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Geoscientific
Model Development
Discussions

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

Anonymous Referee #1

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Turner et al. present a study in which they develop a parameterization of the subgrid-scale variability of cloud water for liquid water clouds, and apply it for the precipitation formation scheme. This is a comprehensive study, involving test cases from large-eddy simulation models constrained by observations for marine boundary-layer clouds as well as one mesoscale test case, which, however, is only briefly presented.
The study is very useful for atmospheric models, and a very nice example of the application of large-eddy simulations for parameterization development down to the application at a mesoscale such as advocated, e.g., by the GEWEX cloud system studies.
The topic is pertinent to "Geosci. Model Dev." and the manuscript is generally written in an excellent English. It should be published, but I think that the manuscript would very much improve if at several points, substantially more information was given.

(page and line numbers refer to the "printer-friendly" version)

Major remarks
It would be very useful to add a few sketches to describe the scheme.

1. How do the four PDFs look like?
2. How do the PDFs look for CF_H = 0 and CF_H > 0?
3. A sketch on how the overlap of rain fraction is handled.

Specific remarks
p1643: should the affiliation name be in upper cases?
p1644 l5: PDF should be spelled out here
p1645 l12: frequency of occurrence of clouds?
p1645 l15: does a problem with too much overcast skies matter here? It would indicate a problem with the grid-box mean relative humidity, rather than a problem with the subgrid-scale distribution.
p1645 l16: is there an upper bound as well?
p 1646 l3: It is understandable that the senior authors involved in this study may believe that they solved the problem of precipitation in large-scale models in their earlier research. However, also for general circulation model it remains a challenge, and the "drizzle problem" described for the mesoscale models on p1645 l16 also is a problem in GCMs.
p 1647 l28: a superfluous space
p1647 l24: it would be useful to discuss the works Jess, Spichtinger and Lohmann, A statistical subgrid-scale algorithm for precipitation formation in stratiform clouds in the ECHAM5 single column model, Atmos. Chem. Phys. Discuss., 11, 9335-9374 (2011) and Zhang, Lohmann and Lin, A new statistically based autoconversion rate parameterization for use in large-scale models, J. Geophys. Res., 107, 4750 (2002) in

this context.
p1648 l20: The cloud microphysical scheme employed in this study needs more details, and the reader should not be left with the reference (particularly since one of these is only a conference proceedings reference). Specifically, it is important to note that rain and snow are prognostic quantities, which are transported by advection, and to report the formulas for autoconversion (Kessler 1969 as stated on p1650 l20); and for accretion.
p1649 l18: how do the CCN translate to droplet number concentrations? are the latter then fixed, or do they depend on updraft velocities?
p1650 l3: For the models in use here, no assumption is necessary. A subgrid scheme for cloud fraciton is used.
p1650 l5: This is unclear. Why would the subgrid-scale variability of cloud water be generally more homogeneous if a cloud fills the entire grid-box? Is that not also a contradiction to the statement by the authors that they think such a scheme is most useful for models with a resolution of order 1 - 5 km?
p1650 l7: it would be good not to mix abbreviations and symbols with identical meanings. In general, symbols are preferable.
p1650 l12: The very crucial parameter of the autoconversion threshold needs to be defined clearly. It seems to be chosen at 10 - 12 μm in mean volume radius (p1644 l23), which would translate to about 0.4 g m^{-3} in liquid water content for a droplet number concentration of 100 cm^{-3} (smaller ones for the other droplet number concentrations) according to p1645 l2.
p 1650 l24: a reference is missing here.
p1651 l7: until $\tilde{q}_c = q_{cR}$? Does this not imply the PDF is always symmetric?
p 1651 l25: which level?
p1651 l28: so a 2D field is stored? is this one advected? or how could it be consistent with the advected 3D rain? how is the evaporation of rain handled? - all this needs explanation.
p1652 l9: also multi-layered clouds are an issue.

p1652 l15: probably not within CF_L, but within $RF - CF_H$, which in this case is less than CF_L.
p1653 l12: the second “DM-50” probably should read “DM-100”
p1657 l26: this is an astonishing result from the observations, and one is tempted to believe more in the model. Or is there an explanation?
p1658 l4: “produce *surface* rain at all”
p1659 l9: “BL” should be spelled out here, where it occurs the first time
p1669 Table 4: “simulated *surface* precipitation”
p1672 Fig. 1: it would be useful to show the autoconversion threshold in the plots
p1683 Fig. 12: “South-West”

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