Responses to the Reviewer 1 comments
(comments in black, responses in red)

This manuscript introduces a phase space that helps to understand the activation, deactivation, condensation, and evaporation of haze particles and cloud droplets in a unified fashion. The phase space is applied to the results of two simulation cases, a turbulent rising parcel and a convection cloud chamber. Overall, this manuscript addresses an interesting and relevant topic. I have reviewed a previous version of this manuscript submitted to the Journal of the Atmospheric Sciences. The most important change from that version is its framing as a Technical Note, which I consider very appropriate as the manuscript does not contain substantial new findings but provides a concept to be applied in future studies. I consider this manuscript adequate for publication in Atmospheric Chemistry and Physics once my comments are addressed.

We appreciate the sincere evaluation of our submission.

Major Comments

Does it make sense to distinguish Q3 and Q4 for all radii smaller than the activation radius?

Conceptually, the regions Q3 and Q4 of the phase space are distinct, with the prior representing evaporation and the latter condensation. This is probably adequate for (super-)saturated conditions that a particle experiences inside the cloud. Outside the cloud, haze particles are usually in equilibrium with their environment, which is sustained by quick changes between evaporation and condensation (time series in Fig. 7). Thus, I recommend to introduce a fifth region to consider this equilibrium state. It should cover the entire range of $S - S_{eq}$ values, and all radii up to the equilibrium radius at saturation.

On the Koehler curve, $S_{eq} = 0$ points (i.e., those with radii equal to the critical radii divided by square root of 3) correspond to the equilibrium droplet radii for vanishing environmental supersaturation (i.e., RH = 100%). We added those points to Fig. 1. The only significance of the wet radius corresponding to RH = 100% is that a haze droplet outside a cloud (i.e., with RH < 100%) has the equilibrium radius smaller than its $S_{eq} = 0$ radius. We mention that in the discussion of Fig. 1.

On our diagram, the "equilibrium region" that the reviewer suggests is a 1D space along the $S - S_{eq} = 0$ line and radii smaller that the critical radius divided by square root of 3. Those are haze droplets that have equilibrium radii for RH < 100%, that is, haze droplets outside the cloud. In contrast to the critical radius, we do not see any significance of growing droplets passing this radius. For illustration, we show below Fig. 5 from the manuscript with extra lines in both panels that correspond to the critical radius divided by the square root of 3. Do those lines bring additional information into the panels? We do not think so.

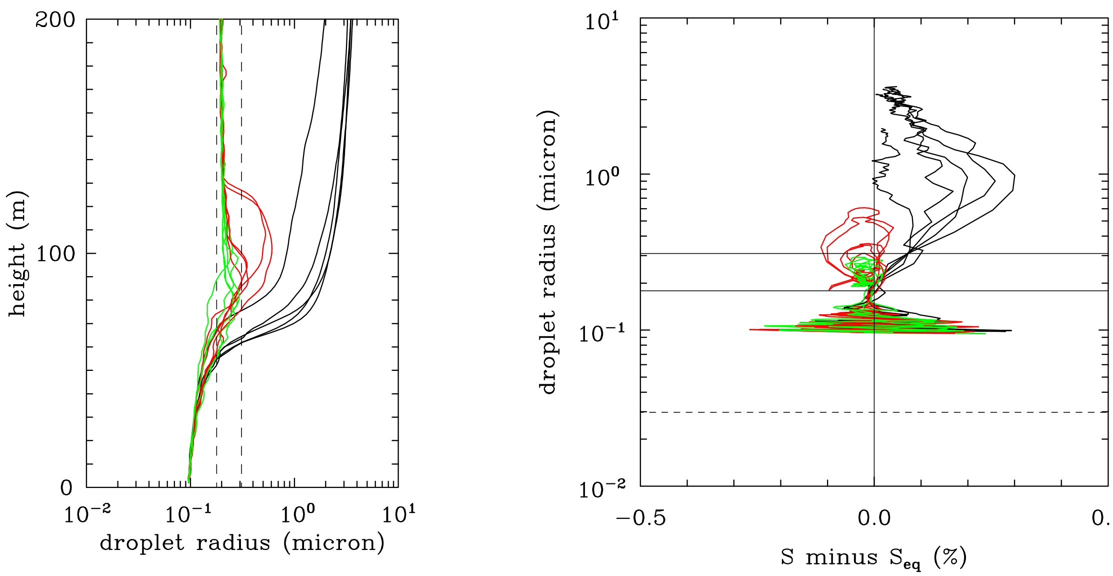

Figure 5 from the manuscript with extra lines in left and right panels showing the radius corresponding to the zero of the Koehler curve. Please compare with the figure 5 in the text that has no additional lines.

Minor Comments

Sec. 1: I enjoyed reading this introduction to cloud droplet formation. However, I was wondering why the authors did not include the diffusional growth equation (and maybe an equation for the development of supersaturation in an adiabatic parcel). This would naturally integrate some of the dynamics considered in the introduced phase space.

Per the suggestion, we revised the introduction and added a droplet growth equation. Since the second case we consider, the Pi chamber case, is different than the adiabatic parcel, we do not feel bringing adiabatic parcel equations is needed.

Ll. 87 – 89: References to Nenes et al. (2001) and Mordy (1959) seem to be appropriate.

In the revised introduction, we include references to Mordy and Nenes et al .

Ll. 241 – 243: What exactly is “not well visible in the right panel”?

Green lines are congested and thus not well visible. We removed the statement in question.

L. 398: In the abstract (ll. 18 – 20), the authors promised to use the phase space to identify differences in droplet formation in the analyzed cases. This line seems to be the only location where this is actually done. Could the authors comment a little more on the differences of droplet formation in “natural and laboratory clouds”?

We feel the discussion in sections 3 and 4 are exactly what the reviewer is asking about. We added a sentence in the summary section that highlights the differences.

Technical Comments

Ll. 32 ff.: Change “Koehler” to “Köhler”.

Done.

Ll. 43 ff.: Change “paper” to “technical note”.

Done.

Ll. 250 – 258: Is “GYK24” different from “GKY24”?

GKY24 is the correct abbreviation. This error has been corrected.