Responses to the comments

Dear Editor,

Thank you for handling and carefully reviewing our manuscript. The comments and suggestions would helpe us to improve the paper.

Following these comments and suggestions, we take a lot of efforts to revised the manuscript, re-draw the most of the imaging in the article, and modified the inaccurate information to avoid the ambiguity.

We response every comments sentence by sentence. Please find the comments in blue italics and our reply in black.

Comments

1. You do not need the same 3 colour bars per line, just use a single one since they repeat themselves. In addition if you were to put the 1 colour bar on the side of the Figures you would be able to expand there size. I recommend that you make the numbers on these colour bars more legible (larger font). Please apply these recommendations to ALL Figures: 3, 4, 5, 6 and 8 & 9. When colour bars are all the same on the Figure, I expect to see a UNIQUE colour bar.

Reply: Thank you for the valuable suggestion, we re-drawed the Figures 3, 4, 5, 6 and 8 & 9, using single colour bar and make the numbers on these colour bars more legible. Please see Fig.3 in Page 10, Fig.4 in Page 11, Fig.5 in Page 13, Fig.6 in Page 14, Fig.8 in Page 17 and Fig.9 in Page 18 of the revised manuscript.

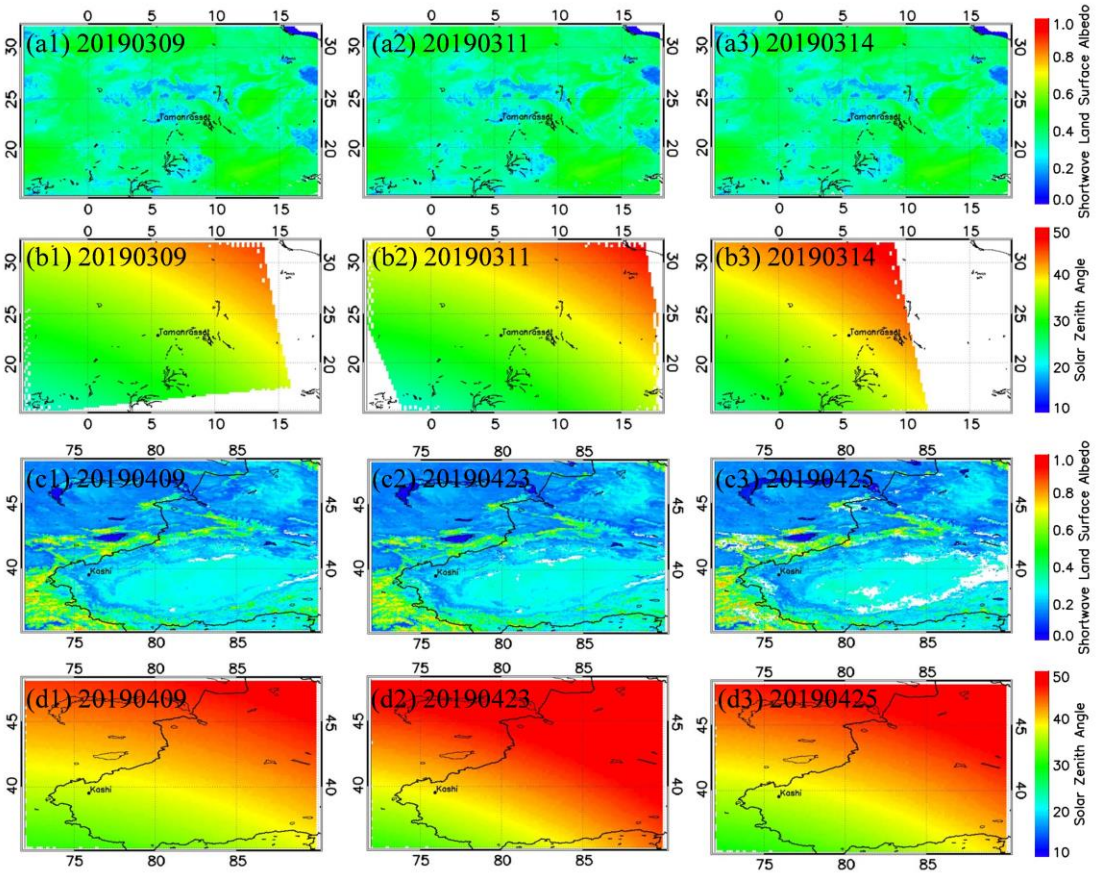

Figure 3: SW LSA and SZA over the Sahara Desert and the Taklimakan Desert derived from AQUA/MODIS.

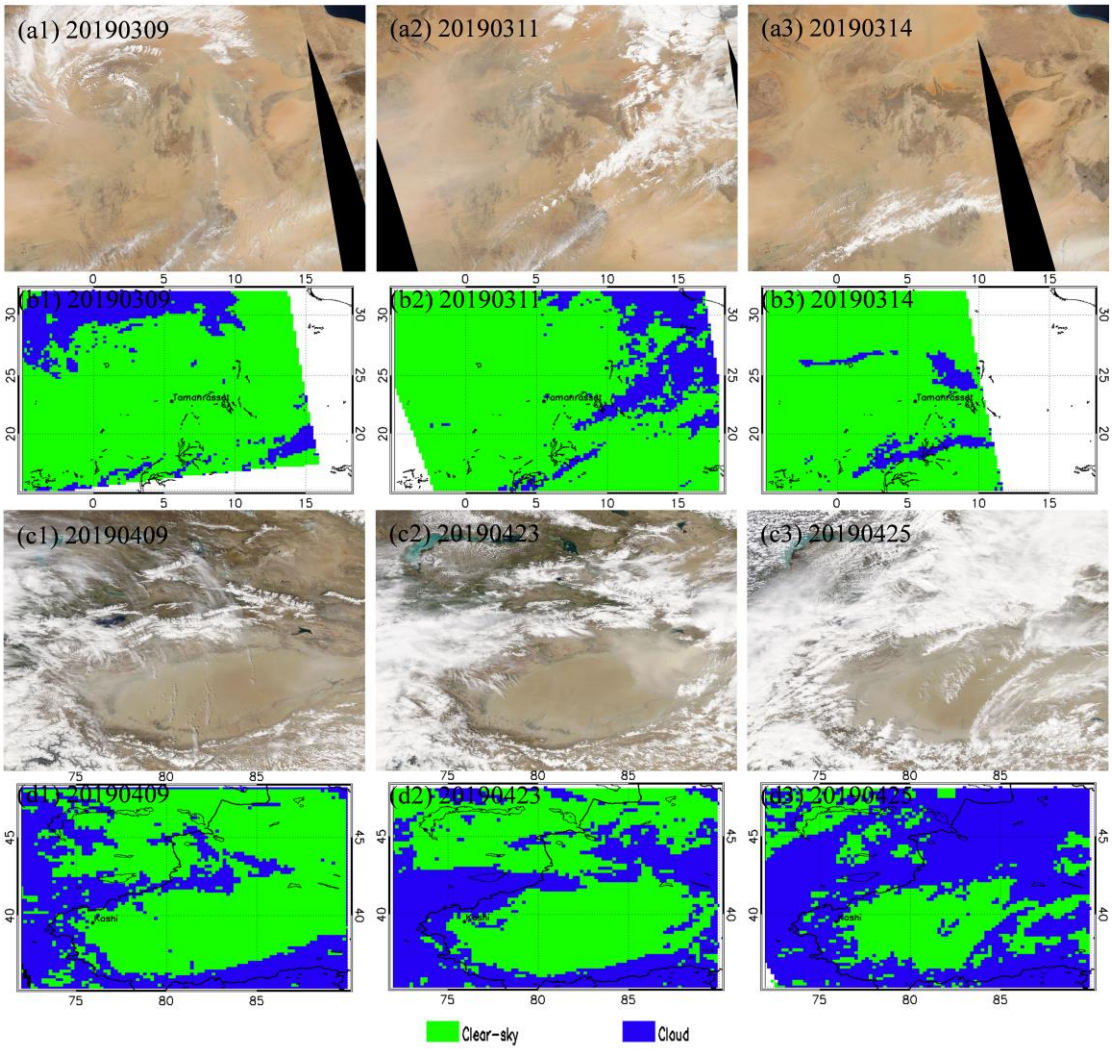

Figure 4: True color images and cloud detections from AQUA/MODIS observations.

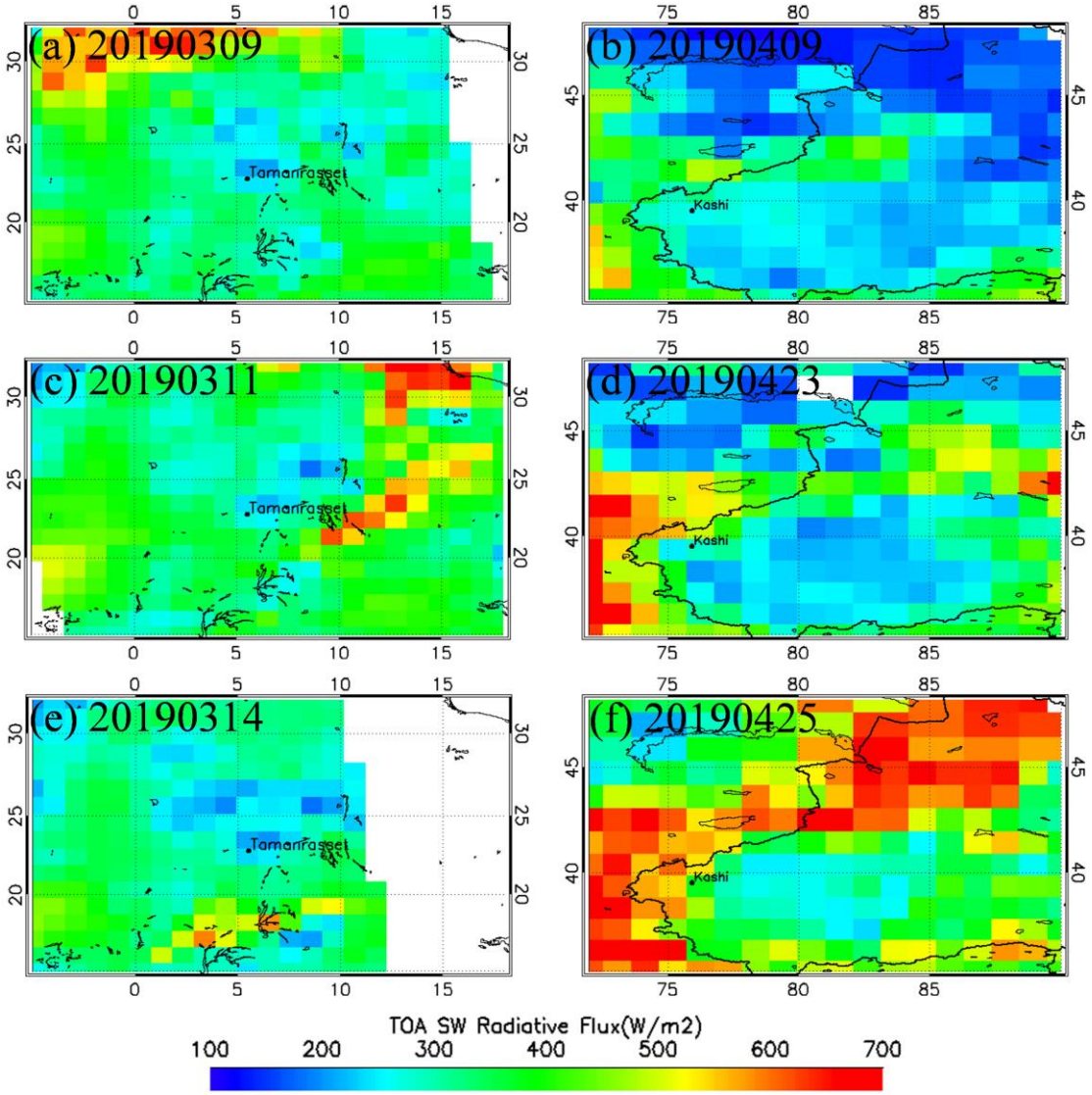

Figure 5: TOA SW radiative flux derived from AQUA/CERES over the Sahara Desert on March 2019 and over the Taklimakan Desert on April 2019.

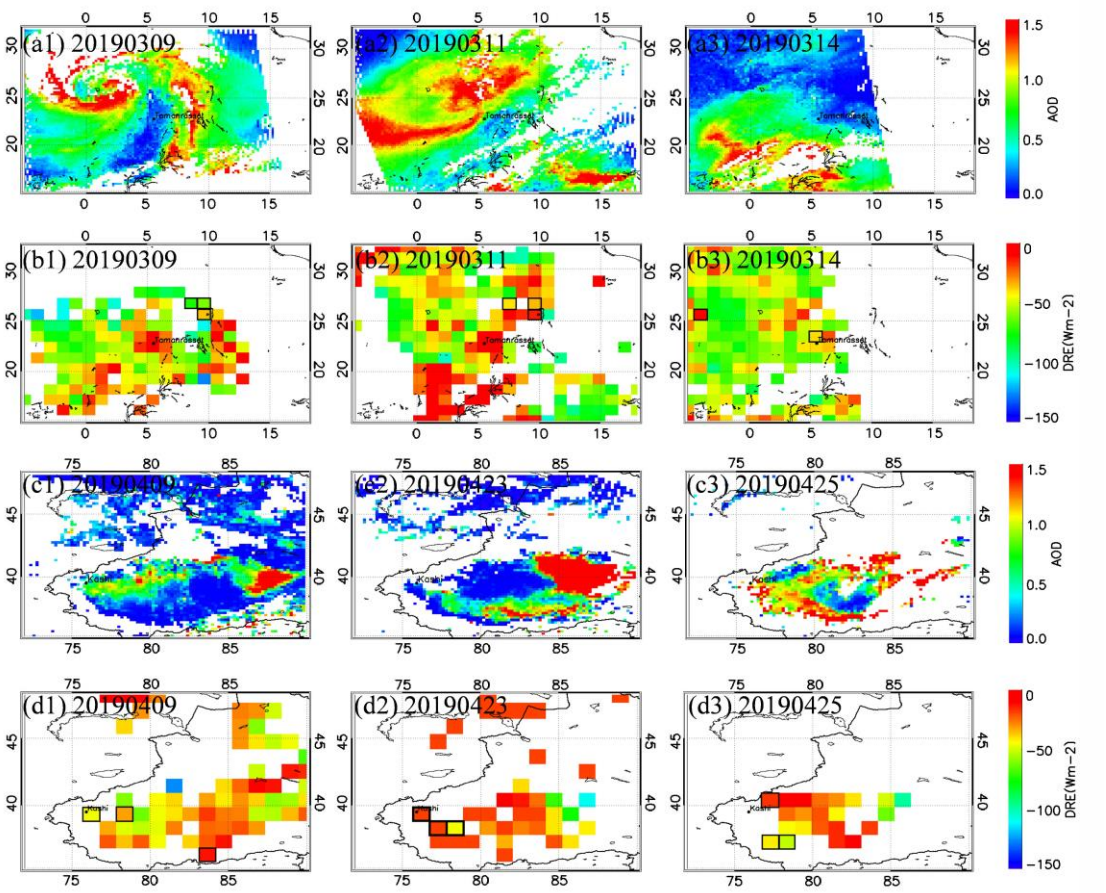

Figure 6: AOD and DRE_{dust} of dust storms over the Sahara Desert in March 2019 and over the Taklimakan Desert in April 2019.

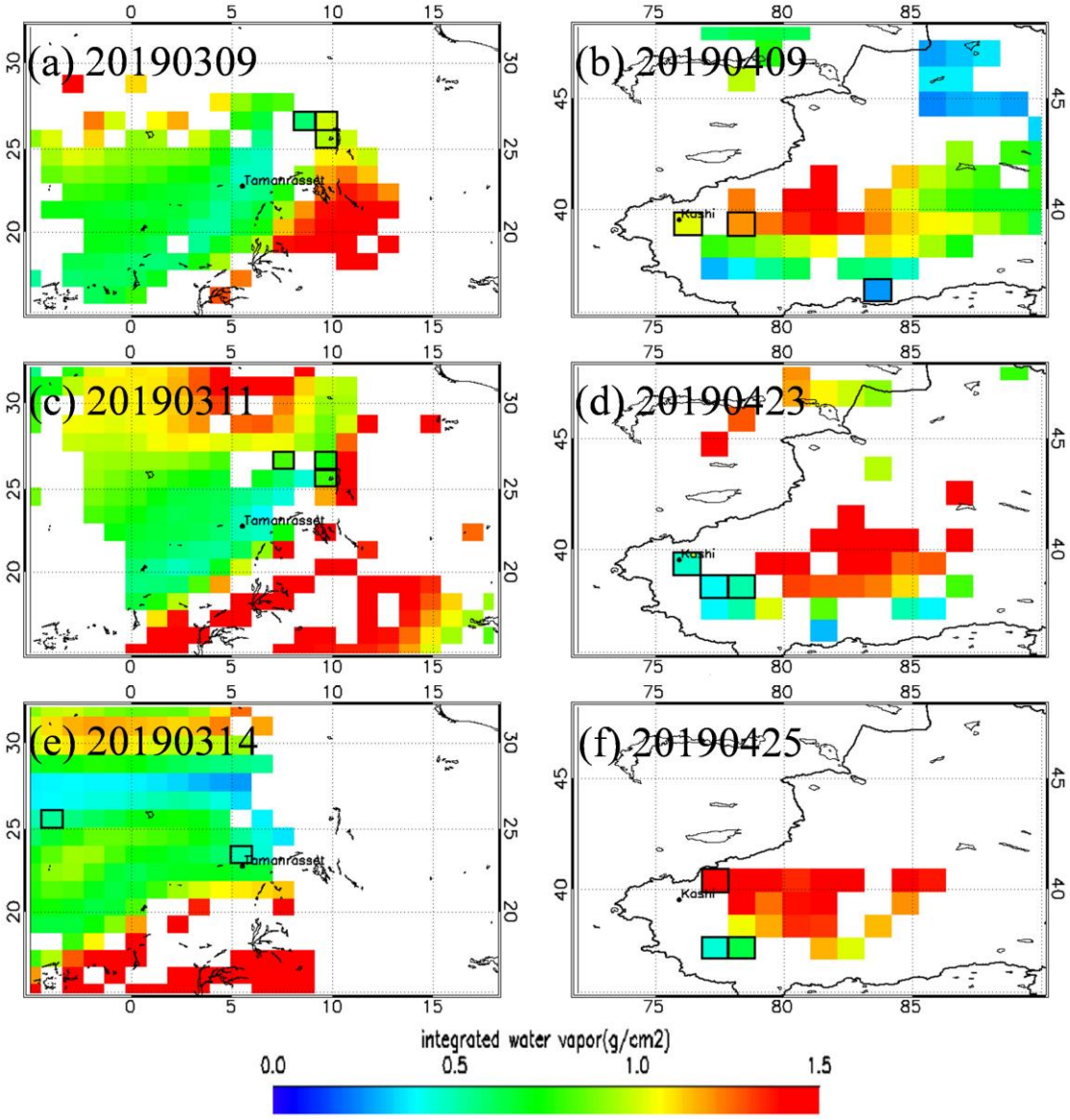

Figure 8: Integrated water vapor (g/cm^2) from European Centre for Medium-range Weather Forecasts (ECMWF) reanalysis dataset over the Sahara Desert in March 2019 and over the Taklimakan Desert in April 2019.

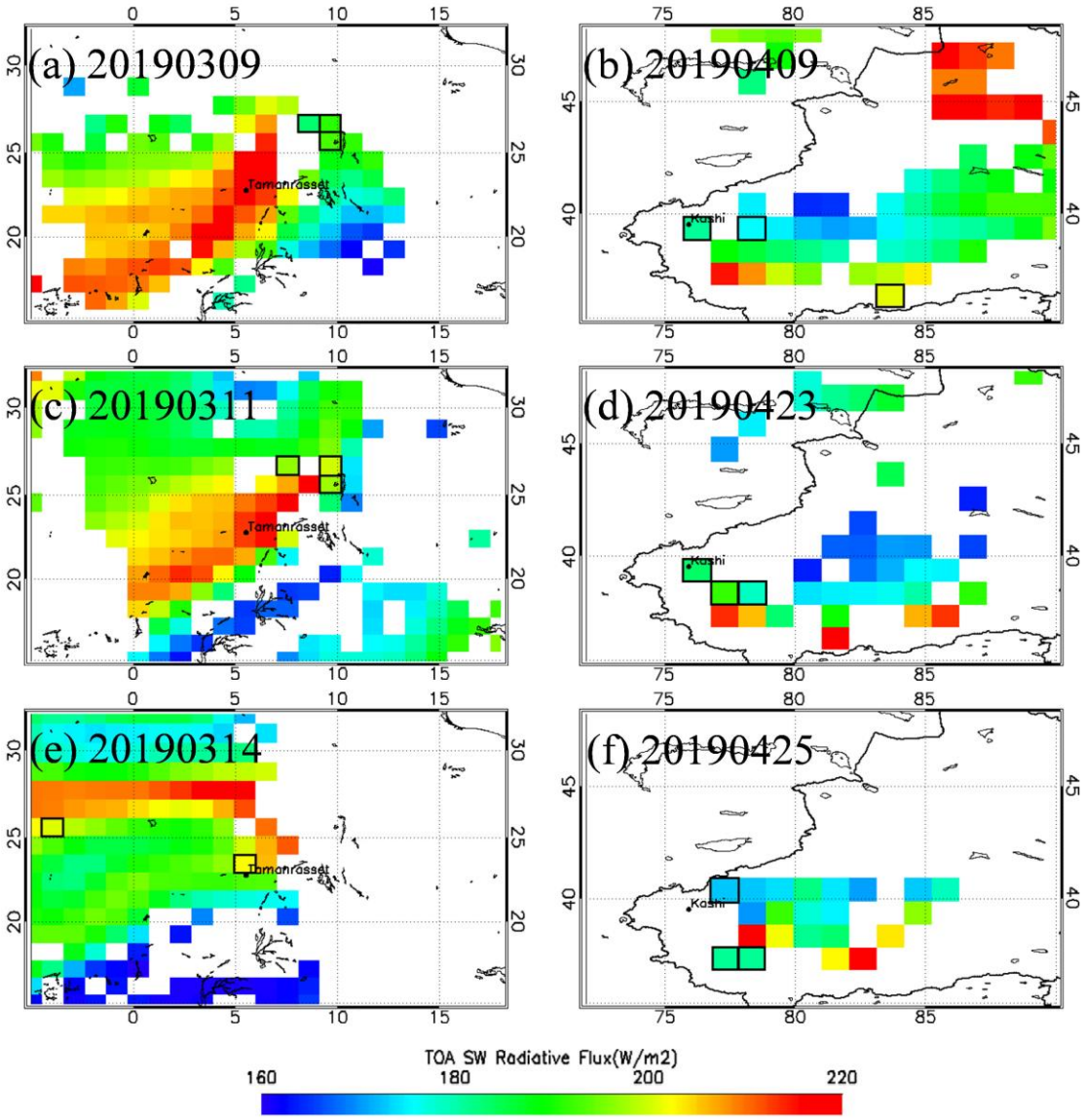

Figure 9: SBDART simulated clear-sky TOA radiative flux by using integrated water vapor (g/cm^2) from ECMWF reanalysis dataset over the Sahara Desert in March 2019 and over the Taklimakan Desert in April 2019.

2. The aerosols measure in Tamanrassett DO NOT represent the dust aerosol from Sahara due to the variations in mineralogical composition of soil over the region. Please make that clear in your text. The same would apply for Kashi with respect to the Taklamakan Desert.

Reply: Thank you for your reminding. It is ture that the dust aerosol properties derived from single site measurements could not represent the whole source region due to the variations in mineralogical composition of soil over the region. The large spatial variability of aerosols and the lack of an adequate database on their properties make DRE_{dust} and $DRFE_{dust}$ much very difficult to be estimated (Satheesh and Srinivasan, 2006). In this paper, we using a satellite-based method to estimate the $DRFE_{dust}$ over land without any assumptions of the dust aerosol properties to overcame the problem successfully and got a good result. In order to evaluate DRE_{dust} and $DRFE_{dust}$ accurately, more ground observations are needed for represents the dust aerosol properties variation in the whole source region in detail. However, there can not have so many ground observation sites in practice. Therefore, some previous

studies using dust aerosol properties derived from single site to represents dust aerosol properties of the research area (Li et al., 2020;Guirado-Fuentes et al., 2014;Garc á et al., 2014;Garc á et al., 2012).

In the paper, we chose the satellite data around Tamanrasset and Kashi to estimate the $DRFE_{dust}$, and we consider the slope of the linear regression line through these data points (Fig.7) could presents the mean $DRFE_{dust}$ around Tamanrasset and Kashi. We have modified the inaccurate information to avoid the ambiguity. Please see Lines 26-30 in Page1, Lines 92-93 in Page 4, Lines 216-220 in Page 9, Lines 407-409 and Lines 413-417 in Page 21, Lines 424-426 in Page 22, Lines 441-443 and Lines 449-453 in Page 23, Lines 461-464 in Page 24, Lines 467-469 in Page 25 and Lines 527-530 in Page 28 of the revised manuscript.

3. The following is incorrect:

14. Line 257: "Thus, dust aerosols have a negative radiative effect in the SW spectrum." ...Here again --how do I get this from Fig 6, where all numbers are positive? If you want to discuss radiative effect, why not show radiative effect in the figure? ...I see you have rad effect in Fig 7. Why not delay this discussion until then?

Reply: Dust aerosols have higher SW albedo than land surface albedo in clear-sky conditions, and dust aerosols reflect more SW radiation to TOA. DREdust was defined as the radiative fluxes difference between clear (Fclr) and dust loading (Fdust) conditions (Garrett and Zhao, 2006; Christopher et al., 2000;Ramanathan et al., 1989).

DRE dust = Fclr - Fdust

Therefore dust aerosols have a negative radiative effect in the SW spectrum. It also can be founded in Fig. 6 in the revised manuscript, we delayed this discussion behind Fig. 6 in the revised manuscript. Please see Lines 312-313 in Page 15 of the revised manuscript.

Dust aerosols can either have a positive or a negative radiative effect at the TOA as discussed by many authors (Sokolik and Toon (1999); Claquin et al., 1999; Liu and Seinfeld (1999) Balkanski et al.(2007) Miller et al. (2004 and 2011)…. If you were talking about the surface radiative effect in clear-sky then you would be right, it is always negative.

Also, please check your definition of DRE dust, is it 'Fclr – Fdust' or 'Fdust- Fclr' that you are discussing?

Reply: DRE_{dust} is defined as the upward radiative flux difference between clear (F_{clr}) and dust loading (F_{dust}) conditions ($DRE_{dust}=F_{clr}-F_{dust}$). And here we discuses the shortwave (SW) DRE_{dust} at the top of the atmosphere (TOA) in this paper. Dust aerosols have higher SW albedo than land surface in clear-sky conditions, and dust aerosols reflect more SW radiation to TOA, therefore dust aerosols causing negative SW DRE_{dust} at the TOA. Previous studies also show dust causes SW negative radiative effect at the TOA (Xia and Zong, 2009;Tian et al., 2019;Lin et al., 2009;Li et al., 2020;Li et al., 2004;Jose et al., 2016;Garc á et al., 2014;Garc á et al., 2012;Christopher and Zhang, 2002;Bi et al., 2014).

4. Please correct this sentence as I could not figure out what you meant in lines 379-380: " However, the contents of the SW radiative flux change little with the increase of the height 379 of dust layer (within 1.5Wm-2, 0.47%). "

Reply: It has been rewritten as "However, the SW radiative flux change little (within $1.5Wm^{-2}$, 0.47%) with the increase of the height of dust layer.". Please see Lines 379-380 in Page 19 of the revised manuscript.

5. There is no such thing as a dust aerosol typical of the Sahara since it is mineralogy that mostly determines optical properties. The same is true for the Taklimakan Desert. If you convey this message anywhere in the paper, it should be edited.

Reply: Thank you for the valuable suggestion. Following the suggestion, we have modified the inaccurate information to avoid the ambiguity. Please see Lines 26-30 in Page1, Lines 92-93 in Page 4, Lines 216-220 in Page 9, Lines 407-409 and Lines 413-417 in Page 21, Lines 424-426 in Page 22, Lines 441-443 and Lines 449-453 in Page 23, Lines 461-464 in Page 24, Lines 467-469 in Page 25 and Lines 527-530 in Page 28 of the revised manuscript.

6. This sentence needs to be modified to better reflect what you mean to say:
"Therefore, the uncertainties can be evaluated more reasonably."

Reply: It has been rewritten as "Therefore, the uncertainties can be estimated objectively.". Please see Line 519 in Page 28 of the revised manuscript.

References

Bi, J., Shi, J., Xie, Y., Liu, Y., Takamura, T., and Khatri, P.: Dust Aerosol Characteristics and Shortwave Radiative Impact at a Gobi Desert of Northwest China during the Spring of 2012, Journal of the Meteorological Society of Japan. Ser. II, 92A, 33-56, 10.2151/jmsj.2014-A03, 2014.

Christopher, S. A., and Zhang, J.: Shortwave Aerosol Radiative Forcing from MODIS and CERES observations over the oceans, Geophysical Research Letters, 29, 6-1-6-4, 10.1029/2002gl014803, 2002.

Garc á, O. E., D áz, J. P., Exp ósito, F. J., D áz, 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, 10.5194/acp-12-5129-2012, 2012.

Garc á, R. D., Garc á, O. E., Cuevas, E., Cachorro, V. E., Romero-Campos, P. M., Ramos, R., and de Frutos, A. M.: Solar radiation measurements compared to simulations at the BSRN Iza ña station. Mineral dust radiative forcing and efficiency study, Journal of Geophysical Research: Atmospheres, 119, 179-194, https://doi.org/10.1002/2013JD020301, 2014.

Guirado-Fuentes, C., Cuevas, E., Cachorro, V., Toledano, C., Alonso-P érez, S., Bustos, J., Basart, S., Romero, P., Camino, C., Mimouni, M., Zeudmi, L., Goloub, P., Baldasano, J., and Frutos Baraja, A.: Aerosol characterization at the Saharan AERONET site Tamanrasset, Atmospheric Chemistry and Physics, 14, 11753-11773, 10.5194/acp-14-11753-2014, 2014.

Jose, S., Gharai, B., Rao, P. V. N., and Dutt, C. B. S.: Satellite-based shortwave aerosol radiative forcing of dust storm over the Arabian Sea, Atmospheric Science Letters, 17, 43-50, https://doi.org/10.1002/asl.597, 2016.

Li, F., Vogelmann, A. M., and Ramanathan, V.: Saharan Dust Aerosol Radiative Forcing Measured from Space, Journal of Climate, 17, 2558-2571, 10.1175/1520-0442(2004)017<2558:SDARFM>2.0.CO;2, 2004.

Li, L., Li, Z., Chang, W., Ou, Y., Goloub, P., Li, C., Li, K., Hu, Q., Wang, J., and Wendisch, M.: Aerosol solar radiative forcing near the Taklimakan Desert based on radiative transfer and regional meteorological simulations during the Dust Aerosol Observation-Kashi campaign, Atmos. Chem. Phys.,

20, 10845-10864, 10.5194/acp-20-10845-2020, 2020.
Lin, C., Guang-Yu, S., Ling-Zhi, Z., and Sai-Chun, T.: Assessment of Dust Aerosol Optical Depth and Shortwave Radiative Forcing over the Northwest Pacific Ocean in Spring Based on Satellite Observations, Atmospheric and Oceanic Science Letters, 2009.
Satheesh, S. K., and Srinivasan, J.: A Method to Estimate Aerosol Radiative Forcing from Spectral Optical Depths, Journal of Atmospheric Sciences, 63, 1082, 10.1175/jas3663.1, 2006.
Tian, L., Zhang, P., and Chen, L.: Estimation of the Dust Aerosol Shortwave Direct Forcing Over Land Based on an Equi-albedo Method From Satellite Measurements, Journal of Geophysical Research: Atmospheres, 124, 8793-8807, 10.1029/2019JD030974, 2019.
Xia, X., and Zong, X.: Shortwave versus longwave direct radiative forcing by Taklimakan dust aerosols, Geophysical Research Letters, 36, 10.1029/2009gl037237, 2009.