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Atmospheric Chemistry and Physics
Discussions

Interactive comment on "Seasonal and spatial variations in aerosol vertical distribution and optical properties over China from long-term satellite and groundbased remote sensing" *by* Pengfei Tian et al.

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This paper describes aerosol climatology over China using CALIPSO/CALIOP. The method used in this paper is rather simple using CALIPO version 3 level 2 data, but the results are interesting and merit publishing in ACP. The paper is generally well-written. However, some of descriptions are not correct or not reasonable. Especially, previous works are not properly reviewed and some of the references are not original and not suitable. Response: The authors are grateful for the helpful comments by this referee. All the comments and concerns raised by the referee have been considered

and incorporated into the revised manuscript.

Specific comments P2 First paragraph: In my opinion, It is not appropriate to cite too many papers with a single simple statement. In the first sentence, citing Boucher et al., is reasonable, but it is not clear at all why He et al. and Peng et al. are cited here. The same thing for the following sentences. Response: We have provided justifications for those relevant references, which have shown that the proper representation of mixing state is key to the assess the atmospheric stability because of black carbon particles.

P9 l.9 The sentence "The retrieved aerosol extinction coefficients suffer from large uncertainties ....." is miss leading. What about CALIOP level 2 data? Similar layer type classification and retrieval method using variable lidar ratio can be used for ground-based lidars. It is fine that the AOD-constrained retrieval method is used in this paper. But that is not clearly mentioned. That should be mentioned also in the caption of Fig. 2. Response: (1) This sentence has been removed from the revised manuscript. (2) CALIOP level 2 aerosol extinction coefficients suffer from uncertainties caused by the pre-assigned lidar ratios for certain aerosol types (Papagiannopoulos et al., 2016). However, the data quality of the CALIOP level 2 aerosol extinction coefficients is good enough in estimating regional aerosol climatology (Yu et al., 2010; Winker et al., 2013; Amiridis et al., 2015). (3) The AOD-constrained retrieval method has been mentioned in the caption of Fig. 2 in the revised manuscript. P9 l.12: It is not Huang et al. who first introduced the AOD-constrained Fernald method. The method was used already in 1994, for example, in Takamura et al, Appl. Opt. 33 (30) 7132-7140 (1994). If the AOD-constrained method was employed, it would be useful to present a histogram of the derived lidar ratio value. Response: (1) We have cited Takamura et al. (1994) for the AOD-constrained Fernald method. We have also revised our description to make it clearer to readers. (2) A histogram of the derived lidar ratio has been included in the supplement of the revised manuscript (Fig. S11).

P12, l.19: The volume depolarization ratio includes molecular scattering contribution. The discussion is consequently not very quantitative (though it is still useful). The definition in Eq. (4) is fine, and the contribution in the lower height is dominant. So the contribution of molecular scattering is probably not significant. The situation should be mentioned. Response: This situation has been discussed in the revised manuscript.

Figure 8: Definition of height should be provided. The profile with a large secondary peak in PRD MAM seems unusual as a climatological profile. What is the number of profiles averaged in this profile? The number of the data used and the error bars of the profiles should be presented. If the secondary peak is real, the source of aerosols in the secondary peak must be discussed. The descriptions in p. 18, l. 2-3 do not explain the cause of the secondary peak. Fan et al. paper is on the meteorological condition on October, not MAM. As to the vertical profile in Guangzhou, the following paper should be cited. It describes non-dust aerosol climatology in Beijing and Guangzhou using ground-based lidars and CALIOP. Hara et al., (2011) "Seasonal Characteristics of Spherical Aerosol Distribution in Eastern Asia: Integrated Analysis Using Ground/Space-Based Lidars and a Chemical Transport Model" Scientific Online Letter on the Atmosphere, Vol. 7, 121-124, doi:10.2151/sola.2011-031 (https://www.jstage.jst.go.jp/article/sola/7/0/7_0_121/_article/) Response: (1) The definition of height has been added in the caption of Fig. 10 of the revised manuscript. (2) In our study, 3200 aerosol layers were detected by CALIOP in the PRD region in spring. The extinction coefficient of the detected aerosol layers were used to calculate an average profile. The average extinction profile with error bars in the PRD region in spring is shown in Fig. S12. (3) The profile with a large peak in the PRD MAM seems to be true, which has been proven by a recently published paper (Heese et al., 2016). Heese et al. (2016) used a multi-wavelengths Raman and depolarization lidar to observe aerosol vertical distribution at Sun Yat-sen University of Guangzhou in the PRD region. They found a lofted aerosol layer in the altitudes of 2 to 5 km in spring and characterized the aerosol type using the aerosol optical properties. They also used backward trajectory analysis to determine the origin and the sources of the lofted layers. They found that particles in the lofted aerosol layers in the PRD region are locally and regionally produced pollution mixtures. (4) The recommended refer-

ence has been cited in the revised manuscript. References Amiridis, V., Marinou, E., Tsekeri, A., Wandinger, U., Schwarz, A., Giannakaki, E., Mamouri, R., Kokkalis, P., Binietoglou, I., Solomos, S., Herekakis, T., Kazadzis, S., Gerasopoulos, E., Proestakis, E., Kottas, M., Balis, D., Papayannis, A., Kontoes, C., Kourtidis, K., Papagiannopoulos, N., Mona, L., Pappalardo, G., Le Rille, O., and Ansmann, A.: LIVAS: a 3-D multi-wavelength aerosol/cloud database based on CALIPSO and EARLINET, Atmos. Chem. Phys., 15, 7127-7153, doi:10.5194/acp-15-7127-2015, 2015. Heese, B., Baars, H., Bohlmann, S., Althausen, D., and Deng, R.: Continuous vertical aerosol profiling with a multi-wavelength Raman polarization lidar over the Pearl River Delta, China, Atmos. Chem. Phys. Discuss., 2016, 1-25, doi:10.5194/acp-2016-733, 2016. Papagiannopoulos, N., Mona, L., Alados-Arboledas, L., Amiridis, V., Baars, H., Binietoglou, I., Bortoli, D., D'Amico, G., Giunta, A., Guerrero-Rascado, J.L., Schwarz, A., Pereira, S., Spinelli, N., Wandinger, U., Wang, X., and Pappalardo, G.: CALIPSO climatological products: evaluation and suggestions from EARLINET, Atmos. Chem. Phys., 16, 2341-2357, 2016, doi:10.5194/acp-16-2341-2016, 2016. Takamura, T., Sasano, Y., and Hayasaka, T.: Tropospheric aerosol optical properties derived from lidar, sun photometer, and optical particle counter measurements, Appl. Opt., 33, 7132-7140, doi:10.1364/AO.33.007132, 1994. Winker, D.M., Tackett, J.L., Getzewich, B.J., Liu, Z., Vaughan, M.A., and Rogers, R.R.: The global 3-D distribution of tropospheric aerosols as characterized by CALIOP, Atmos. Chem. Phys., 13, 3345-3361, doi:10.5194/acp-13-3345-2013, 2013. Yu, H., Chin, M., Winker, D.M., Omar, A.H., Liu, Z., Kittaka, C., and Diehl, T.: Global view of aerosol vertical distributions from CALIPSO lidar measurements and GOCART simulations: Regional and seasonal variations, J. Geophys. Res., 115, D00H30, doi:10.1029/2009JD013364, 2010.

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