To Anonymous Reviewer #2: (Comment ID:acp-2020-60-RC2)

Dear Reviewer,

Thank you very much for your detailed and supportive comments. You raised important issues in the comments. They can help us to improve the manuscript to a better scientific level. We have carefully taken these comments into consideration and have revised our manuscript accordingly. Please find below the comments in blue italics and our responses in black and the changes in bold.

Responses to major comments:

1. P2L35-38: This sentence is confusing to me. If my understanding is right, it is meant to express the dust originated from Taklimakan Desert (TD) exerts influences the air quality and climate over the downstream regions via long-range transport. Therefore, please try to be specific instead of using general words. However, some key references are missing, since both observations (Liu et al., 2019, doi:10.1029/2019GL083508.) and model simulations (Chen et al., 2017, doi: 10.1007/s11430-016-9051-0) suggested that the dusts generated in TD have LESS impacts on downstream regions due to the unique terrain and low-level background wind climatology, compared with those from other deserts in northwestern China.

Reply: We thank the reviewer for pointing out these issues around influences of dust aerosol particles originated from Taklimakan Desert. In response to the comments, we have rephrased this sentence in a more specific way. The suggested references have been added. Please find them in the second paragraph of section "1 Introduction" in the revised manuscript:

"**As one of the largest sandy deserts in the world, the Taklimakan Desert located in the Xinjiang Uygur Autonomous Region of China is a main source region of Asian dust (Huang et al., 2009), which influences not only surrounding areas such as the Tibetan Plateau (Liu et al., 2008; Chen et al., 2013; Yuan et al., 2019), but also wide regions in Eastern Asia (Mikami et al., 2006; Liu et al., 2011b; Yuan et al., 2019), even North America and Greenland through long-range transports across the Pacific Ocean (Bory et al., 2003; Chen et al., 2017; Liu et al., 2019).**"

The issue of less impacts of Taklimakan dust particles on downstream regions due to the unique terrain and low-level background wind climatology, and the reason that the experimental site was selected near Taklimakan desert instead of the Gobi desert were also referred and discussed. Please find them in the subsection "2.1 Observation site" in the revised manuscript:

"**In addition to the Kashi station near the Taklimakan Desert, SONET also maintains two dust aerosol observation stations (i.e., Zhangye and Minqin stations) in the Gobi Desert which is another important source of Asian dust. Although some studies reported that the dust generated in Taklimakan Desert exerts a less influence on long-range downstream regions due to the unique terrain and low-level background wind climatology compared to those in Gobi Desert (Chen et al., 2017; Liu et al., 2019), Taklimakan Desert is more representative to study the effects of dust aerosol solar radiative forcing on local region than the Gobi Desert because of its huge dust emission capability (Chen et al., 2017).**"

"**According to the SONET long-term measurements from 2013, the Kashi site is frequently affected by dust, where the multi-year average *AOD* is up to 0.56±0.18 at 500 nm; moreover, the Ångström exponent (*AE*, 440~870 nm) and fine-mode fraction (*FMF*, 500 nm) at Kashi are the lowest (with the multi-year average values of 0.54±0.27 and 0.40±0.14, respectively) among all 16 sites within SONET around China (Li et al., 2018). In contrast, the multiyear average *AOD*s (500 nm) at Zhangye (0.28±0.11) and Minqin (0.26±0.11) are only half of that at Kashi or less (Li et al., 2018). Meanwhile, their average values of *AE* and *FMF* are also greater than those at Kashi (Li et al., 2018). They all imply coarse particles are more dominant in the Taklimakan Desert in comparison with the Gobi Desert.**"

References:

Bory, A. J., Biscaye, P. E., and Grousset, F. E.: Two distinct seasonal Asian source regions for mineral dust deposited in Greenland (NorthGRIP), Geophys. Res. Lett., 30, 1167, doi:10.1029/2002GL016446, 2003.

Chen, S., Huang, J., Zhao, C., Qian, Y., Leung, L. R., and Yang, B.: Modeling the transport and radiative forcing of Taklimakan dust over the Tibetan Plateau: A case study in the summer of 2006, J. Geophys. Res. Atmos., 118, 797-812, doi:10.1002/jgrd.50122, 2013.

Chen, S., Huang, J., Li, J., Jia, R., Jiang, N., Kang, L., Ma, X., and Xie, T.: Comparison of dust emissions, transport, and deposition between the Taklimakan Desert and Gobi Desert from 2007 to 2011. Science China Earth Sciences, 60(1), 1338-1355, doi:10.1007/s11430-016-9051-0, 2017.

Huang, J., Fu, Q., Su, J., Tang, Q., Minnis, P., Hu, Y., Yi, Y., and Zhao, Q.: Taklimakan dust aerosol radiative heating derived from CALIPSO observations using the Fu-Liou radiation model with CERES constraints, Atmos. Chem. Phys., 9, 4011-4021, doi:10.5194/acp-9-4011-2009, 2009.

Mikami, M., Shi, G., Uno, I., Yabuki, S., Iwasaka, Y., Yasui, M., Aoki, T., Tanaka, T.Y., Kurosaki, Y., Masuda, K., Uchiyama, A., Matsuki, A., Sakai, T., Takemi, T., Nakawo, M., Seino, N., Ishizuka, M., Satake, S., Fujita, K., Hara, Y., Kai, K., Kanayama, S., Hayashi, M., Du, M., Kanai, Y., Yamada, Y., Zhang, X.Y., Shen, Z., Zhou, H., Abe, O., Nagai, T., Tsutsumi, Y., Chiba, M., and Suzuki, J.: Aeolian dust experiment on climate impact: An overview of Japan-China joint project ADEC, Global and Planetary Change, 52, 142-172, doi:10.1016/j.gloplacha.2006.03.001, 2006.

Li, Z. Q., Xu, H., Li, K. T., Li, D. H., Xie, Y. S., Li, L., Zhang, Y., Gu, X. F., Zhao, W., Tian, Q. J., Deng, R. R., Su, X. L., Huang, B., Qiao, Y. L., Cui, W. Y., Hu, Y., Gong, C. L., Wang, Y. Q., Wang, X. F., Wang, J. P., Du, W. B., Pan, Z. Q., Li, Z. Z., and Bu, D.: Comprehensive Study of Optical, Physical, Chemical, and Radiative

Properties of Total Columnar Atmospheric Aerosols over China: An Overview of Sun-Sky Radiometer Observation Network (SONET) Measurements, Bulletin of the American Meteorological Society, 99, 739-755, doi:10.1175/BAMS-D-17-0133.1, 2018.

Liu, L., Guo, J., Gong, H., Li, Z., Chen, W., Wu, R., Wang, L., Xu, H., Li, J., Chen, D., and Zhai, P.: Contrasting Influence of Gobi and Taklimakan Deserts on the Dust Aerosols in Western North America. Geophysical Research Letters, 46(15), 9064-9071, doi:10.1029/2019GL083508, 2019.

Liu, J., Zheng, Y., Li, Z., Flynn, C., Welton, E. J., and Cribb, M.: Transport, vertical structure and radiative properties of dust events in southeast China determined from ground and space sensors, Atmospheric Environment, 45(35), 6469-6480, doi:10.1016/j.atmosenv.2011.04.031, 2011b.

Liu, Z., Liu, D., Huang, J., Vaughan, M., Uno, I., Sugimoto, N., Kittaka, C., Trepte, C., Wang, Z., Hostetler, C., and Winker, D.: Airborne dust distributions over the Tibetan Plateau and surrounding areas derived from the first year of CALIPSO lidar observations, Atmos. Chem. Phys., 8, 5045–5060, doi:10.5194/acp-8-5045-2008, 2008.

Yuan, T., Chen, S., Huang, J., Wu, D., Lu, H., Zhang, G., Ma, X., Chen, Z., Luo, Y., and Ma, X.: Influence of Dynamic and Thermal Forcing on the Meridional Transport of Taklimakan Desert Dust in Spring and Summer. Journal of Climate, 32(3), 749-767, DOI: 10.1175/JCLI-D-18-0361.1, 2019.

2. Figures 3, 5, 10, 12: The X-axis can be considered to be revised (more minor ticks and labels are needed to be given), given the ASRF and ASRFE are only able to be estimated during daytime without clouds. Another important issue is the cloud-induced impact on the radiation reaching the surface. The authors are better to analyze the day-by-day variation of cloud (fraction) over the study sites of Kashi, which is concurrent with the ground-based aerosol remote sensing and radiation observations. I believe this will provide more insights into the community of aerosol radiative forcing.

Reply: **More minor ticks and labels of the x-axes have been added in Figs. 4 (old Fig. 3), 5, 10**. For Fig. 12, in order to compare the WRF-Chem simulations and observations point by point, we interpolated the observations of $PM_{2.5}$, PM_{10}, and *AOD* at 675 nm to the corresponding assimilation time of 0:00, 6:00, 12:00 and 18:00 UTC of each day. Please also see the statement "The second one-month simulation was assimilated the observations of $PM_{2.5}$, PM_{10} and *AOD* with GSI at 0:00, 6:00, 12:00 and 18:00 UTC with the assimilation window of ±3 h centered at the analysis time." in the first paragraph of subsection "3.3.3 Model setup". So, the ticks and labels were given with daily intervals in Fig. 12. For each day, there are four sets of $PM_{2.5}$, PM_{10} in Figs. 12a and c. But normally less than four sets of *AOD* can be obtained owing to cloud screening or other quality control operation (see Fig. 12e). **To clarify this, the caption of Fig. 12 has been changed into: "Comparisons of the surface-layer $PM_{2.5}$ (a, b), PM_{10} (c, d) concentrations and *AOD* at 675 nm (e, f) among the observations, the WRF-Chem simulations with and without data assimilations (DA) in April 2019. The observations have been interpolated to 0:00, 6:00, 12:00, 18:00 UTC of each day.**"

We thank the comment on cloud-induced impacts which raises an important issue. We fully agree with the reviewer that the magnitudes of direct solar radiative forcing of aerosol particles are affected by above, surrounding, and underlying clouds. The information of day-by-day variation of cloud fraction is valuable for estimation of solar radiation reaching the land surface. However, the cloud-induced impact on the radiation at surface is beyond the direct scope of this paper. "The focus of this study is to quantify of direct *ASRF* and *ASRFE* at the TOA, BOA, and in ATM under cloud-free sky conditions …" (see Paragraph 1 of the subsection "3.2 Radiative transfer simulation"). The cloud-free conditions were controlled by cloud screening and quality assurance procedures utilizing multi-angle observations of the sun-sky radiometer through the almucantar and principal plane scans in the entire sky before inversion (Smirnov et al., 2000; Holben et al., 2006; Li et al., 2015, 2018; Giles et al., 2019). The measurements of all sky view camera were also adopted as the ancillary evidences to assess cloud presence in this study. Inevitably, few small clouds out of the observation directions and super-thin clouds may escape from the cloud detection processing. They have impacts on the radiation reaching the surface more or less. However, to obtain the fraction of these clouds, the existing cloud detection methods should be significantly improved. We thank the reviewer for pushing us on this point and this issue will be considered in subsequent research.

References:

Giles, D. M., Sinyuk, A., Sorokin, M. S., Schafer J. S., Smirnov, A., Slutsker, I., Eck, T. F., Holben, B. N., Lewis, J. R., Campbell, J. R., Welton, E. J., Korkin, S. V., and Lyapustin, A. I.: Advancements in the Aerosol Robotic Network (AERONET) Version 3 database - Automated near-real-time quality control algorithm with improved cloud screening for Sun photometer aerosol optical depth (AOD) measurements, Atmospheric Measurement Techniques, 12, 169-209, doi:10.5194/amt-12-169-2019, 2019.

Holben, B. N., Eck, T. F., Slutsker, I., Smirnov, A., Sinyuk, A., Schafer, J., Giles, D., and Dubovik, O. : Aeronet's version 2.0 quality assurance criteria, Proceedings of SPIE - The International Society for Optical Engineering, 6408, doi: 10.1117/12.706524, 2006.

Li, Z., Li, D., Li, K., Xu, H., Cheng, X., Chen, C., Xie, Y., Li, L., Li, L., Li, W., Lv, Y., Qie, L., Zhang, Y., and Gu, X.: Sun/sky radiometer observation network with the extension of multi-wavelength polarization measurements, Journal of Remote Sensing, 19, 496-520, doi:10.11834/jrs.20144129, 2015.

Li, Z. Q., Xu, H., Li, K. T., Li, D. H., Xie, Y. S., Li, L., Zhang, Y., Gu, X. F., Zhao, W., Tian, Q. J., Deng, R. R., Su, X. L., Huang, B., Qiao, Y. L., Cui, W. Y., Hu, Y., Gong, C. L., Wang, Y. Q., Wang, X. F., Wang, J. P., Du, W. B., Pan, Z. Q., Li, Z. Z., and Bu, D.: Comprehensive Study of Optical, Physical, Chemical, and Radiative Properties of Total Columnar Atmospheric Aerosols over China: An Overview of Sun-Sky Radiometer Observation Network (SONET) Measurements, Bulletin of the American Meteorological Society, 99, 739-755, doi:10.1175/BAMS-D-17-0133.1, 2018.

Smirnov, A., Holben, B. N., Eck, T. F., Dubovik, O., and Slutsker, I.: Cloud-Screening and Quality Control Algorithms for the AERONET Database, Remote Sensing of Environment, 73(3), 337-349, doi:10.1016/S0034-4257(00)00109-7, 2000.

3. Figure 11: The readers would like to know how the ASRF is derived from AERONET, instead of the performance of ASRF product. The details will shed light on the difference between ASRF from RT model and ASRF from AERONET.

Reply: In response to this comment we have added more details about how the *ASRF* is derived from AERONET and the difference from the AERONET definition. Please find them in the first paragraph of subsection "4.3 Difference from AERONET products" in the revised manuscript:

"For AERONET, broadband upward and downward irradiances in the SW ranges from 0.2 to 4.0 μm were calculated by radiative transfer model with retrieved aerosol properties as model inputs (http://aeronet.gsfc.nasa.gov). However, AERONET adopts different definition of *ASRF* that only taking the downward irradiance at the BOA and the upward irradiance at the TOA into consideration (García et al., 2012). The upward irradiances with and without aerosols in Eq. (2), along with the downward irradiances with and without aerosols in Eq. (1), are not taken into account. Omitting the downward irradiances will not make much difference in *ASRF* at the TOA. But for *ASRF* at the BOA, it is predictable that neglecting the upward irradiance will lead to obvious difference."

References:

García, O. E., Díaz, J. P., Expósito, F. J., Díaz, A. M., Dubovik, O., Derimian, Y., Dubuisson, P., and Roger, J. C.: Shortwave radiative forcing and efficiency of key aerosol types using AERONET data, Atmos. Chem. Phys., 12, 5129-5145, doi:10.5194/acp-12-5129-2012, 2012.

Responses to minor comments:

1. Abstract: What are the two simulations in "The percent difference of daily mean ASRF between the two simulations." ? which is supposed to be described specifically.

Reply: Following this comment, we specified the two simulations in this sentence. It has been rewritten as "**The percent difference of daily mean *ASRF* between the RT and WRF-Chem simulations may exceed 50 % in heavy dust episode**". Please find it in lines 22-23 in the abstract of the revised manuscript.

2. P2L34: The dust aerosol originated from western China was revealed to exert significant impact on the mesoscale convection in downwind regions such as North China (Li et al., 2017, *doi: 10.1038/s41598-017-12681-0), which exemplified well the dynamic effect of dust. Therefore, this reference can be considered to be added here.*

Reply: We thank the reviewer for the comment and providing reference. We have carefully review the literature. The suggested reference has been added:

"**Mineral dust is the most abundant large aerosol type in the atmosphere (Ansmann et al., 2011), which has a tremendous impact on radiation budget, not only through scattering process, but also due to absorption of solar (0.3~5 µm), also called shortwave (SW) radiation (Otto et al., 2007; García et al., 2012; Valenzuela et al., 2012; Lenoble et al., 2013), with potential dynamic consequences (Wendisch et al., 2008; Li et al., 2017).**"

Please find it in lines 31-34 of the section "1 Introduction" in the revised manuscript.

References:

Ansmann, A., Petzold, A., Kandler, K., Tegen, I., Wendisch, M., Müller, D., Weinzierl, B., Müller, T., and Heintzenberg, J.: Saharan Mineral Dust Experiments SAMUM-1 and SAMUM-2: What have we learned? Tellus, 63B, 403-429. doi:10.1111/j.1600-0889.2011.00555.x, 2011.

García, O. E., Díaz, J. P., Expósito, F. J., Díaz, A. M., Dubovik, O., Derimian, Y., Dubuisson, P., and Roger, J. C.: Shortwave radiative forcing and efficiency of key aerosol types using AERONET data, Atmos. Chem. Phys., 12, 5129-5145, doi:10.5194/acp-12-5129-2012, 2012.

Lenoble, J., Remer, L., and Tanré, D.: Aerosol Remote Sensing, Springer Berlin Heidelberg, doi:10.1007/978-3-642-17725-5, 2013.

Li, R., Dong, X., Guo, J., Fu, Y., Zhao, C., Wang, Y., and Min, Q.: The implications of dust ice nuclei effect on cloud top temperature in a complex mesoscale convective system, Sci Rep, 7, 13826, https://doi.org/10.1038/s41598-017-12681-0, 2017.

Otto, S., de Reus, M., Trautmann, T., Thomas, A., Wendisch, M., and Borrmann, S.: Atmospheric radiative effects of an in-situ measured Saharan dust plume and the role of large particles. Atmos. Chem. Phys., 7, 4887-4903, 2007.

Valenzuela, A., Olmo, F. J., Lyamani, H., Anton, M., Quirantes, A., and Alados-Arboledas, L.: Aerosol radiative forcing during African desert dust events (2005–2010) over Southeastern Spain, Atmos. Chem. Phys., 12, 10331-10351, doi:10.5194/acp-12-10331-2012, 2012.

Wendisch, M., Hellmuth, O., Ansmann, A., Heintzenberg, J., Engelmann, R., Althausen, D., Eichler, H., Müller, D., Hu, M., Zhang, Y., and Mao, J.: Radiative and dynamic effects of absorbing aerosol particles over the Pearl River Delta, China, Atmos. Environ., 42, 6405-6416, doi:10.1016/j.atmosenv.2008.02.033, 2008.

3. P2L34-35: Recent studies also show that the dust RF strongly depends on the overlapping pattern of dust aerosol and cloud layer in the vertical. Therefore, this sentence might as well be revised to "The dust radiative effects also depend on the surface albedo over the desert (Bierwirth et al., 2009) and the underlying clouds as well (Waquet et al., 2013, doi: 10.1002/2013GL057482; Xu et al., 2017, doi: 10.1016/j.atmosenv.2017.07.036)".

Reply: We thank the reviewer for pointing out this issue. We rephased this sentence as:

“**Moreover, the dust radiative effects also depend on the surface albedo over the desert and the cloud layer in the vertical as well (Bierwirth et al., 2009; Waquet et al., 2013; Xu et al., 2017).**”

Please find it in lines 40-41 of the section “1 Introduction” in the revised manuscript.

References:

Bierwirth, E., Wendisch, M., Ehrlich, A., Heese, B., Tesche, M., Althausen, D., Schladitz, A., Müller, D., Otto, S., Trautmann, T., Dinter, T., von Hoyningen-Huene, W., and Kahn, R.: Spectral surface albedo over Morocco and its impact on radiative forcing of Saharan dust, Tellus, 61B, 252-269, DOI: 10.1111/j.1600-0889.2008.00395.x, 2009.

Waquet, F., Peers, F., Ducos, F., Goloub, P., Platnick, S., Riedi, J., Tanré, D., and Thieuleux, F.: Global analysis of aerosol properties above clouds, Geophysical Research Letters, 40(21), 5809-5814, doi:10.1002/2013GL057482, 2013.

Xu, H., Guo, J., Wang, Y., Zhao, C., Zhang, Z., Min, M., Miao, Y., Liu, H., He, J., Zhou, S., and Zhai, P: Warming effect of dust aerosols modulated by overlapping clouds below, Atmospheric Environment, 166, 393-402, http://dx.doi.org/10.1016/j.atmosenv.2017.07.036, 2017.

4. P2L50: “were used” should be revised.

Reply: The sentence “For these estimates, simulations by the regional climate model version 4 (RegCM4) for the years of 2000~2009 were used” has been removed in the revised manuscript.

5.P2L58-61: what does “the modulate effects” mean? Besides, it seems strange in “performances of models…validated by comparing with the observations of AOD..” . I guess it is supposed to mean that ASRF from model …validated against that incorporating the observations of AOD…. Please clarify it or make modifications to them.

Reply: These sentences might be misleading. Here we were trying to say that comparisons of dust aerosol properties between the model simulations and the observations are not enough to confirm the dust radiative forcing simulations. The radiative forcing results estimated by various models should also be corroborated carefully against the direct observations of irradiances. We have revised these sentences to clarify this point:

“**The simulated results of dust aerosol radiative forcing have rarely been confirmed, especially in the Taklimakan Desert (Xia et al., 2009). Performances of various models sometimes were evaluated against the observations of aerosol optical depth (*AOD*), aerosol extinction profile, single scattering albedo (*SSA*), and particle size distribution (Zhao et al.,**

2010; Chen et al., 2014). Nevertheless, comparison of irradiance is indispensable to provide direct evidence for corroborating the *ASRF* simulated results."

Please find them in lines 55-60 in section "1 Introduction" in the revised manuscript.

References:

Chen, S., Zhao, C., Qian, Y., Leung, L. R., Huang, J., Huang, Z., Bi, J., Zhang, Y., Shi, J., Yang, L., Li, D., and Li, J.: Regional modeling of dust mass balance and radiative forcing over East Asia using WRF-Chem, Aeolian Research, 15, 15-30, http://dx.doi.org/10.1016/j.aeolia.2014.02.001, 2014.

Xia, X., and Zong, X.: Shortwave versus longwave direct radiative forcing by Taklimakan dust aerosols, Geophysical Research Letters, 36(7), L07803, doi:10.1029/2009GL037237, 2009.

Zhao, C., Liu, X., Leung, L. R., Johnson, B., Mcfarlane, S. A., Gustafson, W. I., Fast, J. D., and Easter, R. C.: The spatial distribution of mineral dust and its shortwave radiative forcing over North Africa: modeling sensitivities to dust emissions and aerosol size treatments, Atmos. Chem. Phys., 10, 8821-8838, doi:10.5194/acp-10-8821-2010, 2010.

6. P3L84: Please specify the years in "more than six years".

Reply: We specified the start year of the long-term observations at the Kashi site and rephrased this sentence to:

"**According to the SONET long-term measurements from 2013, the Kashi site is frequently affected by dust, where the multi-year average *AOD* is up to 0.56±0.18 at 500 nm;…**"

Please find it in lines 93-94 in subsection "2.1 Observation site" in the revised manuscript.

7. P3L85-85: it needs some references to support this statement "…the lowest among all sites in China. " . it really depends on the stations you refer to. e.g., the aerosol properties at Tazhong should be dominated by dust aerosol if you have observations therein.

Reply: We fully agree with this comment and rephrased this sentence to:

"…**moreover, the Ångström exponent (*AE*, 440~870 nm) and fine-mode fraction (*FMF*, 500 nm) at Kashi are the lowest (with the multi-year average values of 0.54±0.27 and 0.40±0.14, respectively) among all 16 sites within SONET around China (Li et al., 2018).**"

Please find it in lines 94-96 in the subsection "2.1 Observation site" in the revised manuscript.

References:

Li, Z. Q., Xu, H., Li, K. T., Li, D. H., Xie, Y. S., Li, L., Zhang, Y., Gu, X. F., Zhao, W., Tian, Q. J., Deng, R. R., Su, X. L., Huang, B., Qiao, Y. L., Cui, W. Y., Hu, Y., Gong, C. L., Wang, Y. Q., Wang, X. F., Wang, J. P., Du, W. B., Pan, Z. Q., Li, Z. Z., and Bu, D.: Comprehensive Study of Optical, Physical, Chemical, and Radiative Properties of Total Columnar Atmospheric Aerosols over China: An Overview of Sun-Sky Radiometer Observation Network (SONET) Measurements, Bulletin of the American Meteorological Society, 99, 739-755, doi:10.1175/BAMS-D-17-0133.1, 2018.

8. P5L122-123: More details are needed for the sounding measurements, including the launching time and location, sampling resolution, data uncertainties, e.t.c. Reference support is required.

Reply: We added more detailed descriptions of the sounding balloon measurements. The launching time and location were specified. Actually, the sampling resolutions of the measurements were not fixed. They always changed with the local atmospheric conditions at the balloon releasing time. Thus, we used the number of atmospheric layers in the vertical profile as well as the lowest and the highest layers in the atmosphere to sketch the sampling grids. They are valuable information to specify the vertical profiles in the radiative transfer model. Uncertainties in the sounding measurements of the whole pressure, temperature, and relative humidity profiles at Kashi station have not been reported in literatures. However, according to China Meteorological Administration, the measurement procedure was standardized and the data quality was guaranteed following the operational specifications for conventional upper-air meteorological observations. The corresponding reference support was provided. To address this comment, we added the descriptions about the sounding measurements as follow:

"**During the campaign, atmospheric profiles, including the vertical distributions of the atmospheric pressure, temperature, and relative humidity, were collected from sounding balloon measurements operated by Kashi regional meteorological bureau. Data quality was controlled following the operational specifications for conventional upper-air meteorological observations (China Meteorological Administration, 2010). The sounding balloons incorporate radiosondes were regularly launched twice a day around 0:00 and 12:00 UTC at Kashi weather station (39.46°N, 75.98°E, 1291 m above mean sea level). Normally there were more than 60 layers were specified from land surface to over 35 km.**"

Please find them in lines 130-136 in the subsection "2.2 Instrumentation".

References:

China Meteorological Administration, Operational specifications for conventional upper-air meteorological observations, China Meteorological Press, Beijing, China, 2010.

9. P7L149-151: I am confused again for the descriptions shown here are not consistent with those in Fig. 3. For instance, "The maximum PM10 concentration ..from 24 to 25 April 2019 was up

to 4 mg m-3" cannot be derived from Fig. 3. Also, "no CE318 measurement around the peak time of dust outbreak." disagreed with continuous AOD curves.

Reply: Here we were trying to explain that parts of the PM_{10} results were not shown in the original Fig. 3. Around the peak time of the heavy dust storm outbreak from 24 to 25 April 2019, the optical properties at some moments were not available due to the measurements of sun-sky radiometer in these conditions cannot satisfy the inversion criteria (Holben et al., 2006; Li et al., 2018). Thus, only the mass concentration results at the corresponding moments were presented for comparing with the CE318-derived aerosol optical depth and Ångström exponent parameters directly in this figure.

In the revised manuscript, we have tried to make the statements more concise and focused on descriptions of the aerosol properties relating to solar radiative forcing and efficiency. **Some less relevant and confusing details (e.g., "The maximum PM_{10} concentration during the heavy dust storm episode from 24 to 25 April 2019 was up to 4 mg m^{-3}. However, only moderate values of PM_{10} are shown in Fig. 3 because there was no CE318 measurement around the peak time of dust outbreak.") were removed from this context.** Following the suggestions from the other reviewer (specific comment 5 of "acp-2020-60-RC1"), this segment has been moved to the "Results" section. Please see the first paragraph of subsection "4.1 Aerosol solar radiative forcing and efficiency".

References:

Holben, B. N., Eck, T. F., Slutsker, I., Smirnov, A., Sinyuk, A., Schafer, J., Giles, D., and Dubovik, O. : Aeronet's version 2.0 quality assurance criteria, Proceedings of SPIE - The International Society for Optical Engineering, 6408, doi: 10.1117/12.706524, 2006.

Li, Z. Q., Xu, H., Li, K. T., Li, D. H., Xie, Y. S., Li, L., Zhang, Y., Gu, X. F., Zhao, W., Tian, Q. J., Deng, R. R., Su, X. L., Huang, B., Qiao, Y. L., Cui, W. Y., Hu, Y., Gong, C. L., Wang, Y. Q., Wang, X. F., Wang, J. P., Du, W. B., Pan, Z. Q., Li, Z. Z., and Bu, D.: Comprehensive Study of Optical, Physical, Chemical, and Radiative Properties of Total Columnar Atmospheric Aerosols over China: An Overview of Sun-Sky Radiometer Observation Network (SONET) Measurements, Bulletin of the American Meteorological Society, 99, 739-755, doi:10.1175/BAMS-D-17-0133.1, 2018.