Atmospheric Chemistry and Physics Discussions

Atmos. Chem. Phys. Discuss., referee comment RC2
https://doi.org/10.5194/acp-2021-859-RC2, 2021

Comment on acp-2021-859

Anonymous Referee #2

Referee comment on "Quantifying albedo susceptibility biases in shallow clouds" by Graham Feingold et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-859-RC2, 2021

General comment:

This study analyzes output of LES simulations for marine stratocumulus clouds to investigate how small-scale cloud variables and their relationships to aerosols are aggregated to manifest the albedo susceptibility bias occurring at larger scales typical of satellite-based analysis with L2 and L3 datasets. For this purpose, theoretical relationships between key statistical properties are reviewed and applied to the LES output to quantify the albedo susceptibility bias as a function of several statistical properties and cloud water susceptibility for different aggregation scales. This study offers a nice demonstration of how spatial cloud inhomogeneity and non-linear aerosol-cloud relationships are a source of uncertainty in quantifying the albedo susceptibility, directly relevant to radiative forcing due to aerosol-cloud interaction. I have some minor comments mostly regarding the presentation and/or clarification as listed below and I would recommend the manuscript to be considered for publication in ACP after the authors properly address the comments.

Specific comment:

Section 3.1: It is hard (at least for me) to understand in detail how the LES output variables (at the native model grid resolution) are averaged and/or aggregated into different spatial scales. In particular, I am confused with the term “aggregated” which seems to mean “averaged” for some parts and to mean “accumulated” for other parts. I would appreciate the authors to clarify if each “aggregated” means “averaged” or “accumulated”. Please look at the Minor Points listed below for specific locations in the text for this clarification.

Line 188-190: “This is because L3 averaging has a stronger smoothing effect on broken cloud fields, and therefore somewhat unexpectedly reduces the averaging bias for broken cloud fields compared to solid cloud fields”: Does this explain the negative values of the

albedo susceptibility in Fig. 3b?

Section 4.1.3: The argument here associated with Fig. 10 is of particular importance in the context of cloud water adjustment and its impact on albedo. It is interesting to see that the tight correlation between S0 and L adjustment biases relates inversely with cloud fraction between L2 and L3. How can this reversed relation be understood? Please add some more discussion.

Minor point:

Equation 6: Is this B_x inverse of the bias?

Fig. 1: Are the numbers labelled for contours in percent?

Line 135: Insert 'of' between 'fields' and 'drop'

Line 138: "Both cloud water and rain water contribute to tau and re": Does this mean that re is computed as the ratio of third to second moments of the whole range of the bimodal size distribution? If so, is it consistent with what satellite measurement looks at given satellite measurement is sensitive primarily to the cloud mode alone?

Line 146: "aggregated": Does this mean "averaged"?

Line 151: "at the pixel level": Does this mean the model native resolution (200m)?

Line 162: "aggregated": Does this mean "averaged"? Namely, are tau and re first averaged to n=4 and n=30, and then Equations (2) and (3) are applied to them to derive Nc and L?

Line 201: Fig. 3 -> Fig. 4 (?)

Line 206: Does this "aggregate" mean "average"?

Line 214: Please state that b(6km) and b(800m) are denoted as b_hat_overbar and b_hat, respectively.

Fig. 3 etc.: Please put the panel titles as “L2”, “L3” and “L2N”.