Biogeosciences
Discussions

Interactive comment on "Inferring past land-use induced changes in surface albedo from satellite observations: a useful tool to evaluate model simulations" *by* J. P. Boisier et al.

Anonymous Referee #2

General Comments

The manuscript by Boisier and co-authors offers a unique approach to evaluating the effect of land-use induced land cover changes on surface albedo and climate. The authors used MODIS albedo with NSIDC snow data to develop spatially- and seasonally-varying albedo maps for pre-industrial and present-day time periods for each model in the LUCID intercomparison project. Comparisons between reconstructions and models indicate that while the mean responses match observations very well, there are large variations in individual reconstructions and model-data biases. Model differences in plant functional type alebedo parameterizations are suggested as the pri-

mary drivers. The overall methodology and results are insightful, well-executed, and interesting to the broader community of Earth System modelers and researchers of anthropogenic climate impacts. There are, however, a number of issues that need to be addressed before publication as a Biogeosciences final revised paper. In places the writing is dense and somewhat confusing to the reader, particularly in the methods section. Numerous aspects of the methodology need to be better explained, as they are either referenced out to other LUCID papers or not discussed at all. Although the methods are generally appropriate, there is a known bias in MODIS albedo at high zenith angles that needs to be addressed. It is also unclear why the authors chose to use only 'black sky' albedo from MODIS.

Specific Comments

1) In general, the readers would benefit from an elaboration on the LUCID experimental design. Particularly, the construction of vegetation maps and the fact that only land use changes (ie. non-natural vegetation) were implemented needs to be made clearer.

2) Related to above, the methods section is often terse and confusing. Please more carefully describe how the reconstruction of albedos was performed. Additionally, how was the observed $\Delta\alpha/\Delta$FH calculated? Was the FH term derived from an average of all the models' FH's, or was it directly from the LUCID vegetation maps? If so, what decisions on land use transitions were made?

3) MODIS albedo has a known bias in high latitudes in winter, when zenith angles are particularly large (see Wang & Zender 2010, 10.1029/2009JF001436). The authors need to address and devise a method to deal with this bias, as these values can cause misrepresentative seasonal albedo patterns.

4) A large underlying factor for the different model representations presented here is the way in which modeling groups implemented the different vegetation maps, and how this results in substantially different deforestation rates. The authors should give some text as to how the implementations and deforestation rates are so different, as it's not

intuitive to readers unless they've read the other LUCID papers. Are there opinions on which implementations are more realistic?

5) Related to above, another potential source of uncertainty involves the translation/aggregation from individual modeling groups' Plant Functional Types into the 5 land cover types used here. Please address.

6) Why did the authors choose to use black sky instead of white sky albedo? Albedo within the land surface models should be calculated as a weighted average of black and white sky.

7) It would be nice to have some sort of figure, map or otherwise, showing the distance of interpolation needed for grid-cells in the reconstructed albedo maps.

8) From Figure 8, it seems that some models have significant temperature responses, and that this would change snow distributions between the two time periods. I'd like to see some indication of how influenced the simulations (changing snow cover distributions).

9) More discussion on uncertainties would be helpful. Sources include the use of only 5 land cover classes, distances for grid-cell interpolation, choice of snow cover datasets, albedo products, the use of the same climatic and snow conditions for pre-industrial and present day, inconsistencies between PFT/LC aggregations, implementations of land cover changes, etc.

10) In the discussion, globally-averaged forcings are given. However, these albedo changes are highly regionalized, and will affect those regions strongest. This could be made clearer.

11) In the discussion, the authors could suggest a further study that quantifies the contribution of natural vegetation changes to climate

12) Can the authors offer any hypotheses on why different models parameterize albedo within their PFTs so differently, as this is identified as the major source of inter-model

discrepencies?

13) In Figure 8c, the intersection of the dashed and dotted line is quite interesting, as it shows the expected temperature response (as predicted by the models) per change in surface albedo (as predicted by MODIS) within the analyzed box. The authors should consider discussing this result.

14) It would be nice somewhere to be able to compare the forcings from LCC-induced albedo changes to the biogeochemical (released GHGs mainly). Is there a reference for this?

15) The authors mention Myhre et al. 2005 in several places, but do not distinguish their study from this or explain why it's novel or a useful extension.

Technical Corrections/Comments

[pg 12506, line 19] consider also stating that the models show differences among themselves, ie. there are not many overarching consistent biases

[pg 12508, lines 2-3] for which time period are the observations? Just saying "modern-day" would help clarify

[pg 12508, first paragraph] Are the natural vegetation maps the same between the two sets of simulations? From the LUCID experiments, I think so, but they're different between modeling groups. This needs to be made clear to the reader here in the methods.

[pg 12508, line 8] what are these dominating non-radiative effects? Elaborate a little please.

[pg 12508, line 18] This first sentence is confusing. What do you mean by "difficult to disclose one of the LUCID vegetation' reconstructions"? I'm guessing the authors mean that it is difficult to validate the vegetation reconstructions in general.

[pg 12508, line 27] I would imagine the height/LAI parameters of crops matters a lot for

albedo as well

[pg 12509, line 9] change to "LUCID models' albedo sensitivities", as I assume you mean multiple models as indicated by "their"

[pg 12509, line 20] State that the "vegetation" maps only change in crop/pasture distribution, ie. natural vegetation is the same. Also, how were these vegetation maps derived?

[pg 12510, line 1] again, distinguish between land use and natural vegetation. It's confusing as written.

[pg 12510, line 13] These first sentences are confusing. What does "global interplation" mean here?

[pg 12510, line 25] Please describe this technique more clearly. Do you mean that the albedos of grid-cells that had less than 95% of one dominant LCG were derived using interpolation of the pure grid-cells? What exactly is the "spatially nearest value method"?

[pg 12510, line 27] I would suggest not saying "degraded", as this has a strong negative connotation. Instead maybe say something like "spatially aggregated", or "upscaled".

[pg 12511, line 6] change to "We used snow cover data from NISDC instead of MODIS because..."

[pg 12511, line 20 - 22] Again, it would be good to give the reader some idea of what these different implementations are, and how they can arrive at such different deforestation estimates from the same LC maps. It's unintuitive if one hasn't read the other LUCID papers.

[pg 12514, lines 19 - 20] It's unclear what you mean here by "is calculated from the ensemble of grid-cells within the selected region"

[pg 12517, line 10] Do you mean "LUCID models' snow cover and albedo sensitivities

to LCC"? I assume you mean the various models (plural) used in the comparison

[pg 12519, last paragraph] Please elaborate more on what this means. I believe it relates to the fact that a high snow bias will, on top of the normalized albedo response, bias the models even higher because the starting point for snow is higher, ie. nonlinearity. Please explain this further if this paragraph is to be included; it's a confusing to the reader as is, and is a relatively minor point.

[pg12523, line 4] Radiative forcing is not the same as surface forcing. The two are comparable, but this needs to be made clear to the reader.

[Table 1] Spell out "SIC", "PD", and "PI" in last column. Include version numbers in the model footnote.

[Table 4] Include an explanation of what alpha-driven means here, so the table can stand by itself.

[Figure 4] Eliminate "[ ]" from y-axis. "Reconstructed" spelled incorrectly.

[Figure 6] There must have been variation in modeled albedo between years and ensembles. Can you make error bars for the solid lines as well?

[Figure 7] An intermediate panel showing albedo vs. SWE would help interpretation.

[Figure 8b] Was the averaging done across all snow levels?

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