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Atmospheric Chemistry and Physics Discussions

# *Interactive comment on* "The impact of circulation patterns on regional transport pathways and air quality over Beijing and its surroundings" *by* J. P. Zhang et al.

**Anonymous Referee #1**

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General comments:

In this work, the authors investigated the potential impacts of regional atmospheric circulation patterns, which are determined via obliquely rotated T-mode principal component analysis (PCA) of surface layer pressure over North China, on regional transport pathways and air quality over Beijing. The authors found that CT 1 (high to the west with a strong pressure gradient), which is characterized by a northwestern origin, and CT 6 (high to the northwest), which has air mass sources mostly from the north and east, are the two favorable CTs for good air quality in Beijing. And they believed that CTs are the primary drivers of day-to-day variations in pollutant concentrations over



Beijing and its vicinity. I have some questions which are needed to be addressed.

1. How about the contributions of local emissions and air pollutants from surround regions to the air quality in Beijing? How do CTs impact on Beijing air quality? Via reducing local pollutants concentration or transporting air pollutants to Beijing?

2. What are the major differences between northern air mass and southern air mass and their impacts on Beijing air quality? Dust storm, which usually comes with northern air mass, can impact Beijing air quality and PM10 concentration. The impact of dust storm on Beijing air quality is expected to be associated with certain atmospheric circulation patterns. But I do not find this information in CTs analysis.

Special comments:

1. P33466, L3: "provided holistic evaluation". It is hard to say the evaluation in this study is holistic.

2. P33466, L9-16. It seems the authors believed that regional transport pathways associated with the 9 CTs show more significant impacts on Beijing air quality rather than local meteorology. How do the authors think about the impacts of local meteorology associated with the 9 CTs on Beijing air quality?

3. P33467, L1: "e.g. frequent precipitation". Based on table 1, precipitation day frequency associated with the 9 CTs has little impact on air quality. CT 8 and 9 have high precipitation day frequency, but they still have bad visibility.

4. P33467, L3-6. The relative contribution of synoptic circulation to SO2 can be high up to 41$\pm$36%, two times higher than other species. Why?

5. P33470, L14-15. Why is the domain determined from 32 to 49 N and 103 to 129 E? Can the region of the domain be changed? If the domain is changed, how about the results associated with CTs? Will the conclusion be changed? Sensitive study should be presented here.

6. P33470, L16-18. Why do the authors not include 06:00 UTC (14:00 LT) reanalysis data to represent daily circulation type? The radiosonde coverage shows little relation to surface layer pressure which is used to determine CTs in this study. If the authors use the 06:00 UTC or 0000+06:00 UTC reanalysis data, what are the major changes to the conclusions? It should be discussed in the manuscript.

7. P33470, L19-22. Beijing is a megacity, while Beijing Capital International Airport is located at suburbs about 20-30 km away from downtown. How can the meteorology parameters measured at the rural site to represent the local meteorology characteristics at the urban region?

8. P33471, section 2.2. Here, the authors only used one site air pollutants measurements to represent Beijing air quality. It is a problem. How to evaluate the representativeness of PKU site?

9. P33474, L25-27. The modeling results from WRF are very important for FLEXPART and footprints simulations and related discussions. The validation of WRF results is too weak in this paper. Statistical analysis of measurements and simulations is better than just say "were generally in good agreement with the observations". One site validation is not enough. Many WMO sites can provide basic measurements of meteorology parameters. Synoptic chart can also be used to evaluate the wind field and precipitation field. Planetary boundary layer height and wind field are important for air pollutant transport and trajectories simulation. Therefore, PBLH and vertical wind field should be validated too.

10. P33478, L10. Why does CT 3 have good visibility (11.1 km)? CT 3 has low wind speed (2.08 m/s), low PBLH (1.14 km), high RH (65.7%) and most local sources. All these are not favorable for good visibility.

11. P33481, L17-19. CT 3 has heavy PM10 and BC loading, but its AOD are not very high. Why?



12. P33482, L10-12. Particles also have large variations of the emission rate. Why the distributions (variances) of the particle concentration in some specific CT are not as large as those of the gaseous concentration?

13. P33482, L14-15. According to the authors' previous explanation, CT 1 can transport northern clean air to reduce local air pollutant concentrations in Beijing. But we found SO2 concentration is very high under CT 1. Fossil fuel combustion for heating can also enhance BC emission, why is BC loading still very low under CT 1?

14. P33483, L8-10. Did the authors analyze the relations between CTs and sulfate concentration? How about the variations of ammonium and nitrate during the same period? They are major components of particle pollutant in Beijing, thus the authors should discuss about them. How about O3 during the same period?

15. P33483, L12-17. According to Fig. 10, CT 5 and 9 are associated with high SO2 concentration, while CT 6 and 8 are associated with low SO2 concentration. From Aug 24th to 30th, the dominate CT is 5 and 9, but SO2 concentration is always very low. Why?

16. P33483, L24-29. The authors said "under emission control the air quality improved significantly during the Olympics". Now the authors concluded that "The large variations in air pollutant concentrations and the delay in air quality improvement cannot be explained by the control measures only because the pollutant episodes and clean Olympics episode were characterized by different circulation types". How do the authors comment on the contribution of emission control to air quality improvement during the Olympics?

17. P33485, L10- P33486, L13. I think the quantitative analysis of the impacts of synoptic circulation and emission reduction on air quality during the Beijing Olympics is not solid. The assuming of the relationships between CTs and air quality parameters in the same season (month) are constant in different years is not right. During the period 2000-2009 (except 2008), the background air pollutant concentration, the re-

gional emission distribution and intensity have been changed significantly. Therefore, the relationships between CTs and air quality parameters in the same season will be changed. Why is SO2 so sensitive to synoptic circulation? According to the discussion at P33482, L14-15, SO2 concentration is more sensitive to emission rate rather than CTs.

18. P33486, L17-20. The two are not comparable.

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