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# ***Interactive comment on* “Characteristics of the raindrop distributions in RICO shallow cumulus” by O. Geoffroy et al.**

**Anonymous Referee #2**

Received and published: 11 March 2014

## Overview

This paper attempts to characterize the raindrop distributions observed during the RICO campaign; focussing on the characteristic shape parameter in both an assumed gamma or lognormal distribution. The data for this study are taken from the in situ measurements made by aircraft flying both through clouds and below clouds. The authors further attempt to parametrize the shape parameter as a function of measurable (or modelled) parameters with a view to obtaining a more accurate representation of rain evolution in models and to assist in the interpretation of remote sensing data.

## General Comments

Overall the paper is relevant to the needs of the community with uncertainty in micro-

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physical evolution being a key aspect to our understanding and modelling of clouds and precipitation. I believe the authors are correct in stating that much of the work done in this area has concentrated on deeper, more heavily precipitation convective cases and so this work contributes to fill a gap in our knowledge.

The methods used are reasonable well explained and the layout is reasonable. There are, however, one or two inconsistencies in the arguments presented and these should be addressed before final publication.

### Specific Comments

#### 1) Inconsistencies in the argument:

It is argued, by reference to relation (3), that the variation in volume mean diameter with height makes it unsuitable for use as the independent variable in a parametrization. The authors go on to present a parametrization with  $(N_r * q_r)$  as the independent variable, but make no attempt to show that this meets their implied criterion of being invariant with height. Plots should be shown, e.g. as an additional row in figure 2, of the product of  $N_r$  and  $q_r$ . By eye, I would suggest that there will still be a systematic decrease with height. If so, a convincing argument as to why  $(N_r * q_r)$  is more suitable than  $D_v$  should be made.

#### 2) Inconsistencies in the argument:

At the bottom of page 686, the authors state that "...it is reasonable to assume that all kinds of rain spectra typical of shallow cumulus are statistically represented.", However, at the bottom of page 688, it is further stated that "...values derived in this study may be more representative of the first stages of rain development..."

#### 3) Application to an LES:

It is somewhat unclear as to whether the conclusion to take from this study is that the shape parameter is important or not. While there is a clear indication from the data that the shape parameter can vary substantially, there are implica-

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tions regarding LES simulations carried out by the authors that demonstrate a lack of sensitivity to the use of a variable shape parameter. This is perhaps not surprising given other uncertainties associated with bulk microphysics schemes and interaction with dynamics which may negate or overshadow the impact associated with the shape parameter. I would point the authors to Shipway and Hill, 2012 (<http://onlinelibrary.wiley.com/doi/10.1002/qj.1913/full>) which explores some of the microphysical sensitivities (including representation of the 3rd moment) in an idealized framework. In particular, figure 7 demonstrates that having a variable shape parameter (triple moment scheme) only seems to provide a significant benefit in very heavily precipitating conditions. It would be nice to see some more detail from the LES simulations including exactly what was simulated (a particular day or the RICO composite period which is weakly precipitating).

4) The details of figure 5 are too small to make out and needs to be redone. It could perhaps be reorientated to use the full width of the page.

5) There are numerous recurring errors in the grammar. Some examples are pointed out below, but the authors should check this again carefully.

Technical comments:

page 678:

line 2: insert ...'AN' analytical distribution...

line 3: IT IS COMMON for the Gamma DISTRIBUTION and ... Lognormal DISTRIBUTION TO BE USED

line 4: ...studies of the literature... should be ... studies IN the literature...

line 4: ...rain DROP distribution...

line 6: change to ...rain distributionS THROUGHOUT THE DEPTH OF the cloudy...

line 11: clarify what is meant by "the rain variable"

line 12: ..in function of... should be ...as a function of..

line 18: should be ... at local scaleS, i.e. at scaleS of...

line 19: should be ...of A few dozen...

line 24: Could a reference be given to explain why c-c is roughly to the sixth power?

page 679:

line 14: missing article, ...Ultimately, THE local raindrop...

line 18: ..as functions.. should be ...as a function of.. (singular)

line 19: missing comma - ...order p, Mp...

line 21: strictly speaking the distribution isn't a probability distribution

End of page 679- beginning of 680: It should be made clear that much of this discussion relates to commonly used parametrizations of these processes and there is not a direct relationship between the stated moments and the physical processes. Sedimentation for example is dependent upon Reynolds or Best number, rather than simple the moments.

page 680:

line 16: re interval of definition. Why couldn't nu be less than 0 - is it constrained or you just don't see that in this study?

equation 3: There is an error here.  $1/Dv$  should appear outside of the bracketted expression.

page 685:

line 6-8: You don't list the rain water content here.

line 26: No need to repeat "(collection, evaporation, sedimentation)"

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page 689:

line 8: reference to fig 5a-c. I think there are missing labels on figure 5 (c.f. specific comment 4)

page 690:

line 12: I think this should refer to figure 6, not figure 4

line 12: It isn't clear to me how the powers (0.25 and 0.1) were chosen

line 12: brackets should be placed around (Nrqr) to avoid confusion.

page 691:

line 18: Addision "on" should be removed

page 192:

line 3: ...in function... should be ...AS A function...

Fig 2 caption, line 2: (top row, right) should be (top row, center)

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Interactive comment on Atmos. Chem. Phys. Discuss., 14, 677, 2014.

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