

Interactive comment on “Use of a mobile laboratory to evaluate changes in on-road air pollutants during the Beijing 2008 Summer Olympics” by M. Wang et al.

M. Wang et al.

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We would like to thank the referee#2 for the comments and suggestions, which contribute to improve the quality of our paper. We have implemented all the comments and suggestions in the revised manuscript. Below please find a detailed point-by-point response to each comment.

Specific comments: Comment 1: More attention should be paid to the explanation of what pollution control measures were implemented, the goal of each measure, and the timing of implementation as it is central to most of the rest of the discussion. Merging of information from table 2 and table a1 as well as a translated version of the Chinese

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web-site documenting these measures would be very useful. Use of time divisions as set forth in table a1 might be rethought in favor of using the simple designation of before, during and after Olympics.

Response: Accepted. We revised sentences, figures and tables to make the temporal nature of our measurements more clear. The main contents of Chinese website were translated in table 2.

On page 10, line 5 to 14, we stated “Generally, these measures were classified into before (before 19 Jul 2008), during (20 Jul 2008-19 Sep 2008) and post (after 20 Sep 2008) full-scale control periods, according to magnitudes and scales of control measures. The full-scale control period included comprehensive control for industrial and construction activities, traffic emission as well as gas evaporation. To better clarify the effectiveness of different control measures especially during the Olympics and Paralympics, we further divided the full-scale control period into four stages: before Olympics(20 Jul 2008-7 Aug 2008), during Olympics(8-23 Aug 2008), between Olympics and Paralympics(24 Aug 2008-6 Sep 2008), during Paralympics (7-19 Sep 2008).”

To further highlight the temporal variation, we revised table 2 by merging previous table 2 and table A1, two columns showing corresponding periods of different control measures based on the statements above. The concentrations of various kinds of air pollutants in table A1 have been removed since these data are shown in Fig. 7.

Comment 2: The overall description of inlets, instrumentation, and their performance needs a great deal of clarification and additional characterization. Without such work, it is difficult to assess the merit of these measurements. Response: Accepted. The description of inlets, instrumentation and their performance were carefully rewritten, following with the referee’s suggestion. (1) We add a new section 2.2 inlet system and totally rewritten the descriptions following the referee’s suggestion. More details on the constructions of each inlet, how they work and their efficiency tests were carefully

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described. Please find from page 5, line 17 to page 7, line 2: "As shown in Fig. 1, Four individual sampling inlet systems were constructed to minimize pollutant loss in the inlet and to enhance the sampling efficiency. The experimental test of measured average residence time for gas species between the sampling system inlet and being detected by gas analyzers, particle instruments and BC instrument(MAAP) are 18s, 5s and 3s which were 9%,25% and 17% errors , respectively with respect to calculated values." Meanwhile, we also made changes to the figure 1 by enlarging inlet images to make its construction more clear. (2)The instruments' performances were described on page 7, line 10 to 15: "The working principle of the NO-NO₂-NO_x analyzer (ECOTECH Model 9841A, Australia) is based on the chemiluminescence technique. The CO monitor (ECOTECH Model 9830A) is based on CO absorption of non-dispersive infrared radiation (NDIR) at a wavelength of 4.6 microns. SO₂ was measured by an analyzer with fluorescence technique."

Comment 3: The authors repeatedly imply that only a mobile laboratory is capable of assessing temporal and spatial variability. A good network of stationary measurements should also capture temporal and spatial variability. In fact, measurements from such a network of stations would be extremely helpful in showing when the mobile laboratory measured emissions from the vehicles directly surrounding it and when the measurements were more heavily affected by regional conditions. Such measurements would also help to show that their mobile measurements indeed reflect either temporal or spatial variability in a quantity that might otherwise be conserved over the extent of the study time and area.

Response: The referee's comment is correct. We changed the sentence "Such data cannot be obtained by stationary monitoring sites" into "Such data cannot be obtained by currently existing and equipped stationary monitoring sites". One of the advantages of mobile laboratory is that it can easily move to capture the variances of pollutants with fast response instruments while monitoring. Certainly, the mobile laboratory is not the only way to assess temporal and spatial variability. A well-designed monitoring net-

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work with similar instruments to mobile laboratory may have their own advantage. Considering the huge funding requirement on an equipped station, a mobile laboratory is an economical way to accomplish such work. The referee's suggestion about a good support from stationary measurement is very useful. However, due to the lack of enough monitoring stations to establish an effective network in our measurement route, we just made simple comparisons between mobile lab and stationary measurement. Daily average comparison of CO, a traffic source indicator in the study, was done among the mobile laboratory, PKU and PKH data during the measurement. Figure 1 showed similar trends between mobile lab data and the PKU, PKH data. This helps us to prove the reliability of mobile lab instruments during our measurement period. The differences of the values were due to on-road concentration by mobile monitoring and ambient concentration by PKU and PKH which were influenced by their surroundings.

Fig. 1. Time serial of CO concentration at mobile lab, PKU station and PKH station on every cruise days

Comment 4: A number of correlations were put forth with relatively little to justify their presence in the discussion. What am I to draw from tables 3, 4, and 5? The claim that the benzene/toluene ratio changed due to the cessation of painting activity, while possible, is not very well justified. Did somebody keep track of painting activity before, during and after the games? Fugitive solvent emissions are also claimed to be a source but somehow this is no longer considered as a factor. Why?

Response: (1) In our manuscript, table 3, 4, 5 calculated correlations between different air pollutants or air pollutants and meteorological conditions. The purpose for table 3 was to show the weak correlations between air pollutants and WS, RH, T during our measurement period. This indicated meteorological condition may not be the major impact during our measurement period. Table 4 showed correlations between air pollutants, the purpose was to distinguish and find out sources of those air pollutants. Here, we found that BTEX, NO_x and CO have high correlations while BC and S (PM₁) also well correlated, indicating that they might come from similar sources. In table 5, by

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dividing the period into before and after August 8th, we tried to investigate the changes of sources of BC and S(PM1) when the environmental background changed due to the stricter traffic control strategy. High correlations changes from SO₂ to other vehicle emission species (NO_x, CO and BTEX), indicated BC and S (PM1) may come from industrial or power station emissions from outside before 8 August while from vehicle exhaust thereafter. All of the descriptions have been stated in the manuscript, please have a check. (2) Accepted. It was indeed true that the low B/T ratio may be caused by many factors. We focused more on painting activity because when the time was close to the beginning of Olympics, a large number of building walls facing to the streets were painted. Previous studies on B/T ratio showed that the B/T ratio with low value may be caused by painting evaporation. This leads us to the idea of the changing of painting activities. However, we don't have detail information about when and where the painting activities were carried out, we cannot record the painting activities as a function of time. Nevertheless, we used the correlation between toluene and NO_x to show the importance of painting in comparison to vehicle emissions. Please see page 19, line 12 to 18: "To further demonstrate this suppose, a daily correlation between Toluene (solvent indicator) and NO_x (traffic emission indicator) has been calculated (SPSS 15.0) and shown in Fig. 8. Apparently, correlations(r) from 19 July to 4 August were low(r<0.22), while after August 4, the correlations jumped to higher than 4 most of time. This significant difference was tested by two-tailed t-test(SPSS 15.0), showing p <0.01. This provides another evidence that contribution from painting was reduced after August 5"

Technical Comments: Comment 1: The authors wish to distinguish between larger particulate matter in the air and individual chemicals in the air and often use "aerosol phase" and "gas phase" to make this distinction. It might be more accurate to say aerosols and chemicals suspended in the air or something to this effect as they are both technically suspended in the "gas phase".

Response: Accepted. The "aerosol phase" was changed to aerosols. The "gas phase"

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refers to all the gas species in our paper, etc. NO_x, CO, SO₂ and BTEX, while "aerosols" includes particles and BC.

Comment 2: A large number of semicolons are used to separate ideas in sentences throughout this paper. Although their use is not necessarily grammatically forbidden, it does tend to produce very long sentences that can be difficult to understand. Response: Accepted. The long sentences have been revised.

Comment 3: 12858 Line 3-4: "...innovative..." The word innovate implies something never before seen or that marks a significant departure from status quo. As the authors cite many examples of other mobile laboratories and do not clarify how their own laboratory marks a significant departure from previous efforts, a word such as versatile would be more appropriate.

Response: Accepted. The word "innovative" was changed into "versatile".

Comment 4: 12858 Line 9: "...ethyl benzene, m-, p-, and o-xylene...". It would be more accurate to say "the sum of ethylbenzene, m-, p-, and o-xylene" as the PTR-MS on board is unable to distinguish the individual isomers. Attention should be given to this distinction throughout as it is often misused.

Response: Accepted. The words "ethyl benzene, m-, p-, and o-xylene" was changed to "the sum of ethylbenzene, m-, p-, and o-xylene".

Comment 5: 12858 Line 12: "...Concentrations increased again after the control period ended..." Is this in comparison to the control period? Specify what increased with respect to what.

Response: Accepted. this is in comparison to the control period.

Comment 6:12858 Line 10-16: What is the normal variation in the concentrations of these chemicals over the time period in question for other years and at other times of the day?

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Response: We agree with the referee that it would be very helpful to evaluate the control measures by comparing this work with historical data sets. However, to our best knowledge this work is the very first mobile measurement conducted in Beijing area.

Comment 7:12859 Line 13: The reference to Rogers 2006 here seems misplaced. Doesn't this have to do with measurements in Mexico City rather than Beijing?

Response: Accepted. The reference to Rogers 2006 was misplaced. The correct reference is (Kirchstetter et al., 1999).

Comment 8: 12859 Line 14: "...formations..." Should be "...formation..."

Response: Accepted.

Comment 9: 12859 Line 19: Is the citation for Hao correct here? The previous reference by Han has to do with cars up until 2020. Does Hao also fortuitously use the year 2020?

Response: Accepted. The reference Han, 2008 was cited here. Hao, 2006 was change into the sentence on page 12859, line 18 "The number of automobiles in Beijing has increased rapidly in recent years at an annual rate of about 15% (Hao et al., 2006; Chan et al., 2008);"

Comment 10:12859 Line 21: "...on-road automobiles in Beijing emitted..." Presumably these automobiles still emit now. Include the year/years from this study in which automobiles emitted.

Response: The data reported by Liu et al. (2007) was calculated based on on-road survey. No specific date of the survey was provided. It is reasonable to assume this emission data were before 2005.

Comment 11: 12859 Line 22: "...Furthermore, chemical mass balance modeling with VOC observations during 2002-2003 showed that automobile exhaust was

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responsible..." Change to: "Chemical mass balance modeling using VOC observations made between 2002 and 2003 showed..."

Response: Accepted. The sentence has been changed to "Chemical mass balance modeling using VOC observations made between 2002 and 2003 showed that automobile exhaust was responsible for 57.7% of the VOC emissions in Beijing (Liu et al., 2005)".

Comment 12: 12860 Line 4: What are the Euro IV standards?

Response: Euro IV standards is also the name "European emission standard". It is defined as the acceptable limits for exhaust emissions of new vehicles sold in EU member states, including Euro 1, 2, 3, 4...stages. In Beijing, one of the measures was to improve the oil quality which is equivalent to Euro 4 standard.

Comment 13: 12860 Line 7: "...the web site <http://www.bjepb.gov.cn/bjhb/tabid/681n-fold/15395/frtid/40Default.aspx>." The listed link is, as one might expect, in Chinese. As APC is an English language publication, it would be useful to distill the contents of this web site into a table/time line in English and to tell the user ahead of time that the provided link is to a Chinese language web site. Although tables 2 and A1 purportedly do this, it would be helpful to combine them such that the time divisions made by the authors are more easily cross referenced with respect to the regulations imposed and their date of imposition. The divisions of table A1 don't seem to add very much to the simple before, during and after- analysis.

Response: Accepted. We have revised the table and descriptions according to the referee's suggestion. Details of responses, please see specific comments 1 above.

Comment 14: 12860 Line15: "...in situ rapid response..." Add a comma: "in situ, rapid response..."

Response: Accepted.

Comment 15: 12860 Line16: "...of traffic emissions; such data cannot be obtained

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by stationary monitoring sites.” Reword the second half of this statement which is misleading and get rid of the semicolon. It is possible to obtain data like that reported using identically equipped stationary monitoring sites spread densely over the study area. Since this infrastructure does not exist, a mobile laboratory is one alternative to obtaining the information. One might write something like: “Such data cannot be obtained by currently existing and equipped stationary monitoring sites.”

Response: Accepted. The sentence was corrected accordingly.

Comment 16: 12860 Line16: “Rarely has the use of a mobile laboratory for temporal and spatial analysis been reported.” Is there a reason for this? Maybe it is difficult to link changes in measured parameters unambiguously to either temporal variations in the study area, spatial variations in the study area, or very local emissions without having additional information from stationary measurement sites or other mobile labs simultaneously in motion.

Response: Accepted. We changed the sentence on page 4, line 19 to 23: “Most previous studies focused on ultrafine particle (UFP) measurements along motorways, such as “chase studies” for specific vehicle emission factors (Canagaratna et al., 2004; Herndon et al., 2005). Rarely has the use of a mobile laboratory for temporal and spatial analysis been reported.” to “Many of previous studies focused on ultrafine particle (UFP) measurements along motorways, such as “chase studies” for specific vehicle emission factors (Canagaratna et al., 2004; Herndon et al., 2005). Others were reported for temporal and spatial analysis in and around certain city and country (Bukowiecki et al., 2003; Weijers et al., 2004; Isakov et al., 2007).”.

Comment 17:12860 Line26: “...in situ, on-road...”

Response: Accepted.

Comment 18:12860 Line 27:“... aerosol phase...” Remove the word “phase”.

Response: Accepted.

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Comment 19:12861 Line 15: “...were deployed...” The word “deployed” should be used in conjunction with some indication of what was deployed where. This makes it sound as if the UPS system was only sometimes built into the van and at other times, only the generators were built into the van.

Response: Accepted. We changed the word “deployed” into “installed on the mobile van”.

Comment 20: 12861 Line 21: “The gaseous pollutant inlet...” How long was it? What was the air flow through it. What is the typical residence time of a chemical prior to reaching instrumentation. Why was there a glass manifold? Where was the glass manifold (in the van I presume)? Was there a pump attached? If residence time was variable and depended on the speed of the platform, how were line-losses characterized as a function of the speed of the vehicle? How was the residence time reported on 12862 Line 8 derived? Did you inject gaseous/aerosol standards and watch to see how long it took to detect them while travelling at speed? Did you simply calculate based on the flow rate of gases you believe to be passing through the tubes? If the flow through the lines is variable, it is highly advisable to study particle/gas/chemical losses in these lines as a function of the speed of the van. Why is no such study reported?

Response: The referee’s suggestions are important. We add a new section 2.2 inlet system and almost rewritten the descriptions. More details on the constructions of each inlet, like how they work and their efficiency tests were carefully described. Please find from page 5, line 17 to page 7, line 2: “As shown in Fig. 1, Four individual sampling inlet systems were constructed to minimize pollutant loss in the inlet and to enhance the sampling efficiency...The experimental test of measured average residence time for gas-phase species between the sampling system inlet and being detected by gas analyzers, particle instruments and BC instrument(MAAP) are 18s, 5s and 3s which were 9%,25% and 17% errors , respectively with respect to calculated values.” Meanwhile, we also made changes to the figure 1 by enlarging inlet images to make its construction more clear. As we mentioned in our paper, during our measurement, the driving

C5006

speed was kept at 60km/h. We used this speed for several reasons. First, it is the optimal speed to get the minimal loss of particles by calculation. Second, it is also the optimal speed on road. If the driving speed was too low, the exhausts from mobile lab would be observed; if the speed was too high, more directed emissions from surrounding vehicles would be detected. Due to the four lanes of the Fourth Ring Road at each direction and relatively light traffic during our measurement period in the afternoon, we were able to maintain a constant speed of 60km/h. However, the referee's suggestion is correct. It is our next step to design a versatile inlet system, which will not require to drive at constant speed and we will test the pollutants losses in lines as function of driving speed.

Comment 21: 12861 Line 25: "Airflows containing particles were forced..." How were they "forced" to enter the cone? Later, there are two inner diameters listed. Exactly which part is being described here? Figure 1 leaves a lot to the imagination. How do you isokinetically feed a flow from the cone shaped part into the other section. What is the advantage to having an inlet that requires you to drive at 60 km per hour? It seems to me that being in traffic requires constant adjustment of speed to safely navigate streets and this limits your "versatile" laboratory to only those roads on which it is possible to travel at this speed. Does this mean that only the data taken at this speed is valid? If speed is such an important factor, why don't you report a full characterization of your inlets at a variety of speeds? Why isn't there a plot of average speed for the many measurement trips reported in this work?

Response: Accepted. The details has been shown in response to comment 19.

Comment 22: 12862 Line 12: "...were mainly research-grade commercial instruments..." The words "mainly research grade" are meaningless. Leave them out or clarify exactly what it is about each instrument that makes it suitable for research and others not. Do you simply wish to make the distinction between home-built instrumentation and commercial instrumentation?

C5007

Response: Accepted. The words "mainly research grade" have been removed.

Comment 23: 12862 Line 13: "...with an emphasis on high time resolutions." Reword: "...with preference for instruments having high time resolution"

Response: Accepted. We have reword the sentence accordingly.

Comment 24: 12862 Lines 14-18: Is this referring to all trace gas measurement devices? If so, the PTRMS should also be listed here. You go on to describe the working principle of the PTRMS but don't describe the working principles of the instruments used to measure NO_x, CO, and SO₂. Why not? The reference Fortner 2009 does not belong in a list of references describing the operational principles of a PTRMS. Leave it out in line 24.

Response: Accepted. On page 12862, lines 14-18, the gas analyzers were only used to measure NO_x, CO and SO₂. We put PTRMS description in another paragraph because its principle and performance were complex and completely different from gas analyzers. We added the principles of the gas analyzers on page 7, line 10 to 15: "The working principle of the NO-NO₂-NO_x analyzer by ECOTECH (Model 9841A, Australia) is based on the chemiluminescence technique. The CO monitor (ECOTECH Model 9830A) is based on CO absorption of non-dispersive infrared radiation (NDIR) at a wavelength of 4.6 microns. SO₂ was measured by an ECOTECH Model 9850A analyzer fluorescence technique," The reference "Fortner, 2009" has been removed.

Comment 25: Line 24: "...xylene..." This should be the sum of the xylene isomers and ethylbenzene."

Response: Accepted.

Comment 26: Line 27: Why is Fortner 2009 cited here? To the best of my knowledge they don't provide an in depth description of catalytic converter design which is the information that a user would be expecting in the reference cited at this point. Any comment as to the reliability of background determination in PTRMS instruments?

C5008

What about identification of the signals related to benzene, toluene, and xylenes etc. and the chemical itself. A longer discussion is given in Rogers 2006 but none here.

Response: We agree with the referee and we have added Rogers et al. (2006) here to provide a more detailed description about the catalytic convertor. Because the same catalytic convertor was used in Fortner et al. (2009) and this work, Fortner et al. (2009) can provide a general reference about its performance.

Comment 27: 12863 Line 1-5: What is an EPA TO-15 standard? From a cursory look at the EPA document itself, it seems that it presents methods for canister analysis of air samples rather than a method of producing standards. Were the standards used for this work collected in canisters? Did you collect the canisters yourselves? Where did you send them for analysis? Why is this paragraph grouped under instrumentation and not under 2.3 Quality Assurance and control?

Response: We did not collect any canister during the campaign. The referee is right that TO-15 is an analysis procedure established by the EPA and a series of VOC standards were used accordingly. In this work, we just want to state that the VOC standards used in PTR-MS calibrations met the specification of TO-15 regulations. We have clarified this point in our manuscript.

Comment 28: 12863 Line 5-10: Previously, you described two sample inlets. Here you introduce a third. Describe all sampling lines together in one section.

Response: Accepted. We added 2.2 in inlet system section to clearly the description of the four sampling inlets located on the mobile lab. Please see page 5, line 16, section 2.2.

Comment 29: 12863 Line 10: What does a TI 3550 measure and why does it have a diffusing charging sensor? It doesn't seem to be in any of the tables of instrumentation and it is difficult to tell why this sentence is here.

Response: The TSI Model 3550 instrument was used to measure PM1 human lung-

C5009

deposited surface area. The working principle is based on diffusion charging of sampled particles, followed by detection of the aerosol using an electrometer. Aerosol enters the instrument at 2.5 L/min. The flow is spitted with 1 L/min passing through a filter and an ionizer, and 1.5 L/min being measured as aerosol flow. The flows are recombined in a mixing chamber where aerosol particles are charged by diffusion. The charged aerosol passes through a trap to remove excess ions and desired amount of small particles. The voltage applied to the trap determines the amount of particles removed along with the ions. The aerosol then moves on to an aerosol electrometer for charge measurement. In the electrometer, current is passed from the particles to a conductive filter and measured by a very sensitive amplifier. A microprocessor controls the instrument flows and measures various operational parameters. The name of the instrument has been shown in table 1, line 5: "Active surface area. . .". Following with the referee's suggestion, we changed the name of the instrument "Diffusion Charging(DC)" to "Nanoparticle Surface Area Monitor", which was mentioned in the manual of TSI 3550 Nanoparticle Surface Area Monitor. We also added the sentence on page 8, line 12: "The working principle is based on diffusion charging of sampled particles, followed by detection of the aerosol using an electrometer, with a flow rate of 2.5 SLPM." to briefly describe its working principle.

Comment 30: 12863 Line 14: Was this computer the same as the IPC mentioned earlier?

Response: No, it's another computer, only recording data from Nanoparticle Surface Area Monitor.

Comment 31: 12863 Line 14: Revise sentence: "A freely rotating, high-resolution video camera installed atop the mobile laboratory continuously provided multi-angle views of on-road conditions to identify potential emission sources."

Response: Accepted.

Comment 32: 12863 Line 16: What particular model of Motorola GPS did you install?

C5010

Response: The model of Trimble GPS is GT5011-ST.

Comment 33: 12863 Line 23: "...and could be used to represent meteorological conditions along the 4th ring road..." What is meant by use of the word "represent"? From Figure 2 it seems that these stations were relatively close to the ring road. These were simply meteorological conditions measured within X km from the ring road. Are the authors implying that only meteorological conditions measured directly on the road are actually applicable for analysis? Again, this relates to the implication in the introduction of this work that stationary measurements cannot provide the same data as that of a mobile lab. This wording also goes against the claim that meteorological conditions were mostly homogeneous over the city of Beijing.

Response: On-road meteorological conditions in north, east, south and west part may be different because of the influences of buildings, constructions and other factors. Since the wind speed and wind directions on mobile lab were not available, we carefully selected three meteorological stations from Chinese Academy of Meteorological Sciences, which were close to the Fourth Ring Road and located in different part of the road. Therefore, we believe that the variations of wind speed and directions in the three meteorological stations represent the on-road meteorological conditions during our measurement period. The rose plots from the three stations showed similar wind speed and directions distributions, and therefore, indicated that the wind speed and directions of different parts of the road were mostly homogeneous over the city of Beijing.

Comment 34: 12863 Line 26: Once again, the authors use the phrase "gas-phase instruments" without including the PTR-MS. These belong together throughout the article. Please check this carefully throughout.

Response: Accepted. We changed the phrase "gas-phase instruments" to "Gas analyzers(NO_x, CO, SO₂)", the special name for gases etc. NO_x, CO, SO₂ made by Ecotech company.

C5011

Comment 35: 12864 Line 3: "Difference between the calibration results and the concentrations of the standards was less than 4%." I think this phrase is supposed to mean that NO, CO and SO₂ values output while measuring the standard gas were only in error from the quoted value delivered with the standard by 4%. Please clarify this.

Response: Accepted.. The sentence was changed to "The error of the calibration results by detecting standard gases with respect to the concentrations of standards was less than 4%."

Comment 36: 12864 Line 7: The limit of detection is printed as 0.3 ppbv for BTEX. Is this value good for benzene, toluene, xylenes+ethylbenzene individually or for the sum of all of them? Previously, it was stated that you only calibrated from several ppbv to several hundred ppbv. Later in the paper, values ranging from 0.4 to 0.6 are reported reported. How does this relate to the statement that "Gas-phase instruments were automatically zeroed and calibrated to 80 % of the detection range..."

Response: The individual detection limit for benzene, toluene, or xylene+ethylbenzene was less than 0.3 ppb. The dynamic range of the PTR-MS calibration was from a few ppbv to one hundred ppbv to accommodate the highly variable on-road VOC concentrations. We believe it is reasonable to assume the PTR-MS would response to VOC signal linearly even below the calibration range as long as it was higher than the detection limit. The statement "Gas-phase instruments were automatically zeroed and calibrated to 80 % of the detection range..." does not apply to the PTR-MS measurements.

Comment 37: 12864 Line 11 to 19: A great deal more information is required if you are going to make such a comparison. Exactly which instruments are installed at the PKU laboratory? How are they calibrated? How far was the PKU lab sampling line separated from the mobile lab sampling line? If the mobile lab was parked near the lab (and not moving at 60 km/h), how exactly did the inlets on the mobile lab function?

C5012

What were the line losses like?

Response: To describe intercomparison more clearly, we add the following sentence on page 9, line 3 to 8: "The instruments on PKU monitoring station for intercomparison such as NO_x, CO, SO₂ and BC were the same as those in the mobile lab, while a standard PTR-MS (Ionicon) was used on PKU monitoring station. Calibrations for each of the instruments were conducted everyday with similar method as the instruments on the mobile lab. Calculated loss efficiencies for gas-phases and BC while stopping for intercomparison were less than 1%(Hinds, 1999)."

Comment 38: 12864 Line 25: Does sampling only at 16:00 in the afternoon introduce a bias into your measurements? Can we expect to see other results at different times in the day? This highlights a great disadvantage to having a sampling inlet that only functions or is characterized for movement at 60 km/hr.

Response: The sampling time usually recorded at 15:30 to 16:00. Obviously, other time in a day is OK, but we chose this time for three reasons. First, it was the time without traffic jam which was good for sampling. Second, all the instruments in the mobile lab need about 4-5 hours to achieve a stable and good working condition before sampling. Third, the atmospheric boundary layer was well developed at this sampling time and the vertical mixing would be consistent. Keeping a constant driving speed can keep steady air flow in the sampling, which is good for sampling efficiency. The speed limitation in the 4th Ring (our route) is 80 km/h. Based on our calculation, 60 km/h is an optimal speed to attain high sampling efficiency, which is not too fast to keep a constant speed and not too slow to be affected by self-pollution.

Comment 39: 12865 Line 2-4: Why not put a N, S, W, E on Fig. 2 to show this. Also, on the corners that run diagonally, to which quarter do they belong (see for example N.E. corner on Figure 2. . . .does that belong to the north or to the east)? What is the goal in dividing into 16 equal sections? This has to do with binning of measurements for purposes of correlation later. Please state this somewhere.

C5013

Response: Accepted. The N, S, W, E were shown in Fig. 2. The diagonal bin in northeast belonged to the north line. Each of the N, S, W, E line included four bins. Each bin was about 4 km in length and could reflect detailed conditions of on-road air pollutant variations and their correlations. We tried our best to divide the line as much as possible, but it would bring enormous work in statistics and the output was similar. We stated it, please see on page 10, line 24 to 27.

Comment 40: 12865 Line 14-16: Why not discuss this or present it when the Chinese web site was given? This seems out of place here.

Response: Accepted. We added sentences On page 10, line 5 to 14, "Generally, these measures were classified into before(before 19 Jul 2008), during(20 Jul 2008-19 Sep 2008) and post(after 20 Sep 2008) full-scale control periods, according to magnitudes and scales of control measures. The full-scale control period included comprehensive control on industrial and construction activities, traffic emission as well as gas evaporation. To better clarify the effectiveness of different control measures especially during the Olympics and Paralympics, we further divided the full-scale control period into four stages, full scale control: before Olympics(20 Jul 2008-7 Aug 2008), during Olympics(8-23 Aug 2008), between Olympics and Paralympics(24 Aug 2008-6 Sep 2008), during Paralympics (7-19 Sep 2008)." The website maybe removed by Chinese government recently, because the information was out of date now.

Comment 41: 12865 Line 20: "...benzene, toluene, BTEX..." State either "sum of benzene, toluene, xylenes and ethyl benzene" or simply "BTEX" but not both.

Response: Accepted..

Comment 42: 12865 Line 21-23: There seem to be at least two different categorizations of the data with respect to pollution controls during the Olympics. One with three divisions (before, during, after) and a second with a number of divisions (as per table A1). These need to be reconciled with one another. This information also needs to be reconciled with Table 2 that actually lists the control measured implemented and

C5014

date of implementation. It would be wise to discuss all of this at one point early on so that readers know what is going on. In addition, in Table A1, the row with national holidays comes as a bit of a surprise after what is stated in the text. In addition, the Post Olympics period should be listed as 20 Sept -???. We are still currently in the post Olympic period and so was the 6th of October.

Response: Accepted. Details please see specific comment 1.

Comment 43: 12866 Line 1: 60 km/hr... what was the deviation from this value? How often did you deviate. By what amount did you deviate?

Response: Accepted.. The driving speed was 60 ± 5 km/hr.

Comment 44: 12867 Line 4: "These differences suggest that the pollutants were influenced by different emission sources and subsequently by different control measures." The chain of logic isn't entirely clear here. The fundamental observation is that for the suite of chemicals observed, PM, BTEX, and NO_x had the same mixing ratios before and after the Olympic controls. CO went down post olympics in comparison to pre-olympics while SO₂, BC, and PM₁ actually went up post Olympic compared to pre-olympics. While it may be that these chemicals have different sources and these different sources might be differently affected by pollution control measures, the way this is worded is a bit odd.

Response: Accepted. This sentence was removed.

Comment 45: 12867 Line 6-21: First of all, within the error bars it can certainly be said that over the three averaging periods there are differences. Except for BC and PM₁, there are clear differences between pre, during, and post Olympics. There is, however, some significant variation within each of these time periods. Discussion moves on to prevailing wind directions during this time period. However, Figure 5 shows only wind roses averaged over the entire measurement period, demonstrating that prevailing wind directions across Beijing were relatively homogeneous. The conclusions

C5015

about pre-, during, and post-olympics are simply not pictured. It would be nice to see the average wind roses for each of these time periods in order to confirm the author's hypothesis that winds from the southwest resulted in generally higher loading of pollutants following passage of air over the city during the pre-olympics but not during or after the olympics.

Response: First, the purpose of 3.1 section was to show an overview variations of air pollutants we measured during the measurement periods. The differences of each period, pre, during and post control measures, have been indicated in Fig. 3 already. The focus of Fig. 4 and line 6-21 was to show the spatial differences of these pollutants in different control periods rather than the time variations. We concerned more on the control effectiveness on the four direction lines. Second, due to the variations stated above in 3.1, in 3.2, we tried to estimate how significant the meteorological condition influenced. The referee's suggestion is correct. It is better to draw wind roses for pre, during and post control periods. However, since the time resolution of WD and WS data from three meteorological stations were hour-average, which means the plots were not enough to draw wind rose pictures. Thus, it was difficult to draw such pictures in details. Nevertheless, the three meteorological stations which were located in NW, NE and SW were chosen to demonstrate that wind conditions within measurement trip were homogeneous with dominant wind from south.

Comment 46: 12868 Line 2 to Line 13: Although it is interesting to look at correlations, it helps the reader along to say why we expect to see one in the first place.

Response: The time resolution in the three meteorological stations was 3 hour in average. We selected the PKH station because the temperature and relative humidity data there were 1 minute average, which were available for us to make correlations with the pollutants measured on the mobile lab. Meanwhile, the PKH station was located in the centre of Beijing city(Fig. 2) and temperature, relative humidity usually showed slight differences within a Beijing city. Therefore, we believe that the PKH station data could reflect the temperature and relative humidity variations in Beijing during our measure-

C5016

ment periods.

Comment 47: 12868 Line 15: “.By selecting the high-frequency distributions of RH and T among the whole data, the ranges in RH and T were chosen as 35-62% and 25-35 C, respectively.”Please clarify how the data was treated here. 12868 Line 18-23: “However, benzene concentrations varied in different periods. . .” Yes, this was noted previously in section 3.1. Why are you repeating it here? This has nothing to do with correlations that were being discussed. Consider cutting this entire paragraph and restructuring the section having to do with correlations into a more cogent discussion. If you have nothing to say about correlations, then leave its discussion out entirely.

Response: The paragraph here does not repeat the discussions in previous sections. In table 3, we found weak correlations between air pollutants and T, RH. To identify how significant the T and RH influences were, we chose the high frequency distribution of RH and T, and drew their correlations to benzene, an indicator of air pollutants. The extreme values of RH and T were excluded because they may come from abnormal data by instrument or unusual weather which will influence the correlations. Then, to clearly investigate the significance of other factors in addition to RH and T, we restricted RH and T in a short, similar range as pre-control period, from 50–60% for RH and 30oC–32oC for T and found that despite of similar ranges of RH and T, there was still obvious differences of benzene concentrations during full control period, with respect to pre and post full control period. Since benzene was an important indicator of traffics and so forth, therefore, the large difference may be caused by control strategies. We have revised the descriptions, please see it on page 14, line 19 to page 15 line 2.

Comment 48: 12869 Line 11: Has the abbreviation LDV been introduced before this point? The same comment applies to HDV which appears slightly later.

Response: The full name of LDV is Light Duty Vehicle, which has been introduced in Abstract, please see page 12858, line17.

Comment 49: 12869 These two paragraphs could be greatly condensed. Describe the

C5017

postulated sources of each of the chemicals measured. Discuss how this relates to the correlations actually seen. Dividing the chemicals up as was done seems counter-productive and somewhat misleading. Essentially all of the chemicals/aerosols have some connection to traffic. The question is how much is traffic and how much is due to other factors.

Response: Accepted. The two paragraphs have been rewritten. Please see section 3.3.1 on page 15, line 4 to page 16, line 3, “Both CO and NO_x are commonly used as traffic emission indicators. Table 4 shows significant positive correlations between the concentrations (averaged over each of the 16 segments of the Fourth Ring Road throughout the whole campaign) of CO and BTEX and of NO_x and BTEX, which ranged from 0.66 to 0.76 and 0.60 to 0.70, respectively. Benzene is a marker of volatile aromatic hydrocarbons in regions of intensive traffic (Khoder, 2007). It displayed strong correlations ($r > 0.86$) with other BTEX species in our study, which indicated that vehicular sources controlled most part of BTEX concentrations. Thus, it was concluded that most of the CO, NO_x, BTEX measured in this study were likely from motor vehicle emissions, which previous studies have estimated as accounting for 74% of the NO_x and 57.7% of VOCs emitted in Beijing (Hao et al., 2005; Liu et al., 2005). Given that emissions from LDVs with gasoline engines have been identified as the major portion of the total vehicular emissions in Beijing (Hao et al., 2005; Song et al., 2007), concentrations of on-road air pollutants (e.g., CO, NO_x, and BTEX species) should be well correlated with the number of LDVs on the road, as will be discussed in a later section. BC is emitted by combustion source such as vehicles, power plants and biomass burning. S(PM₁) served as an indicator of fine particles in our study. A good association was shown between S(PM₁) and BC ($r = 0.7$, table 4), but both of them correlated weakly with CO and NO_x ($r < 0.43$, table 4). The correlation between S(PM₁) and BC indicated that on-road fine particles and BC came from similar sources. The weak correlation with CO and NO_x suggested that BC and S(PM₁) in Beijing might have other sources other than LDVs. Since industrial activities were curtailed and biomass combustion was strictly prohibited during the Olympics, we inferred that BC and S(PM₁)

C5018

could be generated by HDVs with diesel engines which have been reported in other researches (Fruin et al., 2004; de Castro et al., 2008), even though HDV exhaust does not constitute a major portion of overall traffic exhaust in Beijing.”

Comment 50: 12869 Line 22: “Since industrial activities have been slow down...” Change to “Since industrial activities were curtailed and biomass combustion was strictly prohibited...”

Response: Accepted.

Comment 51: 12870 Why do you need to make new divisions in time? If you insist on doing so, what do I have as far as pollution controls to distinguish between these periods? For instance, what is the difference between full scale control and full scale control during olympics. Aren't these identical? If not, why? It seems to me that the authors wish to demonstrate the correlation between vehicle numbers/hr and measurements. With this goal in mind, a simple time binning system should suffice where the binning has no connection to the application of regulations and simply has a good number of points that show trends clearly. It also seems as if this graph is the centerpiece of the discussion of the various measurements.

Response: The time divisions have been explained in section 2.5 and shown in table 2. The method to draw a time serials of traffic speed in details was good to show the trends more clearly. However, the dates to monitor traffic speed sometimes were not consistent with measurement days, but may be one or two days before or after the measurement days. Therefore, we gave up using time serials of traffic speed. However, these days were still belonged to one of the six periods and the trends between traffic speed and air pollutants variations could also be identified.

Comment 52: 12871 Line 8: “... other emission sources, such as industry emission and biomass burning...” Change to “...other emission sources, such as industrial activities and biomass burning...”

C5019

Response: Accepted.

Comment 53: 12871 Line 11: “BC and SPM1 have weak correlations with CO and NO_x, with correlation coefficients r having values less than 0.43...was stronger (r values greater than 0.45)”

Response: Accepted.

Comment 54: 12871 Line 13: “...since the SO₂ was strictly regulated in Beijing, the only possible remaining source of this chemical is from outside the city.”

Response: Accepted.

Comment 55: 12871 Line 23-28 and 12872 Line 1 to 7: Was the choice of August 8 really based on Figure 7 or did it come from the change in the benzene/toluene ratio pictured in figure 8? Response: It was based on Figure 7c, because high correlations between BC, SO₂ and HDV traffic speed can only be observed after 8 August, this lead us to believe that BC, SO₂ may mainly influence from different source. This is the reason to do the next step in table 5.

Comment 56: 12872 Line 6-7: “... were mainly come from vehicular sources, most likely HDVs with diesel fueled engine.” Revise to: “...mainly came from vehicular sources...”

Response: Accepted.

Comment 57: 12872 Line 11: “This ratio is useful for estimating the photochemical age of an air mass (Khoder, 2007) and is therefore another indicator of the effectiveness of traffic control measures.” Explain why an indicator of age indicates effectiveness immediately rather than waiting until the end of the paragraph. Response: Accepted. The sentence “and is therefore another indicator of the effectiveness of traffic control measures.” was changed to “and is therefore a good indicator of different emission sources.”

C5020

Comment 58: 12872 Line 18: "...variation in the B/T as is shown in Fig 8." Change to "...variation in the B/T ratio as is shown in Fig. 8."

Response: Accepted.

Comment 59: 12872 Line 19: "... which allows it to record emission plumes and reflect traffic-related factors such as traffic density, vehicle types, fuel composition. . ." Change to: "...which allows it to register passage of different emission plumes reflecting traffic-related factors such as traffic density, vehicle types, fuel composition. . ."

Response: Accepted.

Comment 60: 12872 Line 28: "This suggests that the lower B/T ratio before 4 August may have been caused by the heavy. . ." The authors present no evidence that reduction in painting activity rather than fugitive emissions or some other factor played any sort of large role. Do you have records showing how much painting was done as a function of time? Why the focus on painting?

Response: Accepted. It was true that the low B/T ratio may be caused by many factors. We focused more on painting activity because when it was close to the beginning of Olympics, a large number of building walls facing to the streets were painted. Previous studies on B/T ratio showed that the B/T ratio with low value may be caused by painting evaporation. This leads us to the idea of the changing of painting activities. However, we don't have detail information about when and where the painting activities were carried out, we cannot record the painting activities as a function of time. Nevertheless, we used the correlation between toluene and NOx to show the importance of painting in comparison to vehicle emissions.. Please see page 19, line 12 to 19: "To further demonstrate this suppose, a daily correlation between Toluene(solvent indicator) and NOx(traffic emission indicator) has been calculated (SPSS 15.0) and shown in Fig. 8. Apparently, correlations(r) from 19 July to 3 August were low($r < 0.22$), while after 4 August, the correlations increased dramatically, most of which were higher than 4. This significant difference was tested by two-tailed t-test (SPSS 15.0), showing $p < 0.01$. This

C5021

result leads us to confirm more about our conclusion. What's more, painting solvents contributed more on the low B/T level from 19 July to 3 August."

Comment 61: 12873 Line 6-8: "Studies earlier in this century have examined traffic-related BTEX behavior in the city of Beijing (Barletta et al., 2005; Song et al., 2007; Wei et al., 2007). . . ." Change to "Previous studies have examined traffic-related BTEX behavior in the city of Beijing (Barletta et al., 2005; Song et al., 2007; Wei et al., 2007) generally using roadside measurements employing gas chromatograph/mass spectrometry (GC-MS) or GC-flame ionization detection (GC-FID). Table 6 compares the B/T values obtained from these studies with our own work."

Response: Accepted.

Comment 62: 12873 Line 17: The authors say that they simply measured their values closer to the source and that this accounts for observed differences. Could there also be an instrumental contribution from the use of the PTRMS for measurement as opposed to GC-MS which is hinted at earlier in the paragraph? Could it be a change in the fuel mixture or solvent usage compared with previous studies? In short, why does it have to be due to proximity to the traffic? If it is proximity to the traffic, then how can your measurements be looked at spatially and temporally? If you are mainly influenced by local emissions, you won't have much to say about spatial or temporal variations over the entire study area because they would be drowned out or combined with a large dose of local emissions. Did you look at the traffic directly around you to find out what kind of correlations exist?

Response: Accepted. The differences of B/T ratio between our work and previous studies may be caused by several factors. We added the sentence page 20, line 1 to 3: "These differences may be caused by several factors: the changes in fuel mixtures for Euro 4 standard after 1 March, 2008 in comparison to previous Euro 3 standard; the differences between these instruments; what's more, the B/T is considered to increase with increasing distance from the pollution source (Gelencser et al., 1997; Simon et al.,

C5022

2004). Apparently, our mobile laboratory with PTR-MS measured vehicular exhaust at the shortest distance from its sources. ” Comment 63: 12873 Line 25: “. . .model stimulation and stationary measurements and real-time regional observation is needed to validate these results.” Change to: “. . .model simulations and stationary measurements. Real time regional observations are needed to validate these predictions.”

Response: Accepted.

Comment 64: 12874 Line 3: “. . .Ring Road on 6 August; prevailing winds were from the southwest and south.” Change to “. . .Ring Road on 6 August. Prevailing winds during these measurements were from the south and southwest.”

Response: Accepted.

Comment 65: 12874 Line 12: “. . .SPM1, indicating that they were from similar combustion sources.”

Response: Accepted.

Comment 66:12874 Line 14: “. . .PKU site, while background increases with broad peaks. . .” Change to “PKU site. Background increases with broad peaks. . .”

Response: Accepted.

Comment 67: 12874 Line 16: “. . .from local industrial sources lying a relatively short distance from the road (approximately 12 km). Along Jingshi Highway, the peaks likely reflect sources lying within a larger radius (30 km), showing the effects of regional transport.”

Response: Accepted.

Comment 68:12874 Line 21: “This study demonstrates that the mobile laboratory is a. . .”

Response: Accepted.

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Comment 69:12874 Line 23-24: Perhaps revise in this way: “The mobile laboratory collected data that could not have been obtained through currently existing and equipped stationary observation sites in the Beijing area.”

Response: Accepted.

Comment 70:12875 Line 10: “. . .gradually after the Olympic regulations were lifted, especially after the traffic control period. . .”

Response: Accepted.

Comment 71:12875 Line 13: “. . .were shown afterward, a trend also reflected in the number of HDVs on the road.”

Response: Accepted.

Comment 72: 12875 Line 15: “. . .indicated that they had similar local emission or regional transport sources which were later controlled.”

Response: Accepted.

Comment 73: 12875 Line 19: “The B/T ratio, regarded as a source indicator. . .”

Response: Accepted.

Comment 74: 12875 Line 20: “in the period after 8 August.”

Response: Accepted.

Comment 75: 12875 Line 21: I do not like how this is stated. While it might be true that this ratio changed due to a change in the amount of painting occurring before and after the Olympics, there is no hard evidence for it. All that can be said is that the ratio changed and there are a number of possible reasons for this change, one of which might be a change in the amount of painting.

Response: Accepted. We analyzed the correlations between toluene and NO_x to find out the causes by other painting or fugitive iol evaporations. We added sentences

C5024

to make the results more conclusive, please see page 19, line 12 to 18: "To further demonstrate this suppose, a daily correlation between Toluene (solvent indicator) and NOx (traffic emission indicator) has been calculated (SPSS 15.0) and shown in Fig. 8. Apparently, correlations(r) from 19 July to 4 August were low($r < 0.22$), while after August 4, the correlations jumped to higher than 4 most of the time. This significant difference was tested by two-tailed t-test(SPSS 15.0), showing $p < 0.01$. This provides evidence that contribution from painting was reduced after August 5."

Comment 76: 12875 Line 26: "...implemented by the Beijing EPB were able to effect short term improvements in air quality."

Response: Accepted.

Comment 77: 12881: The Parameter listed for the PTRMS is "VOCs". However, no VOC mixing ratios other than those related to BTEX are listed. Change this entry to BTEX. In the detection limit column, the words "Common standard" are used. What is the common standard? Please report a number for the devices used or state what the common standard is.

Response: Accepted. The words were revised accordingly. Please see table 1.

Comment 78: 12882: "Before" is not a starting date. Where were the heavy industrial polluters relocated? Who were the heavy industrial polluters? Where was the desulfurization facility installed? "50% of government cars were not allowed to drive. Diesel and heavily polluting vehicles not allowed to drive in Beijing. Only those vehicles meeting emission standards equivalent to Euro II were allowed to enter Beijing." "Start of full scale control: Reduce or stop production at certain factories surrounding Beijing." "Extra 20% of governmental cars were not allowed to drive. Temporarily close some gas stations Increase bus fleet and transit frequency. Lifting of regulations adopted from July 20." 12886: 0.49 ± 0.55 not $0.49-0.55$

Response: (1)Accepted. The word "Before" was changed to "unknown" because no

C5025

exact day for this measure was reported, while the ending day can be known.

(2)The sentences have been changed to "Relocating heavy industrial polluters, etc. Shou gang steel factory and other factories in south area of Beijing; install desulfurization facility in factories around Beijing"

(3)The descriptions on the measures were revised again, according to the referee's suggestion.

Comment 79:12887: Revise this table. Consider putting the national holidays as a foot note. The post olympics period comprises everything from 20 Sept on to today.

Response: Accepted.

Comment 80:12888: Consider making a close-up picture of the inlets and give a better description of each of the three inlets. Make sure these descriptions are together. Why is the PTRMS attached to the aerosol sampling inlet in the picture of the van in Figure 1 although it is making measurements of gas-phase molecules rather than aerosols?

Response: Accepted. The figure 1 was changed with more details. The PTR-MS inlet was individually located beside the aerosol inlet and sampling tube. It was not attached to any of other inlets.

Comment 81:12889:"The 4th Ring Road was chosen as the sampling route. For analysis purposes, this route was binned into 16 sections of equal length seen here colored red and blue." "The red stars show meteorological stations and places where traffic speed was recorded."

Response: Accepted.

Comment 82:12890: In the figure caption, describe the meaning of the white areas. The symbol for micrometers is a μ rather than the greek letter μ . How many bins are there per Cardinal directions? Figure labels of x axis don't seem to be aligned.

Response: Corrected.

C5026

Comment 83:12893: "... each of the road lines shown in Fig.2." Does this second sentence mean that you only included points for which there also existed a point for RH and T?

Response: Yes.

Comment 84:12894: "...on policy changes; before full scale control..." Units of traffic speed are "units/h". Is "km/h" intended? Where does the 8th of August fall in this plot?

Response: Accepted. The sentence was changed to "...on policy changes; before full scale control...". The "unit/h" was changed to "units/h". The 8th of August is the boundary between "Full scale control: before Olympics(July 20 to August 7)" and "Full scale control: during Olympics (August 8 to 23)".

Comment 85:12895: Units of traffic speed are "units/h". Is "km/h" intended? Where does the 8th of August fall in this plot?

Response: Accepted. The "unit/h" was changed to "units/h". The 8th of August is the boundary between "Full scale control: before Olympics(July 20 to August 7)" and "Full scale control: during Olympics (August 8 to 23)".

Comment 86:12896: Units of traffic speed are "units/h". Is "km/h" intended? Where does the 8th of August fall in this plot?

Response: Accepted. The "unit/h" was changed to "units/h". The 8th of August is the boundary between "Full scale control: before Olympics(July 20 to August 7)" and "Full scale control: during Olympics (August 8 to 23)", which was shown by a red dashed line.

Comment 87:12897: "The ratio of benzene to toluene for all cruises. The light grey line represents minute averages. The black line with symbols shows daily averages. The red line shows the average ratio as calculated for the stable period (from ??? to ????)."

Response: Accepted.

C5027

Comment 88:12898: "...The long dashed line in (b)..."

Response: Accepted.

Reference: Fortner, E. C., Zheng, J., Zhang, R., Berk Knighton, W., Volkamer, R. M., Sheehy, P., Molina, L. and André, M.: Measurements of Volatile Organic Compounds Using Proton Transfer Reaction - Mass Spectrometry during the MILAGRO 2006 Campaign, *Atmos. Chem. Phys.*, 9, 467 - 481, 2009, www.atmos-chem-phys.net/9/467/2009/.

Kirchstetter, T. W., Harley, R. A., Kreisberg, N. M., Stolzenburg, M. R., and Hering, S. V.: On-road measurement of fine particle and nitrogen oxide emissions from light- and heavy-duty motor vehicles, *Atmos. Environ.*, 33, 2955-2968, 1999.

Liu, H., He, K. B., Wang, Q. D., Huo, H., Lents, J., Davis, N., Nikkila, N., Chen, C. H., Osses, M., and He, C. Y.: Comparison of Vehicle Activity and Emission Inventory between Beijing and Shanghai, *J. Air & Waste Manage. Assoc.*, 57, 1172-1177, 2007,

Rogers, T. M., Grimsrud, E. P., Herndon, S. C., Jayne, J. T., Kolb, C. E., Allwine, E., Westberg, H., Lamb, B. K., Zavala, M., Molina, L.T., Molina, M. J. and Knighton, W. B. : On-road measurements of volatile organic compounds in the Mexico City metropolitan area using proton transfer reaction mass spectrometry, *International Journal of Mass Spectrometry* 252, 26 - 37, 2006,

Interactive comment on *Atmos. Chem. Phys. Discuss.*, 9, 12857, 2009.

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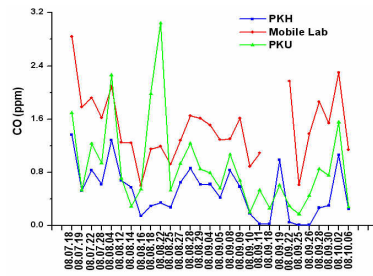


Figure 1. Daily average concentrations of CO measured by the mobile laboratory and at two fix stations PKU and PKH.

Fig. 1. CO concentration

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