Response to RC3

We thank the reviewer for their comments and very positive feedback on the quality of our work.

Below, we list our responses to their comments and suggestions. More changes than listed have been implemented to accommodate the suggestions by the other three reviewers.

SPECIFIC COMMENTS

The “ice” and “snow” categories are very important in this study. First, these should be clearly defined in the paper; these are categories of small and large unrimed ice crystals in bulk and bin microphysics (mp) schemes. In traditional bulk schemes such as ICON’s SB two-moment scheme, these ice-phase categories are predefined and with prescribed physical properties (e.g. capacitance, mass-fall speed parameters) and have the necessary but purely artificial process of conversion between categories. In nature, there is no such thing as “conversion from ice to snow”. In traditional category-based scheme, the way this process is “parameterized” ultimately impacts the relative distribution of ice and snow, subsequently impacting the mp growth rates and distribution of hydrometeor mass.

With this in mind, how general are your conclusions with respect to the mp scheme used? Would you expect the same results/conclusions using a different category-based mp scheme (with different ice-to-snow conversion) or with a property-based scheme (like P3) which uses generic ice-phase categories with no artificial conversion? I think it would be useful to add some discussion (e.g. in the Conclusion section) on this topic.

We focus our analysis on hydrometeors and vapor in the UTLS at the end of the WCB ascent, where virtually all hydrometeors are ice. The amount of snow at the end of the ascent is very small (qs is on average 10^{-3} g/kg and Ns on average 500 1/kg, compared to $5*10^{-2}$ g/kg for qi and $2.5*10^{6}$ 1/kg for Ni).

Therefore, at and after the end of the ascent, we do not look at snow. When we talk about snow during the ascent, we use the definitions from the Seifert and Beheng (2006) microphysics scheme, which is referenced in the method section. It is not common to define the hydrometeor species exactly when making use of well-known and widely used physical schemes.

The point on the choice of microphysics scheme is important, but apart from pure speculation, we are not able to determine what differences one would see in such a complex system as a WCB when another scheme is used. However, to address this point, we add the following sentence in the conclusion (Line 750):

“However, this study consists of only one case study using one microphysics scheme, and it isn't clear how representative our findings are of WCBs (or other model configurations and microphysics schemes) in general.”

MINOR POINTS

1. The description of saturation adjustment in ICON (line 216) seems not quite right. Presumably supersaturation with respect to ice can remain. This seems to be better explained on line 479, but perhaps it should be clarified earlier.

This is a good point. We have made clear that the saturation adjustment scheme is designed to produce 100% relative humidity over **water**. The beginning of the paragraph now reads (Line 240):

“As discussed in the introduction, when a cloud contains liquid water, the saturation adjustment scheme used in ICON instantaneously removes supersaturation or in-cloud sub-saturation by condensing or evaporating excess or deficient water vapour until a relative humidity of 100% over water is achieved.”

2. Line 315: If the units for ice number are in # kg^-1, this is “number mixing ratio”, not number concentration. Concentration units in # m^-3 (as correctly indicated in eqn. (2)).

Thank you for pointing this out. We have changed “number concentration” to “number mixing ratio” where it is appropriate.

3. 5: In the first color bar, the two dark red colors for “max_qc” and “max_qs” are very hard to distinguish.

The colors in the bottom figure are not labels, but indicate the spearman correlation coefficient for the correlation of max_qX with the CCN scaling factor, given the colorbar below. That the colors match very well from left to right with the colorbar is a coincidence. If max_qc and max_qs have similar spearman correlation coefficients, then they have a similar color.

4. The paragraph starting on line 671 seems more like it should belong in the Introduction section.

This paragraph provides a context for our study within the current body of research, highlighting the novel aspects that distinguish it from similar publications. We have chosen to include it in the section where we discuss our results, which keeps the

introduction focused on the literature overview. Since no other reviewer seems to object, we would prefer to keep this paragraph where it is, but if the reviewer insists, we can move it to the introduction.