Response to Reviewer #2

General Comments:

The response of cloud microphysical processes and precipitation to changes in aerosol particle concentration is still uncertain. This article presents numerical sensitivity tests on how the cloud processes and precipitation from mixed-phase orographic clouds are changed due to changes in the concentration of cloud condensation nuclei and ice forming nuclei. The results are interesting and are generally well presented. It should be publishable in ACP if the following specific issues could be considered in revision.

- Thanks for the helpful suggestions to improve the paper. Please see our point-by-point responses as below.

Specific Comments:

1) Line 51-53: Remove "Supercooled liquid occurred commonly in clouds over the Sierra Nevada during the cold season (Rosenfeld et al., 2013)", since the similar sen- tence also appears in line 54-55.

-Done.

2) Line 67: "pollution aerosols" may be replaced by "anthropogenic aerosols".

-Done.

3) Change Line 73-74 to "The impacts of aerosols on clouds not only depend on aerosols properties, but also on the dynamics and thermodynamics of the clouds".

- Changed to "Aerosol impacts on clouds not only depend on aerosol properties, but also dynamics and thermodynamics".

4) Line 146: "which is referred to as INP concentration": this notation may not be proper, because the concentration of aerosol particles with diameter larger than 0.5 um is not the concentration of INP, just as a factor.

- We apologize for the confusion in using the term of INP. Besides deleting "which is referred to as INP concentration" here, we have clarified at L156-158, "…so in this paper we vary the constant $n_{a>0.5\mu m}$ over a range of relevant conditions to investigate the impacts of varied INP concentration".

5) Line 166: The scheme for deposition nucleation should also be briefly described, since it dominates ice formation in the cold case.

- FAN2014 detailed why deposition/condensation freezing is not included. Adding deposition/condensation freezing produces large amount of small ice particles that are not observed for those cases. We have added the sentence "Adding deposition/condensation freezing produces large amount of small ice particles, which is not consistent with observations, thereby deposition/condensation freezing is not included, as discussed in FAN2014" (P8 L164-166).

6) Line 185: ". . .with the initial INP concentration of 0.1, 1, 10, and 100 cm-3, respectively": these are concentrations of coarse mode aerosol particles, not IN. This should be clarified.

- Yes, we have changed to dust/bio (or INP proxy) throughout the paper. We have also further frame the INP concentration range used and have added to the present discussion of how dust/bio particle concentrations relate to INP concentrations as a function of temperature (P9 L196-203).

- In addition, in our model, INP proxy concentration is a single prognostic variable separately from CCN. For the simulation of the observed case in FAN2014, it is initiated with the concentrations of clear-sky aerosol particles with diameter larger than 0.5 μm in the dust layer. Since our model does not have full aerosol simulations and INP proxy concentration in our model is not a factor from the predicted aerosol simulations, saying "they are the concentrations of coarse mode aerosol particles" would confuse people. We have added text to clarify, i.e., "As described in FAN2014, dust/bio particle concentration (i.e., IN proxies) is a single prognostic variable separate from CCN. For the simulation of the observed case in FAN2014, dust/bio concentration is initiated with the concentration of clear-sky aerosol particles with diameter larger than 0.5 μm in the dust layer" (L172-175).

7) Line 192: ". . . are around 30 (2) and 120 (4) cm-3, respectively": the concentra- tions of INPs should be the coarse mode aerosol particles. When we talk about the concentration of INP, we must indicate at which temperature.

- This comment is the same as #6. Please see our response above.

8) Line 237-239: This is most likely caused by the treatment of snow particles in the model. Since most of the droplets transferred to snow when INP was high, the concentration and mass of water droplets must be lower. How the large drops are treated when they are frozen? Are they also transferred to snow?

- It could be. But even the ice nucleation forms mainly cloud ice, the large amount of ice could lead to lower rain concentrations due to conversion through WBF and riming. Yes, large droplets are transferred to snow when immersion freezing occurs (cloud ice and snow are represented with one set of size bins and distinguished with a radius of 150 microns).

9) Line 296: "...have ice nucleation occurring (Fig. 6b)": through which nucleation mechanism?

- Only immersion freezing from DeMott et al. 2015 is considered in the simulations, as stated in the model setup and mentioned in the paragraph above. We have also mentioned specifically here (L348 in the current manuscript).

10) Line 372: "Atmospheric rivers" are mentioned several times, but it is not a commonly known concept. It should be explained at the beginning.

- In fact, the terminology is commonly known and is the dynamical and thermodynamic environment for precipitation events over the western US. This is explained at the beginning (L72-74).

11) Line 401-404: It should not be the upper limit, if deposition nucleation and condensation freezing are not included.

- As we discussed in FAN2014 and earlier in this paper, deposition/condensation nucleation should not be the case for those clouds since it forms a great amount of small ice crystals that were not observed by aircraft measurements. In addition, deposition/condensation nucleation does not directly convert liquid to ice, and it competes for INPs with immersion freezing (less immersion freezing will occur if deposition/condensation nucleation occurs). So, the largest effect on the SCW and cloud phase should be through immersion freezing with a given INP condition.

12) Line 405-406: the CCN effect is much more significant than INP when the concentration of CCN is 1000 cm-3 or above.

- That was for precipitation. For the liquid fraction discussed here, we do not see that as shown in Fig. 12, although the more significant CCN effect is seen for CCN > 300 cm^{-3}, but it is still smaller compared with the INP effect.

13) Line 438-439: Remove "in our model simulation with the fast version of SBM in which ice habits are not considered".

- In fact this was added to address one of the comments from a coauthor because the HM processes are sensitive to ice habits in nature but this fast version of SBM does not consider this in the HM processes.

14) Line 441-442: Remove "in the model simulation".

- We prefer to keep it since recent observations suggested secondary ice nucleation could be significant but the model might not able to simulate it. There might be additional secondary ice nucleation mechanisms besides HM processes, or the parameterization of HM processes is not adequate.

15) Page 42: The ordinates should be provided for Figure 10.

- The ordinates have been refined.

16) Page 43: The ordinates of the left panel should be provided for Figure 11.

- The ordinates have been refined.

17) Page 44: The unit of temperature in the figure should be corrected.

- Sorry we forgot to mark that the grey contour lines are the geophysical height in meters. They are not temperatures. It has been noted in the current figure caption.