Response to reviewer #2

General comments

In this manuscript, the authors presented a new integrated terrestrial model, PALADYN, which includes major physical and biogeochemical processes at an intermediate complexity. The model was developed on the basis of previous models such as LPJ and TRIFFID but includes several recent findings such as new stomatal conductance model. Although many terrestrial models for similar purposes have been developed, this model has several unique and intriguing features. In particular, inclusion of peatland and permafrost carbon dynamics will allow the model to simulate long-term (e.g., glacial time scale) simulations as proposed by the authors. This manuscript includes more than hundred equations, many tables, and schematic diagrams to fully describe the model.
To demonstrate the model performance, the authors compared major terrestrial variables with contemporary observational datasets. Overall, these results show good performance of the model, but the authors provided only very brief explanations. Although I agree that scientific insights are not necessarily included into the manuscript, I recommend clarifying the characteristics of the PALADYN model, especially in comparison with other models. Therefore, I conclude that the manuscript needs minor revision before acceptance for publication. Please look my specific comments for details.

The model evaluation section has been extended to include a more in depth and quantitative analysis of the model performance, including also discussions of the model performance relative to state-of-the-art land surface models, where appropriate. To back up the qualitative analyses of model performance we additionally computed some quantitative metrics like correlation and root mean square error for a number of modelled quantities. These values are directly included in the figures to allow the reader to get a quick quantitative measure of model performance.

Specific comments

Line 103: It seems that the model don't have a separate type for crops. Do you have an idea to include croplands to account for agriculture?

We are not planning to include crops in the model. A representation of agriculture is out of the scope of the model, which is mainly designed to represent natural processes.

Line 171: In Eq.(2), the symbol sigma seems to represent Stefan-Boltzman constant, but no definition was provided.

Sigma is the Stefan-Boltzmann constant and is defined in Table 1. For clarity now this is stated also after Eq. (2).

Line 286: Vegetation height hv is later estimated by Eq. (81). It is helpful for readers to explain this at this point.

We added a reference to Eq. (81) as suggested.

Line 397: In Eq. (42), what kind of phenomenon does the last turnover term represent? Stem flow?

The last term in Eq. (42) crudely parameterizes all canopy water removal terms excluding evaporation. It therefore includes e.g. stem flow, dripping from the leaves and water removal by wind.

Line 456: It seems that Figure 2 does not include the surface runoff Rw. Can you include Rw into Figure 2?

Rw has been included into Figure 2 and several other variables in Figure 2 have been renamed to match the variable names used in the equations.

Line 566: Is this the single-sided (or projected) specific leaf area?

Yes, SLA is the one-sided leaf area per leaf carbon mass. This is now explicitly stated in the text.

Line 606: The statement is at least partially incorrect. In East Siberia, a broad area of forest is dominated by larch, a deciduous needleleaf species.

The sentence was probably not clear enough and has been reformulated. Since the model has only a single PFT to represent deciduous and evergreen needleleaf trees, both deciduous and evergreen trees share the same PFT-specific parameters (including the specific leaf area, SLA). In the model, deciduous needleleaf trees would be competitive in East Siberia if their SLA would be higher (as would be appropriate according e.g. to the TRY database) than the value of 6 m2/kgC used in the model for needleleaf trees. By assuming that needleleaf trees are evergreen independently of the climatic conditions, we allow some needleleaf forest to grow e.g. in east Siberia, where it would not grow otherwise.

Line 745: How did you determine the stable and radiocarbon isotope ratios of the atmospheric CO2? As you know, it has been changed by the Suess effect.

So far, regarding carbon isotopes, in the paper we have shown only the isotopic discrimination during photosynthesis, which does not depend on the isotope ratios of atmospheric CO2. The issue of stable and radiocarbon isotope ratios of the atmospheric CO2 will be discussed in a future paper where carbon isotopes will be evaluated in more detail.

Line 772: "Manua" should be replaced by "Mauna".

Corrected.

Line 821: In terms of wetland extent, the model estimate seems to underestimate in Southeast Asia. I guess that the GIEMS data includes a substantial fraction of paddy fields. Is it correct?

Yes, the wetlands in Southeast Asia in GIEMS include a substantial fraction from rice cultivations. The paragraph comparing the modelled wetland extent with GIEMS has been expanded in the paper and this issue is now discussed. (see also response to reviewer#1)

Line 852: Can you say something about the simulated discrimination in relation to C3 and C4 plant distribution? Do you confirm that distribution and functional contribution of C3 and C4 plants were reasonably simulated?

In the revised version of the manuscript we added some discussion of the simulated discrimination shown in Fig. (21). As shown in Fig. (22) the model reproduces the difference in discrimination between C3 and C4 plants. This, together with the modelled C4/C3 grass distribution, explains the low discrimination values in subtropical areas, particularly in Africa, in agreement with other modelling studies (e.g. Scholze et al. (2003)).

References:

Scholze, M., Kaplan, J. O., Knorr, W., & Heimann, M. (2003). Climate and interannual variability of the atmosphere-biosphere 13 CO 2 flux. *Geophysical Research Letters*, *30*(2), 1097. http://doi.org/10.1029/2002GL015631