1. Response to Pro.f T.T. Cheng

General comments:
This paper studied more than 10 years' measurements of aerosol optical depths and Angstrom exponents made for 50 sites of CARSNET compiled into a climatology of aerosol optical properties for China. This is an outstanding work about the ground-based aerosol optical property study. It lets us see a detailed full-scale description of AOD observations over China. The results would benefit us a lot in comprehending the temporal and special distribution aerosol optical property over China. Also the data would be worthful to those communities of aerosol satellite retrieval, modelling validation, numerical assimilation, etc. I do think CARSNET contributions to science would be extremely important for Chinese science and the world in future. This article is clearly structured and English usage is very good, well suited for the publication in ACP. I just have few minor suggestions for the author to consider before the final publication.
Response: The authors would like to thank for the reviewer's positive comments.

Special comments:
(1) Introduction part: I suggest the authors include more related references about ground-based aerosol optical property study of China. As far as I know, there are at least 10 references about Cimel aerosol optical property study which the authors ignored to cite in the context.
Response: According to the reviewer's suggestion, the following 14 references have been added in the revised paper:

1. *Chaudhry, Z., Martins, J. V., Li, Z., Tsay, S.-C., Chen, H., Wang, P., Wen, T. , Li, C., and Dickerson, R. R.: In situ measurements of aerosol mass concentration and radiative properties in Xianghe, southeast of Beijing, J. Geophys. Res., 112, D23S90, 2007. doi:10.1029/2007JD009055.*
2. *Che, H., Xia, X., Zhu, J., Wang, H., Wang, Y., Sun, J., Zhang, X., and Shi, G.: Aerosol optical properties under the condition of heavy haze over an urban site of Beijing, China. Environ. Sci. Pollut. R., 22, 1043-1053, 2015a. DOI: 10.1007/s11356-014-3415-5*
3. *Che, H., Zhao, H., Wu, Y., Xia, X., Zhu, J., Wang, H., Wang, Y., Sun, J., Yu, J., Zhang, X., and Shi, G.: Analyses of aerosol optical properties and direct radiative forcing over urban and industrial regions in Northeast China. Meteorol. Atmos. Phys., 127, 345-354, 2015b. DOI 10.1007/s00703-015-0367-3.*
4. *Chen, J., Jiang, H., Wang, B., Xiao, Z., Jiang, Z., Zhou, G., and Yu, S: Aerosol optical properties from Sun-photometric measurements in Hangzhou, China, Int. J. Remote. Sens.,33, 2451-2461, 2012. doi: 10.1080/01431161.2011.611184.*
5. *Cheng, T., Liu, Y., Lu, D., Xu, Y., and Li, H.: Aerosol properties and radiative forcing in Hunshan Dake desert, northern China, Atmos. Environ., 40, 2169-2179, 2006. doi:10.1016/j.atmosenv.2005.11.054*
6. *Cheng, T., Xu, C., Duan, J., Wang, Y., Leng, C., Tao, J., Che, H., He, Q., Wu, Y., Zhang, R., Li, X., Chen, J., Kong, L., and Yu, X.: Seasonal variation and*

difference of aerosol optical properties in columnar and surface atmospheres over Shanghai, Atmos. Environ., 2015. doi: 10.1016/j.atmosenv.2015.05.029 (in press).

7. *Li, B., Yuan, H., Feng, N., and Tao, S.: Comparing MODIS and AERONET aerosol optical depth over China, Int. J. Remote. Sens., 30, 6519-6529, 2009.*
8. *Logan, T., Xi, B., and Dong, X.: A comparison of the mineral dust absorptive properties between two Asian dust events, Atmosphere, 4, 1-16, 2013. doi:10.3390/atmos4010001.*
9. *Wu, Y., Zhu, J., Che, H., Xia, X., and Zhang, R.: Column-integrated aerosol optical properties and direct radiative forcing based on sun photometer measurements at a semi-arid rural site in Northeast China, Atmos. Res., 157, 15 56-65, http://dx.doi.org/10.1016/j.atmosres.2015.01.021.*
10. *Xue, Y., Xu, H., Guang, J., Mei, L., Guo, J., Li, C., Mikusauskas, R., and He, X.: Observation of an agricultural biomass burning in central and east China using merged aerosol optical depth data from multiple satellite missions, Int. J. Remote. Sens., 35, 5971-5983, 2014. http://dx.doi.org/10.1080/2150704X.2014.943321.*
11. *Yu, X., Zhu, B., Yin, Y., Fan, S., and Chen, A.: Seasonal variation of columnar aerosol optical properties in Yangtze River Delta in China, Adv. Atmos. Sci., 28, 1326-1335, 2011.*
12. *Zhang, J., Chen, J., Xia, X., Che, H., Fan, X., Xie, Y., Chen, H., and Lu, D.: Heavy aerosol loading over the Bohai Bay as revealed by ground and satellite remote sensing, Atmos. Environ., 2015. doi:10.1016/j.atmosenv.2015.03.048. (in press).*
13. *Zhuang B.L., Wang T.J., Li S., Liu J., Talbot R., Mao H.T., Yang X.Q., Fu C.B., Yin C.Q., Zhu J.L., Che H.Z., and Zhang X.Y.: Optical properties and radiative forcing of urban aerosols in Nanjing, China, Atmos. Environ., 83, 43-52, 2014. http://dx.doi.org/10.1016/j.atmosenv.2013.10.052.*
14. *Zhou, C. Gong, S., Zhang, X., Liu, H., Xue, M., Cao, G., An, X., Che, H., Zhang, Y., and Niu, T.: Towards the improvements of simulating the chemical and optical properties of Chinese aerosols using an online coupled model CUACE/Aero. Tellus B, 64, 18965, 2012. http://dx.doi.org/10.3402/tellusb.v64i0.18965*

(2) Page 12719, line 18-19: One more reference of Wang et al. 2011 JGR should be added.
Response: The Wang et al. (2011 JGR) has been added in the revised context.

(3) Page 12722, line 4: It should be “Holben et al., 1998”. Please correct it.
Response: This mistake has been corrected in the revised manuscript.

(4) 3 Results: CARSNET measurements: I suggest the authors add more literatures related to prove their explanations and speculations.
Response: In the Result part, the authors have added some related publications to support the explanations and the speculations.

2. Response to Reviewer 1

Anonymous Referee #1

Received and published: 27 May 2015

The manuscript presented by H. Che et al. is an excellent compilation of a climatology of aerosol optical depth and Angstrom exponents in China, including a large number of sites with a good temporal coverage. Useful and reasonable comments are added to the main results, with an adequate use of references. Therefore, I consider this article to be very adequate to ACP. I already wrote a revision for ACPD. Therefore, I will only add a few general suggestions to the authors:

Response: The authors would like to thank the reviewer for the positive comments.

1 Page 12728, line 10: please define "fugitive dust"

Response: The definition of “fugtive dust” has been added in the revised paper. The fugitive dust refers to aerosol particles that are lifted into the air either by man-made or natural activities in urban open areas, which is typically the result from activities such as the physical movement of soil, vehicles traveling over unpaved surfaces, heavy equipment operation, blasting, and wind.

2 Many of the figures are not explicitly referred in the text. Please refer to them in the appropiate paragraphs.

Response: The type writing mistakes of the figure numbers have been corrected in the revised version.

3 Figures 6-15: the authors could add one or two horizontal hair-lines to the different histograms indicating the annual average for the whole database, and for the subgroup (urban, remote, etc) so the reader can easily point out the station AOD variation in relation to the group average.

Response: According to the reviewer’s suggestion, the horizontal hair-lines about the annual averages have been added in the revised paper.

4 Finally, I also suggest using the acronym "AE" for Angstrom Exponent instead of "Alpha".

Response: The term of “Alpha” has been instead by the “AE” in the revised manuscript.

3. Response to Reviewer 3

General Comments:

The paper is very interesting and well written. As the authors state at the beginning, the presented database is very useful for future studies on climate and the atmospheric environment over China.
Response: The authors would like to appreciate the reviewer's positive comments.

The authors also say that other parameters, such as single scattering albedo, should be measured in the future. However I wonder if some of these retrievals are already available for at least some sites, and particular cases. In fact it is very difficult understanding the origin and type of particles analyzing only AOD and Angstrom exponent.
Response: Yes. The authors agree with the reviewer. There are already some retrievals about SSA and size distributions for some CARSNET sites for the research of urban pollution events. For all sites data processing, it is conducting now.

For example at the end of page 10 and the beginning of page 11, it is written that large Alpha (>1.20) were found along the southern reaches of the Yangtze River and at clean sites of NE China. In these two cases particles are very different and in the southern sites there is very high AOD, whereas in the northeast sites AOD is smaller. I expect very absorbing particles in the former respect to the latter, and this information (given by SSA) would be very useful in this case.
Response: Yes. We agree that the speculation could be right. Recently, we analyzed the SSA of urban and suburban region of Yangtze River and found that the SSA of urban area is obviously lower than the suburban ones which suggests the absorbing particles in urban areas are more than suburban clean ones in Yangtze River region.

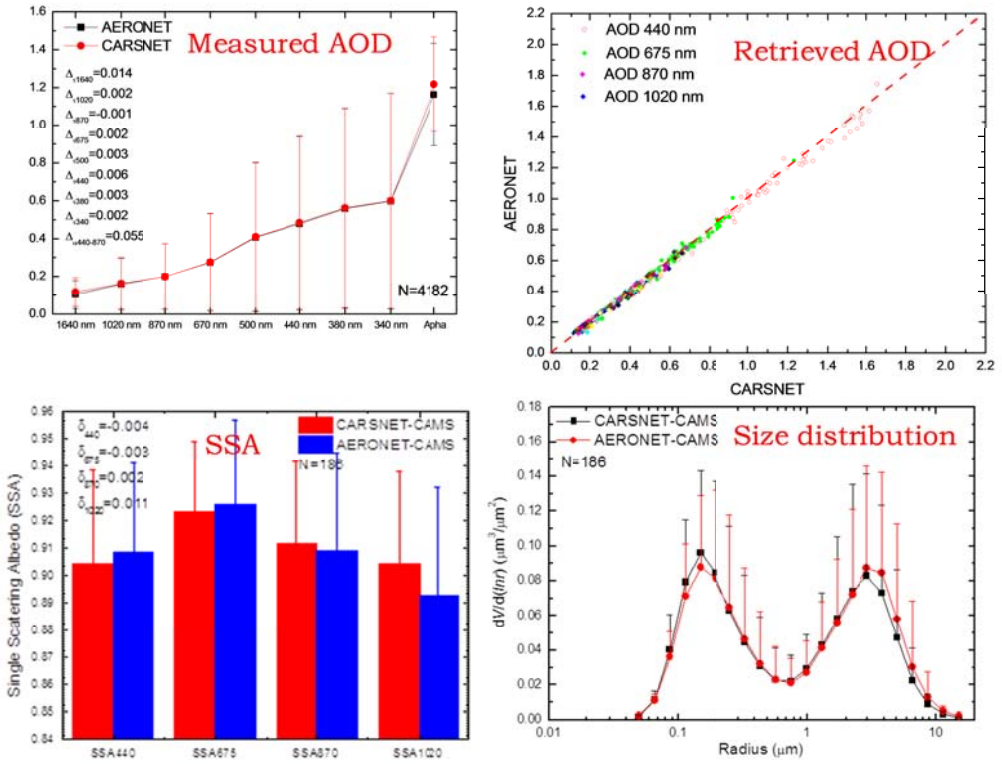
Another case is at the beginning of section 3.2.1 where the AOD variation at Akedala from June-July to October-December is supposed to be due to local burning of coal for cooking and heating. If possible, I suggest the authors to provide SSA albedo results in the above cases and in similar others.
Response: So far we have not processed the SSA data of Akedala site. The explanation in this article is just offer a possible reason and needs to be prove in future.

Specific Comments
Below find minor suggestions:
1) Abstract and summary: specify the wavelength AOD is referred to, and the wavelengths used for the calculation of Angstrom exponent.
Response: The wavelength information has been added in the revised manuscript.

2) pag 7, line 3: I think that "urban sites" are not the "d" ensamble of rural sites, but it

the the 3rd ensamble (remote, rural, urban). Remove "d".
Response: Yes. According to the reviewer's suggestion, "(d)" has been deleted in the revised manuscript.

3) Pag 7 line 24: Did you develop you own retrieval software, or did you use the AERONET official software? Why these values are not presented in this paper?.
Response: Yes. We combined Dubovik's processing code and the pre-processing code written by Dr. V. Estelles and improved by X. Xia and H.Che to processing sky measurements of CARSNET. The inter-comparison between AERONET results and CARSNET ones show good consistencies (see Figure below). The related publication is preparing and this manuscript is mainly focus on AOD and AE. Thus we did not mention much about the retrieval in this paper.



4) Pag 8 line 10: not all the instrument types has the 500 nm wavelength. Does the master instrument has it? Has the master instrument the largest number of wavelengths in order to make possible the intercalibration of all the types of Cimel?
Response: Yes. The master instruments have 9 wavelengths at 340, 380, 440, 500, 670, 870, 940, 1020, and 1640 nm. Thus the masters could be used for the inter-calibration of all types of Cimel field instruments of CARSNET.

5) pag9 line 6: was the interpolation performed for daily averages or for all the data?
Response: The interpolation was performed for daily averages based on the annual inter-calibration coefficients.

6) Figure 2, at which wavelength is the AOD? what the box at the right bottom of Figures 2 should indicate?.
Response: AOD at this paper refers to AOD at 440nm. The right bottom of Figures 2 is part of map of whole China including the islands of South China Sea region.

7) Figure3: the Nanning area seems to be very polluted, all the year. Can you provide any reason? is this site affected by Hong Kong or it produces emissions by itself?
Response: Nanning is far from Hong Kong where pollutions could hardly be transported to Nanning. The AOD is high mainly due to the emissions by Nanning itself. Nanning is the capital city of Guangxi Zhuang Autonomous Region of China with more than 7 million people and 1 million vehicles there. Moreover, it belongs to basin geophysical characteristic. The AOD is high all the year could be related to this special geographical characteristic, which is against pollution diffusion.

8) Pag 13: What are the values of AOD and Alpha shown in line 21? In line 16-17 it is written that the mean values are 0.42 and 0.82.
Response: They are the average values of AOD and AE over 11 rural desert sites. Now it has been corrected as “The average AODs and Alphas at the CLP stations were higher than those over the desert regions (0.34 ± 0.12 for AOD and 0.55 ± 0.19 for AE).”

9) In the text the references to Figures 6-10 are missing.
Response: The references to Figure 6-10 have been added in the revised manuscript.

10) Pag 25, lines 24-25: the meaning of the following sentence is not clear
“ CARSNET operates two pairs of sites with both urban sites and rural stations.
Response: The sentence has been revised as following “Among CARSNET sites, there are Beijing and Lanzhou with both urban sites and rural stations.”

4. Response to Short Comment of Sandip Pal

I wonder if the authors could refer and discuss the article mentioned below while discussing long-term aerosol climatology w.r.t. aerosol columnar content and aerosol optical depth. I definitely think these types of measurements are rare in Asia. Pal, S and Devara PCS, 2012: A wavelet-based spectral analysis of long-term time series of optical properties of aerosols obtained by lidar and radiometer measurements over an urban station in Western India, Journal of Atmospheric and Solar-Terrestrial Physics, 84–85, 75–87

Response: Thanks a lot for important comments. Sure, we will take account of the citation and inter-comparison of long-term AOD variation between China and India according to the latest publication you mentioned in the new revised manuscript. Yes, these types of long-term aerosol optical properties measurements are rare in Asia, especially in the polluted regions such as China, India. These data would be helpful for the aerosol satellite and modelling validations."