

Interactive comment on “Biases in the albedo sensitivity to deforestation in CMIP5 models and their impacts on the associated historical Radiative Forcing” by Quentin Lejeune et al.

Anonymous Referee #3

Received and published: 5 June 2020

This paper presents an approach to diagnosing CMIP5 model outputs with regard to the albedo changes and hence resultant radiative forcing from land cover change from trees to crops/grasses. It borrows the ideas from the analysis of observational data, that is, space for time to reconstruct albedo values of trees and crops/grasses and their differences via an unmixing technique based on linear regression over grid cells within local spatial windows. It compares results among CMIP5 models and between these models and observational data. The evaluation of the reconstruction approach using a model CLM also helps us understand the effectiveness of this approach that has been used to analyze observational data. The study uses both observational and modeling data that varies in terms of native spatial resolutions, temporal resolutions,

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and temporal coverages. This diversity in data strengths the investigation but also requires more efforts to achieve a clear and lucid description of methodology and results. I found the description of the methodology and the presentation of the results need some particular improvements. I admit that my knowledge is more on the observational side of studies on land cover and biophysical effects. Some of my questions may have common answers within the hard-core modelling community. Nonetheless, I believe addressing these issues would help the comprehension of the study by a wider audience.

First, Section 2.3.1 needs some clarification in text. I have several questions concerning the understanding of the described method. See detailed comments below. In particular, the line 191-192 states a post-reconstruction estimates of albedo changes by calculating the differences in albedo between trees and crops/grasses. Then the section 2.3.2 looks like a direct estimate of albedo changes from deforestation rate. So, what is the distinction between post-reconstruction estimates and the direct estimates in Section 2.3.2? And which estimates of albedo changes do you present in the results, e.g. Fig. 3, 4, and 9 to 13, and Table 1?

Second, as you use observational and modeling data of different temporal spans/coverages, please specify the year/temporal periods or the temporal coverages for all the figures and tables. For example, Fig 1 & 2, which year/temporal periods are you presenting? In particular for albedo changes, between which year/temporal periods are the presented difference, e.g., Fig. 3 & 4. Almost all the figure/table captions need such clarification. Also, better clarify the spatial resolution of your results. I haven't found explicit statement on the spatial resolution of your reconstructed albedo per land cover class or reconstructed albedo changes per land cover change from trees to crops/grasses. Line 158 says “big boxes of a size of 5 times 5 grid cells”, and the grid cells of CMIP5 model outputs you are using have a size of 2 deg (line 90). Does this mean your reconstructed albedo values and albedo changes have a resolution of 10 deg?!

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Third, about the radiative forcing from albedo changes. Here you are estimating and showing spatially-explicit RF. I'm not convinced that a single value for k (line 242-243) is enough to account for different solar angles at different latitudes. In Lenton and Vaughan (2009), they were looking into the global effect of geoengineering and a single value of k based on annual global mean transmittance was justified. But I'm convinced it is justified here. Also do you calculate RF from albedo changes month by month? Your presented results seems annual average of RF (fig. 11, 12). Then how do you average monthly changes since your reconstructed albedo changes clearly show monthly differences (fig. 3, 4, 9, 10)

Detailed comments,

1. Line 85-90, Please, even if just in supplementary materials, provide an explicit translation from GlobCover's land cover legend into your trees and crops/grasses for traceability.
2. Line 89, black sky albedo at what solar angle?
3. Section 2.1.2, specify the spatial resolution of D18 data in degrees for easier reading and easier comparison between presented datasets.
4. Line 131, Each grid cell in D18 dataset refers to a specific land cover change, i.e. a pair of land cover classes. What do you mean here by grouping land cover fractions in CMIP5 outputs within one land cover class? Furthermore, D18 provides albedo changes for 45 land cover transitions. How come the consistency with D18 is the reason for focusing just on transition between trees and crops/grasses?
5. Line 165, "inferior to" and "superior to"... maybe just simply say "less than"... ? simple words like "larger than" is enough and better for reading? There are more such cases in the rest of the text to be fixed.

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6. Line 184 – 185, What does it mean by "land cover classes are represented" in a grid cell? lcf is larger than zero? If fewer than two grid cells have $lcf > 0$ for a class, then this class will not be considered in the regression at all. The Eq (2) will have one fewer term on the right side? But will that one grid cell with $lcf > 0$ (if there is one) for this class be used in such a regression that does not include this class? If so, isn't this inappropriate? If not, please clarify here.
7. Line 186 – 187, 15 is more than half of 25 grid cells in a big box. So in each big box, you can only estimate albedo for either snow-covered land cover classes or snow-free land cover classes. But NOT for both snow-covered and snow-free?
8. Line 187, "where the sum of all the included predictors exceeds 90%.", Please clarify this sentence. Do you mean that at least 90% areal fraction of a big box, that is $0.9 \times 25 \text{ cells} = 22.5$ cells-equivalent area, is needed for the sum of all the lcf over the included snow-covered OR snow-free grid cells? Or 90% is per EACH grid cell? This sentence reads like the former/first explanation.
9. Section 2.3.2, Eq. (9) and (10), Confusing symbols and texts here. What is difference between the meanings of the $\delta\alpha_{tr \rightarrow cg}$ in Eq. (9) and the $\delta\alpha_{tr \rightarrow cg}(i)$ in Eq. (10)? The $\delta\alpha_{tr \rightarrow cg}$ in Eq. (9) is albedo change as a results of transition from trees to crops/grasses. To me, this means the same as albedo changes due to deforestation that is defined by the $lcc_{tr \rightarrow cg}$, transition rate from trees to crops/grasses. If $\delta\alpha_{tr \rightarrow cg}$ in Eq (9) is a known quantity since you need it for the regression and it means the albedo change due to deforestation, what is the physical rational of the Eq (9)? And what is the point of using regression to achieve the estimate by Eq. (10)? And how did you get the value of $\delta\alpha_{tr \rightarrow cg}$ on the left side of the Eq. (9)? Is it from the methods given in Section 2.3.1 line 191-192? Please clarify.
10. Line 218, "a jackknife resampling is conducted: Alternatively, and as", some typo here? esp. about the weird punctuation marks?

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11. Line 248, the $\delta\alpha_{tr \rightarrow cg}$ is estimated per month. Do you also estimate RF per month?
12. Line 250-251, it reads very unclear even considering the preceding texts and the context. Please elaborate on this.
13. Section 2.5, no information about how you estimated albedo changes of land cover change from trees to crops/grasses in this subgrid experiment. But your results presented such subgrid estimates of albedo changes (figure 3&4, table 1).
14. Line 263, what do you mean by "pixel" here? A grid cell in the CLM simulation? If so, be consistent in the terminology.
15. Line 263 – 265, Do you differentiate snow-covered and snow-free fractions of a grid cell when you calculate albedo values for trees or crops/grasses in this area-weighted average? If so, can you provide some explanation here?
16. Section 3.2, Which estimate of albedo changes are you presenting here, the estimate by Section 2.3.1, line 191-192, or the estimate by Section 2.3.2?
17. Line 464, what information in "for which this information is available"? This last part reads redundant and only adds confusion to this sentence.
18. Fig. 1 caption, what's the absolute difference here? You mean albedo values?
19. Almost all the figures of maps, good to have the maps here for spatial comparison. But it is only qualitative. Can you present a scatter plot over common grid cells between subgrid estimates and reconstructed estimates?
20. Fig. 10 v.s. Fig. 11, why the different sets of models for albedo changes and RF?
21. Fig. 11, why not present a model mean as fig. 12?