Earth Syst. Dynam. Discuss.,
https://doi.org/10.5194/esd-2019-94-AC2, 2020


Earth System Dynamics
Discussions

ESDD

Interactive comment

# *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.

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Received and published: 16 July 2020

Thanks to the reviewer for the useful and overall positive comments.

As specified in the response to Ryan Bright's comment, we have decided to follow his suggestion to use the CERES-based albedo change albedo kernel (CACK) from Bright and O'Halloran (2019) for the Radiative Forcing calculations. As a result, the values of global RF associated with historical conversions between trees and crops/grasses are systematically less negative by ∼20-30% for each of the CMIP5 models considered in Section 5 (see the revised Figures 11 and 12 in attachment).

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Surface albedo is indeed influenced by both the vegetation canopy and the soil, and this is the case in both satellite-derived observational products and climate models. It is true that both the vegetation canopy and the soil can exhibit variations in solar reflectance even for a same land cover, e.g. due to variations in Leaf Area Index or in soil texture. If such variations occur within a 'big box' of 5X5 grid cells, this can indeed introduce noise to the reconstruction methodology, and thus explain a substantial part of the RMSE of the reconstruction methodology discussed in Section 3.

When preparing the revised manuscript, we have added brief discussions of the quality of the employed observational datasets. The GlobAlbedo and MODIS MCD43C3 albedo products are considered to be of very good quality overall and show good agreement (global R2 of 0.85). Some problems associated with snow detection were identified in GlobAlbedo but the resulting artifacts are most significant at very high latitudes (>70°), which are of lesser interest for our study (Muller et al, 2013). Imprecisions in land cover datasets such as GlobCover and ESA-CCI may especially arise via misclassification between land cover types within the broad trees or crops/grasses classes (e.g., between two types of trees) or the difficulty to properly identify medium-sized or mixed-type vegetation (i.e., shrub or savanna-like). In contrast, because these products are best at distinguishing very distinct land cover types such as trees and crops/grasses, the satellite-derived albedo values of these two broad classes (retrieved following the methodology presented in Section 2.1.1) as well as their differences (obtained from the D18 data) are characterised by relatively low uncertainties.

At the time the CLM4.5 simulation was conducted, CRUNCEP V4 was the recommended forcing data set (Chapter 26 in Oleson et al., 2013). Indeed, CLM offline simulations forced by GSWP3 represent surface albedo better than simulations forced by CRUNCEP (http://www.cesm.ucar.edu/models/cesm2/land/). However, the main purpose of this simulation is to demonstrate that the reconstruction method retrieves similar albedo alterations due to land-cover changes as the subgrid method. Therefore, the performance of this particular simulation is no major concern, as long as the simulated albedo is realistic to a sufficient extent.

Line 23: “Constraining” the global RF estimates by using the albedo changes due to conversions between trees and crops/grasses from satellite data instead of the individual CMIP5 models indeed leads to a somewhat unexpected increase in the model range. This result occurs because of two models which exhibit unrealistic historical conversion rates from trees to crops/grasses, which we therefore decided to discard for the final estimation of the RF from historical land-cover changes. This second step can also be considered as an observational constraint, and we can modify the corresponding sentence in the abstract accordingly.

Lines 26-28 and 300: We will take these remarks concerning the language into account when proofreading the manuscript again.

References: Muller, J.-P. et al. (2013) GlobAlbedo Final Product Validation Report. Oleson, K. W. et al. (2013) ‘NCAR/TN-503+STR NCAR Technical Note Technical Description of version 4.5 of the Community Land Model (CLM) Coordinating Lead Authors’. Available at: http://library.ucar.edu/research/publish-technote (Accessed: 31 December 2019).

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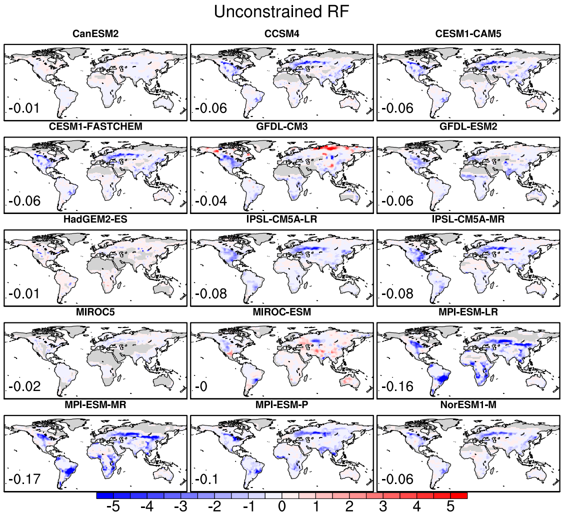


**Fig. 1.** Revised Figure 11.



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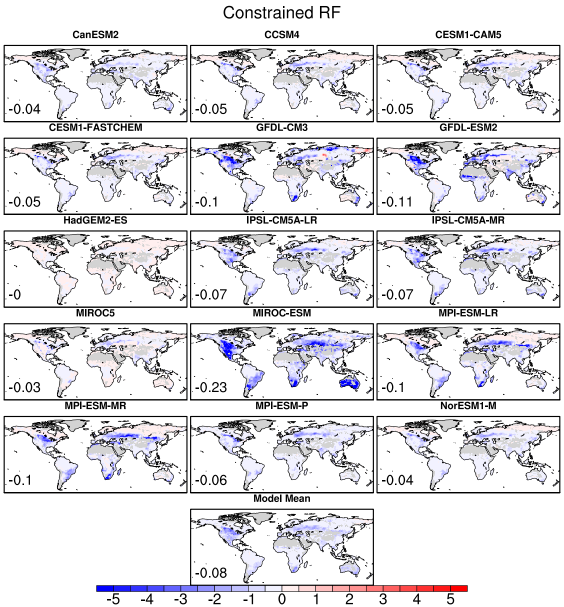


**Fig. 2.** Revised Figure 12.



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