Geosci. Model Dev. Discuss., 4, C1565–C1570, 2012
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Geoscientific Model Development Discussions

GMDD
4, C1565–C1570, 2012

Interactive Comment

Interactive comment on "A subgrid parameterization scheme for precipitation" *by* S. Turner et al.

S. Turner et al.

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Dear referee,

Thank you for these thoughtful comments, which provide an improved version of this paper. I apologize for the delay in sending the replies.

Note that three figures and one appendix are added to explain the new parameterization, following the referees comments.

AC: Author Comment | RC: Referee Comment

RC: 1. P1654 L6-10: Text states that Figs. 3a and b show good agreement between modeled and observed qr_tilde and observations. In fact, SM values are very small

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relative to observed means, and DM-50 values are high, especially around 500m and toward the end of the integration.

AC: Yes, the text is changed as followed:

Before: Figure 3a and b show ... The simulated profiles are similar to the observed ones, with a quasi-adiabatic increase with height above cloud base.

After: Figure 3a and b show ... The simulated profiles of qc_tilde are similar to the observed ones, with a quasi-adiabatic increase with height above cloud base. For qr_tilde profiles, the SM ones are lower than the observed ones and the opposite for the DM-50 ones.

RC: 2. P1658 L2: Provide a brief description of how TESTB93 differs from the other SM parameterizations.

AC: Yes, a description is added as followed:

Before: Figure 7b is similar to Fig. 7a for the SCM results, and a test simulation has been added following Bechtold et al. (1993) (named SM-TESTB93).

After: Figure 7b is similar to Fig. 7a for the SCM results, and a test simulation has been added following Bechtold et al. (1993) (named SM-TESTB93). The main difference between this last test and all other simulations is that the cloud water is uniformly distributed in the cloud fraction and the rain fraction is defined to be the same as the cloud fraction. There is then no splitting of the cloud water in two regions and it takes a longer time to produce rain since the whole cloud fraction must reach the threshold value to produce rain.

RC: 3. P1658 L11-13: Text states that significant values of q r_tilde are generated in both the standard and subgrid schemes (Figs. 8c,d). However, no qr_tilde is evident on Fig. 8c for SM-CTRL.

AC: Yes, text is changed as followed:

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Before: Figure 8c and d are ... Both the standard and the subgrid precipitation schemes generate significant values of qr_tilde because the qc_tilde values are greater than the autoconversion threshold over most of the cloud depth. This feature is intrinsic to the subgrid convection scheme, which predicts a realistic grid CWC mean value but distributes it over a cloud fraction that is too small, thus overestimating qc_tilde.

After: Figure 8c and d are ... Both the standard and the subgrid precipitation schemes generate significant values of qc_tilde, greater than the autoconversion threshold over most of the cloud depth. This feature is intrinsic to the subgrid convection scheme, which predicts a realistic grid CWC mean value but distributes it over a cloud fraction that is too small, thus overestimating qc_tilde. However, the standard scheme was not able to produce rain while the new scheme is generating rain of the order of the observed one .

Please also note the supplement to this comment:
http://www.geosci-model-dev-discuss.net/4/C1565/2012/gmdd-4-C1565-2012-supplement.pdf

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Interactive comment on Geosci. Model Dev. Discuss., 4, 1643, 2011.

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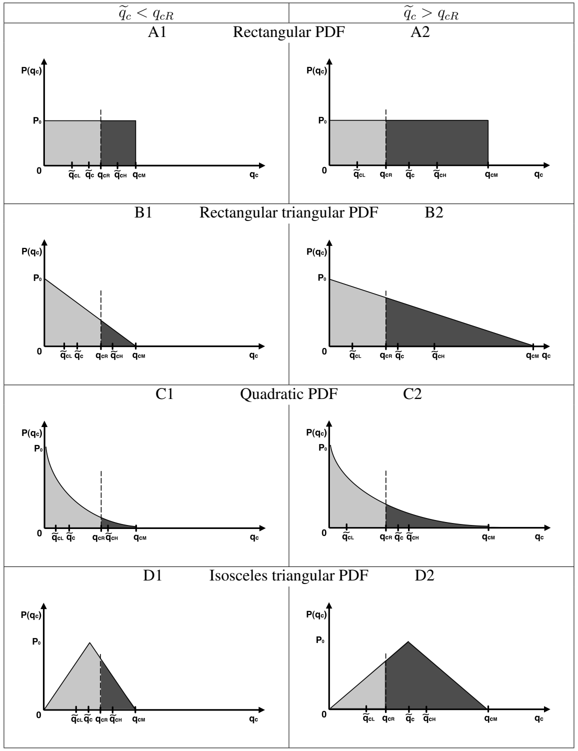

Figure 1: Graphs of the four PDF forms used to represent the CWC. Light grey represents regions of low CWC and dark grey represents high CWC. The local mean CWC, the local low CWC and local high CWC are, respectively, $\widetilde{q}_c$, $\widetilde{q}_{cL}$ and $\widetilde{q}_{cH}$. The autoconversion threshold is q_{cR}, and the maximum value of the CWC is q_{cM}.

Fig. 1.

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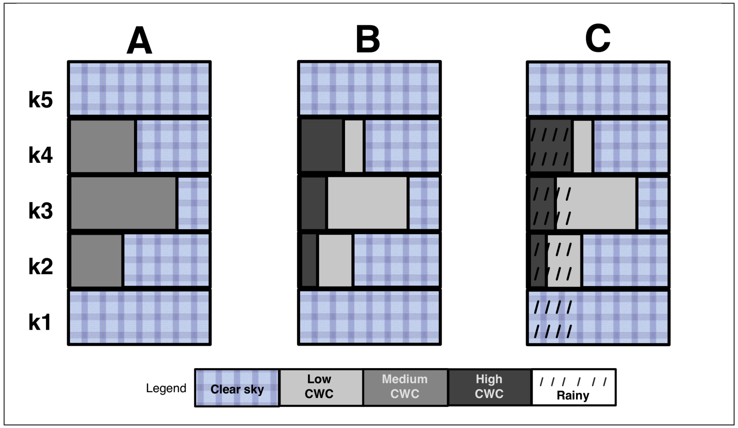

Figure 3: A, B and C are the successive steps of the numerical treatment of the cloud and rain vertical overlap in a model column. (A) The maximum cloud overlap is applied for adjacent or non-adjacent layers. (B) The same maximum cloud overlap of (A) is applied for the new parameterization using the splitting of the CWC in two regions, and maximally overlapping the high CWC regions. (C) The rain is falling vertically with a maximum vertical overlap.

Fig. 2.

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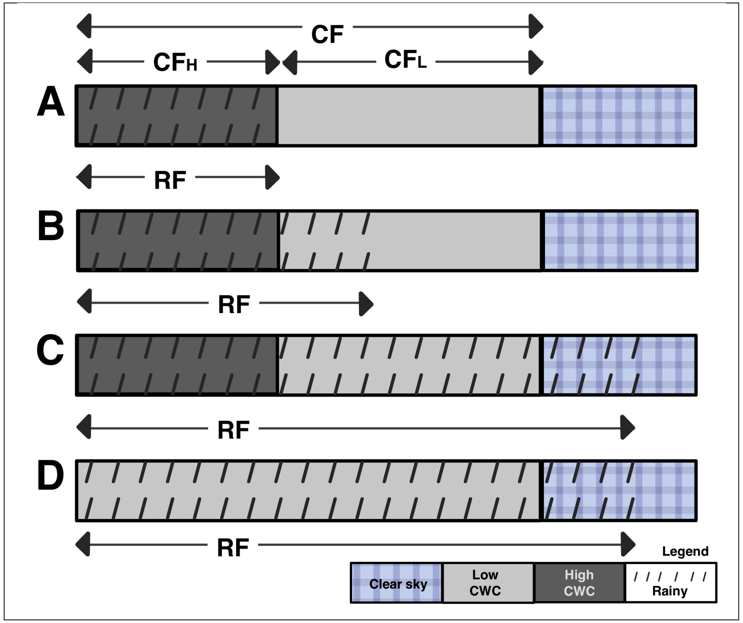

Figure 4: Four horizontal views of a grid box, with the splitting of the CWC in two regions of low and high CWC. RF and CF are the rain and the cloud fractions, with CF_L representing the cloud fraction in the low CWC region and CF_H the cloud fraction in the high CWC region (see text for details about differences in accretion and rain evaporation in A, B, C and D).

Fig. 3.

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