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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Formation and evolution mechanism of regional haze: a case study in the megacity Beijing, China" *by* X. Liu et al.

Anonymous Referee #2

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Overall

This paper presents measurements of aerosol properties and meteorological conditions during a severe 8-day haze period occurred in Beijing, China, with the aim of identifying the formation and evolution mechanisms of haze. Chemical, physical, and optical measurements of the gas- and particle-phase aerosols are described, and satellite images are used to support the analysis. The main conclusion is that the formation of the haze is the result of a combination of several factors, including high-level pollutants, stagnant air, and the new particle formation, with the new particle formation being the most important factor. While the high-level pollutants and the meteorological conditions are relatively well-established reasons for the formation of haze, the new contribution from this study is that new particle formation is the most important factor

that causes haze formation. However, there is lack evidence or analysis that supports this argument, and more in-depth analysis is needed to justify this conclusion. In addition, despite the multiple measurements, e.g., gas-phase, light scattering/absorption, and satellite images, they are presented independently, in other words, these measurements are not integrated to substantiate the main results. For example, is there quantitative relation of new particle formation and light scattering/extinction? Therefore, more comprehensive analysis could be done to support the conclusions. There are also some descriptions in the text that are not consistent with what the figures show. Specific comments are presented below.

Specific comments

1. New particle formation is considered to be the most important factor contributing the formation of haze. This is argument is not justified in the manuscript. There are three paragraphs in Section 3.2.4 discussing new particle formation, but only the third paragraph describes the new particle formation observed during this study (Fig.9). It is not stated how and why new particle formation is the more important than the other parameters, such as the synoptic weather system. Also Fig. 9 shows that particle grew from 100 nm during non-haze period (Sep 20-23) to 200 nm in haze period (Sep 24-27), the 200 nm particles are too small to significantly enhance aerosol light scattering. To me, it seems the high-level pollutants and the meteorological conditions are the most important parameters for haze formation as well as new particle formation.

2. Section 3.2.5, the discussion of the impact of hygroscopic growth on aerosol scattering is quite general. There is no analysis of how hygroscopic growth during this measurement affects the aerosol scattering and contributes to the haze formation or evolution.

3. Did the optical measurements give consistent results? For example, bext is the sum of bsp and bap, but this is not support by Fig. 2.

4. P16267, L13, "Pollutants SO2, NO2 and CO, being the emissions from biomass,

fuel and coal burning, had the same increasing trend from 20–27 September."

It seems the SO2 and NO2 are quite stable and increasing trend is not clear. The trends of SO2/NO2 and CO are also different as shown in Fig. 1.

5. P16269, L7, "In addition, the air temperature sharply decreased on 24 September, and the decreasing trend remained till 26 September, which could have caused the lack of the thermal dynamics for the development of the PBL"

The temperature on September 25-26 is 1-2 degrees lower than on September 20-23, so the sharp temperature decrease did not last till 26 September (Fig. 6).

6. P16269, L9, "The RH increased from 24 September, which could have resulted in the hygroscopic growth of aerosol scattering."

The increase of RH from 24 September is not obvious (Fig. 6), and there is no relation of RH and visibility or light scattering.

7. P16269, L2, "low wind speed provided a longer contact time among aerosols and trace gases, and could possibly enhance the formations of new particles"

Low wind speed favors accumulation of aerosols and hence aerosol surface area increases under low wind speed conditions, which could inhibit new particle formation. This can be seen from Fig. 6 and Fig. 9: When wind speed is low during September 23-27, new particle formation did not occur. How does low wind speed enhance new particle formation?

8. P16271, P12, "High temperature and high humidity promoted the photochemical formation of particulate matters."

I don't think high humidity promotes photochemical formation of particles. What is the basis of this argument?

9. P16273, Section 3.2.6, this section describes the relation of visibility and PM2.5, which is not related to the "formation and evolution mechanisms of regional haze " of

Section 3. So Section 3.2.6 could be Section 4.

10. P16275, L1, "At the beginning, plenty of sunlight and higher temperature provided favorable conditions for photochemical reactions and generated more ozone and fine particles."

The temperature is not significantly higher at the beginning of the measurement (Fig. 6) and less ozone (not more ozone) was formed at the beginning (Fig. 1).

Technical corrections

1. The APS data are not shown in the text or in the figures, so APS should be removed from the experimental section and Table 1.

2. The figure legends in Figure 4 and Figure 7 are too small and hard to read.

3. Figure 7, add (a), (b)... to the figure legends.

4. P16260, L8, remove "(RH)" in the abstract since it is defined at L26 on this page.

5. P16261, L17, change "frequently has occurred" to "has frequently occurred."

6. P16262, L3, change "yr" to "years."

7. P16262, L4, change "extremely haze" to "extreme haze."

8. P16262, L6, "Haze episodes have been now characterized by increasing frequencies, longer duration and expanding sphere." Are there references for this sentence?

9. Section 2.2 re-order the description of the measurements in this section or in Table 1 to make them in the same order for smooth reading.

10. P16266, equation (1), define "Vis" in the equation as visibility here rather than on P16268.

11. P16266, "In this study, we used the coefficient of variance of LIDAR signals calculated by Eq. (2) to detect the height of the PBL." This sentence is not very clear. Also,

are there references for this method?

12. P16269, L10, “which could have resulted in the hygroscopic growth of aerosol scattering.” The “hygroscopic growth of aerosol scattering” in this sentence is not clear.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 16259, 2012.