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Discussions

Interactive comment on "Improving vegetation phenological parameterization of a land surface model" *by* B. Chen and M. Che

B. Chen and M. Che

Baozhang.Chen@igsnrr.ac.cn

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Response to Anonymous Referee 1 Comment: Chen and Che compared two types of modeling approaches of vegetation leaf phenology: based on Growing Season Index (GSI) or Growing Degree Day (GDD) in the framework of the Dynamic Land Model (DLM). Using GPP data from FLUXNET sites and near-surface remote sensing data from the PhenoCam network as the benchmark, the authors found that DLM-GSI has generally better performance than DLM-GDD and therefore concluded that using GSI phenology model improved DLM. The study itself doesn't have evident flaws, however there is a large room to improve the presentation quality. Major points: This manuscript may give the readers an impression that GSI model is better than GDD model. But obviously this is not the truth. The authors optimized the GSI model but remain GDD model as default in CLM. I would expect the performance of the GDD model will be

similar as the GSI model after optimization. I suggest the authors should add a paragraph of discussion on this point, with explicit statement that the study doesn't suggest GSI model is better than GDD model. Otherwise it is too ambitious since GDD is a big family of models. Response: Thanks for this comments. It is true that the study doesn't suggest GSI model is better than GDD model. The purpose of comparison of the model efficiency of DLM-GSI with DLM-GDD using the in situ data in this study is to assess that how model accuracy will increase if more representation complexity is involved, instead of just simply comparing the performance of GSI with GDD. This suggestions will followed that a paragraph of discussion on this point will added onto the manuscript when we do the revision. The paragraph is as follows. Most widely used land surface models (LSMs) simulate phenophases using prescribed dates empirically derived functions based on cumulative chilling and forcing units (Yang et al., 2012). Recent studies, however, have demonstrated that current representations of phenology in LSMs are not realistic (Melaas et al., 2016). Compared to the observed values, the Abiases of simulated phenophases using the two versions of DLM were not small, although the Abiases of using DLM-GSI were comparatively less, indicating that the two phenology models still must be further developed in future. In addition, the DLM must also be improved, particularly by obtaining more accurate simulated variables as inputs for the phenology model. Richardson et al. (2012) also found a large bias of the predicted onset of spring phenology using LSMs by comparing with in situ data from eddy covariance sites located in North American deciduous forests (early by more than 2 weeks and, in some cases, by as much as 10 weeks). While the sources of the bias was different for each model, overly simplified model representations and overfitting of model coefficients (or both) are widely known sources of error in phenological models (Linkosalo et al., 2008; Melaas et al., 2013). In addition, model-based phenology representations fail to capture local- to regional-scale variability arising from differences in species composition because there are large interspecific differences in leaf-out timing, even when individuals are exposed to the same conditions (Lechowicz, 1984; Murray et al., 1989; Polgar and Primack, 2011; Melaas et al., 2015). Models range in scope from specific to quite broad. The GDD model simply assumes that the ecosystem phenology is barely controlled by environmental conditions (temperature, moisture and etc.) and more suitable for larger scales, while the GSI tries to additionally consider the factors of ecosystem processes besides the environmental conditions and consequently it is more suitable for smaller scales and needs more information as input. Depending on the complexity of the model, different factors are included or omitted. The purpose of comparison of the model efficiency of DLM-GSI with DLM-GDD using the in situ data in this study is to assess that how model accuracy will increase if more representation complexity is involved, instead of just simply comparing the performance of GSI with GDD. To assess their applicability with certain accuracy, the parameters of the GSI scheme were further optimized using GPP data but those for GDD scheme were simply adopted from the CLM model. As more data on phenological response to climate change emerge, and a better understanding of physiological mechanisms controlling leaf-out develops, more accurate representations of ecosystem dynamics will be possible (Clark et al., 2001; Lebourgeois et al., 2010). Refs related: Yang X, Mustard JF, Tang JW, Xu H (2012) Regional-scale phenology modeling based on meteorological records and remote sensing observations. Journal of Geophysical Research-Biogeosciences, 117.G3, 1–18. Richardson AD, Anderson RS, Arain MA et al. (2012) Terrestrial biosphere models need better representation of vegetation phenology: results from the North American Carbon Program Site Synthesis. Global Change Biology, 18, 566–584. Linkosalo T, Lappalainen HK, Hari P (2008) A comparison of phenological models of leaf bud burst and flowering of boreal trees using independent observations. Tree Physiology, 28, 1873–1882. Melaas EK, Friedl MA, Zhu Z (2013) Detecting interannual variation in deciduous broadleaf forest phenology using Landsat TM/ETM plus data. Remote Sensing of Environment, 132, 176–185. Melaas EK, Friedl MA, Richardson AD (2016) Multiscale modeling of spring phenology across Deciduous Forests in the Eastern United States, Global Change Biology, 22, 792–805.

Lechowicz MJ (1984) Why do temperate deciduous trees leaf out at different times –

adaptations and ecology of forest communities. American Naturalist, 124, 821–842. Murray MB, Cannell MGR, Smith RI (1989) Date of budburst of 15 tree species in Britain following climatic warming. Journal of Applied Ecology, 26,693–700. Polgar and Primack (2011) Leaf-out phenology of temperate woody plants: from trees to ecosystems, New Phytologist, 191, 926–941. Lebourgeois F, Pierrat JC, Perez V, Piedallu C, Cecchini S, Ulrich E (2010) Simulating phenological shifts in French temperate forests under two climatic change scenarios and four driving global circulation models. International Journal of Biometeorology 54, 563–581. Clark JS, Carpenter SR, Barber M, Collins S, Dobson A, Foley JA, Lodge DM, Pascual M, Pielke R, Pizer W et al. (2001) Ecological forecasts: an emerging imperative. Science 293, 657–660.

Comments: The source of FLUXNET data is missing in this paper. The authors must clarify it. However, FLUXNET has already released the 2015 version data (freely available at http://fluxnet.fluxdata.org/data/fluxnet2015-dataset/), which includes a lot more site years, especially recent-year data. If the authors can use the 2015 data and obviously there would be more GCC data from PhenoCam sites can be involved. It seems to me a weak point that only one PhenoCam site was used in this study. Response: The source of FLUXNET data was given as (http://fluxnet.ornl.gov/) (see Line 271 Page 14 please). When we prepare this paper the fluxnet data for 2015 were not available. We will further use these valuable data in our future work.

Comments: There are many grammar mistakes through the manuscript. I strongly suggest the authors seek help to polish the written English in this paper. Specific points: L17-19: but the authors state that GSI model hasn't been used in LSMs in the main text L52: simulating –> simulate L53: delete "change" L59-60: the statement is not right. LAI in CLM can be either prescribed or prognostic. L62: Can you give examples of implicit and explicit+implicit phenology models? L66: starts- >originates; add reference to "Reaumur's approach" L79: insert "as" before "important factors" L96-99: please rephrase this sentence. It is not clear whether combining EASS and CLM4 happened firstly or coupling phenology model to DLM happened earlier? L107: common used

–> widely-used L112: the authors should provide clear reasons why they considered GPP into the analysis in this paper L118: absorbed –> borrowed L167: Does CTEM use GSI? If yes, why the authors argue that no LSM uses GSI? L168: Maybe I am wrong, but how net photosynthesis can be positive before leafout? L272: requirements –> criteria L275: describe what are Level 3 and Level 4 data? L298: measured –> derived L327: position –> location L328: I understand there is no overlap between PhenoCam data and fluxnet data at most sites, but please explicitly clarify this point to the readers L334-346 should move this paragraph into discussions L354: change the sentence to: the effects of phenology on GPP can be evaluated by using the two model versions. Response: Many thanks. All these suggestions will be followed when we do the revision.

Comments: Discussions: Perhaps the authors can make some comments on possible reasons of that DLM-GSI is better than DLM-GDD in their study. Although it is not a must, I believe it will make the paper more interesting. Response: Yes, this suggestion will be followed. Thanks. See our response to your "Major points".

Please also note the supplement to this comment:
http://www.biogeosciences-discuss.net/bg-2016-165/bg-2016-165-AC1-supplement.pdf

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