

Interactive comment on “Quantifying the range of the dust direct radiative effect due to source mineralogy uncertainty” by Longlei Li et al.

Longlei Li et al.

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Received and published: 17 October 2020

COMMENT

The manuscript describes the uncertainty of the top-of-the-atmosphere dust direct radiative forcing due to current uncertainties in the surface soil mineralogy. Especially the importance of iron oxides is high-lighted.

The manuscript is well-organized and include detailed description of the results. It is recommended for publication after consideration of the minor comments below.

RESPONSE

Thank this reviewer much for the careful reading of the manuscript and for the com-

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ments. We have made changes to the manuscript to reflect the suggestions. Text from the manuscript is quoted with double quotation marks. Please see the figure we created and cited here as Fig. R1 in the supplement material.

COMMENT

Page 2, lines 45-46: The sentence starting with “These two...” is unclear. Please rewrite.

RESPONSE

We merged this and the sentence right before into one:

“Dust aerosol (here defined as soil particles suspended in the atmosphere) perturbs the radiative energy balance directly by scattering and absorbing shortwave and long-wave radiation known as the aerosol-radiation interaction (Boucher et al., 2013) and indirectly by changing the cloud albedo and lifetime by acting as cloud condensation nuclei (CCN) and ice nuclei (IN) (Nenes et al., 2014) and by increasing diabatic heating in the atmosphere and evaporating cloud (Hansen et al., 1997; Bollasina et al., 2008; Jacobson, 2012) known as the aerosol-cloud interaction (Boucher et al., 2013).”

COMMENT

Page 2, line 54: The net dust DRE is given. May you also include numbers for other DREs so the reader can have an idea about the dust DRE magnitude in relation to other processes?

RESPONSE

We now provide the SW DRE and LW DRE in addition to NET DRE.

“A recent review which synthesized data on dust abundance, optical properties, and size distribution estimated that the shortwave, longwave, and net direct radiative effects (DRE) of dust range between $[-0.81, -0.15]$, $[0.17, 0.48]$, and $[-0.48, +0.20]$ W m⁻², respectively (Kok et al, 2017).”

COMMENT

Page 7, line 193: Remove “in the model”.

RESPONSE

Done.

COMMENT

Page 10, line 297: Remove “.” after “)”.

RESPONSE

Done.

COMMENT

Page 10, line 297: What is a “simple double call”?

RESPONSE

This sentence shows how to calculate the dust radiation effect in MONARCH. We rewrote this sentence as:

“The radiation flux is diagnosed twice, one with all aerosol species and the other one solely without dust aerosol to determine the DRE for bulk dust.”

COMMENT

Page 15, line 465: Should ΔF_{upp} be ΔF_{hig} ?

RESPONSE

Yes, changed.

COMMENT

Page 21, line 650: Change “7a” to “7”.

RESPONSE

Done.

COMMENT

Page 24, line 752: The region of Australia is marked with a star in Fig 11a, indicating that the result is statistically significant. This is the opposite of what is said in the text.

RESPONSE

“except Australia” deleted.

COMMENT

Page 25, line 784: Change “African” to “Africa”.

RESPONSE

Done.

COMMENT

Page 26, lines 797-808: The radiative parameterization is discussed. However, it is not clear that the same radiative transfer solution method is used in both the line-by-line and the parameterized calculations. If the methods are different, for example if one of the methods use more streams, this will potentially cause significant differences.

RESPONSE

As the reviewer commented and what we had pointed out in the main text (“these GCMs underestimate the DRE and dust warming mostly due to the use of the two-stream delta-Eddington approximation in RRTMG and the radiative model’s low band resolution”), the majority of the bias compared to the line-by-line calculation is due to the use of the two-streams delta-Eddington approximation in CESM over North Africa.

For clarity, we modified the text a little bit:

“these GCMs underestimate the DRE and dust warming mostly due to 1) the use of the two-stream delta-Eddington approximation (major error source) in RRTMG in comparison to the 16 streams used in the line-by-line run, and 2) the radiative model’s low band resolution (minor error source compared to that in 1)”.

COMMENT

Page 28, line 867: Change “that goethite” to “than goethite”.

RESPONSE

Done.

COMMENT

Page 30, line 922: Change “of other” to “of the other”.

RESPONSE

Done.

COMMENT

Page 31, lines 956-958: Unclear sentence (too many whiles?), please rewrite.

RESPONSE

Changed to: “For instance, CAM5 reproduced observational dust deposition within a factor of 10 in general (Fig. R1). At sites such as Colle del Lys and Colle Gnifetti in Europe, the baseline simulation in CAM5 greatly overestimated the surface deposition, while over the South Pacific the model greatly underestimated the deposition.”

COMMENT

Page 31, line 958: Change “exits” to “exists”.

RESPONSE

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Done.

COMMENT

Page 45, line 1370: What is meant by “and are repeated”?

RESPONSE

Panel a) for example had been shown before in Fig. 1a of Scanza et al., (2015). Here we repeated the processing with the MMT taken from Clauquin et al., (1999) and show this information again. We deleted “and are repeated” as it is not a core element of the caption; we believe that solely saying “has been shown previously” is informative enough. Similarly, we also deleted “and are repeated” in the caption of Fig. 2.

COMMENT

Page 46, line 1388; page 47, line 1392; page 48, line 1404; page 52, line 1456; Fig. S13: The acronym DOD is used in the captions and figures. It is not mentioned anywhere in the text. In the text you use AOD dust. Please use only one notation for the dust AOD throughout the manuscript.

RESPONSE

Now we are using DOD all throughout the manuscript in the captions, figures, and texts.

COMMENT

Page 53, lines 1474-1475: Unclear sentence, please rewrite.

RESPONSE

Now it reads like: “All the model results were processed onto $2.5^{\circ} \times 1.9^{\circ}$ (longitude by latitude) horizontal grids for further calculation.”

COMMENT

Table S2: Please provide full reference to the CESM User Guide.

RESPONSE

We inserted a link to the table caption:

http://www.cesm.ucar.edu/models/cesm1.0/cam/docs/description/cam5_desc.pdf

Please also note the supplement to this comment:

<https://acp.copernicus.org/preprints/acp-2020-547/acp-2020-547-AC2-supplement.pdf>

Interactive comment on Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2020-547>, 2020.

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