Atmospheric Chemistry and Physics Discussions

Atmos. Chem. Phys. Discuss., author comment AC2
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Reply on RC2

Kalli Furtado and Paul Field

Author comment on "A strong statistical link between aerosol indirect effects and the self-similarity of rainfall distributions" by Kalli Furtado and Paul Field, Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-443-AC2, 2021

We agree with your suggestion that our assertion of "universal" scaling from one simulation is perhaps quite a stretch. Rather than completely revise the language, we give some further evidence that the "universal function" holds for different storm types/climatological contexts and different microphysics schemes/parameters.

To strengthen the claim of 'universality', we added a new section (Section 7.3) which includes the following:
1) the universal distribution for 20 case studies of mid-latitude weather, using a convection-permitting (1.5km resolution) regional model over the UK;
2) universal pdfs for three large (17 x 12 degree) regions, covering tropical Pacific, north-eastern Pacific, and Southern Ocean, from 20-years of daily mean precipitation from AMIP simulations with a global climate model.

The inclusion of the UK cases samples a variety of different meteorological regimes. The global simulation samples a different microphysics scheme (a single-moment scheme), and convection-scheme rainfall, in three different climatological backgrounds (tropical deep convection, subtropical stratocumulus, and mid-latitude storm tracks). The results show that the 'universal' distribution is approximately independent of the factors sampled.

The comparison to the UK NWP cases encompasses a different aerosol microphysics scheme (but the same cloud microphysics).
The global AMIP simulations use a different cloud microphysics (the single moment scheme used in Furtado 2018) and a convection parametrization. So, the similarity of the non-dimensional pdf across these simulations strengthens the claim that some form of 'universality' is at work (at least for the Unified Model). Please see the revised manuscipt for the full details.

RC: As it is, I believe the title puts it best: there is evidence for a strong statistical link between AIE and self-similar distributions, but I am not convinced that this is the last word on the characteristics of the underlying distribution.
Response: we agree with this; I've added sentences to the last paragraph of conclusions to this effect.

You made several very helpful Minor/typographical comments; these are addressed in bold below (and in the manuscript):

L270: "assumption corresponds to the simplification" **Corrected**
L292: "fewer than two moments" **Corrected**
L301: I am confused – the parameters in Table 1 have different symbols. Please correct.
Thanks for noticing this! These are parameters needed to get the prefactor x **and exponent** y **parametrically from the aerosol number,** $Nsol$**; we've corrected the description in the text (Eq. 11) and symbols used in Table 1.**
L301: Do you mean Figure 6b? Hard to tell because it looks like the axis labels are wrong.
I've corrected the axis labels in 6a.
L305: There is no factor of M2(n) in Eq. 7. Do you mean M1(n)?
Yes, M1(n); corrected
L310: I think you mean "M0,…,M3" **Corrected**
L319-321: What is your metric for "capturing the trends" in Fig. 7? It looks to me like you get a great fit for M0 and then the fit degrades with increasing moment order. Even M1 is pretty far off for single moment Na=1.
Agreed! We've revised the discussion of this Figure:
"*In most cases, the predictions are able to reproduce the simulated values of the moments reasonably well. The agreement is slightly less good for some values of the single-moment reconstructions and for the highest-order moment tested.*"

L351-353: Scale breaks are common in systems like these due to both statistical noise and violations of scaling laws. Can you rule out the latter?
We can't rule this out – it's definitely possible; I think this possibility is covered by our concluding remarks about "*understanding the extent to this* [universality] *hold* s"

L391: "the probability distribution of"…of what? **corrected**
L396: "We do not if the distribution is…"
L404: Should there be an "and" between the definitions of r1 and r2? **Yes! corrected**
L414-415: This sentence is confusing. I suggest you break it into two and reword.
Simplified to: "*The choice of* $M0$ *and* M1 *is arbitrary: as shown by Field and Shutts (2009), any pair of moments could be used for the reconstructions.*"
L416: "a family of power-law relationships" **corrected**
L424: "a detailed understanding of how aerosols…" **corrected**
L427: "rather than seeking a physical reason for why aerosols…" **corrected**
L434: "choose these moments" **corrected**
L460: "next" instead of "nest" **corrected!**
Fig. 4 caption: "and hence the sensitivity of…" **corrected**
Fig. 6a: should axes read "M1,fit" and "M1" instead of referencing M2?
corrected
Fig. 9: I am confused about which regime is which in the figure. Could you descriptively label the x-ticks instead of the visually-distracting cloud fraction bounds?
I hope it's ok, I've left the quantitively descriptive labels; I know they are a bit cumbersome, but I think they help with reproducibility of the results.