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Interactive comment on "Numerical evidence for cloud droplet nucleation at the cloud-environment interface" *by* J. Sun et al.

A. Khain

khain@vms.huji.ac.il

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Review of the article : " Numerical evidence for cloud droplet nucleation at the cloud-environment interface", by J. Sun, H. Leighton, M. K. Yau, and P. Ariya

The paper shows that the gradient of pressure fluctuations increases vertical velocity in the front of the ascending volume, which can lead to increase in relative humidity and droplet nucleation near cloud base. The simulations performed for short time period showed that in developing clouds droplet nucleation may take place near cloud top that can lead to droplet spectrum broadening near cloud top. The results are of interest and this study is worth to publish. The minor revisions are required.

1. In the conclusion the text says: " This finding can explain why the observed liquid

water content and the temperature of cumulus clouds in the early stage are less than the adiabatic values of air parcels ascending from the cloud base". To my understanding, the authors want to say that the cloud volumes near cloud top ascend not from the cloud base level, but from higher levels (higher lifting condensation levels) being forced to ascend by the pressure fluctuations caused by volumes ascending from lower levels. As a result, the volumes near cloud top have LWC lower that the adiabatic value calculated for the parcels ascending from the cloud base. If this statement is correct, it would be important to include it into the article.

2. It would be important to add some discussion about possible consequences of the effects discussed in the study, for instance: a) decrease in liquid water fraction with height is not always a result of a dilution with environment, but can take place in adiabatic volumes just because of different lifting condensation levels of parcels ascending within a cloud. b) small droplets observed near cloud edges can be formed not because of evaporation caused by the mixing with dry environment, but due to in-cloud nucleation. c) this process leads to the DSD broadening toward smaller sizes.

3. It would be interesting to see a discussion how the effects found in the study can be distinguished from the effects of mixing and entrainment.

4. In my opinion, it would be reasonable to include references to a set of studies, where process of in-cloud nucleation and formation of small droplets at the upper levels is discussed (e.g., Pinsky and Khain 2002; Segal et al. 2003; Prabha et al, 2011; Khain et al. 2012). In these studies small droplets arise by nucleation of small cloud condensational nuclei ascending within cloudy volumes when vertical velocity of the parcels increases (or droplet concentration decreases) leading to supersaturations exceeding the values that took place in the volumes earlier. Such acceleration can be reached both due to bouyancy and the pressure fluctuations. 5. Note that friction between ascending volumes and neighboring volumes can lead to acceleration of the latter volumes and to nucleation of small droplets. Such effect was simulated by Khain and Pokrovsky (2004).

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