

Geosci. Model Dev. Discuss., referee comment RC2
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Comment on gmd-2022-1

Anonymous Referee #2

Referee comment on "LPJ-GUESS/LSMv1.0: a next-generation land surface model with high ecological realism" by David Martín Belda et al., Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2022-1-RC2>, 2022

In this manuscript, Belda et al. present several new improvements of the dynamic global vegetation model LPJ-GUESS on sub-daily scale processes such as radiation, heat fluxes and soil physics. These improvements are critical for a fully online coupling of LPJ-GUESS with Earth system models to better depict the feedback between vegetation and climate. It is well-known that LPJ-GUESS has initially focused on describing detailed vegetation dynamics, and in recent years, has been developed more towards a fully fledged land surface model. There have been attempts to couple LPJ-GUESS with a global climate (EC-Earth) and a regional climate model (RCA) to investigate climate-vegetation feedbacks, but these attempts suffers from the fact that the processes of LPJ-GUESS occurring on daily scale, which can hardly fit into the hourly (or even shorter) time scale required by climate models, such as sensitive and latent heat fluxes. As a result, LPJ-GUESS has only been coupled with climate models in a "light" fashion in previous studies, e.g., sending yearly vegetation cover changes from LPJ-GUESS to climate models, but not heat fluxes from LPJ-GUESS to the climate models.

The development of LPJ-GUESS in this manuscript fills an important gap, and thus is of high scientific value. Overall, the manuscript is well-written. I would just like to point out several weak points in the analyses and discussion, and hope these points could be improved before being accepted and published in GMD.

Major comments.

- The benefits of implementing a new radiative transfer scheme and soil physics are not sufficiently analyzed or discussed. The implementation of sunlit and shaded leaves should have some impact on the radiative budgets and the simulation of PAR. It would be good to show a comparison of PAR between old and new versions of LPJ-GUESS to just showcase the differences. The implementation of more soil layers and sub-daily calculation of soil temperature and moisture may have an impact on soil C and N cycle and thus influence NEE or Rh, which might be better discussed in the light of Table 8.

- The choice of leaving Vcmax outside of the sub-daily loop, needs to be explained and discussed. Choosing to update Vcmax on daily scale (not subdaily or even longer time scale) should be justified. Also in Section 2.2.4, it is not clearly explained how the net photosynthetic rate (A_n) is derived in the model. Are stomatal conductance and A_n co-determining each other? How CO₂ impacts A_n ? How does nitrogen limitation affect A_n ? Does nitrogen limitation operate on a daily or sub-daily scale? These calculations might be similar to the old model version of LPJ-GUESS, but still it is useful to explain here. Since there is a mixed use of daily and sub-daily variables in Section 2.2.4, it would be clearer if all the variables in the equations are clearly denoted whether they are daily or hourly variables to avoid mis-understanding.

- The comparison between the new and old versions of LPJ-GUESS is not very clear to me, because the differences between the two experiments can be due to either the newly implemented codes in this manuscript (direct effect) or the differences in the PFT cover fractions of the two experiments as shown in Table 6 (an indirect effect of the newly implemented codes). It would be interesting to tease out the direct and indirect effects of the newly implemented codes on heat fluxes. I am wondering if it is possible to do a set of sensitivity experiments using the new version of LPJ-GUESS but with prescribed PFT cover fractions from the old version of LPJ-GUESS?

Other comments:

Line 56-57: Please shortly explain the deficiencies of the existing “coupled biosphere-atmosphere regional and global studies” using LPJ-GUESS. This will help the reader to better understand the importance of this work.

Line 230: Why set the same optical properties for all the PFTs? There should be data available to help parameterize these parameters for different PFTs.

Line 236-237: Have you considered the effect of soil moisture on soil optical properties?

Equation 47: " $V_{\text{sun, day}}$ " should be " $V_{\text{max, sun, day}}$ "?

Line 328: Does heat capacity also depend on organic matter content?

Line 359-360: Please explain in more details why such overestimation happens?

Line 375-377: What time step of LPJ-GUESS is used in the simulation? Half hour or 1 hour or 3 hour? Why do hourly averaging for the forcing data instead of using the original half-hourly forcing data which might be more physically consistent for different forcing variables.

Section 3.2: It is not clearly explained how soil properties were set for each site simulation.

Line 388-389: Please show the spin-up plot (e.g., in supplement). How does the new LSM version of LPJ-GUESS affect the C and N cycle in soil?

Figure 7-13: please add (a, b, c, d, e) for each subplot.

Line 422: "dry season": please specify which months.

Line 434-435: Where do "the systematic overestimation of sensible and latent heat fluxes" (i.e., excess energy) come from in the model?

Line 443: Please add (measured value) after 200 Wm^{-2} .

Section 3.4.4: I am wondering if this section should be moved to the front as section 3.4.1, so that the readers could have a rough picture about the vegetation cover in each simulation. Please also explain how much soil decomposition affects NEE in the LSM version of LPJ-GUESS. The whole section should be shortened.

Line 553 and 560: remove "somewhat".