Review of "Radiative forcing of anthropogenic aerosols on cirrus clouds using a hybrid ice nucleation scheme"
(Apr 30, 2020)

I thank the authors for nicely addressing a lot of my concerns, and including a new sensitivity test in the study.

In my opinion there are still a few issues in the manuscript that I would like to point out.

General comments:

1.) By including a form of a significance in their global map plots, the authors often confirmed my worries about the statistical significance of regional changes to several plotted quantities. The authors would ideally follow the work by Chen and Gettleman, 2013 strategy, which decreases the natural variability (and increases the signal to noise ratio) by running a longer simulation that is nudged always to the meteorology of one specific year only.
I do understand that may not be possible in the current study. However, it may still be beneficial to either extend the simulations for several years or add additional ensemble runs to increase the significance and confidence in a lot of the results, particularly those related to radiative flux anomalies.

2.) Visualization
I give some more suggestions to the authors regarding their visualization. and would appreciate if they would take those points into consideration both now and in the future.

(i) An article should ideally contain the minimum number of figures necessary to deliver the scientific message. I suggest therefore to:

- move to the appendix panels b,d,f of figure 6
- think whether they really need to show both all-sky net radiative forcing and cloud radiative forcing in figures 7,8,9,12.

(ii) All zonally averaged plots should also include some form of statistical significance (e.g. standard deviation)

(iii) The authors should think about stippling the significant gridboxes in a way that does not prevent the reader to read the value below the dots. (e.g. you could try using smaller dots or hatching)

(iv) A bar chart showing global and maybe other zonally averaged (e.g. tropics, northern hemispheric mid latitudes) quantities, particularly radiative fluxes, may be easy to digest and a nice complement to

figures 6,7,8,9. Such a bar plot should indeed also include a form of uncertainty (standard deviation?)

3.) Comment on the simulated ice crystal burden

The ice crystal number concentration burden shown in Figure 2a) seems to be missing the observed increases in ice number over orography, particularly over the Andes, Rockies, the Antarctic mountains, and Greenland.
I would suggest that your follow up studies compare also regional ice crystal number patterns in your model to those observed by CALIPSO-CloudSat (e.g. Sourdeval et al., 2017, Gryspeerdt et al., 2017). I therefore assume your model does not include an orographic wave drag parameterization, or something similar that enhances updrafts over orography?

A comment about the missing ice crystal burden peak over such regions would be appropriate at some point in the manuscript (maybe in section 3.1 when describing results from Figure 2).

Specific comments:

Line 136:
I think Kuebbeler et al., 2014 was not the first to add the effect of orographic waves into the ECHAM model. A more appropriate citation there may be Joos et al., 2008, while Kuebbeler et al. 2014 could still be cited as another study showing the dominant role of homogeneous ice nucleation, maybe in line 64.

Lines 317 – 320:
Does this mean that part of the large Ni peak in the warm pool originates from anvil detrained ice water content and detrained vapour (if vapour is detrained). Or the opposite, the detrained ice is suppressing ice nucleation by decreasing the RH_{ice} by vapour deposition?

Lines 474-476 and Figure 3e,f:
I do not see any significance in Figure 3e and 3f.
Do panels 3b-f, 4b-f, 5b-f include the significance like panels 3a,4a,5a? If not, please add significance stippling/hatching to those panels!

Additional comment:
I would find it useful if your answer below would find the way to the manuscript text.

Why is the effect not larger in the midlatitudes, where soot emissions are the largest?

Re: The number concentration of ice nuclei from homogeneous nucleation is

largest in the tropics as shown in Figure 3(c), so the effect of inhibiting homogeneous nucleation as a result of adding the heterogeneous nucleation of soot is larger in the tropics although soot emission is larger in midlatitudes.

References

Chen and Gettelman, 2013, Simulated radiative forcing from contrails and contrail cirrus
Gryspeerdt et al., 2018: Ice crystal number concentration estimates from lidar–radar satellite remote sensing – Part 2: Controls on the ice crystal number concentration
Joos et al., 2008: Orographic cirrus in the global climate model ECHAM5
Kuebbeler et al., 2014: Dust ice nuclei effects on cirrus
Sourdeval et al., 2018: Ice crystal number concentration estimates from lidar–radar satellite remote sensing – Part 1: Method and evaluation