

Referee #1

I now recommend only one further refinement. Specifically, the paper outline in Line 53 starts with “Next, in Section 2.2, we will...”, which suggests that a previous sentence that mentions Section 2.1 is missing. Therefore, a new sentence should be added here to describe what Section 2.1 does.

Thanks for spotting this one, “Section 2.2” should have been “2.1 and 2.2”, something went wrong with the section labels after re-organizing the introduction structure.

Referee #2 (Philipp Gregor)

The manuscript is improved and I believe that the authors have done a good job in addressing the comments. The described bugs in the raytracing code related to ice treatment are severe, however seemingly of small influence on the results and not apparent when viewed from outside. I appreciate that the authors corrected this.

I have a few additional comments, which I hope the authors will address.

Thank you once again.

Please find our response to your comments below in the blue text.

General Comments:

While the description of settings is by far more detailed in the revised manuscript, some details are often only given in Figure captions and not in the textual description of the results. Examples are albedo 0 for the altocumulus fields in 5.4.2 only given in Fig. 11 or in section 5.1 the SZA 45° only given in Fig. 8. I suggest revising this for a complete and sorted description of the experiments in the text.

Albedo of 0 in figure 11 refers to that figure specifically, as we run the altocumulus also with 0.8 to test the effect of albedo (last paragraph of section 5.4.2.). However, we now explicitly state that all simulations are run with an albedo of 0 by default, unless stated otherwise (in which case the effect of albedo is being tested). For clarity I have added the SZA and albedo settings in a handful more occasions where these specifics were only part of the figure caption.

While I do believe the authors based on the presented results, that the Monte Carlo raytracing was run to a point where the noise does not systematically affect the conclusions and results, noise is still very obvious in the figures. While re-running experiments, a standard deviation should have been easy to compute alongside and given in the manuscript. I think it would be helpful to at least mention the noise when introducing

the raytracer. The decreased resolution of the towering cumulus case (Lines 288-290) indicates that runtime in comparison to noise may indeed have been a point of consideration.

The reason we have to reduce the resolution is due GPU memory limitations, not computational time. A 4x increase in resolution would require $4 \times 4 \times 4 = 64$ x more GPU memory for a similar domain size. Multi GPU is not yet supported for this experimental setup, so we simply have had to accept lower resolution.

We think that while running with many more rays will further reduce statistical noise, it does not reduce the true uncertainty of the experiments, and so providing uncertainty based on Monte Carlo noise can be a bit misleading.

We disagree that the noise is ‘very obvious’, except in Figure 8b. However, we do not discuss noise anywhere in the text. We have added “As for the number of rays, or sample per pixel, we set to this to a high enough to get a clear signal, typically 256 to 1024.” to section 3.1

Specific comments:

L. 113-114: This is a bit confusing to me. To my understanding the growth of the cumulus congestus causes the shadow to appear while the reappearance in the time series refers to the reappearance of direct irradiance (the Sun). Could you formulate this a bit clearer?

This ambiguity has been fixed.

L. 117: “away from clear-sky region[s].”

Fixed.

L. 291: “naturally influenced [by] turbulence”

Fixed.

L. 257: “is effectively infinite [as] long as”

Fixed.

Section 4.1.1., Fig. 4, or 5.2: Please indicate the averaged y-region for the cloud gap case.

Added text to explain this. The subset is so small that it won’t be readable in the figure. It’s the center 150 meters of the 200 meter diameter circle.

L. 360: “... can rarely irradiance enhancement ...” probably not correct English

“can rarely [cause]” - Fixed.

L. 360: “the cloud only [??] meters thin”

“is” - I think I was making a summation with the previous “is” but that’s not correct English... Thanks.

L. 435-436: “... direct beam location would focus on one spot when.” Sentence seems to miss second half.

“when” can be removed, sorry, and thanks for spotting this one.

L. 437-438: “magnitude of such effects [is] hard to estimate”

Indeed, fixed.

L. 442: “solar zenith angle of 0[°] unrealistic.”

Fixed.

Fig. 12c: y-Axis unit: Is “W m⁻²” correct here or should it be “%” as in the following figures?

It is correct, but I understand your question. 4 W/m² is very little, but it’s averaged over a large area where nothing happens.

L. 477: “We identify [...] three distinct”

Fixed.

Fig. A4, A5, A6: The naming of the number concentration experiments is inconsistent between Figures and captions (nc200, ncx2, nc_x2, ...). Also, the titles of the a) and b) subfigures is irrelevant. Please Fix.

I made the captions consistent with the figures. I don’t think it hurts to leave the subfigure titles up.