Response to Anonymous Referee #2

We would like to thank referee 2 for his helpful comments. Please find below our response (the referee's comments are in italic).

This paper explores the extension of a shallow convection scheme to represent deep convection. Several precipitation-related modifications, such as those of the subcloud layer TKE, cloud base thermodynamic properties, and entrainment/detrainment rates are added to the UW shallow convection scheme. The new additions and their param- eters are guided by cloud-resolving simulations (CRM), and the new parameterizations are tested against the CRM simulations as well. The paper is well written and a welcome contribution to the effort of developing unified convective schemes that cover both shallow and deep convection and can be published in ACP with only minor revisions.

Thanks

1. *There seems to be some synergy between this paper and that by Brian Mapes and Richard Neale on adding an org variable to the UW scheme. It would be useful to discuss potential connections.*

Yes we will add a paragraph in the introduction (before the last paragraph) to discuss potential connections.

2. *It seems the role of PBLH in Eq. 1 is in determining the potential energy that is released by the evaporation of precipitation: the longer the downdraft can go the more potential energy is released. But at the end of section 3.1.1, it is said that the effect of the stabilization of the PBL is also expressed by the use of PBLH in Eq. 1. The latter role seems different from the first role. Could you clarify this a bit more?*

That is why we use PBLH rather than cloud base height in our equation (1).

3. *Eq 2 and Fig. 4: Does the data support a second-order polynomial fit? Why not just a linear fit?*

In terms of fitting accuracy, a second-order polynomial fit is more accurate but, as suggested by the referee, a linear fit seems to work equally well when used in our single column model experiments. We will thus simplify Eq. (2b).

4. *Eq. 3. The anchor points are defined in terms of fixed height. Shouldn't they vary from one place to another? For example, if one considers ice processes to be important, the 0C line would vary from one latitude to another.*

The anchor points will indirectly vary from one place to another as they depend upon the height of the cloud base, which varies from one place to another. Note that we will simplify the formulation of ε_o in our revised version, using only one anchor point (besides the value at cloud base). For more explanation on this, we refer to our response to referee #4.

5. *Pg. 19, line 14. How is the mixing rate diagnosed in SAM?*

We diagnose the mixing rate as in previous LES studies (to be added at the beginning of section 4.1): We use the equations for a simple plume model: $\frac{\partial M}{\partial z} = M(\varepsilon - \delta)$ and $\frac{\partial \psi}{\partial z} = \varepsilon(\bar{\psi} - \psi)$. We sample all the cloudy points to compute the mass flux M and average it over a one-hour time interval. As approximately conserved updraft variable ψ we employ the mass-flux weighted frozen moist static energy, which is again sampled over all cloudy points and hourly averaged. $\bar{\psi}$ corresponds to the domain and hourly averaged frozen moist static energy. Knowing ε and δ we can compute ε_o by solving the buoyancy sorting relations.

6. *Pg. 20, line 15, the relative humidity threshold for the onset of stratiform cloud formation is not discussed in the paper. A brief description of what it does and the rationale would be useful.*

The total grid-box averaged cloud amount, as displayed for instance in Fig. 9, is the result of the collective contribution of three cloud types: convective, layered and stratocumulus. The cloud amount of the convective clouds is related to the convective mass flux, while the cloud amount of layered clouds and stratocumulus is a function of relative humidity. Relative humidity must exceed a threshold for the latter clouds to form, whereby this threshold is a tunable model parameter. We will expand the text accordingly.

Technical comments:

Fig. 3, the green lines are too thin and a little hard to see in some places.

We will modify Fig. 3 accordingly.

Pg 13, line 1, pro bin -> per bin?

Thanks, we will correct it.