermal upwinds of ~ 2-3 m/ sec the PBL is mixed within about 15-30 minutes. p14009, lines 20-26, given an estimated liquid water content, what fraction of HCHO do you expect to be scavenged by cloud water, most likely less than 30%? Convective transport is important but the higher altitude HCHO need not have been scavenged

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and then released upon cloud evaporation. Author reply: Commented also in detail in the text. Scavenging depends on cloud microphysics and chemistry, none of which is available for the clouds encountered. The statement was added as in aged air masses water vapour and aerosols would stay in the residual layer by far longer than CH₂O which photolyses the next morning. Noon and afternoon CH₂O above the surface well mixed layer thus has to be freshly advected. p14010, lines 3-4, this sentence is not clear, what was observed by Korman, 2005?, Author reply: Free tropospheric low mixing ratios of ~ 100-200 ppt, corrected in the text p14010, lines 6-7, can you add particles and RH to the vertical profile plots? Author reply: Yes, included in Fig. 5 and 6 p14010, line 8, ascents and descents >corrected p14010, lines 21-28, It is not clear how discussion of this episode relates to the data presented. Author reply: This paragraph was included to discuss the difficulties to define a general planetary boundary layer height for the whole area. This PBL height is necessary for remote sensing techniques. Though available the data of these instruments are not shown in this manuscript. p14010, line 26, plume-like >corrected p14011, line 2, FORMAT >corrected p14011, line 14, what is a reasonable correlation? Please show the comparison. Author reply: The word reasonable was omitted, data are shown in Fig. 4 now p14011, line 23 and onward, are the comparisons with the three sites for the multi-day periods selected to determine diurnal variations? Have you done this? Author reply: Yes, explicitly mentioned in the text. p14012, line 5, ascent corrected

Please also note the Supplement to this comment.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 13999, 2009.