

REVIEW OF EGUSPHERE-2025-3486

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

Anonymous Reviewer

Summary

This paper examines the use of two different metrics utilizing the scale-invariant nature of clouds as a quantifiable measure of the geometric characteristics of large-scale cloud fields based on satellite observations. Of special interest here is the distinction between the individual and ensemble fractal dimensions, and the latter is found to be a more robust representation of the geometric characteristics of the cloud field.

I found this paper to be interesting and scientifically meaningful. I do have a few issues with technical details and some of the assumptions made in this paper, but overall I believe that the work needs to be considered positively.

Comments

L23

The use of fractal dimensions to compare satellite observations to numerical simulations comes up a number of times in this paper, but the authors seem to conflate different scales and resolutions. Here, the authors mention kilometre-scale climate models; is the argument that satellite images (at 250-m resolution with MODIS, for example), can be used as a link “quite directly to climate physics” of these climate models? How?

L26

The two papers cited here are pretty clear about the measure of uncertainty, so the authors could be more clear about the struggle to accurately represent the radiative effects of clouds. Also, there have been quite a number of studies recently on this very topic since 2020.

L87

It would be nice to see the actual resolution, and exactly how much it varies.

L120

A “simple linear fit” can mean two things. Either that the (unwieldy) distribution has been estimated by a linear function, or that the power-law fit worked exceptionally well. Can we have a figure that actually shows the linear fit?

L214

It is indeed true that the perimeter and the size of a cloud are positively correlated, but the relationship is not linear (cf. <https://doi.org/10.5194/acp-13-7795-2013>). Either this significantly affects the power-law relationship, or I think it should be made clear that the power-law fit is not an exact representation of the cloud size distribution.

L225

I believe the authors are being intentionally ambiguous here, as the cloud field geometry being “tied to” turbulent processes can be used to mean anything; if the authors are implying that the ensemble fractal dimension D_e from satellite images can be used to infer the strength of turbulent mixing processes, or thermodynamic properties, then I would love to see more details.

L280

There is very little discussion on how the linear fits in Figure 10 were obtained. The power-law distributions on the log-log plots are only marginally linear, and they are dependent on the choice of the bins and other factors (see the comment below); one could also argue that the *intermediate* sizes used for the linear fit have been cherry-picked. There is a lot of literature on using the power-law fit for the cloud size distribution, and I believe there is much to be justified here.

L281

This sounds like a significant amount of large clouds being filtered out. I do understand the need to filter truncated clouds, but given that larger clouds naturally have higher chances of extending beyond the observed domain, it sounds like a considerable chunk of the cloud field that is being omitted. For a typical MODIS scene, how much of the observed cloud field has been filtered out at this stage?

The authors mention that including those clouds will result in “a substantial bias”, but could it be the other way around? Also, why the bins that include 50% of whole clouds? These choices seem too arbitrary to me.

Ultimately, I think this directly opposes the main goal of this paper, which is to come up with a measure of geometric features of a cloud field, especially for convective organization.

Figure 10

The exponents are missing on the y-axis (same for Figure 11).

I am not sure if I agree with the observation. The slope D_{box} does tend towards 0 for small and large values of ε (for very different reasons), but I am not sure if we can say it tends towards 1, unless the authors mean that the slope is close to 1 for small ε , in which case I disagree.

L300

I do not see how this number came about; is 1.7 just an average across all estimates of the ensemble fractal dimension? I feel like these numbers depend more on the filtering of large clouds and the linear fit than the actual properties of the cloud field, as they behave differently at smaller thresholds.

L330

I believe it should be “strict definition of the fractal dimension”.

L332

See my first comment.