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Interactive comment on "Effect of mosaic representation of vegetation in land surface schemes on simulated energy and carbon balances" *by* R. Li and V. K. Arora

Anonymous Referee #1

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The manuscript by Li and Arora investigates how the representation of vegetation in land surface schemes impacts the simulated energy and carbon balances. Specifically, they investigate the difference between a mosaic and a composite scheme. In a mosaic approach the spatial heterogeneity of the land surface is represented by dividing each model grid cell into different patches of plant functional types. Each patch is parameterized separately in terms of water and energy fluxes. In a composite approach the grid cell water and energy fluxes are calculated based on grid-cell averaged structural and physiological attributes of the single patches. As a consequence the terrestrial ecosystem dynamic of the single patches of plant functional types is either forced with parameters specific for the patch (mosaic approach) or with a grid box averaged value

(composite approach). This will lead to changes in the carbon balance.

While the impact of the vegetation representation on water and energy fluxes has been studied with a number of vegetation schemes in different models, the impact on the carbon cycle has not been investigated before. The topic of the manuscript fits nicely into the scope of the journal and in general the manuscript is written in a very concise and structured manner. However, I have some major concerns with the setup of the presented simulations and the conclusions taken from them.

The study was performed for four sites (1 in Canada, 1 in Siberia, 1 in East USA, and 1 in Africa). For each site the two dominant vegetation types were identified, which then were assumed to each cover 50% of the gridbox.

I do not understand why not the observed vegetation distribution was used in this study. The 50% assumption leads to rather extreme differences between the mosaic and composite approach. The authors state that using more then two different plant functional types would make the analysis more complex. However, in the end the results are compared to observed values for vegetation density and vegetation biomass. These can not be matched by the model when not the observed vegetation distribution is used. If it makes the analysis easier one could still restrict the analysis to two pfts per grid cell but use more realistic cover fractions than 50% and 50%.

Although the four sites cover temperate, boreal and tropical zones, they do not reflect the range of possible differences between a mosaic and composite approach. While these differences are influenced by differences in climate and dominant plant functional types, they also arise from the heterogeneity of the landscape considered. In transition zones, for example, one might for example find co-existence of several pfts possible leading to even larger differences between the two approaches.

The study was probably limited to four sites due to computational constraints. However, throughout the manuscript is should be clear that the changes simulated here do not reflect the range of possible changes one would expect when conducting this study on

a global scale, but are very specific to the sites chosen for this study. It is not clear what the maximum 47% difference in carbon fluxes and pool sizes mentioned in the abstract refer too.

In addition in the current setup the difference between composite approach and mosaic approach are twofold: (1) the composite approach leads to different grid-averaged fluxes and states and (2) in the composite approach each pft uses the the grid-averaged fluxes/states (which are not identical to the mosaic averaged ones) instead of the pft specific ones. This is not really mentioned in the manuscript. One could disentangle this further by forcing the terrestrial ecosystem model with grid averaged fluxes and states from the mosaic approach and compare this to a forcing with pft specific fluxes and states from the mosaic approach.

The manuscript states that the mosaic approach is more realistic, e.g. Page 5865:" The mosaic approach offers more realistic representation of vegetation than the composite approach, which each PFT experiencing environmental conditions which are influenced by its own structural vegetation attributes." This is probably arguable and will depend on the heterogeneity of the landscape. As stated in the introduction the mosaic approach is valid for landscapes which large patches while the composite approach is better suited for well mixed landscapes. This will also crucially depend on the resolution of your model. This should be further discussed in the manuscript also in the light of other studies. The small changes in the energy fluxes between composite and mosaic approach is this in line with the previous studies mentioned in the manuscript?

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