Reply to: Interactive comment on “A case study of dust aerosol radiative properties over Lanzhou, China” by L. Zhang et al.

Anonymous Referee #1

Comment 1:

Page 6, line 14-25: it is better to show the results of aerosol LR by table list.

Reply: Grateful to the suggestion of the referee. The LR will be illustrated by Table 2 as follows:

Table 2. Lidar ratio from observations and numerical simulation

Authors	Aerosol type	Location and period	LR , sr (532 nm)
Ackermann, 1998	continental aerosol maritime aerosol dust aerosol	Numerical simulation	40–80 15–30 17–25
Liu et al., 2002b	Asian dust aerosol	Japan, 1998–1999	42–55
Immler and Schrems, 2003	Saharan dust aerosol	Atlantic Ocean June, 2000	45
Balis et al., 2004	Dust aerosol	Thessaloniki, Greece 2001–2002	20–100
He et al., 2006	Oceanic aerosol	Hong Kong, China 2003–2004	18–44
Xia, 2006; Han, 2007	Pollution, Dust aerosol	Lanzhou, China	20–25
Chiang et al., 2008	Background aerosol Dust aerosol	Taiwan, China 2002–2004	47 ± 15 44 ± 19
Xie et al., 2008	Moderate pollution Heavy pollution Asian dust aerosol	Beijing, China December 2007	60.8 ± 13.5 43.7 ± 8.3 38.3 ± 9.8

Comment 2:

Page 7, line 6-10: it is useful for the characteristics of wind speed, temperature and humidity by routine meteorological data. Please give more detail, if possible.

Reply: A More detailed description has been added to the revised manuscript. It is of vital significance to analyze wind, temperature, humidity and other meteorological characteristics by the routine meteorological data observed at the corresponding site and time period. Nevertheless, due to insufficient routine meteorological observation data during the dust storm the research used the data of wind speed and direction from three-axis sonic anemometer CSAT3, surface temperature and relative humidity from Vaisala HMP45C-L/7, and vertical profiles of temperature and relative humidity from microwave radiometer TP/WVP-3000 instead.

The revision is as follows:

The maximum wind speed was about 10.0 m/s. The relative humidity and temperature were shown in Fig. 2, of which the surface relative humidity and temperature were measured by Vaisala HMP45C-L/7, while the vertical profiles of relative humidity and temperature observed by profiling microwave radiometer TP/WVP-3000. During the dust storm, the surface relative humidity presented a diminishing trend from 60% at 00:00 to 10% at 20:00 on 27 March (see Fig. 2b). The surface temperature was 15.0 ℃ at 12:00 on 27 March when no dust storm remained, and it was 12.5 ℃ at 12:00 on 28 March (see Fig. 2c), which means that dust aerosol probably plays a part in the cooling process of the surface.

Comment 3:

Page 9, line 1-10: Please add more description for the AOD obtained by sunphotometer.

Reply: The retrieval method of AOD by the data of sunphotometer has been elaborated in the revised manuscript as follows:

The sunphotometer measures direct solar radiance in voltage shown in Eq. (5):

$$V_\lambda = \left(V_{0\lambda} / R^2\right)\exp\left(-\tau_\lambda m\right) \tag{5}$$

Where V_λ is the wavelength specific voltage, $V_{0\lambda}$ the calibration constant, R the Sun-Earth distance, and m the relative optical air mass which is approximated as the secant of the solar zenith angle. $V_{0\lambda}$ can be derived from the Langley method. If $V_{0\lambda}$ is already known, the optical depth can be obtained by Eq. (6):

$$\tau_\lambda = -\ln\left[V_\lambda / \left(V_{0\lambda} / R^2\right)\right] / m \tag{6}$$

It is obviously known that the accuracy of τ_λ depends on the accuracy of V_λ and $V_{0\lambda}$. The total optical depth is the results of attenuation by molecules, aerosol, ozone, water vapour, and other uniformly mixed gases, and each of these components can be separated. The atmospheric scattering optical depth can be derived in Rayleigh scattering theory (Hansen and Travis, 1974). The ozone optical depth can be obtained based on tabulated values of ozone absorption coefficient and assumption about ozone amount (Komhyr et al., 1989). The optical depth resulted from other mixed gases can usually be ignored because the impacts of such gases are beyond the band of the sunphotometer. Then the aerosol optical depth (AOD) can be calculated by Eq. (7):

$$\tau_{a\lambda} = \tau_\lambda - \tau_{oz\lambda} - \tau_{r\lambda} \tag{7}$$

The level 1.5 cloud-screened AOD data at 1020, 870, 675, and 440 nm from AERONET are used to derive the AOD at 532 nm using Eq. (8) for a comparison with AOD retrieved by micropulse lidar:

$$\ln\left(\tau_{a\lambda}\right) = \mathrm{a}_1 + \mathrm{a}_2 \ln(\lambda) + \mathrm{a}_3 \left[\ln(\lambda)\right]^2 \tag{8}$$

Comment 4:

Figure 5 and Figure 7, it is different for the peak value of AOD and PM_{10} concentration. i. e. the peak value of AOD at 12:00 March 28 and PM_{10} is at 22:00 March 27. Please give the possible reason.

Reply: The discrepancy of the peak value of AOD and PM_{10} concentration at different time (shown in Fig. 5 and 7) can be discussed in two points.

1. The aerosol vertical distribution was inhomogenous during the dust storm. AOD retrieved from lidar observation reflects integrated extinction properties within lidar detecting range, while PM_{10} concentration measured on ground surface represents the surface aerosol concentration.

2. The aerosol size distribution was changing at different stages of the dust storm. AOD has the scattering effect of the total particulates suspending in the atmosphere, while the PM_{10} concentration reveals the concentration of the particles with a dynamic diameter of less than 10 μm.

References

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