ACP Second Review (preprint on EGUsphere at:
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Title: Radiative effect by cirrus cloud and contrails – A comprehensive sensitivity study
Author(s): Kevin Wolf, Nicolas Bellouin, and Olivier Boucher
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GENERAL COMMENTS:

The manuscript has been greatly improved and, in general, the authors have done a great job in response to the review comments I have made. However, they mention Section 2.4 titled "Approximation of radiative transfer in the thermal-infrared", which somehow was not included in the revised version of this manuscript. This section is critical since it describes how radiation transfer is treated in the thermal infrared (TIR) spectrum; it is needed to properly understand the TIR results of this sensitivity study. This manuscript should not be published without it.

SPECIFIC COMMENTS:

1. On comment #7 from 1st review:
Equation 13: Is this equation used in libRadtran? If not, what is the point in mentioning it? Cloud property input to libRadtran consists of IWC and re, suggesting the zero-scattering approximation might be used for TIR hemispheric fluxes: $\varepsilon = 1 - \exp(-5\,\tau_{abs}/3)$ where ε is cloud emissivity and τ_{abs} is the cloud absorption optical depth. Please indicate whether ε is calculated in libRadtran, and how it is calculated if applicable.

Author response: The DISORT solver in libradtran (Buras et al 2011) calculates scattering in the TIR on basis of the bulk-scattering properties of ice crystals, analog to the solar wavelength range. Thus, the zero-scattering approximation is not used in the simulations. **Equation 13** was added to the manuscript to provide guidance for the reader. To avoid misinterpretation the equation **is brought into context and is expanded to section "2.4 Approximation of radiative transfer in the thermal-infrared"**, to incorporate suggestions from other Reviewers.

Referee comment for 2nd review: The author response above is puzzling since the referee is finding no section 2.4 titled "Approximation of radiative transfer in the thermal-infrared" in the revised manuscript nor in the track-changes version (the diff file) of the manuscript. In the current revised manuscript, there is no discussion of how RT in the thermal infrared (TIR) is dealt with, which is critical for a RT sensitivity study presenting results in both the solar and TIR. Since the authors mention Sect. 2.4 in their response having the title "Approximation of

radiative transfer in the thermal-infrared", it appears that this section was mistakenly omitted from the manuscript. The manuscript should not be published without this section.

2. On comment #8 from 1st review:
Lines 209 – 213 and Eq. 14: Eqn. (14) appears flawed since, in principle, there should be an emissivity term (ε) for both the surface and the ice cloud. But since typically $\varepsilon \approx 1$ at the surface, does ε in (14) correspond only to the ice cloud? If so, it would be incorrect to multiply it by T_{sfc}^4 (which Eq. 14 does). Later, ΔF_{tir} is shown for IWC, re, and ice crystal shape, so it appears that ε refers to the ice cloud and therefore $\varepsilon < 1$, but how then does ε depend on IWC, re and ice particle shape? The dependence of ΔF_{tir} on cloud properties is a complete black-box mystery and this needs to be explained.

Author response: As mentioned in our reply to comment 7, a dedicated section for TIR RT was added to the manuscript. It is primarily based on the TIR RT approximation given by Corti and Peter (2009). Equation 14 is now replaced by Eq. 20. Major steps to derive Eq. 20 are given in the manuscript; details can be found in Corti and Peter (2009).

Referee comment for 2nd review: Same as above regarding comment #1.

3. Figure 4d: The dot-dash curve showing the absolute difference in ΔF between plates and aggregates appears flawed for IWC > 0.02 g/m^3, assuming Fig. 4a is correct. Perhaps I have overlooked something, but in Fig. 4a for $\theta = 30°$ and $r_e = 25$ µm (dot-dashed), ΔF_{sol} appears fairly constant between plates and aggregates for IWC > 0.02 g/m^3, indicating that their absolute difference in Fig. 4d should be approximately constant for IWC > 0.02 g/m^3 (with the dot-dash line being approximately horizontal). If there is such an error, this will affect Fig. 4f as well. The other curves look reasonable, as well as the curves in Fig. 4g.

I now see that Fig. 4a and Fig. 3b are different, although they should be the same if I understand correctly. The curves plotted in Fig. 3b appear consistent with those in Fig. 4d, suggesting that Fig. 4a is flawed.

4. Lines 391-395: Manfred Wendish wrote a paper on this topic in JAS(?) around 2008 I'm guessing.

5. Lines 398-399: The decreasing order at $r_e = 5$ µm (droxtals, plates, aggregates) changes when r_e is larger to droxtals, aggregates and plates in Fig. 4b.

6. Lines 410-11: "relative differences exceed the absolute value by a factor of 10." How is this evident from the two plots where one is unitless and the other has units?

7. I did not have time to carefully review the sections that came after Sect. 3.1, and the authors are encouraged to do so due to the above comments pertaining to Sect. 3.1 (#s 3 – 6) and the technical comments below.

TECHNICAL COMMENTS: Line numbers correspond to the revised manuscript.

1. Line 90: The net RE given by => The net RE is given by?

2. Lines 93-94: Redundant portion of sentence.

3. Line 103: Although the meaning of TIR might be inferred from lines 91-92, it is customary to explicitly state its meaning, like "The thermal infrared radiances (TIR) include …"

4. Line 175: Are you sure you want $\Lambda = -1/(a \cdot b)$ since this would make the exponent in (4) positive?

5. Equation 10: Since you are approximating τ_{ice} for solar radiation only, this equation can be further simplified by noting $Q_e \approx 2$.

6. Line 212: "The altitude of 1500 k was selected" => The altitude of 1500 m was selected?

7. Line 378-9: Mitchell (1996) => Mitchell (2002)?

8. Line 389: 50 W m^{-2} looks reasonable for plates at $r_e = 5$ μm, but I think this discussion is relating droxtals to aggregates, in which case the number looks closer to 25 W m^{-2} for IWC = 0.024 g m^{-3}.