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Atmospheric Chemistry and Physics
Discussions

Interactive comment on "Technical Note: The horizontal scale-dependence of the cloud overlap parameter alpha" *by* I. Astin and L. Di Girolamo

Anonymous Referee #2

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Review of the technical note 'The horizontal scale-dependence of the cloud overlap parameter alpha' by I. Astin and l. Di Girolamo, submitted to Atmos. Chem. Phys.

The cloud overlap parameter alpha is a numerical value that quantifies the degree of overlap between two cloud layers that may or may not have the same value of cloud fraction, using a combination of random and maximum overlap assumptions. The manuscript addresses idealized derivations of alpha as a function of horizontal scale (i.e., changing grid box size) for two vertically-stacked cloud layers with in a given grid box. The question of horizontal scale dependence of alpha is an important question because of the different grid box sizes used in climate models. The derivations and symbolism follow from previous literature and the equations for alpha are rewritten in terms of the horizontal correlation coefficient R and the vertical correlation coeffi-

cient rho. Alpha_1 signifies the cloud overlap parameter at a smaller grid box size and alpha_2 signifies the cloud overlap parameter at a grid box size twice the size of the smaller grid box. Both Alpha_1 and alpha_2 are related to each other as a function of different values of R and rho and the authors show that alpha can either increase or decrease with scale depending on the value of R and rho. This paper is short and dense and contains two figures summarizing the calculations and a supplemental Matlab program for readers to repeat the results.

The reviewer became lost in the algebra and assumptions discussed used around Eqns. 12 and 13, and onwards, which made following the rest of the paper very challenging. After reading the paper several times, these difficulties were not really alleviated, so I suspect most general readers of this paper will get little out of it despite a small niche of researchers working on cloud overlap issues. The authors were very clear about the very specific motivation of this paper. However, the paper at times comes across as a very technical document that assumes the reader is intimately familiar with previous literature on cloud overlap. This manuscript is not an easy read and it does not flow well. There is an enormous amount of Earth remote sensing data, especially from space, that can be brought to bear on this problem. This includes CloudSat and CALIPSO for vertical profiling of multiple cloud layers and deriving vertical correlations, and imagers such as MODIS that can be used to determine horizontal correlations between adjacent 'grids' of observed clouds. The authors did not touch on real world applications and data besides a few cursory references to a few previous papers. Some further discussion on the wealth of available data and how it can be used to address these issues should be discussed.

All in all, this paper does seem to offer an interesting perspective on the cloud overlap problem. Showing that cloud overlap is sensitive to the vertical and horizontal correlations of cloud fraction, and that alpha can increase or decrease with scale depending on the magnitude of the correlations, is a novel and useful result – albeit for very idealized calculations. This paper requires some significant revisions to improve its clarity and content and usefulness to the general community. However, in this reviewer's opinion, that should not prevent it from publication in ACP. Some specific comments follow below:

The abstract starts off clearly enough, but after line 13 it gets detailed and it is unclear as to how these details should be considered take-home messages. Keep the abstract clear and to the point because this is as far as most readers will get.

Line 13: clouds are deeper

Section 2. It is difficult to tell apart the uppercase and lowercase 'c' for cloud fraction. Furthermore, the 'rand' and 'max' subscripts are lowercase and uppercase depending on the case of 'c', but this is not true for the subscripts 'a' and 'b' (e.g., eqn. 5). Would it help if 'a' and 'b' changed to uppercase if 'C' was uppercase? 'C_T' and 'c_t' follow this convention.

Section 3, lines 19-23: Regarding the question of averaging two adjacent grid boxes, the idealized nature of this study is appreciated and well taken. But, if that grid box is averaged in the zonal or meridional direction, could there be anisotropies in certain cloud regimes that would lead to a breakdown of this approach in a practical setting, or may blur out the signal shown in this paper in real data? Furthermore, can there be 'scale breaks' in particular cloud regimes that could cause different values of R depending on whether the grid box was averaged over a scale in which a scale break in power density or variance is observed? For instance, see Wood and Hartmann, 2006, J. Climate for low cloud examples (there are non-overlapping examples). I could not find an obvious reference for this issue relating to overlapping clouds.

p. 9805, line 15: With regard to the time averaging, over what time scales are we taking about here? A day? Week? Month? Season? Since this is an idealized study, at what time scale would the averaging need to occur at for this study's results to hold?

Line 16: in the parentheses, should it say 'and the altitude between a and b'?

p. 9806, line 6: not sure if this is an error or the mixed notation wasn't defined. A lowercase 'c' is mixed with an uppercase subscript 'MAX'.

Before line 12, I was able to follow the algebra and assumptions after multiple readings. After line 12, it was impossible to figure out all of the details and steps. How does eqn. 12 follow from eqn. 2? I don't see it. Same for eqn. 13. Through eqns 17, it appears the authors are deriving forms of the algebraic relationships that will be functions of R so that relationships between alpha_1, alpha_2, and R (i.e., Fig. 1) can be calculated. Some discussion and clear description of what the authors are doing in simple words will be very helpful here.

p. 9807, lines 9 to 11: Can't this depend on the cloud regime of interest?

From lines 20 and onwards, now the authors are rewriting the algebraic relationships in terms of rho to gather additional insight on the vertical correlation issue. Again, a few additional and simple words on what is being done will benefit the reader.

p. 9808, eqns 19 and 20, where did they come from? How do you get these from two triangularly distributed random variables?

Conclusions, lines 7-10: R and rho can be obtained from real data. How does this study shine light on the use of remote sensing data for the cloud overlap problem and its relation to horizontal scale dependence?

Line 13, which published results? Please describe.

Lines 17-20: again, can test with real data. Also, same comment for lines 21-25. How do the authors conclude R must be small? Can't they say something more quantitative and definitive based on real data?

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