Geosci. Model Dev. Discuss.,
doi:10.5194/gmd-2017-65-RC1, 2017

Geoscientific Model Development Discussions
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EGU

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 #1

Received and published: 3 May 2017

This paper represents a great amount of work in model development, and in general it is well justified, well written, and the availability of such a model will contribute towards science both through using the improved model and informing other model developers. Therefore I recommend that it should be published in this journal, but with some clarifications and a bit of consolidation.

Firstly, the paper is rather long. I am not convinced that separating the analysis in figures 8-10 into different continents (Europe/Asia/America) is really relevant to the model developments here. Differences between the PFT's should still be visible in the aggregate results. Consolidating these would reduce the figures and you could remove some of the discussion of inter-continental differences from the text. These

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Discussion paper

are interesting but the paper would benefit from being a bit shorter.

Throughout the manuscript you have used the word "summergreen", which I have never heard before and we always use "deciduous". I'm not sure summergreen in really a word in English and maybe you should used deciduous instead? Sorry if I'm wrong here.

Specific comments * P1 Line 17 what you mean by "a larger phenological plasticity" isn't entirely clear to me. Maybe because I am not a specialist in vegetation but I think this will be read by other 'general' land surface modellers so could maybe be a bit clearer. Do you mean the phenology varies more in the season? Or more quickly over time?

* P1 Lines 23-26. Please check all of these numbers for the percentage changes. I can't find them all in the main text or they don't seem to be consistent - for example, the change in roughness is quoted as 25% in the main text (page 20, line 33), but 41% in the abstract.

* P5 line 6 "coefficients a1 and a2" - should be "b1" instead of "a2" as it seems to be called b1 in the table. Furthermore, you said you chose values so that stomatal conductance would not depend strongly on VPD but then the multiplier of VPD (b1) takes a larger value for NVP's than for the original grasses so this seems a bit counter-intuitive. Could you add a bit more explanation here?

* Section 2.2.3: For the NVP's, when you have negative NPP you induce a biomass loss function. But presumably the negative NPP itself should also lead to a biomass loss. I am interested to know how this works - are these are somehow linked or are they two separate loss terms?

* Section 2.2.3 and Figure 1. Why did you reduce the turnover again after a certain amount of time? (ie why does the line on figure 1 decrease again after it reaches its maximum?) It would be helpful to provide some evidence from the literature or some

more scientific justification here.

* P6 A few issues around equation 4 (which is labelled as 3 by the way!). Underneath the equation you wrote "b is the daily leaf biomass" but this is in units of gCmˆ(-2), which doesn't have any units of time, so it isn't 'daily'? Do you mean the value gets updated daily? I suggest removing the word 'daily' here. However, there should be some units of time in the turnover rate and I think these might actually be in lcoef, which you have given as no units, I think this should maybe have units of dayˆ(-1) or similar? Difficult for me to tell from the information here but please check it. Another point about this equation, why does it only apply when LAI>LAI_max instead of LAI>LAI_lim? Using LAI_max means it will jump from zero when you reach LAI_max, whereas if you start turning over when it reaches LAI_lim, it will increase smoothly from zero. Maybe this was a typo, but if not, can you explain why you do it? Thanks!

* P8 Equation (10). This is quite a complicated equation and it would be really useful to see what the moisture function actually looks like. I suggest you add a plot of this. I looked in the paper that you referred to but it was not easy to immediately see it, and the moisture function for respiration is important so would be great to include the plot here.

* P9 line 4/5 says that albedo and roughness were set the same as C3 grasses. I guess for NVP's the roughness could be quite different from grass? Could you add a comment on possible differences? Either here or in the discussion.

* P10 Equation 11a) The text says it's a logarithmic function, but this does not seem to be the case? Equation 11b) Bottom line of fraction should have Dˆ(gamma) not Dˆ2 Given these equations, I am not sure it makes sense to fix the crown area but still vary the biomass and height. This means that the allometric relations don't hold (for the case without dynamic vegetation), because the allometric relations are basically the relationship between height and area (or diameter- but these are related), yet you are varying the height and not the area. Could you comment on this? Are you assuming

that the number of individuals changes in order to keep the crown area fixed? If so, please make that clearer in the text.

* P10 Section 2.3.2 In the introduction you said that shrubs accumulate more snow in winter than trees (p3 line 13), but in this section you seem to treat them both together. What is the reason for this?

* P10 equation (13) I can guess what you are doing here - assuming that with very few shrubs they'll be spread out so they won't accumulate much snow, and with a lot of shrubs of course the snow will be the same as the grid box mean because they are covering the whole grid box. But what is the justification for peaking in the middle? Maybe with just a few shrubs they would still accumulate snow? Did you get this function from somewhere or did you come up with it yourself? Could you either (in the first case) add a reference or (in the second case) give a bit more explanation of the physical reasoning?

* P11 Equation (15) I am not sure I agree about the form of this. Because you are integrating, the mortality rate (as a fraction of biomass) depends on the height of the shrub. Imagine your temperature is just constant with z, then the mortality rate will be proportional to (H-Hmin) and thus higher for a taller shrub - despite both being at the same temperature. Is this something you wanted to include in the model? If so, you should discuss it. If not, I would suggest you instead divide the RHS of the equation (15) for Mce by (H-Hmin).

* P12 first paragraph: I don't quite understand what f_v_max is. Do you prescribe a certain fraction of the grid cell to be occupied by a PFT but then it doesn't necessarily occupy that whole fraction? Please explain this term a bit more.

* P12 equation (17) - you do the weighted average in terms of 'log's, I assume this is standard procedure from somewhere but I haven't see it before. Please add a reference.

* P13 L21-24 not sure what you mean by these things: - "survival or estabilishment limits" - limits in terms of what? Temperature? - "a cumulated degree-day threshold for the development" - maybe here you mean "..for the development of leaves"?

* P14 line 1, talks about methods for wetlands, but surely not all of your sites are wetlands?

* P14 line 32/33, it seems odd that the Arctic grasses are assigned to cold climates but then they all end up in the South! Have you checked this?

* P15 line 7/8 What was the justification for these new distributions, especially with the grass fraction. Why did you include grass but not include any shrubs? Also a bit concerning that your percentages don't add up to 100%. What is the rest?

* P16 : last sentence in section 2.6.1 talks about simulations and spin-up with no context (eg forcing data, soil characteristics?). I assume that the same simulation protocol as described in 2.6.2 is used for these simulations, and you extract the closest grid cells? But then the start of the simulation that it refers to at the end of Section 2.6.1 is not the same as described in Section 2.6.2. You need to more clearly explain what simulations are done/used for the parameter optimization.

* Section 3.1 - the first 3 lines here are more like methods than results. Can you make this an extra (final) section in the methods perhaps?

* P17 line 23 How do you know the water stress in the model is too large? Could you show some evidence for this, or that it was seen in previous studies with ORCHIDEE?

* P20 line 3/4 "too low LAI seems to be simulated in western Siberia" This looks more like the middle of Siberia to me?

* P22 line 14 "plant resistance to water stress" - I thought you added something that made the NVP's recover more slowly from drought, and lose biomass, rather than resist the drought. Sorry if I missed the point here - do the other types of plants instead die in those circumstances? If so, could you clarify this?

* P22 line 32 "especially for NVP's" - Not sure about this. Aren't NVP's less nitrogen limited than other plants?

* P22 at the bottom of the page, you are talking about splitting shrubs into different types. It would be helpful to add in a comment about why it would be useful to do this? (What impact it might have?)

* P23 line 14/15, you are talking about how the seasonal cycle of NVP productivity differs from the vascular plants in the model, but there is no comment about whether these differences are realistic. You also mentioned earlier in the paper about 'representing the observed temporal dynamics of lichen and bryophyte biomass', but no reference to actual observations. It would be helpful to refer to some studies to discuss whether the behaviour of the model is realistic.

* P23 line 37/38, "the new PFTs are more sensitive to climate change than the original ones" - the plots do not seem to fully support this. The fractional changes are maybe larger with the new PFT's, but the 'old' PFT that you show on the plot (boreal broadleaved trees) seems to have the largest absolute change and so potentially the biggest impact on the carbon cycle. I recommend modifying this discussion to account for this.

* P25, Acknowledgements - I suggest you add more details of the projects, not just the acronyms i.e. full names and project numbers.

* P38 Table 5. I think it is interesting that one of the calibrated parameters (b) was calibrated to zero. This appears to remove the acclimation behaviour from the photosynthesis model. Could you add a comment about this in the text? Do you think it's because the air temperature never gets very warm so acclimation isn't necessary?

Technical comments (In general the writing is good but I picked up some grammar/typos on the way through so will list these here.)

* P1 Line 24, "transpiration (+33%)" -> "transpiration (-33%)"

* P2 Line 23/24, "is relatively simple and discretized on few" -> "has been relatively

simple, with few"

* P2 Line 26 "either trees or grasses PFTs." -> "either trees or grasses."

* P2 line 27 "in the reality" -> "in reality"

* P2 line 36 "interactions part" -> "interactions as part"

* P3 line 4, I'm not sure about how you have referenced the CAVM, you have written "Mapping Team et al.", I wonder if it should just be "Mapping team" (and then the names listed are the members of the mapping team, not additional people?)

* P3 line 7 "does not allow to" -> "does not allow it to"

* P3 line 9 "mosses and lichens and shrubs" -> "mosses, lichens and shrubs"

* P3 line 12 "more resistant for hydric" -> "more resistant to hydric" And "or for nitrogen limitation" -> "or to nitrogen limitation"

* P3 line 15 "to warming whereas trees" -> "to warming, whereas trees"

* P4 line 16 "C3 grasses plants" -> "C3 grasses"

* P6 line 1 "cold temperatures" -> "cold temperature"

* P6 line 33 "(use in ORCHIDEE)" -> "(used in ORCHIDEE)"

* P7 line 13 "when NVP get desiccated." -> "when NVPs get desiccated."

* P7 line 30 "NVPs layer" -> "NVP layer"

* P8 line 24 "to define the control litter" -> "to control litter"

* P9 line 12 "processes as trees." -> "processes to trees."

* P9 line 22 "additional shrubs types" -> "additional shrub types"

* P11 line 2 "dynamically the vegetation distribution" -> "the vegetation distribution dynamically"

* P11 equation 16 Change ’else’ to ’otherwise’
* P12 line 6 "there is no woody" -> "there are no woody"
* P12 line 27 "equation described previously" -> "equations described previously"
* P12 line 27 "as well as few" -> "as well as a few"
* P12 line 29 "Cold climates" -> "Cold climate"
* P12 line 34 "themselves function of" -> "themselves functions of"
* P13 line 12 "list of variable" -> "list of variables"
* P13 line 31 "observations located in" -> "observations are located in"
* P16 line 9 "number of iteration" -> "number of iterations"
* P18 line 12 "referred as" -> "referred to as"
* P20 line 25 "occur in early spring" -> "occurs in early spring"
* P20 line 27 "impact the albedo" -> "impacts the albedo"
* P20 line 34 "Contrariwise" -> "Conversely"
* P21 line 14 "5mmd-1" should be "0.5mmd-1" ?
* P21 line 20 "permanent frozen soil" -> "permanently frozen soil"
* P22 line 27 "implies to introduce" -> "implies introducing"
* P22 line 30 "availably" -> "availability"
* P23 line 19 "on the same time" -> "at the same time"
* P24 line 7 "in liason with" -> "in conjunction with"
* P24 line 13 "ecosystem occur" -> "ecosystems occur"
* P24 line 23 "permafrost extension" -> "permafrost extent"

* P24 line 33 "soil water dynamic" -> "soil water dynamics"

* P25 line 5 "and reach around" -> "and reaches around"

* P25 line 11 "reduce locally" -> "locally reduce"

* P25 line 12 "snow dynamic" -> "snow dynamics"

* Table 2 (df) "Maximum number of day for this extra turnover" -> "Maximum number of days ..."

* Table 3 caption "values are choose" -> "values are chosen"

Hope you find this helpful! Best wishes.

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