RC3: 'Comment on acp-2021-859', Anonymous Referee #3, 23 Dec 2021 reply

General

Based on large-eddy simulations of marine cloud fields off California, this study explores the effects that spatial and temporal averaging as explicitly and implicitly done in satellite data analysis can have on the study of aerosol--cloud--climate interactions. The authors present a careful and well-documented analysis that puts existing satellite-based studies into perspective. I think this is a strong paper already, but have a few remarks mostly concerning methodology.

Thank you for the careful review. Text additions are in blue and changes in red.

Details

- *line 10: which biases? Bias of aggregation vs. inndividual models, or the other way around?*

  We have modified the text to make it clear that we refer to the S_o bias (line 10).

- *line 11: Explain L*

  Thank you. This was an omission. We now use liquid water path and define L on first usage.

- *line 49: 'known'*

  Thank you. Corrected on line 52

- *line 89: 'interest'*

  Thank you. Corrected on line 96

- *line 93: 'well-known'*

  Thank you. Corrected on line 66

- *line 96: 'the' standard deviation*

  Thank you. Corrected line 103.

- *line 138: For 'cloud top', do you use the top-most layer of the model, or do you allow for some radiation penetration into the cloud, as found in satellite retrievals at smaller MIR wavelengths?*

The cloud top r_e is calculated based on a liquid water mixing ratio threshold (0.01 g/kg). Because these clouds are strongly capped, the first grid point exceeding this value (when working downward towards the cloud top) almost always exceeds the threshold by a lot. Visual inspection of the data persuaded us that the values were as expected. In other words, we mimic a satellite retrieval in the sense that we use cloud-top r_e, but don't apply a simulator. We now make this clear in the text on lines 155-157.

- *line 146: In the aggregation, did you consider partial cloudiness in your cells as a weighting factor, i.e. via horizontal cloud fraction?*

  Aggregation to 800 m is performed using a simple box-averaging algorithm, since this is essentially what a satellite-based instrument with that sensor resolution would see. To be consistent with the 800 m averaging, we do not perform any weighting when we average to 6 km. Again, we apply the box-average at the 6 km scale.

- *line 148: Why did you choose 800mx800m to get 'close to the typical 1 km …' of MODIS instead of using n=5 directly?*

  Thanks for this question. We have an even number of points in the domain and so we chose to use an even number of points in the box-average. This is now mentioned in the text on lines 168-169.

- *Figures 11 and 12: Harmonizing the color bars on a and b would make it easier to compare both - assuming that any spatial detail was retained in so doing*

  Because the ranges differ significantly, we found that a great deal of dynamic range was lost. This was in part the reason for panel (d)

- *line 289: (sub)adiabatic**a**lly*

  Thank you. Corrected. (line 315)

- *lines 376--380: This is quite substantial, and the result that most surprised me. Based on this insight, do you have suggestions on how to improve Nd retrievals?*

  The typical approach to this problem is to average over fairly large areas. This tends to produce much better results. But as this paper has shown, there are consequences to this averaging with respect to calculation of 'slopes'. Based on this work, we have an idea under development that we hope will improve N_d retrievals and susceptibility calculations. The goal is to test the idea on LES output and then apply it to satellite-based data. However, it is still in its development phase and not ready to be shared.