EGUsphere, referee comment RC2
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Comment on egusphere-2022-923
Anonymous Referee #2

Referee comment on "Mapping of ESA-CCI land cover data to plant functional types for use in the CLASSIC land model" by Libo Wang et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-923-RC2, 2023

We thank Referee #2 for their helpful comments. Our replies to his/her comments are shown in bold below.

Review of "Mapping of ESA-CCI land cover data to plant functional types for use in the CLASSIC land model"

This study focuses on sources of uncertainty in the creation/application of Plant Functional Types (PFTs) in Land Surface Models. The authors highlight the roles of expert judgement and differences in Land Cover (LC) datasets as sources of variation in the distribution and parameterization of PFTs. Focusing on CANADA, the study generates an improved PFT distribution map through the creation of a hybrid LC dataset (combining multiple LC layers) followed by the creation of a new crosswalk table that translates LC to a standard PFT scheme. The study evaluates the influence of this approach using the CLASSIC model to compare simulated winter albedo with new and old PFT representations. The new approach preforms better than model runs based on older PFTs, and the model is evaluated in an interesting sub-pixel PFT composition context.

The motivation for the study is compelling and the crosswalk approach appears to be a tangible improvement to PFT methods.

Thank you for your overall positive review of our manuscript.

A primary area of possible improvement for the manuscript is the acknowledgement of its own study limitations in general. A clear example can be found in Section 3.3 where Table 4 is presented. While the rest of the paper centers around the creation of improved PFTs in Canada, it is unclear to what degree this global version is appropriately validated for general use across other regions (e.g., those which were not compared with the LiDAR dataset). This section provides a qualitative and partially anecdotal assessment but evidence for these points is not presented in this manuscript. Likely this could

require a lot to truly validate, so I would suggest bringing in a more explicit acknowledgement of what the actual use-case and limits for this table are. I realize there is some discussion elsewhere in the manuscript regarding global products described in other papers. In general, the limitations of the approach could be explored more.

Thank you for noting this and for your understanding that it is challenging to truly validate global PFT results presented in Section 3.3 and Table 4, which is beyond the scope of the current study. Considering that our manuscript focuses on Canada (Methods and Results), we agree that it is a bit confusing to have Section 3.3 in the main text as pointed out by Referee #1. We will acknowledge the limitations of the global maps in the main text as suggested, and move Section 3.3 and Table 4 to the Supplement when revising our manuscript.

A final suggestion would be to be more explicit about each step in the creation of these layers and crosswalk tables. It is often unclear exactly what is done. I will note that the paper is presented in a high level of detail in many places.

Thank you for your suggestion. We will add more details and describe each step in the creation of the layers and tables more explicitly when revising our manuscript.

This paper focuses on an important topic for the improvement of Land Surface Models. The manuscript could be improved by acknowledging limitations and by increasing the clarify regarding the details of the methods.

Thank you for your overall positive review of our manuscript. We will acknowledge the limitations and add more details to the methods section when revising our manuscript.

Specific

L3 “found” how?

We will replace it with “Previous studies have shown large differences…”

L4 “differences arise from the differences” needs an edit

Thank you for noting this. We will modify it when revising our manuscript.

L11 What specific study? Maybe it should be “Previous work has shown.” Not sure.

Thank you for noting this. We will use “Previous work has shown.” When revising our manuscript.

L34 It could also be useful to mention (somewhere) what some of the other approaches are beyond PFTs.

Yes, this point is also raised by Referee #1. Beyond PFTs, species-based models represent vegetation at the level of individual plants and species . These models represent spatial variability in the light environment and simulate competitive exclusion, succession, and coexistence of tree species (Smith et al., 2001). This is computationally expensive, which is often being addressed by limiting the spatial scope and temporal frequency. As a compromise, “cohort-based” models have been developed where individual plants with similar properties

(size, age, functional type) are grouped together (Fisher et al., 2018). An alternative to the above is trait-based models which focus on the organism traits representing their physiological, morphological, or life-history characteristics (Zakharova et al., 2019). We will include these in the Introduction when revising our manuscript.

Fisher, R. A., Koven, C. D., Anderegg, W. R. L. et al.: Vegetation demographics in Earth System Models: A review of progress and priorities. Glob Change Biol., 24, 35–54, https://doi.org/10.1111/gcb.13910, 2018.

Smith, B., Prentice, I. C., & Sykes, M. T. : Representation of vegetation dynamics in the modelling of terrestrial ecosystems: Comparing two contrasting approaches within European climate space. Global Ecology & Biogeography, 10, 621–637, 2001.

Zakharova, L., Meyer, K. M., Seifan, M.: Trait-based modelling in ecology: A review of two decades of research, Ecological Modelling, 407, https://doi.org/10.1016/j.ecolmodel.2019.05.008, 2019.

L138 So does this mean that "herbs" in VLCE remain herbs if they are not "croplands" in NALCMS?

Yes, "herbs" in VLCE remain herbs if they are not "croplands" in NALCMS. We will clarify this when revising our manuscript.

L141 I appreciate the detailed description of each dataset.
Thank you for noting this.

L218 How was this disaggregation done?

This was done following the methodology by Melton and Arora (2016). Surface temperature, surface pressure, specific humidity, and wind speed are linearly interpolated. Long-wave radiation is uniformly distributed across a 6 h period, and shortwave radiation is diurnally distributed over a day based on a grid cell's latitude and day of year with the maximum value occurring at solar noon. Precipitation is treated following Arora (1997), where the total 6 h precipitation amount is used to determine the number of wet half hours in a 6 h period. The 6 h precipitation amount is then spread randomly, but conservatively, over the wet half-hourly periods. We will add these and the references when revising our manuscript.

Arora, V.: Land surface modelling in general circulation models: a hydrological perspective, PhD thesis, Department of Civil and Environmental Engineering, University of Melbourne, 1997.

Melton, J. R. and Arora, V. K.: Competition between plant functional types in the Canadian Terrestrial Ecosystem Model (CTEM) v. 2.0, Geoscientific Model Development, 9, 323–361, 2016.

L243 This is a particularly important part of the paper but does not feel fully fleshed out. Very little detail is provided for the creation of the tables, and Figure 2 is leaned on heavily. However, Figure 2 doesn't stand alone for several reasons. Acronyms could be spelled out (even simple ones) and some description of the processes being depicted might help.

Thank you for your suggestions. We will provide more details on the creation of the tables in the text and Figure 2, including spelling out the acronyms and description in the caption of figure 2.

Table 1 Define the numbers above the PFTs

We will add the full names of the PFTs to the caption of Table 1.

Table 1 Why are C3 and C4 grasses combined? You mention separating C3 and C4 using Still et al 2003 (L263) but you also mention combining them because C4 contribution is negligible in Canada (L788). C4 grasses are indeed more common in warmer conditions, but they also do comprise an important part of some grasslands in Canada. It could be useful to define what "negligible" means so that the magnitude of error from this is more explicit. As an example, the percentage of C4 grass species in the regional flora can reach ~24% (C4 Plant Biology 1999). Still et al 2003 is a coarse, global, and physiologically-based estimate.

Table 1 shows the cross-walking table for mapping the 30 m Hybrid land cover map to CLASSIC PFTs. The Hybrid map does not distinguish C3 from C4 vegetation. The splitting of C3 and C4 is based on the fractional distribution of C4 vegetation in Still and Berry (2003), which is at much lower resolution (1deg). Thus the splitting was done at a later stage when producing the PFTs.

Though the main objective of this study is to develop a new cross-walking table over the Canada domain, the ultimate goal is to extend the table to the global scale. It is desirable to split the C3/C4 vegetation based on a global dataset, i.e. Still and Berry (2003). We agree that the resolution of the dataset is rather coarse (1deg), however, we hadn't found a global dataset with finer resolution at the time when carrying out this study.

Based on the fractional distribution of C4 vegetation in Still and Berry (2003) and the Hybrid map, the average fraction is 0.5% for C4 crop and 0.1% for C4 grasses in the Canada domain. We will include this information when revising our manuscript.

L269 It is sometimes unclear exactly what was done, and the LiDAR data are a good example of that. In what way were these data used to inform this partitioning? How well do the LiDAR data align with the other datasets?

We overlay the Lidar plots on the Hybrid land cover map in ArcMap. Samples (20 to 40, note these classes do not cover large areas in Canada) for the four mixed classes (Sub-polar taiga needleleaf forest, Shrubland, Wetland, and Wetland-treed) in the Hybrid map are selected where there are Lidar plots data. The vegetation coverage data (for canopy height above 2 m) from Lidar plots for samples of each class are used to compute an average coverage of tall vegetation (> 2 m) for that class, which is then used to assign forest fractions for these classes in Table 1. We will add these details when revising our manuscript.

L311 "cslass"

Thank you for noting this, we will fix it.