We thank Reviewer #2 for the helpful comments and suggestions provided for our manuscript. As a general comment, Reviewer #2 suggested more in-depth analysis on the impacts of including subgrid parameterization for vertical velocity and cloud microphysics. A similar suggestion was provided by Reviewer #1, so we would like to refer to our answer submitted for Reviewer #1 for the general changes made in the manuscript.

Below, we present our answers to the specific comments given by Reviewer #2, which will also cover the consequent changes made in the manuscript (with Reviewer comments in *italics*)

1.
P5486, lines 1-5. Provide additional details here.

We have added the sentence:
"This ensures that the subcolumn ensemble mean CDNC is larger or equal to the mean CDNC from the last timestep" (last paragraph of Section 3.3).

In other words, if nucleation for current timestep in terms of GCM-scale average is weak and the GCM-scale number of activated is smaller than the GCM-scale CDNC from the last timestep, the number of activated droplets in the subcolumns is multiplied by the fraction f so that the mean number of droplets corresponds to the mean CDNC from the last timestep.

2.
P5487, lines 10-18. Expand the discussion of the retuning procedure. In particular, what are the parameters that are being adjusted to control autoconversion and accretion? It would be useful to add equations showing the autoconversion and accretion formulations in use. Both factors have been retuned to lower values in SUBWRT. Does this reduce the efficiency of the conversion of cloud water to rain? Could the model be retuned by only changing one of the two parameter ccraut or ccauloc?

The parameters for autoconversion and accretion act as linear scaling coefficients for the process-rates, so lower values reduce the amount of water removed by autoconversion/accretion. We have included the formula for autoconversion in Section 5.1 (Eq. 8) where it is specifically needed to explain our results (please consult our response to Reviewer #1).

The model could probably be tuned with only ccraut. However, we performed the model tuning for an early implementation of the subgrid parameterizations by systematically testing different combinations of the two parameters with the aim of balancing the global radiation budget. The combination of ccraut and cauloc used in SUBWRT provided the best combination. Subsequently, the radiative balance was later changed slightly because of bug-fixes etc. but we did not go further to retune the model.

First, the following sentence has been added in Section 4.2:
"Specifically, the linear scaling factors for the process rates of autoconversion of cloud droplets and accretion of cloud droplets by rain (ccraut and cauloc in the model code, respectively) are reduced".

Second, it is now said in the 4th paragraph of Section 5.1:
"... retuning the model is necessary in order to restore a more realistic representation of the cloud water content and, consequently, the global radiation budget (discussed in Section 5.2.1). Thus, the process rate coefficients for autoconversion and accretion (ccraut and cauloc, respectively) are reduced in order to decrease the removal of liquid water from the clouds (see Table 1)".

3.
Figure 4e: the impact of the retuning is particularly striking over marine stratocumulus regions. It would be interesting to analyze this in more details.

We looked at vertical profiles of cloud properties at the stratocumulus regions as well as over other marine and continental areas and found that the reason for the somewhat increased CDNC and LWC especially in the west-coast of South-America originates from the lowest model levels. In SUBW, neither CDNC or LWC shows much of a decrease close to the surface, unlike over most other areas. Moreover, SUBWRT shows that the low levels in the stratocumulus regions are also fairly sensitive to model tuning. We hope to uncover the detailed reasons for this behaviour in our ongoing work when the new model version is used to asses the indirect radiative effects of aerosols.

4.
Section 5.2: I'd recommend to add a comparison of TOA radiative fluxes with satellite observations, for example CERES-EBAF (Loeb et al. 2009, doi:10.1175/2008JCLI2637.1).

We have added Section 5.2.2 and Figure 6 in the revised manuscript for comparison between CERES data and the simulated longwave and shortwave cloud radiative effects (CRE) at TOA. The shortwave CRE is generally too high in all our simulations, with REF and SUBWRT showing virtually similar performance, as compared to CERES. Reasons behind this include at least the rather high total cloud cover featured in all our simulations. While the too strong shortwave CRE is a rather common feature in global models, the TOA fluxes and cloud radiative effects are also directly influenced by model tuning which makes objective assessment of the performance of the parameterizations against observations challenging by itself.

5.
Section 5: how do the overall climatologies of REF and SUBWRT compare? Is there any significant improvement in SUBWRT?

Changes in basic climatology are minor, which is expected since the sea surface temperatures were prescribed by their climatological values in in our simulations. Thus, atmospheric temperature shows virtually no change, which yields in practice no changes e.g. in surface pressure either. For precipitation, a slight shift from convective to stratiform precipitation was found for SUBW, but most of this was again compensated by retuning in SUBWRT. Discussion has been added in Section 5.4 of the revised manuscript.

6.
P5492, line 23: Guo et al. (2010, doi:10.5194/gmd-3-475-2010) went further using a skewed PDF that consistently treats vertical velocity and thermodynamic (cloud) sub-grid variations.

The reference has been added to the manuscript (2nd paragraph in Section 6).

7.
P5493, lines 1-7. It would indeed be very interesting to explore the impact of the subgrid variability on the indirect aerosol effects. Both the treatment of subgrid vertical velocity and the modification of the autoconversion as part of the retuning could impact the indirect effect. Some impact has been documented in other relevant works, for example Rotstayn (2000, doi:10.1029/2000JD900129), Golaz et al. (2011, doi:10.1175/2010JCLI3945.1), Wang et al. (2012, doi:10.1029/2012GL052204).

We have considered the references in the manuscript (3rd paragraph of Section 6).

8.
P5493, lines 7-8: how frequently is the actual CDNC overridden by the imposed minimum value in the radiation?

The highest frequency is found in midlatitude clouds, where on average about 10-15% (locally up to 20%) of the subcolumns are overridden by the minimum CDNC.

We have added the following in the Discussion (last sentence in section 6):

"The fraction of cloudy subcolumns for which the lower tropospheric CDNC is overridden by the minimum CDNC in our experiments was highest at the midlatitudes, being typically 10 − 15 % and locally up to 20 % in the southern hemisphere".

Technical corrections.

P5478, line 14: this is only speculated in this work. Maybe it does not belong in the abstract.

We agree with the Reviewer and have removed this sentence from the abstract.

P5478, lines 17-20: beyond radiative properties, CCN also impact the dynamics of clouds by altering precipitation efficiency.

The following sentence has been added to the first paragraph of the Introduction:
"Moreover, aerosols also have an influence on cloud dynamics by altering precipitation efficiency".

P5482, line 26: What is the added computational cost of the current approach?

The computational cost of the SGW-version is about 20-25% higher compared to the standard McICA implementation in ECHAM-HAM2. The following sentence has been added in the 1st paragraph of Section 6:

"Considering the microphysical properties of clouds explicitly in several subcolumns inside each GCM grid-cell also increases the computational cost of the model: it takes about 20 − 25 % longer to run the new model version (as in SUBW) compared to the standard implementation of McICA and the stochastic cloud generator (as in REF)".