Review for "The relative impact of cloud condensation nuclei and ice nucleating particle concentrations on phase-partitioning in Arctic Mixed-Phase Stratocumulus Clouds"

Solomon et al assess the relative impact of CCN and INP perturbations on the cloud properties of Arctic mixed-phase clouds in a numerical study based on observations obtained at Oliktok Point in Alaska for the night of April 16^{th} 2015. The authors identify a range of interesting mechanisms in which the cloud response to the aerosol may be buffered in the mixed-phase regime as opposed to the warm-phase regime. Furthermore, their results show that INP perturbations proved to be more efficient at altering cloud properties than CCN perturbations for the same fractional increase/decrease. The study is well-conceived, well written, of interest to the readership of ACP and deserves publication following minor revisions.

Minor Comments:

- P1L26: "decrease in CCN and INPs results in an increase in the cloud-top longwave cooling rate". This statement sounds like the cloud-top cooling rate is getting stronger for a decrease in CCN, which is not the case. I suggest to either refer to it as longwave heating rate at cloud top as done in Fig. 3, or rephrase for clarification.

- P3L2: "only a few INPs are needed to glaciate a cloud". I would argue this still to be an open question (as the authors discuss in their conclusions). As this is relevant to the paper a brief discussion on this issue with a wider referencing of the excisiting literature may be appropriate here. References that come to mind include:

  Loewe et al, ACP, 2017: "Modelling micro- and macrophysical contributors to the dissipation of an Arctic mixed-phase cloud during the Arctic Summer Cloud Ocean Study (ASCOS)"

  Stevens et al, ACP, 2018: "A model intercomparison of CCN-limited tenuous clouds in the high Arctic"

- P10L11: "LWP consistent with observations": From the observations it seems that a considerably thicker MPC develops during the night with LWP reaching 60 g/m^2 and values above $40 g/m^2$ for what seems like ~6h of the night. The LWP in the simulations seems understimated. Please comment.

- The layering of the CCN and INP when a prognostic treatment is used is an interesting finding of this study. Can the authors elaborate why they believe turbulent transport to cause the build-up of CCN above the cloud? Would one not expect turbulent mixing of cloud droplets out of the cloud to be similarly efficient to entrainement of CCN from above into the cloud? It seems unclear to me how turbulence could generate a gradient in number concentration? Please elaborate.

- Figure 5: What does Ni+Ns look like at cloud top? Would one not expect changes in Ni here due to the decrease in temperature (Fig. 4d). Here the nucleation of new crystals occurs which then get processed and mixed through the cloud. So while there are no changes in number concentration at cloud base, the increased cloud top cooling may drive changes in ice crystal number concentration elsewhere in the cloud?

- P6L12: Please add for clarification what the remaining pathway for snow formation is in your model? I would assume that only growth of ice crystals by vapour deposition remains?

- The mechanism of CCN and INP changes impacting the LW cloud top cooling rate (even for thick clouds) and the consequent changes in IWP (even for CCN changes only) is very interesting. It had also been found and hypothesised in a different model for a different case by Possner et al. (2017) where an increase in CCN increased cloud-top cooling, which increased the ice crystal number concentration. Ice water mass increased by increased vapour deposition onto the more numerous crystals (similar as to what the authors see in Fig. 7 for their LinIce experiments). While the feedback here manifests itself differently in simulations with CCN seeding only, it is encouraging to see consistency amongst models and different cases where a feedback through cloud-top cooling impacts the ice phase and stabilises the cloud. This may be worth adding to your discussion.

  Possner et al, GRL, 2017: "Cloud response and feedback processes in stratiform mixed phase clouds perturbed by ship exhaust"

- Figure 9a: Consider adding droplet number concentration profile for LinIce2.0 simulation, which is not shown elsewhere in the manuscript, to show how the prognostic treatment of CCN affects the Nd profile.