

Interactive comment on “Towards a more detailed representation of high-latitude vegetation in the global land surface model ORCHIDEE (ORC-HL-VEGv1.0)” by Arsène Druel et al.

Anonymous Referee #3

Received and published: 19 May 2017

Review of:

Towards a more detailed representation of high-latitude vegetation in the global land surface model ORCHIDEE (ORC-HL-VEGv1.0)

By Arsène Druel et al.

This manuscript describes a revision to the ORCHIDEE land surface model to improve the way in which tundra and subarctic vegetation are simulated by the model. The authors achieve this update by implementing three new plant functional types (PFTs) – these are a boreal shrub type, an arctic graminoid type, and a non-vascular plant type – into the model framework. Implementing new PFTs in ORCHIDEE has two steps,

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1) changing process representations where necessary, and 2) defining the set of parameters that characterizes each PFT. The new shrub and grass PFTs needed few changes to process representation to implement, while on the other hand, simulating the non-vascular plant PFT required a different way of dealing with plant water uptake, gross productivity, and mortality. Parameter sets for each of the new PFTs were estimated using a Bayesian estimation process. The authors use the result of the new PFTs, updated process representations, and parameter sets and run the new version of the (ORC16), and compare the result to field-based observations, to satellite remote sensing products, and to the previous version of the model (ORC13) to highlight the effects of the update.

In general, this manuscript is valuable and should be published. It describes a valuable update to ORCHIDEE, which will undoubtedly be used in a number of forthcoming and future studies. The changes to the model lead to improvements in the comparison with observations, and thus represent progress over ORC13. However, the manuscript presentation is not particularly good: the text requires a thorough copyediting to clarify grammar and usage style, some of the figures are too small, and there are a few small issues concerning the presentation of units and values which are elaborated below. Aside from these presentation issues, my major concern of this study was the choice of data used to inform the parameter optimization, and the appropriateness of comparing site-level measurements with model simulations performed on a 2-degree grid.

The largest concern I have with the current study is the authors' apparent inability to assemble a larger, more representative dataset of high-latitude plant characteristics with which to parameterize the model. Their Bayesian optimization relies exclusively on the Peregon et al., 2008 biomass and NPP dataset. These data were specifically collected on *wetland* vegetation, while ORCHIDEE, in this paper, is intended to simulate *upland* vegetation. This mismatch between what the data represent and what the model is trying to simulate is a very serious limitation and calls into question the appropriateness and quality of the model parameterization. Use of such a limited and specialized

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dataset to parameterize a global model might be acceptable in regions of the world for which there are very few ecological and ecophysiological data, e.g., in parts of the tropics, but for the Arctic, it is practically inexcusable because of enormous amount of field research that has been performed over the last 50 years. Data from iconic arctic research sites such as Toolik Lake in North America, Abisko in Europe, and Zackenberg in Greenland were ignored in development of the testing dataset. Large amounts of data on key characteristics such as aboveground biomass were collected in the entire circumarctic region as part of, e.g., the ITEX experiment. Data from all of these locations outside of west Siberia, while perhaps more difficult to assemble, could have provided valuable information on the status of upland tundra and subarctic vegetation that would have been more appropriate for performing the model parameterization. If the authors prefer to not improve their parameterization using more widespread and representative field data, at very least they should explain and justify their choice for using the wetland dataset of limited spatial extent more clearly in the manuscript.

Specific comments

Page 2, line 3

The last glacial inception began around 126.5-120 ka; correct this error

Page 2 line 28

The model described is called BIOME4; please correct the model name

Page 8 line 16

Anoxic conditions affect the activity of all types of soil microorganisms, not only bacteria, e.g., fungi, archaea, and multi-celled microorganisms. Please be more inclusive instead of using the word "bacteria"

Page 13 line 14-18

Why not make the root profile shape parameter a function of the mean active-layer thickness? The model simulates active layer thickness, and presumably most plants would optimize their rooting profile to be compatible with this value

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Page 13 lines 21-23

This sentence is confusing. Please revise for clarity by explaining how this version of ORCHIDEE uses prescribed vegetation cover and therefore survival and establishment limits are not relevant.

Page 13 line 31

Explain why using observational data collected in "boreal wetlands" is appropriate for a parameterizing a global model that simulates predominantly upland systems, indeed, there is no representation of wetlands at all in this version of ORCHIDEE (as far as I could understand).

Page 14 line 14-16

If the model was run on a 2-degree grid, why were the site-level data aggregated only to half-degree? Wouldn't it have made more sense to aggregate the data at the same spatial scale as the model simulations? Also, the choice of dataset (from wetlands) clearly limits the amount of data coming from non-vascular plants, shrubs, and grasses; wouldn't an effort to assemble a more spatially global and upland-representative dataset have helped here?

Page 16 line 4-5

The phrase starting "...in CAVM Mapping Team..." is awkward and hard to understand. Rephrase.

Page 16 line 20-21

As we know multi-annual and decadal climate cycles exist, e.g., ENSO, and that there was a clear trend on climate during the 1st half of the 20th Century, is it appropriate to select individual years randomly over this period for the model spinup? I realize that many other vegetation modeling protocols prescribe the same thing, but that doesn't mean that it is correct. Using a detrended climate timeseries would be a minimum first step towards improving the quality of the model spinup.

Page 17 line 24

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If the 2-degree resolution used to run the model presents problems in terms of comparison with observations, why wasn't the model run at finer resolution, or in an "individual point" model with local forcing. This version of ORCHIDEE does not simulate any 2D spatial processes that would be impossible to implement in a point mode.

Page 17 line 32-34

Making an effort to assemble a larger calibration-evaluation dataset would have helped here. If these data really do not exist, this has to be clearly explained in the manuscript.

Page 18 line 1-2

Again, having more, and more widespread observations might have helped here.

Page 18 line 24-26

I would be very helpful for the reader if the meteorological variables were provided in terms of more ecologically relevant units. For example, provide precipitation in terms of annual totals, and temperature in terms of summertime (JJA) or growing season means (instead of annual? – it's not clear what is provided here).

Page 19 line 16-17

Again, what are these temperature anomalies referring to – seasonal, annual, individual months? A +10 anomaly in winter temperature in an place where the mean winter temperature is -40 C may not really be ecological relevant.

Page 20 line 3-4

The phrase with "...too low LAI..." is awkward. Revise.

Page 21 line 1-2

Again, provide ecologically relevant units, e.g., total transpiration per month.

Page 21 line 11-14

Again, adjust units of evapotranspiration, runoff, etc. to monthly, seasonal, or annual sums. Annual is probably best here.

Page 22 line 35

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In the boreal regions and Arctic, the shrub vegetation is composed of both evergreen and deciduous (summergreen) broadleaved plants (angiosperms), and evergreen needleleaf plants (gymnosperms). Thus, there are at least three types of shrubs.

Figure 5

The maps should be reproduced in a larger size

Figure 6

The plots should be reproduced in larger size, or at least the points should be plotted a bit larger. It is hard to see some of the points, especially the cyan colored dots

Figure 11

The maps should be reproduced in a larger size

Figure 12

The maps should be reproduced in a larger size

Interactive comment on Geosci. Model Dev. Discuss., doi:10.5194/gmd-2017-65, 2017.

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