Response to Referee #2

I'd like to express my gratitude to the reviewer for providing thoughtful and insightful comments on this work, which have led to an improved paper.

Major comments

1. The parameterisations of Franklin (2008) only consider the effects of turbulence on small collector cloud droplets with radii between 10 and 30 microns. This is different to the study of Ayala et al. (2008) (the work which the Wang-Ayala parameterisation is based on) who consider droplets up to 60 microns in radius. For the small droplets considered in Franklin (2008) it is the dissipation range turbulence that governs the droplet motion (e.g. Wang and Maxey 1993) and, therefore, the dissipation rate is the dominant flow property that determines the collision rate, with the Reynolds number effect of significantly less importance. This is clearly illustrated in Figure 4. of Ayala et al. (2008) who show that Reynolds number effects are only apparent for droplets of radius 40 microns and larger, which are larger than the size of droplets considered in Franklin (2008). This result is also described in Wyszogrodzki et al. (2013) who state that small drops with radius less than 30 microns are not affected by the root mean square velocity, or Re_λ. This is the reasoning behind the parameterisations of Franklin (2008) being a function of the dissipation rate only, where equation (4) of Franklin (2008) has been used to eliminate Re_λ. An additional discussion on why the dependence on dissipation rate only is an appropriate assumption is included in the revised paper.

   Making an equivalent non-dimensional equation for equation (4) of Franklin (2008) for Re_λ is trivial. One only needs to divide by a reference value of the dissipation rate, for example we could rewrite this as $Re_\lambda = 2100\left(\varepsilon/\varepsilon_0\right)^{0.12}$ where ε_0 is taken to be 100 cm^2s^{-3}. In fact this approach is taken by Seifert et al. (2010), who use the Wang-Ayala parameterisation to generate an autoconversion scheme for their bulk model that includes the effects of turbulence. Although the derivation of their autoconversion scheme is very different to that used here, they take the same approach in the sense that the dissipation rate and Re_λ are functionally dependent in their calculation of the Reynolds number from the LES flow field, which means that turbulence is only characterized by one of these quantities, the dissipation rate. The parameterized collision kernel that is used to develop the autoconversion parameterisation was shown by Franklin (2008) to represent the DNS data well for the much wider range of dissipation rates used in this work as compared to others (between 100 and 1500 cm^2s^{-3}). The kernel parameter in Seifert et al. (2010) includes a linear dependence on the dissipation rate, which is shown by Franklin et al. (2007) and Ayala et al. (2008) to be an incorrect assumption, with the turbulent enhancement of the collision kernel showing a strong non-linear dependence, increasing as the dissipation rate increases. This dependence is captured in the parameterisations used here.

   It is also worth noting that in the work of Seifert et al. (2010) and Wyszogrodzki et al. (2013), the representation of the turbulent enhancement of the collision efficiency is a linear function of dissipation rate only, there is no dependence on Re_λ .

2. The cloud water evaporation rate is not a function of the cloud droplet number concentration as the reviewer rightly points out. However, the rain water evaporation is a function of both the mass and number concentration of rain water. Including the standard deviation in Figure 9 shows that the variability of the liquid water path is much larger than the difference between the simulations with differing CDNC. Therefore, the argument that the nonmontonic behavior is a statistical artifact rather than a physical one is correct and this point is made in the revised manuscript.

3. The general point here ties in with a couple of Reviewer 1's comments. The differences between the stratocumulus simulations are not statistically significant and this is shown explicitly in the figures that have been replotted to include the standard deviations about the mean. Discussions on the lack of statistical significance and the difference between the bulk schemes are included in the revised manuscript. It is also noted that for the two cloud regimes studied we find that turbulence has a larger effect than cloud droplet number concentrations on shallow cumuli, however, it is the opposite for the stratocumulus case with CDNC having the largest (statistically significant) control on the rain water. These comments have been added to the abstract, results and summary sections.

4. It is important to note that while an older version of the model has been used, the correction to the calculation of the dissipation rate of TKE (which was in error in version 1.1) has been included in all of the simulations. The aim of the work presented in this paper is to compare simulations that use two microphysics schemes that have been developed in exactly the same manner except for the inclusion of turbulent effects on the collision kernel in one of the schemes. To achieve this goal the model version used is not important as long as the model and the simulation set up are the same. The reviewer's idea of comparing two different bulk turbulent schemes (i.e. Franklin (2008) and Seifert et al. (2010)) is a great suggestion for the next step in this work.

Minor comments:

1. This study is now mentioned in the introduction, thank you for the reference.

2. This spelling mistake has been corrected.

3. The value of the cloud-rain water threshold radius used in the simulations is 40 microns for the Seifert and Beheng scheme and the two Franklin schemes. This is different to that used by Savic-Jovcic and Stevens (2008) and is clarified in the text.

4. The reason for using Khairoutdinov and Kogan for the DYCOMS-II case is because this scheme was developed based on large-eddy simulations of stratocumulus and is widely used to model this particular cloud type. Because this scheme was developed for stratocumulus, it neglects processes that are important for shallow cumuli such as self collection and, therefore, we do not use this scheme for the RICO case.