

Interactive comment on “Dome effect of black carbon and its key influencing factors: A one-dimensional modelling study” by Zilin Wang et al.

Anonymous Referee #1

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The authors used WRF-Chem single-column model combining with available in-situ observation to quantify the impacts of some key factors on BC's dome effect. They demonstrated that the dome effect of BC aerosols strongly depends on the vertical distribution and aging process of BC, as well as the underlying land surface. The technical work appears to be competent. The paper contains important addition to existing literature, and is suited for publication to ACP. However, there are several concerns that should be addressed or considered before being accepted for publication.

(1) Model configuration: In terms of mixing state of multiple aerosol chemical compositions, the authors presume that the aerosols in each bin were internally mixed, which

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would overestimate the light-absorbing capability of BC aerosols. In the atmosphere, a large amount of aerosol mass was partitioned onto BC-free particles rather than internally mixing with BC.

(2) P5/L17: When the abbreviation regarding “SNA” first appeared in the paper, the author should also give its full terms.

(3) Why the author only considered BC mixing with SNA? Why not consider other aerosol compositions, especially organic species that play an important role in the mass fraction of aerosol particles.

(4) Figure 1 shows the heating efficiency of BC due to shortwave radiation absorption peaked around 600-800 m. But the strongest upper-air warming exhibited at 1000-1200 m shown in Fig. 2, different with the height of the largest heating efficiency of BC. The author need to explain the reason.

(5) According to the vertical profile of shortwave heating rate included by unit BC mass (Fig. 1), the authors discussed that BC in the upper PBL is more efficient in terms of absorbing shortwave radiation and heating surrounding air masses. To support the author’s statement on the upper PBL, Figure 1 need to show the average PBL height in the afternoon (12:00-16:00 LT) during a heavy polluted episode 23rd-24th December, 2013 in Beijing.

(6) P6/L25-27: The authors state here that Figure 3a displayed the information of the incident solar radiation at the surface, decline in surface temperature and surface sensible heat flux. I did not found these information in Fig. 3a. The authors should check.

(7) In Fig. 3b, what does the black dash line represent? Authors should state it in the caption of the figure 3.

(8) P7/L4: According to the data shown in Fig.4, the increment of increase BC concentration from 0 to 30 $\mu\text{g m}^{-3}$ should be 5 $\mu\text{g m}^{-3}$ rather than 2 $\mu\text{g m}^{-3}$.

(9) P8/L10-15: The calculation method of absorption coefficient amplification factors of

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BC was different with that in the literature. Authors calculated the absorption amplification of BC aerosols based on the BC/SNA ratio during different periods (i.e., clean period: BC/SNA=1:3, haze episode: BC/SNA=1:8). The obtained absorption amplification (i.e, 1.8, 1.7, 1.6 and 1.4 at wavelength 300, 400, 600 and 1000 nm) was then compared with previous laboratory and in-situ observational studies. However, the absorption amplification of BC aerosols in previous studies represents that the enhancement of light absorption of BC-containing particles due to coating materials on BC surface comparing with bare BC.

(10) In Fig.5, authors used BC/SNA ratio of 1:3 and 1:8 to calculate the aerosol absorption coefficient at clean period and haze episode, respectively. They should give the data sources of BC/SNA ratio at different periods. Moreover, Fig.5 also shows the solar spectral irradiance at sea level (bright yellow shadow). However, there was not any discussion on this information in the paper. Why did the authors give solar spectral irradiance at sea level in Fig. 5.

(11) Considering most of days in north China characteristic of RH lower than 50%, I suggest adding a case of RH=30% in Fig.6. Moreover, authors gave the absorption extinction coefficient at a certain wavelength (i.e., 400 nm), they should state it in the caption of the figure 6.

(12) RH at a certain SNA influence not only aerosol particle diameter but also their reflective index (RI). Authors mentioned the change of aerosol particle diameter at different levels of RH (P8/L17-18). Did they also consider the RI change? The authors should give detail description on data process at different levels of RH in Sect. 2 (data and method), such as the diameter growth factors and RI setting in the model calculation.

(13) When investigating the impacts of BC aging process on light absorption, authors discussed the difference of absorption under difference BC/SNA ratio, shown in Fig.5 and Fig.6. However, why they fixed a value of BC/SNA ratio (i.e., 1:6 shown in Fig.

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7) rather than using different BC/SNA ratio as above two figures to further discuss the impacts of BC aging process on PBL height? Figure 5 shows different BC/SNA ratio under different pollution levels (i.e., clean period: BC/SNA=1:3, haze episode: BC/SNA=1:8) based on in-situ observation from literature, indicating that BC/SNA ratio will change with BC concentrations. Therefore, it seems to be unreasonable to assume same BC/SNA ratio under different BC concentrations.

(14) When BC concentration is lower than $2 \mu\text{g m}^{-3}$, the PBL height variations due to specific BC distribution shown in Fig. 9 exhibited significant difference with that shown in Fig.4. Why?

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