Review of "Influence of Cloud Retrieval Errors Due to Three Dimensional Radiative Effects on Calculations of Broadband Cloud Radiative Effect" by Adeleke S. Ademakinwa 2023

November 10, 2023

1 General

The paper is investigating the influence of 3D radiative transfer effects on cloud radiative forcing. To pin down various sources of errors it establishes a framework starting with a LES cloud field, then using a simulated radiance sensor which feeds into a Nakajima King type inversion to gain retrieved optical properties and finally computes broadband fluxes from the retrieved cloud optical properties. Along the way this study evaluates the effects of 3D vs 1D radiative transfer methods. The study is novel, the approach is sound and the manuscript is well written.

The scope of the study is limited to cumulus clouds with small aspect ratios and shortwave CRE. These limits should be presented in the title or abstract. One ingredient in the study is the 3D distribution of clouds which is here taken as granted (coming from the LES output) but in reality is usually not readily available. There are groups working on the 3D reconstruction of cloud scenes (sometimes also called Atmospheric Tomography) and I think it is still an active research field. I would hope that you add a statement that the 3D distribution of clouds is used from the LES and briefly discuss how one could get such info from observations, be it tomography, space carving or stereo methods. Also, I was wondering if you could add yet another flux comparison, namely $F^*_{3D} = g_{3D}(X^*)$. I think it would be interesting to see how a 3D flux compuation on the retrieved cloud properties would fare. At the same time, I concur with the first anonymous reviewer that the effects on 1D vs 3D RT ($\delta Y = Y_{3D} - Y1D$ and $\delta F = F_{1D} - F_{3D}$) has been the subject of previous studies. The length of the study did not bother me and I enjoyed the read throughout but I concur that the respective parts could be trimmed if need be.

There have been moments where I found myself needing to go back and forth looking up details scattered within the manuscript. Hence I have some minor remarks to enhance the readability, see below. After these have been considered, I recommend prompt publication.

2 Specific comments

- Fig 1. really helped to understand the flow of the study. However, I have some suggestions... I recommend to use the notation (symbols like "Y_{3D} or "f_{1D}") throughout the text. Furthermore, the figure would be easier to follow if you introduced a legend for the symbolds in the caption.
- l. 164: Why use SHDOM and MonteCarlo. Is there a particular reason why you would want to use multiple software packages?
- l. 192: I guess using 100m horizontal resolution is convenient because it fits your LES from which you derive the 3D cloud structure etc. but it does not really fit the resolution of the

current generation of satellites. I would encourage to spend a couple of sentences to discuss this in more detail as I would expect that the resolution would potentially alter the impact of 3D effects quite strongly in the framework you proposed.

- l. 214: 0.07 surface albedo seems quite low for the single wavelengths aswell as for the broadband values over vegetation. I was curious and could not understand the choice of 0.07 given the reference of Trishchenko.2003. Please elaborate in more detail where this value comes from.

- l. 276: see general comments section. The vertical structure of the LES is usually not available. Please discuss the need for 3D cloud structure.

- l. 324: it would be easy to imagine a scene that would produce a wrong shadow label due to 3D radiation leakage. E.g. imagine the following: A clear sky domain, one cloud stripe along the y axis, i.e. cld at (x0,y=:,z=z0), sun shining along the y axis with inclined sun. The 3D radiance will probably be lower than the 1D radiance but it is certainly not shadowed. I am not saying that it is not a reasonable choice on your part and I guess it works in most cases but I am curious why you wouldnt use an easier and probably more robust shadow mask. E.g. you could use a raytracer or just the direct radiation component of flux computations.

- l. 507: This is just an example where you could use the symbol notation from fig.1. I think it would be more concise and easier to read e.g. add symbols like F_{3D} or F^*_{1D}. I think it would be great to use these symbols all throughout the text.

- l. 689: photon should be plural. Also Sun should not be in caps - this would be the case everywhere (I am not a native speaker so I am just not sure)?

- l. 702: 7s% should be 7%

- l. 725: typo: studies should be study, affects should be affect

- l. 728: need should be needs?