Review “The nature of ice-nucleating particles affects the radiative properties of tropical convective cloud systems” by R. E. Hawker, et al.

This modeling study investigates the effects of ice nucleating particles (INP) on the radiative properties of tropical convective cloud system. Several widely used INP parameterizations are used in the model, and interestingly the slope of the INP temperature dependence is found to play a key role in the INP effects. The effects of secondary ice production (SIP) are studied, which demonstrate the important role of INP nature for the SIP effects. The study examines the difference aspects of cloud microphysical properties and cloud fraction to understand the INP effects on radiative forcing. Generally, the research topics of INP and SIP and effects on convection are interesting and the results are novel. The manuscript may be accepted for publication after addressing my comments.

Main comments

1. Adding a schematic to illustrate how different slopes of INP temperature dependence could affect cloud microphysics at different vertical layers of convective clouds. That will help readers to better understand the interactions.
2. A better description of model configuration such as model domain, and initial thermodynamical profiles, is required.

Minor comments

1. Line 45: “..INP number concentrations can vary by as much as six orders of magnitude at any one temperature”. Can you add some reasons to explain this large variability?
2. Line 56: “...global models based on known INP-active materials show reasonable skill in simulating global INP concentrations (Vergara-Temprado et al., 2017).” There are also other studies that can be cited here: e.g., Shi and Liu (2019), GRL, compared the modeled INPs with observations.
3. Line 81: “and droplets can freeze homogeneously below around -33°C”. Does your model represent the homogeneous freezing of aerosol droplets below around -37°C?
4. Lines 93-103. You can add one sentence here to introduce your work on SIP effects and dependence on INP parameterizations.
5. Section 2.1.1. Please add a figure in main text showing the model domains and how different models, cloud microphysics, and aerosols are applied to these domains.
6. Line 131. “five hydrometeor classes (cloud droplets, rain droplets, ice crystals, graupel, snow)”. It would be clearer to use “cloud ice” to replace “ice crystals” since ice crystals can contain snow and graupel particles. Also changes the words in text.
7. Line 149. You can make it clear the insoluble aerosol is dust which is used in N12 and A13 parameterizations.
8. Line 158: “predict an ice production rate via heterogeneous freezing”. These ice nucleation parameterizations (M92, N12, D10) only predict INP number concentrations. How do you calculate the ice production rate?
9. Line 159. Do you also represent the CCN wet scavenging?

10. Line 223. It would be good to note that these INP parameterizations only applied to certain temperature ranges and cannot reliably extrapolate to temperatures outside the range.
11. Section 3.5. Line 384. How do other SIP mechanisms impact your results here in this section?
12. Line 399-407. As commented above, a schematic showing the interactions and mechanisms would be helpful for the readers.
13. Line 412. Since CASIM is a two-moment cloud microphysics scheme, why are ice and snow particle numbers not used in the radiation scheme?
14. Line 415. It is not correct to state: “climate models do not typically represent ICNCs”. Please remove.