**Atmospheric
Chemistry
and Physics
Discussions**

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Interactive comment on "Eddy covariance measurements of CO$_2$ and energy fluxes in the city of Beijing" *by* H. Z. Liu et al.

H. Z. Liu et al.

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Referee #1: General comments This is an interesting analysis of CO2 EC observations in Beijing. There is a need to provide more details in a number of places to support the statements made. Most notably analysis of surface characteristics - to show traffic counts and surface footprint - see comments below.

Reply: We would like to thank anonymous Referee #1 for his more detail valuable comments on this manuscript. It is very helpful to improve this paper. Responses to all the points raised by the referee are in the following:

Page 7678, LN14: There is a lot of discussion relative to traffic but no data are provided to support a number of the comments - see below

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Reply: The total amount of traffic for each year is provided in the text. The traffic numbers during the Olympic Games are found in the paper by Pan et al. (Characteristics of urban black carbon concentration around 2008 Beijing Olympic Games, 2010, in Chinese). But unfortunately, the detailed traffic data for other times in the study period are unavailable until now.

Page 7678, LN22: How is urban defined here?

Reply: In China, an urban area is defined as an urban district, city or town with a population density higher than 1500 people/km2.

Page 7679, LN22-24: What is the basis for the order of these references - should be chronological - alphabetical within the year. This applies here and elsewhere in the paper (not annotated)

Reply: Corrected.

Page 7680, LN23-24: It would be better to indicate what the actual impact was - i.e. what the reduction was. There is reference later on to a paper that seems to have the data.

Reply: The percentage has been changed to the actual number.

Page 7681, LN10-13: These characteristics are useful but we need to know what sort of distances they are from the city.

Reply: The distance between Yanshan Mountain and the center of Beijing is about 50 km. The distance between the alluvial plain of the Yongding River and the center of Beijing is about 45 km.

Page 7681, LN16: delete 'mega' here

Reply: Deleted.

Page 7681, LN19: Can only registered vehicles drive in the city? Or could there be a

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lot more actually in the city.

Reply: Yes. Only registered vehicles are allowed within the Ring 5, but also there are some vehicles from other provinces run on Beijing city. However those vehicles are less than 0.1% in Beijing total city area every day.

Page 7682, LN2: that would not be suburban. Here and Table 1. I think the use of this term (and urban) is misleading. It would be better to provide some numerical value for comparison which does not require an interpretation. The Stewart classification may help.

Reply: The word is deleted.

Page 7682, LN9-12: Need detail of footprint methodology used. Method, periods analysed etc. in here as well as in the caption.

Reply: The reference has been added.

Page 7682, LN17-18: Given the comments about the changes - need comment if the area has changed since this analysis (what years do these apply to). If the area has changed again then new values are needed.

Reply: No major change of the land use occurred since 2003 around the tower.

Page 7684, LN11-12: What does the the u* distribution look like? I.e. does this support this decision of not?

Reply: u* statistics are added to give more information to the reader.

Page 7685, LN7: Need to indicate what period this refers to: daily? monthly?

Reply: Corrected. The extreme air temperature here is the daily air temperature.

Page 7685, LN10-11: What measurement height is being used here? Sonic? Profile?

Reply: The measurement height here is the height of the sonic anemometer.

Page 7685, LN15-17: There will also be synotpic influences.

Reply: Corrected. The atmospheric stability was also affected by the weather condition.

Page 7685, LN22-23: No synoptic influences?

Reply: Yes. The wind direction was not only affected by synoptic system but also the local buildings, because the buildings in this sector are higher than the EC system.

Page 7686, LN1: need to indicate for what period these data for.

Reply: Corrected. The precipitation data are measured from 2006-2009.

Page 7686, LN3: Italics like other symbols. I do not really like this uncommon notation. It should at least be subscripted like your Fc.

Reply: Corrected.

Page 7686, LN4: what are the characteristics of precipitation in wet and dry seasons? For example - period of rain and dry. What are the impact on data availability? How quickly are observations being included after rain?

Reply: More than 80% of the precipitation falls in the wet season. EC observation in the periods of rain is inaccurate, and data gaps mostly occur in these times of periods. We deleted these data according the AGC value of LI-7500. These gaps are filled in the gap-filling procedure. The AGC values usually return to normal 2 hours after rain.

Page 7686, LN5-6: The data analyzed in this section – are both the sensible and latent heat flux observed? Or are there hours when the sensible heat flux is observed but latent or CO2 are not ?

Reply: Latent heat and sensible heat flux are filled in the post-processing. The Bowen ratios in the months when data were missing are calculated by filled data.

Page 7686, LN9: changing units - in the paper - make all consistent- in text and figures.

(not all marked)

Reply: Corrected.

Page 7686, LN13: Does it vary that much – provide data or reference to support this

Reply: The figure shows the raw data time series. Some spikes in the data are not removed.

Page 7686, LN14-15: Fig 5c – remarkably flat after the break in data in near the end of 2008. Figure 7 - can you plot this for each year - eg the mean 3 month period for each year is there a big change between years that is being masked by the averaging over the 4 years?

Reply: The high values of Fc from the end of 2008 to 2009 were due to more traffic and the reopening of some factor around Beijing after the Olympic Games. There is no big change between years except for the 2008. The diurnal course of Fc is lower in 2008 than other years. Since the diurnal pattern of Fc was analyzed in the paper by Song and Wang (2012), the diurnal course of Fc in 2008 was deleted in this manuscript.

Page 7686, LN20: discussion about rainfall frequency and high evaporation after the frequent rainfall events rather than the total amount of precipitation. is it the timing of the rain during the day?

Reply: Corrected.

Page 7686, LN22: Is this based on a statistical test?

Reply: The statistical numbers are added.

Page 7687, LN1-2: Given the seasons have been introduced earlier this probably is not needed here - i.e. move some of this earlier

Reply: Corrected.

Page 7687, LN10: units

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Reply: Corrected.

Page 7687, LN10-11: both parts of this need further explanation

Reply: Some of the data, such as traffic data etc., was unavailable until now.

Page 7687, LN17: single

Reply: Corrected.

Page 7687, LN18: In these plots it does not look as though activities are starting earlier. What about the role of vegetation? Is daylights savings used?

Reply: In summer, the people usually start to work earlier than in winter. The vegetation can partly influence the diurnal course, but the two peaks of Fc are mainly due to the human activities. The daytime in the summer is also longer in summer than in winter. This resulted in the evening peak longer in summer than in winter.

Page 7687, LN27: could delete these two words.

Reply: Deleted.

Page 7687, LN28: are there numbers to support this?

Reply: Statistical numbers are added.

Page 7688, LN8: London summer data? Helfter

Reply: The reference is added.

Page 7688, LN11: Analysis of the footprint surface characteristics are needed.

Reply: Analysis of the footprint characteristics is added.

Page 7689, LN17: put annual values in the Table. How does wind direction frequency differ better years? Is the lower annual value for 2008 from the summer?

Reply: Corrected. No major differences of wind direction frequency were found in

different years. The lower value in 2008 was mainly due the Olympic Games in the summer.

Page 7689, LN23: delete this text

Reply: Deleted.

Page 7689, LN23: measurements.

Reply: Corrected.

Page 7690, LN1: need to show some data within the paper to support this conclusion

Reply: Unfortunately, the detailed traffic data are unavailable until now.

Page 7690, LN8: analysis of the footprint data are needed within the paper to support this

Reply: Corrected.

Table1 What is the order of this data? Have these all been gap-filled? It would be useful to indicate what year these data relate to in each study and number of years the are averaged over. The suburban and urban definition are not clear here. Better to use a characteristics that does not require cultural interpretation as I thought some of these sites in this table were different to your classification. Put the individual year values in the table

Reply: The order of this data is corrected chronologically. More information of the dataset is provided in the table.

Fig.3 What percentage of the data are shown in the histogram? Do the data extend to+/- 5? It would be more logical to have the transition plotted between day and night

Reply: The percentages of the cases of z/L at the interval of 0.1 are shown in this histogram. The values of z/L from -5 to 5 are considered in the analysis. The order of the transition is corrected.

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Fig.5 How do you have data when there seems to be a whole month missing? How much data had to be present to be included? Maybe different symbols to indicate variations in data availability? This is a nice plot.

Reply: The Bowen ratios in the months when data were missing are calculated by filled data. More information is provided.

Fig.6 Is there equal data availability for both fluxes? Show interquarile range to help demonstrate the lack of difference between the seasons.

Reply: Yes. The data for different season were almost equal. The figure is corrected.

Fig. 7 x axis- Time (h) - and on previous graphs ie. for all indicate variable and units. Need to indicate which mean

Reply: Corrected. The figure caption is also corrected.

Fig. 8 Need information about the surface relative to these directions. i.e. surface characterisitics of corresponding footprints (i.e. anlayis of data from Figure 1). Reduce the text above the last two columns to the essential material – the rest shoudl be in this caption

Reply: Corrected. More analysis of surface characterisitics of corresponding footprints is added in the text.

Fig.9 Need to have error bars defined in caption.

Reply: Corrected. The error bars are defined in the caption.

Fig.10 Need to have equation and statistics defined in caption. Significant figures of equation needs to be fixed. Put the 2008 Olympics data points in a different symbol.

Reply: Corrected. Significant figures are fixed.

Thanks again for the valuable comments and suggestions.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 7677, 2012.

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