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Atmospheric Chemistry and Physics
Discussions

Interactive comment on "Core and margin in warm convective clouds. Part II: aerosol effects on core properties" *by* Reuven H. Heiblum et al.

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In the study effects of aerosols on the structure of small CU are investigated by analyzing the results of axisymmetric cloud model (single cloud simulations), as well as model of cloud ensemble (SAM) (for investigation of general properties of cloud ensembles). To shorten number of parameters, cloud averaged properties are analyzed. Clouds are characterized by core and margin, and effects of aerosols on these regions are investigated. The paper is of interest.

However, major revision is necessary.

The comments and remarks are presented below.

1. Figures 5, 7, 9 indicate that simulation with low aerosol concentration was performed for inversion base at 2000 m, while in other simulations the inversion base was

at 1500m. Since the cloud dynamical and microphysical structure as well as cloud size depend on the inversion height, the comparison of the aerosol effects should be performed under similar thermodynamic background conditions.

2. The terminology used in the study is not widely accepted and needs better definition. For instance, it is necessary mathematically define what is "condensation efficiency", "diffusion efficiency", etc. (It is possible that such definitions are in Pt 1 of the study. Nevertheless, they should be defined in the present study as well). Note that in addition to equation of diffusion growth ("diffusion efficiency"), there is a turbulent diffusion.

3. Different definitions of cloud cores and cloud margin are interesting. At the same time, these definitions do not agree with the accepted ones. Such definitions lead to a paradox that small dissipating clouds may contain cloud cores. Supposedly, some minimum LWC value should be included into the definition. This will exclude cases, when dissolving cloud with negligible LWC is still considered as combination of cloud core and cloud margin. Below more detailed comments are presented. line 24 Abstract. The values Bcore, Rcore, W core are not defined yet and should be either defined or excluded from the abstract. Line 45. The text reads: "detrainment while losing mass". In cloud physics detrainment is "large scale" outflow, typically near cloud top. Interaction of clouds with environment is characterized by entrainment and mixing. The authors supposedly mean that small cloud volumes leaving the parent cloud loss their mass by evaporation.

Line 57. what difference of DSD do you mean? Line 58. The sentence is not clear or not correct. The nucleation itself that takes place at rN>rNcrit does not accompanied by decrease of S. S decreases as a result of diffusional growth of nucleated droplets.

Line 77. Strictly speaking, the diffusion growth equation is not symmetric with respect of processes of condensation/evaporation. This asymmetry is considered, sometimes, as a mechanism of DSD broadening (e.g. Korolev, 1995, JAS, 52, 3620-3634).

Line 161. Comment concerning the cloud core definitions. The condition W>0 takes place in cloud cores of devolving clouds. Since the time period of cloud developing is relatively short, effects of mixing with surrounding air may not be significant (depending of cloud size and W). At dissolving stage, W<0. So, there is no cloud core in your definition. At the same time LWC in the cloud may has obvious maximum in the cloud center (interior)

line 184. How can be explained updrafts at B<0? Gravity waves?

Line 200. In such case it is difficult to call the condition W>0 as definition of cloud core. Small positive W can take place all over cloud just by turbulent fluctuations. Katzwinkel et al. (2014) and Schmeissner et al. 2015 determine cloud interior as LWC>0.2 gm-3 this condition guaranties that the region chosen is in the cloud interior.

line 202. Fig 1. Figure caption. Define LHS axis, RHS axis. What is "other core types"?

lines 236-240 The mechanism proposed requires additional justification. The another option is that in low CCN case drizzle and rain drops rapidly fall down, so LWC is very low in the subsiding of the air. Another possible mechanism is turbulent mixing between warm core and colder margin air. This mixing should lead to an increase in T, i.e to appearance of positive buoyancy. Can you justify the mechanism that is proposed in the study?

What is the cloud stage? Developing or dissolving? Do you see this effect at cloud center or cloud periphery?

Line 248 How is cloud margin region defined and calculated?

line 254. It is difficult to see the non-monotonic dependence. We see that the maximum cloud mass takes place at high CCN concentration, but lifetime is larger for the low CCN concentration case.

line 285. I do not fully agree with the interpretation. In case of high CCN concentration droplets are small and mixing with surrounding leads to fast complete evaporation of the droplets. Moreover, small droplets fully and easily evaporate also at W<0. At the

same time, larger droplets formed at low CCN concentration evaporate only partially. Why is it necessary to focus on the weak effect of the differences in the evaporation rates?

line 293 At the dissolving stage cloud air descends, i.e. W<0 within cloud body (Schmeisner et al. 2015). The subsiding dramatically decreases RH and leads to droplet evaporation. It is natural, that small droplets evaporate first. This decreases the life time of clouds in polluted air. It would be important to separate two effects: turbulent mixing of clouds with surrounding and their evaporation at W<0. Note that small Cu often dissipate and evaporate within the inversion layer, where turbulence (i.e. mixing is weak). In such case, namely subsiding place dominating role in cloud dissolving.

line 295. Which effect? How can precipitation be considered as a method of...? please reword the sentence.

What kind of expansion can be induced by precipitation? Why the "choice to focus on volume above initial cloud base excludes this effect"? If the precipitation-induced cooling leads to the formation of new clouds, it is impossible to exclude the effect by the choice of the altitude, above which cloud properties are considered.

line 295 Detrainment is the outflow of cloud mass from the cloud. It cannot change the cloud properties. Entrainment of dry environment air into the cloud indeed can lead to subsaturation. Regular (non-turbulent) entrainment takes place near cloud base. At later cloud edges lateral turbulent entrainment and mixing takes place.

line 298. The effect of dilution depends on cloud width. The larger width the lower the effect of lateral mixing is. The increase of decrease of cloud width depends also on LWC. line 300. What is "detrainment growth"?

line 314. To define “diffusion efficiency”.

line 327. It is interesting to see the RH (r) profiles in the humid shell around cloud.

line 375. Do you suppose that dissipating clouds may contain dominating cores? How does it agree with observations?

Line 375. Figure 5 shows that simulations with low CCN concentration were performed for the case of 2000 m inversion altitude. Two other simulations were performed for 1500 m altitude. The clouds should be quite different geometrically and microphysically in such cases. How can such clouds be compared?

Line 417. 1) we see again that there the difference in the inversion level in the simulations. Higher clouds can have larger cloud cover and longer life time etc. 2) It is necessary to add to the figure caption the conditions corresponding to the rows and columns or refer notations in fig 5.

Line 458. I still wonder, how weak downdraft can lead to the temperature of subsiding air higher than in surrounding. Such subsidence should be actually along the moist adiabate. Why the downdrafts should be week? It seems that subsidence accompanied by evaporation leads to cold pool that accelerates formation of new clouds. It seems that positive buoyancy in the area of weak downdraft is the results of horizontal mixing between warm zone with W>0 (with high buoyancy) and the cloud periphery.

line 531. One can suppose that many clouds are isolated even in the clean case. Why do you illustrate the clean case by merging clouds?

Line 572. So, the formation of low RH is the result of averaging over wider layers which contain the inversion layer and layer below LCL. Please confirm.

Line 619. Term convection is not suitable. Besides, if you want to compare T with surrounding, moist adiabatic cooling results in heating as compared with the surrounding.

Line 621. Adiabatic heating is also not exact term. In the situation considered adiabatic heating is accompanied by turbulent mixing and droplet evaporation. So, many factors determine T in this area, so process is not adiabatic.

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