

## ***Interactive comment on “Effects of Cloud Condensation Nuclei and Ice Nucleating Particles on Precipitation Processes and Supercooled Liquid in Mixed-phase Orographic Clouds” by Jiwen Fan et al.***

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Received and published: 21 October 2016

Review of the paper “Effects of cloud condensational nuclei and ice nucleating particles on precipitation processes and supercooled liquid in mixed-phase orographic clouds”, authored by J. Fan, L.R. Leung, D. Rosenfeld and P.J. DeMott.

The study presents a detailed analysis of process of ice formation and of precipitation response of orographic clouds over Sierra Nevada to the changes air temperature, CCN and IN. This study is an extension of the previous study by Fan et al. (2014). The strength of the study is the utilization WRF with spectral bin microphysics and wide use

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budgets to evaluate rates and efficiency of one or another microphysical processes. The paper is of interest. I recommend to accept the paper with minor (from point of view of changes of the text), but important corrections. 1. Line 81. I suppose that reference to studies by: Lynn B., Khain, A. P., D. Rosenfeld, William L. Woodley, 2007: Effects of aerosols on precipitation from orographic clouds. Journal of Geophysical Research, 112, D10225 and to H. Noppel, A. Pokrovsky, B. Lynn, Khain, A. P., and K.D. Beheng 2010: On precipitation enhancement due to a spatial shift of precipitation caused by introducing small aerosols: numerical modeling. J. Geophys. Res., 115, D18212, 17 PP., 2010, doi:10.1029/2009JD012645.

In both cases shift of precipitation by changing of CCN concentration was investigated.

2. Lines 152-158. Please describe the treatment of large AP clearer. Are these APs considered as CCN? Can these particles be activated to drops if  $S > 0$ ? What is soluble fraction of these large APs? (typically soluble fraction is about 0.1-0.2). Do you keep non-soluble fraction within the nucleated drops? 3. Line 160. Do you mean that you consider frozen drops as these large ice particles? Please add a more detailed explanation, even repeating some points from Fan et al. 2014. The paper should be self-consistent. 4. Line 166. What is the way of description of primary ice nucleation? Was it the same as in Khain et al. 2004, where the formula of Meyers et al was used? Or do you use formula by DeMott only for large APs that you consider as IN?

5. Line 182. Do you consider these large AP as IN separately from CCN? What is size of ice particles that form on the INP after its nucleation? What do you do with these AP if supersaturation over water is larger than zero? The questions 3-5 are caused by unclear description of IN treatment. 6. Line 548 and some places above. The statement is not correct. In the study by Lynn et al. (2007) mentioned above a dramatic increase in snow over mountains in case of high CCN concentration is reported and described in detail. In particular they presented figures 6-8 which are, in my opinion, similar to Fig 8 in the paper under revision. 7. Line 550. In the study by Lynn et al. 2007 it is shown that an increase in the AP concentration decreases warm rain

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production and intensifies ice processes. The ice particles are advected downwind producing a substantial increase in snow and other ice precipitation over upwind slope and over the mountain peak. So the mechanism discussed in the study is not new and was described before. Besides, Lynn et al also discussed an important effect of very low relative humidity on the downwind slope. This low RH leads to evaporation of precipitating particles over downwind slope. As a result, effect of aerosols turned out to be also dependent on the wind speed because strong wind advected ice particles into zone of very low RH. So there is an “optimum” combination of APs concentration and wind speed to get maximum snow mass at the upwind slope and over the mountain peak. I propose that the authors discuss the similarities and differences of their results as compared with those reported by Lynn et al. (2007).

Please also note the supplement to this comment:

<http://www.atmos-chem-phys-discuss.net/acp-2016-772/acp-2016-772-RC3-supplement.pdf>

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Interactive comment on Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2016-772, 2016.