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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Dust aerosol radiative effect and influence on urban atmospheric boundary layer" *by* L. Zhang et al.

L. Zhang et al.

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Thank you very much for your valuable comments that have really helped in amending the paper. Authors’ replies are as follows.

1. Q: The paper of Zhang (2001) is not available to a wider scientific community. Therefore, it is difficult to judge what the features and performances of the ANL model described there are. A: The ABL model is developed and improved by Dr. Lei Zhang et al through years, which has been developed into an 1.5-order closure model on the basis of a first-order closure K model (Zhang, et al., 2001). It can be used to work out a better simulation of meteorological field and air pollutant diffusion over urban complex terrains. The model has been validated with the ABL and air quality data and the result shows that the simulated temperature and wind fairly agree with the actually observed temperature, wind profile and surface wind field (Zheng and Zhang, 2006,

2007, Zhang, et al., 2007). According to your helpful comments, it was added in the paper (page4, paragraph 5).

Zhang, L., Chen, C. and Murlis, J. (2001): Study on winter air pollution control in Lanzhou, China. Water Air and Soil Pollution, 127: 351-372. Zheng, F., Zhang, L., and Zhu, J. (2006): Responses of urban atmospheric boundary layer to aerosol radiative effect over complex terrains in winter, Chinese Journal of Atmospheric Sciences, 30(1), 171-179. Zheng, F., Zhang, L., Zhu, J. and Wang, H. (2007): Simulations of aerosol diffusion and distribution in urban atmospheric boundary layer over complex terrains in winter, Plateau Meteorology, 26(3), 532-540. Zhang, L., Chen, M., and Chen, C., Interaction of atmospheric aerosol and temperature, wind fields, accepted by Advances in Atmospheric Sciences.

2. Q: WRF model has its own radiation scheme. The authors did not use it, instead they implemented LOWTRAN. Explain the reasons please. A: Even though the radiative scheme of WRF model is quite good, it is unable to present a satisfactory description of radiative effect in much higher aerosol concentration. It is difficult to input the local lidar data into WRF model at present. In this case, we adopt a comprehensive model by combining the ABL model with LOWTRAN. Moreover, after a long-term improvement, the ABL + LOWTRAN system can well simulate the aerosol radiative effect in urban atmospheric boundary layer.

3. Q: I find it rather insufficient the use of single lidar profile to perform the study and draw conclusions. A: The authors did take such kind of problems into consideration when they decided to use the lidar data. However, it is rather difficult to do synchro multi-spots measurement at one time. Although a single lidar profile is not satisfied to reflect the whole simulation domain during the first stage of sand storm eruption, it is fairly good for the simulation of the floating dust stage in more stable meteorological fields. Generally, the meteorological fields in floating dust air are relatively stable and with comparatively few buoyancy changes of floating dust. According to your helpful comments, it was explained in the paper (page 7, paragraph 1).

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4. Q: The authors do not refer on other cloud conditions that may substantially affect direct radiation forcing and interfere the shown results. A: The purpose of this paper is to simulate the dust aerosol radiative effect on urban atmospheric boundary layer. According to the lidar result, the authors haven’t found the cloud in this layer, so they did not calculate the cloud. According to your helpful comments, it was explained in the paper (page 7, paragraph 2).

5. Q: The results of the study indicating positive forcing in the lower atmosphere during daylight contradict to recent research of e.g. Perez et al (2006), Miller et al (2004a), Miller et al (2004b) listed below. Limitations of the study mentioned above and the fact that dust aerosol does not interact with the atmosphere on-line during the atmospheric model integration (as done in the listed references) may impose some doubts on the validity results shown in the study. The process of dust-radiation interaction has spatial and temporal variability and this is the question if a single point lidar profile data could lead to reliable results. This interaction is also highly dependent on particle size structure of the aerosol what was not taken into account in the study.

A: The aerosol radiative effect depends largely on the composition of aerosol. Because the dust was mixed with local urban air pollutants the dust property was thus changed. In such a case, the simulation result is different from Perez and Miller. According to your helpful comments, it was added in the paper (page 7, paragraph 1).

The paper simulates dust aerosol radiative effect by using the aerosol extinction coefficient profile retrieved from lidar measurement. The lidar is a Mie scattering lidar, and the particles are assumed as sphericity ones and the size is mainly less than 10 m. According to your helpful comments, it was added in the paper (page 6, paragraph 4).

6. Q: The title of the paper refers on urban ABL. However, from the study it is not obvious if the urban or non-urban environments should differ. The aerosol considered in the paper is dust, not e.g. urban pollution. A: The aerosol extinction coefficient

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was measured in Beijing under floating dust condition. Therefore, the result reflects not only dust aerosol but also urban air pollution aerosol. The air pollution in Beijing winter mainly derives from coal burning and automobile tail gas. The pollutants cannot diffuse quickly in floating dust weather. In such a case, the lidar observation data reveal a total atmospheric characteristic including urban atmospheric pollution and sand dust air. Hence the word ‘Urban’ in the title. According to your helpful comments, it was added in the paper (page 7, paragraph 1).

The related contents have been marked in the paper by the blue color typeface.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 15565, 2007.