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Hydrology and Earth System Sciences Discussions

HESSD

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Interactive Comment

Interactive comment on "Skewness as measure of the invariance of instantaneous renormalized drop diameter distributions – Part 1: Convective vs. stratiform precipitation" *by* M. Ignaccolo and C. De Michele

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General Remark 1)
The probability density function of the reduced-centred diameter is expressed as the diameter standard deviation multiplied by the pdf of the diameter. One must remark that such relationship does not hold for the exponential and gamma pdfs that are largely used to model DSDs.

Answer to General Remark 1)

Eq.(3) is not to be intended as Eq.(1) of Sempere Torres et al., 1994. Eq.(3) is simply states that the probability density of Dr is obtained multiplying sigma by the value of the probability density $p_{g,I}(D)$ at $D = \sigma D_R + \mu$. That's all. It is an application of a well known result in statistics about the connection between the distributions $p(x), p(y)$ of two stochastic variables x, y which have a functional relationship, $y = f(x)$, a result valid for any functional form $p(x), f(x)$. Therefore the statement that Eq.(3) "does not hold for the exponential and gamma pdfs" is simply incorrect.

General Remark 2)

The authors then propose to use the skewness parameter of the normalized distribution as a measure of the invariance of the DSD "shape". The reviewer is wondering about the physical significance of the skewness parameter.

Answer to General Remark 2)

All the parameters adopted in the manuscript, see Eq. (8), are functions of the moments of the distribution of drop diameters at the ground. This alone grants them physical "significance". At worst, they are as significant as any parameter used in classical renormalization procedures, since those parameters are also functions of the moments of the distribution. In particular, the skewness is a measure of the asymmetry of the distribution (note renormalized and not renormalized spectra have the same skewness, Eq.(9)).

General Remark 3)

On another hand, the reviewer is also wondering why the authors do not use the kurtosis as another statistical parameter to be used for checking the similarity of the scaled DSDs.

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Answer to General Remark 3)

A metric based on one parameter is the simplest choice, and most importantly we have verified that skewness alone is already enough: the skewness "value determines" also the kurtosis value, so that two renormalized spectra with the "same" skewness have also the "same" kurtosis (Section 3.3.1 and Fig. 3 of the companion paper hess-2011-249).

General Remark 4)

The authors do not display the normalized spectra which could probably be the best solution for convincing the reader of the invariance of the scaled spectra.

Answer to General Remark 4)

The renormalized spectra are already shown in Ignaccolo and De Michele. 2010. See online material, Section 4, In particular Fig. 13. We think that this figure provides convincing evidences.

General Remark 5)

The comments of the results displayed in Fig. 3 about the similarity of the mean convective/stratiform scaled spectra should be mitigated by those of Fig. 1 about their respective occurrence.

Answer to General Remark 5)

We took in account this issue reporting in Table 1 the occurrences of the different types of distributions. From the table one can see that the skewness classes s0, s-1, s+1 are the most frequent.

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General Remark 6)
I am sorry to say the authors did not convince me of the relevance of their novel normalization technique compared to the other recent contributions mentioned in their bibliography. With the objective of studying the invariance of the DSD shape, the proposed scaling appears (reasonably) well suited but it may be of little help for other applications such as establishing relationships between bulk variables of interest in atmospheric sciences. To be provocative I am tempted by asking a major revision of the paper; I think the authors have to demonstrate the added value of their approach.

Answer to General Remark 6)
We would like to point out that the purpose of our manuscripts (this and the companion) is not a comparison between different renormalization procedures. This said, we think that a major revision of the manuscript is not necessary. To prove our point let us first discuss what makes "relevant" a renormalization procedure.

Relevance of a renormalization procedure Renormalization procedures are simply a mathematical transformation of one or more variables which cast the original instantaneous drop diameter spectrum in to a "renormalized" one. What makes "relevant" a renormalization procedure?

(a) invariance (spatial and/or temporal) of renormalized spectra This is a desirable property because one could build a single statistical model relevant to many different locations and/or synoptic situations avoiding the proliferation of ad hoc models. "Physically" the invariance of renormalized spectra means that the dynamics of drop formation and precipitation is invariant with respect to a given transformation.

As for our renormalization procedure, it has the following properties:

"(1) Synoptic origin invariance for a fixed observation site (Darwin, AUS): convective and stratiform precipitation databases have same distribution. (2) Rainfall rate invariance for a fixed observation site (Darwin, AUS): databases built according to different rainfall rate classes (Tokay and Short, 1996) share a common distribution. (3) Cross invariance: the distributions in (1) and (2) are essentially identical. " (lines 15-20, pg. 5607 of the manuscript).

Moreover, as you can see in the companion paper, renormalized spectra, with the exclusion of the "orographic" precipitation, at different locations of Earth's surface are "the same".

What about the classical renormalization procedures? None of the studies based the classical renormalization has succeeded in producing comparable evidences.

(b) "establishing relationships between bulk variables of interest in atmospheric sciences". We have reservations about this being a bona fide relevant property for a renormalization procedures. At cost of being repetitive, two different renormalization procedures are simply two different parametrizations of the same phenomenon. Thus to claim that one parametrization is able to "derive" or "establish" a "physical" property of the phenomenon while another may or may not ("added value") is wrong. It would imply that the physical properties of a phenomenon depend on its parametrization.

For example let us consider the Z-R relationship, namely $Z = AR^B$. It is worth mentioning that power law relationships such as the Z-R are practical relationships derived from least square fits of log-log plot (Z versus R) and do not imply the existence of a "physical/causal" relationship between the variables. In other words, the Z-R relationship may be just a statistical relationship rather than a physical property of the rainfall phenomenon as shown in "Reconsideration of the physical and empirical origins of Z-R relations in radar meteorology ", A. R. Jameson and A. B. Kostinski, Q.J. R. Meteorol. Soc. (2001), 127, pp. 517-538, and "Spurious power-law relations among rainfall and radar parameters ", A. R. Jameson and A. B. Kostinski, Q. J. R. Meteorol. Soc. (2002), 128, pp. 2045–2058.

Whatever the case may be, given a renormalization procedure one can always write $Z = A(p, fR)R^{B(p,fR)}$, where p indicates the set of renormalization parameter/s (in our case p stands for the instantaneous average and standard deviation of drop diameter) while fR represents the instantaneous renormalized spectra (in the case of of Sempere Torres et al. 1994, $A(p, fR)$ is Eq. (23) and $B(p, fR)$ is Eq. (24)). In other words any renormalization procedure can "establish" a power law relationship, or for this matter any desired relationship, between any bulk variables. If $Z = AR^B$ is a real physical property of the rainfall phenomenon than for every renormalization procedure $A(p, fR)$ is a "constant" and $B(p, fR)$ is a "constant".
In summary. Regarding argument (a) "invariance of renormalized spectra": our renormalization outperforms classical renormalizations. Regarding argument (b) "establishing relationships between bulk variables of interest in atmospheric sciences": any type of renormalization can establish such relationships, different renormalizations have different functions A(p,fR) and B(p,fR).

Answer to Specific comments)
All specific comments will be addressed when a revised version of the manuscript is submitted.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 5605, 2011.