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Interactive comment on "Photolysis rates in correlated overlapping cloud fields: Cloud-J 7.3" *by* M. J. Prather

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The author wishes to thank the editor and reviewers for identifying corrections in the coding and improvements to the text. As noted in an earlier response, the Cloud-J code is now revised and available as version 7.3c. There was confusion over the use of "correlation" and whether that implied statistics. The text has been revised to be more consistent and to use the more typical term 'decorrelation length' while keeping 'cc' as the 'cloud correlation factor'.

Specific responses to Editor:

The historic naming of the Fast-J codes has been clarified in the text and in a readme file on the ftp site. The changing of names sounded like a good idea at the time, but

version numbers would have proven better.

Specific responses to Review 1:

Why 4 QCAs yields only 2.8 calls on average to Fast-J is explained in the text where that number is first used, but not the abstract as that would be too cumbersome. The simple explanation is that QCAs use 4 specific optical depth ranges and not all fractional-cloudy atmospheres have all 4 cloud types of the QCA.

The explanation of vertical correlation of clouds and their decorrelation length over which they become randomly overlapped is expanded. While the determination of the decorrelation lengths (see referenced papers) is statistical, their use in Cloud-J is deterministic: (i) the length defines the MAX groupings, and (ii) the correlation factor between the MAX groupings (0.33) is chosen to be intermediate, about an e-fold, between random overlap (0.00) and maximum overlap (1.00). Horizontal correlations are not considered and that should be clear from the derivations. With Fast-J and Cloud-J the calculation centers on a vertical column atmosphere. Thus resolution independence is with respect to the number of vertical layers. The paper notes that number of MAX groups is fixed by altitude and hence is resolution independent. Further, by binning the cloud fraction into a fixed resolution, the number of independent column atmospheres (ICAs) in any MAX group does not depend on the number of layers. For example 10% bins in cloud fraction are used here, leading to a maximum of 10 ICAs in any MAX group.

In revising the section on decorrelation, it became clear that the v7.3 code did not reduce the correlation of overlapping MAX-COR cloud groups when they were separated by a gap (i.e., an extra decorrelation length). This has been corrected with v7.3c. The numbers generated for the Cloud-J evaluation here (many more than shown) changed by at most 0.1% and are not discernible in the GMDD figures and tables.

The function 'modulo' has been expanded from programmer language (mod) to English (thanks).

As noted above and in the revised text, the choice of cc = 0.33 is logical based on the decorrelation length and does not depend on model resolution.

The coding re 'TITCLD' (and similar anomalies) has been corrected (thanks for catching this).

Specific responses to Review 2:

1) The correlation coefficient was incorrect usage and the manuscript is revised as noted above. The definition of cc is now justified, as is the recommendation of G6/.33 as the best physically based model for cloud overlap.

gˆL1 = 1 + cc * (1/fˆL2 - 1)

The derivation of this has several approaches: The RAN ICAs have a weight assigned to the L1-cloud layer that does not depend on the layer above. Hence, the L1-cloud under the L2-cloud (i.e., the cloudy-cloudy ICA) has a fractional area of f1*f2 and that of the L1 cloud under the L2 clear sky is f1*(1-f2). With MAX overlap, the fractional area with L1-cloud and L2-cloud is just f1 (i.e., the largest fractional area that can have clouds in L1 and L2. With MAX there is no L1-cloud under clear sky. (This example assumes that f1 < f2, but the alternate case can be readily assigned in a similar way.) So the purpose of the factor g is to interpolate linearly for the weight of cloud-L1 below cloud-L2 from a value of f1 to 1. The factor g increases linearly between 1 and 1/f2 as cc increases, meeting the requirement that the weight of the cloudy-cloudy ICA increase from f2*f1*g = f1*f2 to f1 as required. This form of g1 is thus the one and only linear function in cc interpolating function between the two limits.

2.) This is an interesting question (consistency of solar flux calculations in terms of global radiative budget under different cloud fraction assumptions), but beyond this researcher. Validation of code with 3D requires one to specific the horizontal spatial correlations, and it is those that will determine agreement between a plane-parallel and 3D approach. Again, an interesting question, but the data just does not come from

typical climate or even high-resolution forecast models.

3.) Apologies, all the atmospheres (from all longitudes) were used with a single solar zenith angle (13.6°) and surface albedo (0.10). This is now noted in the figure caption.

4) Thanks for the pointers. A careful re-read of the text found some additional verb tense problems and these are now fixed. Other wording suggestions are now adopted.

5) The figure has been fixed so that the 'f' notations matches the equations, e.g., fˆL1.

Interactive comment on Geosci. Model Dev. Discuss., 8, 4051, 2015.