

Response to Reviewer #2:

General comments:

General Comments: The authors present a modeling study using the Community Atmosphere Model (CAM) with the bulk aerosol model (BAM) to investigate the positive radiative feedback of dust deposition on snow over East Asia. Due to the large scale climate impacts induced by Tibetan Plateau thermal forcing, this is a particularly important region to investigate. The study includes three 21-year simulations to isolate the radiative forcing associated with decreased snow cover and reflectivity due to dust deposition. There are some minor comments and questions that should be addressed along with deficiencies in overall grammar and sentence structure which are distracting to the content.

Response: Thank the Reviewer very much for the positive comments. We have tried our best to enhance the English in grammar and sentence structure.

Specific Comments:

page 1, line 2: Please correct this sentence to, “: : and removing snow cover through increased snowmelt”

Taken.

page 1, line 6-7: Please correct this sentence to, “Our results show that SRF increases the East Asian dust emissions by 13.7% in the spring, countering a 7.6% decrease in emissions by the : : :”

Taken.

page 1, line 8: Please correct this to, “: : dust cycle, including transport and deposition of dust aerosols over East Asia.”

Taken.

page 1, line 8-10: I suggest rephrasing this and removing “overall dust cycle over this region” as this has been stated in the previous sentence. “The simulations indicate an

increase in dust emissions of 5.1% due to the combined effect of DRF and SRF.”

Taken.

page 1, line 12: Please correct this to, “: : latent heat flux, which in turn increases the aridity and westerly winds over Northwest China and enhances the regional dust cycle.”

Taken.

page 2, line 3: is this eastern China or the east China Sea?

Here, we claimed that dust aerosols can be carried over the wide downwind regions including land (e.g., the eastern China) and sea (e.g., the Pacific ocean).

page 2, line 8: Please change “by” to “as”

Taken.

page 2, line 13: Please rephrase this. The DRF with particle size distribution for dust from Kok, 2011, is less cooling (smaller forcing). The new size distribution results in DRF range of -0.5 W/m^2 to $+0.2 \text{ W/m}^2$ compared to AeroCom results of -0.8 W/m^2 to -0.01 W/m^2 accounting for the possibility that the atmospheric dust burden could be a warming influence on net RF.

We have rewritten it as “The DRF with particle size distribution for dust from Kok (2011) is less cooling (smaller forcing) because atmospheric dust is coarser than represented in current models. The new size distribution results in DRF range of -0.48 W m^{-2} and $+0.2 \text{ W m}^{-2}$, including the possibility that dust causes a net warming of the planet (Kok et al., 2017).”

page 2, line 18: Please change “with” to “by”

Taken.

page 2, line 23: Please change “depending” to “dependent”

Taken.

page 2, line 31: Please remove “also” (last word on this line)

Taken.

page 3, line 1-2: This is a run-on sentence. Please add a full stop after Qu et al., 2014 and start a new sentence with “These studies further claim: : :”

Taken.

page 3, line 5: Please change to “: : aerosol in snow can cause a ± 1 degree warming of the TP, which: : :”

Taken.

page 3, line 7: Replace “through” with “by”

Taken.

page 3, line 9: Please remove “by” before “to explain”

Taken.

page 3, line 13: Replace “affecting” with “impacts on”

Taken.

page 3, line 19: Insert “been” between “not” and “studied”

Taken.

page 3, line 19: Remove “here” and change “extended” to “extend”

Taken.

page 3, line 20: Add a comma after SRF and remove “and” after SRF

Taken.

page 3, lines 18-21: Run-on sentence, please break up this sentence either by adding a semicolon or making this two sentences.

Taken.

page 3, line 23: Change “experiment design,” to “experimental design.” Remove “and furthermore” and begin new sentence “The model: : :”

Taken.

page 3, line 24: Change “observations about the snow cover and the surface temperature” to “observations of snow cover and surface temperature.” Change “The model results about” to “The model results for”

Taken.

page 3, line 29: Remove “detailedly” and insert “in detail” between “described” and “by”

Taken.

page 3, line 31: The improvements to CAM4-BAM are for the dust cycle only.

Taken.

page 3, line 33-34 and p4, line 1: Can the authors be more specific about the impacts from the improved parameterizations? (e.g., dust in CAM4 release version was too absorbing and the size distribution was weighted too heavily on finest mode (bin1))

Yes, we have added the descriptions in the revised manuscript “This improved size distribution decreases the emitted fraction of clay aerosols (< 2 um) in excellent agreement with measurements and exerts a smaller cooling compared released version.”

page 4, line 2: Insert “the” between “investigate” and “East”, change “Asia” to “Asian” and replace “display its” with “the”

Taken.

page 4, line 8-9: Can the authors add the sources of the input datasets used to drive the model? Please also describe the CAM4 and SNICAR setup. Please explain if these are nudged simulations and if so, which meteorology data was used.

Yes, it is a good suggestion. We have added the input datasets “The SST and sea-ice concentration were from a merged version of the HadISST (Rayner et al., 2003) and the optimum interpolation SST data sets described by Hurrell et al. (2008). We conducted three numerical experiments including 21-year free run with a 1-year spin up (no nudging), one with both DRF and SRF (Case1), one with the DRF and without the SRF (Case2), the other one without the DRF and the SRF (Case3), as summarized in Table 1.”

page 4: This study considers the dust-in-snow impact on RF but can the authors add some discussion on the combined deposition of all aerosols on snow? It would have been interesting to consider an additional case with deposition to snow from all radiatively active aerosols to shed light on the impact of dust-in-snow relative to, for example, BC+dust in snow.

Yes, we have added a discussion about BC+dust in snow “It is noted that black carbon (BC) deposited on snow over the TP mainly from South Asia and East Asia (Xu et al., 2009; Wang et al., 2015) also displays a significant positive forcing over this region (Flanner et al., 2009; Qian et al., 2011). Here, we only consider the radiative forcing of the dust-in-snow over the TP ignoring the radiative forcing of the BC-in-snow in our study. Due to neglecting the nonlinear interactions between BC and dust, the dust-in-snow radiative forcing might not be accurate.”

page 4, line 16-17: Please rephrase the second part of this sentence to something like, “compared with changes induced solely by DRF”

Taken.

Figure 2 (c) and (d): The color of the contour showing terrain > 2500m is difficult to see as it blends with the color scale in the figure.

Taken.

page 4, line 24: Please rephrase, “: : dust AOD has larger values over dust source regions (Gobi and Taklamakan deserts), where dust AOD is greater than 0.2 particularly over the Taklamakan desert.”

Taken.

page 4, line 25: Please insert “mean” between “monthly” and “dust”

Taken.

page 4, line 26: Please combine “The result also indicates: :” with the previous sentence, “: : dry, wet and total (dry+wet) deposition, with the highest values in MAM.”

Taken. It is a very good suggestion. Thanks very much.

page 4, line 27-28: I would rephrase “probably because of less rain over Northwest China.” Consider adding citations for the trends in seasonal precipitation over this region (Xu et al., 2008; Kang et al., 2010; Fig. 8, Lau et al., 2006) Kang, S., Xu, Y., You, Q., Flügel, W.A., Pepin, N. and Yao, T., 2010. Review of climate and cryospheric change in the Tibetan Plateau. *Environmental Research Letters*, *5*(1), p.015101. Xu, Z.X., Gong, T.L. and Li, J.Y., 2008. Decadal trend of climate in the Tibetan Plateau. *Regional temperature and precipitation. Hydrological Processes*, *22*(16), pp.3056-3065.

Taken.

page 4, line 29-31: Please change this sentence to, “Additionally, deserts in the western and northeastern regions of TP exhibit peaks in dust deposition, which we expect to further increase the SRF signal.”

Taken.

page 5, Figure 3 (a) and (b): Can the authors provide further discussion on the low bias in the model for SCF during (MAM) and how this will impact their results? What are the implications of the low bias in surface temperature over the Gobi desert?

The bias in the model for SCF and surface temperature over the TP region are mainly due to the model’s coarser horizontal resolution ($0.9^{\circ} \times 1.25^{\circ}$). Hence, we have added the corresponding descriptions in the revised manuscript “Due to the complex topography of the Tibetan Plateau, higher-resolution simulations can resolve more details of the deep valleys and high mountains over and around the TP and make some significant improvements in the simulated climate (Li et al., 2015). Hence, it is necessary to conduct the higher-resolution simulations to address this issue.” **And we also added** “Due to neglecting BC and dust nonlinear interactions, the dust-in-snow radiative forcing might not be accurate. Additionally, the overestimated SCF in the MAM may also artificially increase the dust-in-snow radiative forcing. The overestimated radiative forcing may amplify its feedbacks on the East Asian climate and dust cycle.”

page 5, line 18: Replace “in the” before “MAM” with “during”

Taken.

page 5, line 21: Typo “colume”

Taken.

page 5, line 25: Change “remarkedly” to “markedly”

Taken.

page 5, line 28: Are these statistically significant?

We have deleted the word “significantly”. The changes in dust transport and dry deposition are statistically significant whereas the change in wet deposition is not statistically significant.

page 5, line 29: Please change “is” after “dust emissions” to “are”

Taken.

page 5, line 30-31: Please insert “by 5.1%” between “East Asia” and “with”

Taken.

page 6: The second paragraph in section 3.2 is good but can the authors comment on how well the simulated albedo in Figure 6 (a) matches satellite observations of albedo over this region?

Yes, we have added a description in the revised manuscript “Compared to the MODIS surface albedo over the TP (Meng et al., 2018), the CAM4-BAM model captures its spatial distribution during MAM. However, the model overestimates the surface albedo, which is similar with multi-model ensembles’ results (Li et al., 2016), mainly due to the overestimated SCF and the ignoring BC-in-snow.”

page 6, line 17: Please change “That” after “Figure 7a)” to “This” and remove “that” between “because” and “the”

Taken.

page 6: The negative RF from DRF over the Taklamakan and Gobi deserts from the scattering efficiency explained by simulated AOD would be more conclusive if the model AOD is compared to obs in the dust dominated regions.

Taken.

page 6, line 20: Please change “decrease” after “surface” to “decreasing”

Taken.

page 6, line 25: Please remove “reach” in “(reach above 20 W/m²)”

Taken.

page 6, line 29: Please change “whereas” to “compared to”

Taken.

page 6, line 30: Please change “determines” to “dominates”

Taken.

page 6, line 33: Please change “followings.” to “following sections.”

Taken.

page 7, line 8: Typo “(LHF+LHF)” (LHF+SHF)

Taken.

page 7, line 9: Please change “resulting in” to “thereby”

Taken.

page 7, line 12: Please add “referred to” between “TP” and “as” and change “monsoonal” to “monsoon”

Taken.

page 7, line 19 and 20: I don't think “anonymous” is the right word. Do you mean anomalous?

Taken.

page 7, line 21: Please change “That” between “regions.” and “is” to “This” and remove “that” between “because” and “the”

Taken.

page 7, line 28: Please remove “remarkedly” and add “the” between “affects” and “dust”

Taken.

page 7, line 29: Please change to “which in turn increases the magnitude of the whole dust cycle”

Taken.

page 7, line 34 and page 8, line 1: Please rephrase this sentence, in particular “decreased (increased)” and “over the north of the TP (over the TP)” is confusing.

Yes, It has been changed as “It shows the downward vertical velocity is enhanced in summer (Figure 11a), resulting in the significant decreased surface precipitation (Figure 11b) over the north of the TP, whereas the upward vertical velocity and the surface precipitation are both enhanced over the TP.”

page 8, line 3: Please change “generally” to “general” and “enhances” to “enhancing”

Taken.

page 8, line 11: please change “that” to “the” between “because” and “largest”

Taken.

page 8, line 14: Please rephrase to something like, “The above results indicate the predominate causes for SRF enhancement of the dust cycle over East Asia and is illustrated in Figure 13.”

Taken.

page 8, line 15: Please rephrase to something like, “Dust aerosols emitted from East Asian source regions where precipitation is limited and deposited : : :”

Taken.

page 8, line 18: Please change to “enhancing the south-north temperature gradient and the aridity over: : :”

Taken.

page 8, line 19: Please change “These” to “The”

Taken.

page 8, line 23: Please change “we compares” to “we compare”

Taken.

page 9, line 2-4: This sentence is grammatically incorrect, please try breaking it into two sentences or adding a semicolon.

Taken.

page 9, line 7-9: Please change to “The CAM4-BAM simulations show that SRF increases dust emissions in the spring by 14.78Tg/season (13.7%), thus enhancing dust transport and deposition over East Asia.”

Taken.

page 9, line 12-14: Please change to something like, “Dust-in-snow reduces the albedo over the TP which warms the TP and enhances TP thermal effects and the regional dust cycle; increased sensible and latent heat fluxes from the surface result in increased aridity and westerly winds over North China.”

Taken.

page 9, line 14: Please change “In generally” to “In general”

Taken.

page 9, line 15: Remove “overall”

Taken.