Geoscientific Model Development Discussions

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Comment on gmd-2021-61

Anonymous Referee #1

Referee comment on "Empirical values and assumptions in the convection schemes of numerical models" by Anahí Villalba-Pradas and Francisco J. Tapiador, Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2021-61-RC1, 2021

Review "Empirical values and assumptions in the convection of numerical models"
by Villalba-Pradas and Tapiador

Paper Summary: This is a review on the convection scheme with a focus on three main elements of the parameterization: the triggering of convection, the cloud model and the closure type. It also presents an emphasis on the choice of the free parameters in those three elements of the convection parameterization. This paper is interesting and presents a complete overview of the different assumptions made for entrainment/detrainement, microphysics which are rarely discussed. However, I think that three key points should be taken into account for the paper to be accepted. First, differences in assumptions and constitution between parameterization of shallow convection and parameterization of deep convection should be highlighted and how the presence of both is taken or not into account in the triggering or closure. Second, a schematic that summarizes the main elements of a convection parameterization should be used and may help understanding the different tables. Third, the conclusion needs a re-writing to address the major challenges that convection parameterization is facing.

Major Comments:

I found that the common elements and differences between parameterization used for shallow convection and deep convection should be more emphasized and discussed. Right now, most examples refer to parameterization of deep convection while some of them refer to parameterization of shallow convection with no specific discussion. I see two possible options: 1/ to get rid of the examples referring to shallow convection parameterization but a discussion on the main differences could be added at the end, 2/ to end each section, by one dedicated to the shallow convection.

There are very few illustrations which is common in a review paper. However, one schematic summarizing the main elements of a convection parameterization could be helpful.

The conclusion section should be revisited. It could be organized with 1/ an historic view of the development of the convection scheme organized around the main challenges faced and 2/ a list of the remaining challenge for convection parameterization (for that you can refer to Rio et al 2019 which listed 3 main challenges). You may also refer to Couvreux et al 2021 which propose a new methodology for combining tuning and parameterization development. 3/ a summary of the main differences between shallow and deep convection regarding trigger, cloud model and closure, the three main elements addressed in this review.

Minor Comments:

Title: I propose to change 'convection' to 'convection scheme'

- Abstract: 'Convection has to be parameterized in NWP models, GCM models and ESM models': For NWP models it depends of the resolution and the convection. For regional NWP models, most centers now use models that resolve the deep convection. I propose to moderate this sentence

- Table 1: Very long list of acronyms. Is it really useful?

- L 105-110: on the discussion of the tuning and the error compensation, you may want to refer to Couvreux et al 2021

- l133 on the convection being a major source of uncertainty you may also want to refer to Jakob 2010

For section 2, it will be useful to refer to the review of Rio et al 2019 on the parameterization of convection

- l 169: can you explain with one sentence the CISK for the reader.

- L 177: can you add a sentence explaining what 'b~0' means ? No storage in the atmosphere? Is this realistic?

- L 294-300: this discusses criteria on positive buoyancy or unstable parcels. This is not any more really a moisture convergence trigger and should be discussed.

- Section 3.1.2 you may also refer to the ALP and ALE concept detailed in Rio et al (2009), Grandpeix and Lafore (2010) or Hourdin et al (2013)

- Table 3: c(z)=> please check readability. Are you sure that the condition is $w^2<0$ this should be never reached?

- Table 4: It is not really understandable like that. Try to shorten the text.

- Section 4.1.2 should be improved in order to better highlight what distinguish the different elements of a spectral models. Right now this is not very clear. Also, when you mention revision of scheme, be more specific in how this revision has modified certain characteristics of the spectral models.

For ex: l 477-478 is not clear enough. (a simpler closure formulation: what has been changed? How this affect the characteristics of the spectral model => This is should be more indicated in the closure section). Similarly for l 475-477, l 479-481.

- l 549: can you detail a bit more how the Eps_turb is described with an eddy-diffusivity approach and give references.

- l555: suppress the 'in' before (Simpson, 1971).

- l 694-695: should mention that Derbyshire proposed to make the detrainment

proportional to the environmental relative humidity.

- l 704: please recall what a precipitation efficiency is for.

- l 706: change ‘for the same of’ to ‘for the sake of’

l 802-805: please rephrase, this is difficult to understand

l 807 : not clear what are the differences between flux-type and state-type closures

stochastic closures are not mentioned

- l 825 5.2.2 is before 5.2 => check the label of the different subsection

I found the ‘impact of closure’ section not very strong; Should be improved.

- l 850, 852 is not necessary in the conclusion

References:

Couvreux, F., Hourdin, F., Williamson, D., Roehrig, R., Volodina, V.,Villefranque, N., et al. (2020). Process-

based climate model development harnessing machine learning: I. A calibration tool for parameterization improvement. Journal of Advances in Modeling Earth Systems, 12, e2020MS002217. https://doi.org/10.1029/2020MS002217

Grandpeix J, Lafore J (2010) A density current parameterization coupled with Emanuel’s

convection scheme. Part I: the models.J Atmos Sci 67:881–897. doi:10.1175/2009JAS3044.1

Hourdin, F., Grandpeix, J. Y., Rio, C., Bony, S., Jam, A., Cheruy, F., & Roehrig, R. (2013). LMDZ5B: the atmospheric component of the IPSL climate model with revisited parameterizations for clouds and convection. Climate Dynamics, 40, 2193–2222. https://doi.org/10.1007/ s00382-012-1343-y

Jakob, C. (2010). Accelerating progress in global atmospheric model development through improved parameterizations challenges, opportunities, and strategies. Bulletin of the American Meteorological Society, 91(7), 869–876. https://doi.org/10.1175/2009BAMS2898.1

Rio C, Hourdin F, Grandpeix JY, Lafore JP (2009) Shifting the diurnal cycle of parameterized deep convection

over land. Geophysical Research Letters 36(7)

Rio, C., Del Genio, A. D., & Hourdin, F. (2019). Ongoing breakthroughs in convective parameterization. Current Climate Change Reports, 5, 95–111.