Responses to the Reviewer 1 (comments in *italics*, responses in regular font).

This study aims to extend the analysis presented in previous work by Wyszogrodzki et al. (2013), who examined the impacts on cloud and rain when a collision kernel that includes the effects of turbulence was used in a bin microphysics LES model. The results in this present study, however, mostly focus on differences between simulations that differ in CCN concentrations, which somewhat limits the novel aspects of this work. Evaporation of cloud droplets near the edges of clouds and condensate off-loading are shown to determine the differences in cloud top height distributions for simulations with differing CCN concentrations. The study also investigates whether the numerically determined effects of turbulence on shallow convective clouds and rain could be evaluated by observations. It is argued that the temporal variability of the shallow convective cloud fields, and the resolution and uncertainty range of satellite observations mean that it is not possible to evaluate the impacts of turbulence that are seen from modeling studies.

Major comments

1. Some of the main ideas could be developed further. The abstract states that a clear feedback has been documented between the cloud processes and the environment, however, this feedback has not been fully explained or demonstrated. For example, what are the processes that result from the more efficient condensate off-loading and how do these change the environmental profiles?

We agree with this comment and decided to remove this aspect from the paper. The interaction between clouds and their environment, and the impact on the environmental profiles, need to be investigated more thoroughly in subsequent studies.

2. Given that the single cloud simulations of Wyszogrodzki et al. (2013) are used as the basis for explaining the results shown in Section 3, it would be useful to include a discussion of the condensate off-loading mechanism described in the two sets of single cloud simulations in Wyszogrodzki et al. (2013).

A brief discussion of single-cloud simulations from WGWA13 in now included in section 3.1. We also added a table summarizing the rain accumulations in GRAV and TURB simulations as suggested by the Reviewer 2.

3. To extend the results of Wyszogrodzki et al. (2013) and explain the difference in cloud top heights between simulations that use different collision kernels, an additional figure that is the same as Figure 5 but for the N30 GRAV run needs to be included and discussed. Does the comparison of the turbulent and gravitational kernel simulations show a change in the buoyancy that confirms the condensate off-loading mechanism acting to increase cloud buoyancy and therefore cloud top heights? This should be explicitly addressed.

The figure for N30 GRAV simulation in the format of Fig. 5 from the previous version was added. The figure does support the condensate off-loading mechanism.

4. Further analysis of Figures 4 and 5 (plus the additional figure from the point above) would *add to a more thorough explanation of the physical processes involved that determine the differences in cloud top heights between simulations with differing CCN concentration and also different collision kernels. For example, the authors briefly touch on some of the effects seen in the scatter plots, such as entrainment, but this could be extended and would provide more insight into the effects of CCN concentration and choice of collision kernel.*

We are not sure what the reviewer is suggesting here. We added a figure as suggested above and we feel it clearly shows effects we are discussing in the revised narrative.

5. An additional 2 panels in Figure 7 that show the differences between the GRAV30 and TURB30 cases should be included to help illustrate the differences in cloud fraction due to more efficient condensate off-loading that occurs with the use of the turbulent collision kernel.

The condensate unloading has a relatively minor effect on the cloud fraction profiles. We decided not to show the figure suggested by the reviewer. However, we added a table that shows averaged cloud cover from last 3 hours of all simulations. We also address this issue in the discussion section where we refer to a novel simulations methodology, referred to as "microphysical piggybacking" (Grabowski 2014a,b) that we plan on using in the future. As documented in Grabowski (2014a), the piggybacking allows assessing the impact of cloud microphysics on macroscopic cloud properties with unprecedented accuracy.

6. Page 19854, first paragraph: While this discussion is valid for summarizing the cloud top height differences between simulations with different CCN, it does not explain the difference in cloud top heights for simulations with differing collision kernels but the same CCN concentration. For these cases the explanation cannot be due to a shift between the cloudy updrafts and the cloud-edge downdrafts as the downdraft shift in this study has been attributed to the CCN and cloud droplet size difference. Perhaps there is the additional effect of more cloud water in the turbulent cases producing more evaporation.

The discussion has been revised. In a nutshell, there are two competing effects. First, different CCN imply different mean droplet sizes and thus different evaporation rates all other things being equal. Second, different CCN concentrations lead to different conversions of cloud water into drizzle/rain. Although the feedback the reviewer suggests may take place, we prefer not to speculate on its presence, especially in view of highly uncertain subgrid-scale parameterization (e.g., homogeneous versus inhomogeneous mixing).

Minor comments

1. Page 19848, line 13: This should refer to Figure 7.

2. Page 19848, lines 24-25: The NOCOAL case is not shown in Figure 1.

3. Page 19852, line 21: Van Zatem should read Van Zanten.

These have been corrected.

References:

Grabowski, W. W., 2014a: Extracting microphysical impacts in large eddy simulations of shallow convection*.* *J. Atmos. Sci*. (available on Early Online Release).

Grabowski W. W., 2014b: Untangling microphysical impacts on deep convection applying a novel modeling methodology *J. Atmos. Sci*. (submitted).