Review of egusphere-2025-3486

Toward less subjective metrics for quantifying the shape and organization of clouds

Anonymous Reviewer

Here are some additional comments regarding the revised paper and the accompanying response from the authors. Line numbers refer to those in the revised manuscript. I would like to ask the authors to put line numbers in the author response next time.

Comments

L43

This has been mentioned multiple times in the previous review, but I still feel obliged to ask. The authors have noted multiple times that different measures of fractal dimensions in this paper are meant to "characterize statistical relationships between scales rather than statistics at any particular style" (line 43), but what exactly is it that it is supposed to measure? It has to be a measure of *something*, and despite this being mentioned in both reviews, the paper still is not quite clear about it.

The authors seem to oscillate between it being an "objective alternative to a subjective classification scheme" (line 347), and a measure that can be used to evaluate "the accuracy of atmospheric numerical simulations" (line 349). I am not sure if any of these claims are justified by the work presented in this paper. For example, as mentioned in the other review, it has to vary based on some objective state of the cloud field, which I believe should be some turbulent statistics of cloud regions. The paper shows that there is a consistent measure across different scales, but what if it does *not* change over different atmospheric conditions?

From the response from the authors, these claims seem to be more or less speculative. If that is the case, I believe it should be made clear that they are not what is being presented in this paper.

L191

I am *assuming* that the slopes have been obtained by least-squares linear regression, with the uncertainty being standard error estimate?

1. I am asking because I can only guess how these numbers were obtained, especially the uncertainty in the slope of the linear fit, other than that they were obtained from "a simple linear fit" (line 132), and a different set of slopes were obtained "using a least-squared linear regression" (line 248). It may be obvious to the authors, but I would suggest, however simple it may be, being explicit about the method being used.
2. The errors associated with the slopes are also too small – especially the ones in Figure 6, where the standard error is merely 0.1%. If those are standard errors of the parameter in the linear model, they may be correct in a sense, but are not helpful.

L192

It is not clear to me why the authors claim that "filled fractal dimension does not display any statistically significant scale dependence", because I can tell that it does, only slightly less significantly. Given the small errors associated with these slopes, I would say that going from 1.36 to

1.5 is only marginally less scale dependent than going from 1.41 to 1.7 when the standard errors for the parameters of the linear regression are less than 1%, as shown in Figure 5.

This also shows that the parameter-area relationship is not linear, which is what I mentioned in my last review; I suspect that all the linear relationships assumed in this paper are only marginally linear, and I suggest that the authors look at the plot of the residuals against the linear fit to prove otherwise (not just Figure 5, but for other linear fits as well).

L269

One could quantify the effect of ignoring the clouds extending beyond the domain by taking a (slightly) smaller sub-domain and calculating the correlation integral with and without those clouds. I believe it would be a useful exercise to confirm the claims from DeWitt and Garret (2024) about biases due to truncated clouds.

L280

I do admit that my wording was pretty confusing in the last review, so let me rephrase the question: in calculating the box dimension, I have found that (albeit on a slightly different scale) the number of boxes N is highly dependent on the choice of the box size and the location of the boxes (i.e. Where the boxes lie on the cloud perimeter). The uncertainty in the linear fit was more dependent on these choices than the internal variability of the data. There is no discussion on how the box dimension was obtained, which was what I meant to ask in the last review.

L282

From the response, the box dimension shown in Figure 10 is supposedly close to 1 for the "smallest two points". I'd like to see the actual fit; given the *very* small standard errors on the slopes, I expect the slopes will be *very* close to 1.

L298

Based on the response from the authors and previous works, filtering out truncated clouds end up ignoring a large portion of the clouds.

1. The authors acknowledge that a significant number of clouds will be filtered out; I would like to see it mentioned in the actual paper. And no, because a different set of data is being considered for a different analysis, I think it is necessary to be explicit about the effect of manually truncating the histogram.
2. I understand that the 50% filter was recommended by the other study, but I find it no better than the "subjective choice" mentioned in that paper. Why not ignore 100% clouds that are truncated? Isn't this virtually the same as introducing a subjective cut-off to the cloud size distribution, to perform a "simple linear fit" to a distribution that is only marginally linear?
3. Even with filtering, it does appear that there is a bit of a departure from linearity in Figure 12. What do the residuals look like, especially when the offsets are removed? Is there an underlying trend?

L317

I think one should compare D_{e} and D_{box} at the same threshold. So I am not sure if "all three methods [...] point to a value of $D_{\mathrm{e}} \approx 1.7$". The authors are being intentionally ambiguous here, as the only way to get a value of 1.7 is by averaging all fractal dimensions at all thresholds. I think this has to be made clear, not that somehow the fractal dimensions converge to a single value, as they seemingly do not.

I would say that it would be more interesting if the fractal dimensions vary across the smaller sub-domains or over time, for example, which would better align with the suggested goal of this work.