Geoscientific
Model Development
Discussions

Interactive comment on "Variability of phenology and fluxes of water and carbon with observed and simulated soil moisture in the Ent Terrestrial Biosphere Model (Ent TBM version 1.0.1.0.0)" *by* Y. Kim et al.

Y. Kim et al.

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Anonymous Referee #1

General comments

This paper describes the leaf phenology scheme of the Ent model and aims to identify sources of error in the model structure and parameterization through a number of experiments. This is an interesting and timely question as phenology is a key component of land surface models which is as yet not well represented in any of the existing mod-

els. Furthermore, identifying sources of error in complex vegetation models is often difficult so the experimental approach taken by the authors is a very useful tool and should be employed in more modeling studies. The discussion of errors created by both phenology and biomass allocation is valuable as timing of growth and pattern of growth are often discussed separately despite the obvious close link between them.

The phenology scheme used by Kim et al aims to capture cold deciduous phenology, seasonally dry phenology and cold evergreen photosynthesis seasonality. The three components are a combination of parametrisations from other studies and it is not clear to me why the authors did not choose to use either a new parametrisation or a whole scheme from another study such as Jolly et al. (2005) or Caldararu et al. (2014). Having said that, the entire Ent model appears to be made out of components of other models and studies so maybe this is a larger question, not specific to this paper.

The idea behind the phenology scheme appears to be that we do not have a mechanistic understanding of phenology and cannot therefore build a process-based model (p.5819, line 25). This is not strictly true as a large number of plant sciences studies as well as some biogeosciences ones more recently, have tried to understand the physiological drivers behind leaf seasonality. In addition, recent modelling studies are trying to move towards models that incorporate our understanding of plant and ecosystem processes (Prentice et al., 2015; Norby et al., 2015).

The paper is generally well written, with the exception of the introduction, which is lengthy and a bit sloppy. Some of the introduction material can be found in the methods, while some of the methods material can, mysteriously, be found in the results section.

Overall, the Ent phenology model is correct and the results revealed by the experiments undertaken in this paper are interesting and should be applied more widely in the modelling community but the introduction needs re-writing and some of the model assumptions need clarification and justification.

Specific comments

» We would like to express our appreciation to the reviewer for a very close, thoughtful, and helpful review.

» In response to the reviewer's comment that the introduction/methods/results are not clearly separated, we have rearranged to fix this.

p 5810 line 23 The first sentence seems incomplete. Saying "these models" implies to me that there is maybe a sentence missing.

» Please be advised that a mistake in the copyediting process led the incomplete sentence in the beginning of the manuscript. We have corrected it.

In the 1st paragraph of 1. Introduction of the revised manuscript:

"Phenological timing remains a major weakness of land surface dynamic global vegetation models (DGVMs) that are coupled to general circulation models (GCMs), and a primary cause of uncertainty in predicting the trajectory of global atmospheric CO2 (Friedlingstein et al. 2006, Friedlingstein et al. 2014)."

p 5811 line 17 I would suggest deleting or shortening this paragraph, there are a lot of examples here in addition to the ones in the previous paragraph.

» As per reviewer's suggestion, we have shortened the paragraph with deleting abundant literature reviews.

In the 2nd paragraph of 1. Introduction of the revised manuscript:

"Given the strong interactions between phenology and other land surface and ecosystem processes, phenology affects both weather and climate. Seasonal variation in vegetation characteristics have been shown to significantly influence summer precipitation and temperature in the U.S. (Dirmeyer 1994, Xue et al. 1996), and enhance or weaken the feedbacks between soil moisture and precipitation in the continental interior of North America depending on soil moisture conditions and season (Kim and Wang 2007). Levis and Bonan (2004) demonstrated that the coupling between phenol-

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ogy and the atmosphere is critical for models to capture seasonal weather evolution. Tightly linked to phenology, plant carbon allocation, that is, distribution of assimilated carbon among the plant parts, also responds to environmental and climate conditions (such as increases in air temperature, changes in precipitation patterns and elevated atmospheric CO2 concentration). For example, Pumpanen et al. (2012) observed that root biomass and the rate of photosynthesis for silver birch, Norway spruce and Scots pine seedlings increase with higher soil temperature, yet a simultaneous increase in both photosynthesis and respiration rates results in no change in net CO2 exchange and total seedling biomass."

p 5812 line 13 This sentence suggests that the main purpose of coupling DGVMs with GCMs is to represent phenology.

» We have re-written the sentence to clarify the meaning.

In the 3rd paragraph of 1. Introduction of the revised manuscript:

"Terrestrial biosphere models (TBMs) or Dynamic Global Vegetation Models (DGVMs) have been developed and coupled to General Circulation Models (GCMs) (e.g., Foley et al. 1996, Cox 2001, Sitch et al. 2003, Bonan and Levis 2006, Dunne et al. 2013), to account for biophysical and biogeochemical processes and sometimes biogeography, allowing prediction of transient terrestrial ecosystem interactions with climate (Cramer et al. 2001, Friedlingstein et al. 2006). Thus the active role of vegetation phenology can be incorporated into climate modeling."

p 5813 line 12 Again, you might want to shorten this paragraph, the introduction is meant to set the stage for the model, not provide a full review of the Richardson papers.

» We have shortened the review on the Richardson paper and moved it to the phenology subsection.

In the 2nd paragraph of 2.4. Phenology of the revised manuscript:

"Furhtermore, Richardson et al. (2012) conducted an inter-comparison of phenology

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predictions of eleven TBMs (and three biophysics models with prescribed phenology) at five deciduous broadleaf and five evergreen needleleaf Fluxnet sites. They found that, for deciduous forests, most consistently predicted an earlier onset of the growing season and later fall senescence than observed; meanwhile, most models underpredicted the magnitude of peak GDD sums, while those that explicitly or implicitly included a chilling requirement did relatively well in capturing the onset of LAI and GPP for deciduous and evergreen forests, compared to simple temperature threshold schemes."

p 5814 line 2 You might want to move the version enumeration to either the methods or the footnote with the wonderful Tolkien comment, which made me laugh.

» As per reviewer's suggestion, we have moved the version enumeration to the footnote.

In the footnote of 1. Introduction of the revised manuscript:

"2 Enumeration is in order for different levels of dynamics and different physics versions available for each of these. In order, the digits denote: 1) Primary biophysics (leaf, soil biogeochemistry) and base release version (1: leaf biophysics as described in Schmidt et al. 2014; soil biogeochemistry described in this paper). 2) Canopy radiative transfer (0: two-stream as described in Schmidt et al. 2014; 1: ACTS model (Ni-Meister et al. 2010; Yang et al., 2010); 3) Leaf phenology (0: prescribed from satellite data; 1: prognostic, this paper); 4) Carbon allocation/growth (0: allocation with prognostic phenology, without structural growth, this paper; 1: allocation with structural growth). 5) Ecosystem dynamics (0: none; 1: Ecosystem Demography scheme)."

p 5819 line 24 - p 5821 line 18 All this material belongs in the introduction and might need shortening.

» As per reviewer's suggestion, we have re-written the paragraphs and also rearranged with moving two of these paragraphs into the part of introduction section.

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In the 4th and 5th paragraph of 1. Introduction of the revised manuscript:

"Prognostic phenology models have been developed to predict phenological response of vegetation to climate based on empirical evidence, as a mechanistic, process-based treatment is still not fully realizable with current understanding (Sala et al. 2012). The commonly used climatic rule-based approach accounts for temperature, soil moisture, and day length cues to phenology, to predict leaf-on and leaf-off, with these controls often represented as a cumulative functions of one or several climate variables that reach an empirically defined threshold (White et al. 1997). Another approach is based on plant carbon status (Bonan et al. 2003), and predicts leaf-out and senescence on the basis of potential positive carbon assimilation, which is in turn is affected by temperature, moisture, and sometimes nutrient conditions.

All of the above approaches require empirical parameterization of the responses to climate, and a model scheme that is independent of PFT or geographical variation is still a research goal. Jolly et al. (2005) have proposed a very simple and promising bioclimatic Growing Season Index (GSI) for phenology based on linear relations to minimum temperature, photoperiod, and vapor pressure deficit (VPD, as a proxy for soil moisture), which seems to perform well compared to satellite observations at diverse sites. However, it performs less well for arid systems for which VPD may not be a good indicator of available deep soil moisture, and it is not able to capture any seasonal moisture or light sensitivity that has been observed in tropical evergreen forests (Stockli et al. 2011). Forkel et al. (2014) adopted the concept of GSI but used the soil water availability instead of VPD for water limiting function. Phenology depends not only on atmospheric water demand but also on water supply from soil moisture as Migliavacca et al. (2011) have shown that GSI performed better when using a soil moisture limiting function instead of the VPD limiting function. Recently, Caldarau et al. (2014) introduced a promising optimality approach based on the hypothesis that phenology is a strategy for optimal leaf area index, rather than explicit carbon exchange, driven by canopy-level demand for – and constrained by availability of – light and water, limited

by leaf aging. They fitted the model to satellite observations of LAI and demonstrated its capability to reproduce phenological patterns for different vegetation types over the globe within 8-16 days of observations."

In the 1st and 2nd paragraph of 2.4. Phenology of the revised manuscript:

"The phenology scheme in the Ent TBM provides a synthesis, and combines the climatic rule-based approach and carbon balance for deciduous plants to determine the timings and rates of leaf out and leaf senescence by integrating several different modeling studies. We present a diversity of PFTs, adding those with known behaviors that depart from common representations of cold, drought, or light responses. While globally applicable parameterizations of climate rule-based phenology may still be elusive, where available in the literature, we draw from wide surveys that attempt to extrapolate to the global scale.

For deciduous plants, we use parameterizations by Botta et al. (2000). With growing degree day (GDD) and chilling requirement, they examined the possibility of extrapolating existing local models for leaf onset date to the global scale by retrieving leaf onset dates from the NOAA/AVHRR satellite normalized difference vegetation index (NDVI). They identified appropriate leaf onset date models and estimated their parameters for each biome, which are implemented in other ecosystem models (Medvigy et al. 2008). The importance of a chilling requirement is confirmed by Richardson et al. (2012), who conducted an inter-comparison of phenology predictions of eleven TBMs (and three biophysics models with prescribed phenology) at five deciduous broadleaf and five evergreen needleleaf Fluxnet sites. They found that, for deciduous forests, the models consistently predicted an earlier onset of the growing season and later fall senescence than observed; meanwhile, most models under-predicted the magnitude of peak GDD sums, while those that explicitly or implicitly included a chilling requirement did relatively well in capturing the onset of LAI and GPP for deciduous and evergreen forests, compared to simple temperature threshold schemes. For drought deciduous trees and grasses, we also make use of parameterizations of White et al. (1997) who developed

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a regional phenology model for the US, predicting timings of leaf onset and offset based on the satellite NDVI at the 20 km resolution. Their prediction errors are $\sim$1 week, and maximum expected errors are 10-14 days."

p 5819 line 24 As I said above, this statement is not strictly true and since it forms the basis of the chosen phenology scheme you should at least justify it a bit more.

» As per reviewer's suggestion, we have re-written the sentence to clarify it as specific to our climate rule-based approach. If we may, we would like to interpret the approach of Caldararu et al. (2014) as an optimality, top-down constraint-based approach, rather than mechanistic process-based. Rather than simulating leaf level physiology or biochemical processes, they are integrating whole canopy demand for light and water scaled by leaf area index, and this is actually independent of explicit carbon exchange (so it is not actually a carbon optimality model, but LAI optimality model). We are glad to learn of this paper from Reviewer 1, and are quite impressed by their concept and its fairly consistent performance globally. We would like to observe that the independence from carbon exchange may in fact be consistent with the work of Osnas et al. (2013) on leaf mass vs. area traits, in which many traits scale by area, while leaf thickness seems to distinguish species tradeoff strategies. The next challenge is to integrate the leaf area timing of Caldararu et al. (2014) with carbon exchange and allocation. So, we still maintain that a mechanistic understanding of phenology is still elusive, but as phenology is in a sense a strategic behavior of plants, it may make good sense for models to replace the mechanistic approach with an optimality strategy instead (e.g. ecohydrological optimality theory of Rodriguez-Iturbe, Porporato, and co-workers, and a hedging model of co-author Kiang in the last chapter of her dissertation).

In the 4th paragraph of 1. Introduction of the revised manuscript still states:

"Prognostic phenology models have been developed to predict phenological response of vegetation to climate based on empirical evidence, as a process-based treatment is still not fully realizable with current understanding (Sala et al. 2012)."

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However, in the 6th paragraph of 1. Introduction of the revised manuscript, we add:

"Recently, Caldararu et al. (2014) introduced a promising optimality approach based on the hypothesis that phenology is a strategy for optimal leaf area index, rather than explicit carbon exchange, driven by canopy-level demand for – and constrained by availability of – light and water, limited by leaf aging. They fitted the model to satellite observations of LAI and demonstrated its capability to reproduce phenological patterns for different vegetation types over the globe within 8-16 days of observations. Top-down optimality approaches such as this may indeed be the smart way for global scale models way to capture the strategic behaviors inherent in phenology in lieu of mechanistic understanding at the leaf or molecular level; the next step remains to couple them with explicit carbon exchange and allocation."

p 5820 line 15 You might want to mention that the Jolly et al. (2005) scheme has been implemented into a DGVM with good results by Forkel et al. (2014).

» As per reviewer's suggestion, we have added additional explanation relevant to Jolly et al.'s scheme.

In the 2nd paragraph of 2.4 phenology of the revised manuscript:

"Forkel et al. (2014) adopted the concept of GSI but used the soil water availability instead of VPD for water limiting function. Phenology depends not only on atmospheric water demand but also on water supply from soil moisture as Migliavacca et al. (2011) have shown that GSI performed better when using a soil moisture limiting function instead of the VPD limiting function."

p 5820 line 21 See Caldararu et al. (2014) for a globally applicable phenology model.

» As per reviewer's suggestion, we have acknowledged Caldararu's fairly robust results at the global scale in the Introduction, and more precisely noted that is the climate rule-based approach that has difficulty with global scale parameterizations.

In the 1st paragraph of 2.4 phenology of the revised manuscript:

"While globally applicable parameterizations of climate rule-based phenology may still be elusive, where available in the literature, we draw from wide surveys that attempt to extrapolate to the global scale."

p 5821 line 19 What is the relationship between Phenostatus and the various φ factors? Are they the same thing? How do you put everything together? A master equation at this stage would be very helpful.

» We have re-written this part of paragraphs as the original manuscript included some misleading sentences. We have put the description of "phenological factors" and Phenostatus, as well as day length, ld, in a sub-section "2.4.1 Phenology Model Climate Cue Framework," to make the organization clearer. Phenostatus is an indicator for different phenological phases of no-leaf (1), leaf onset (spring) (2), full leaf (3) and leaf offset (fall) (4).

In the two paragraphs of 2.4.1 phenology Model Climate Cue Freamework of the revised manuscript:

"In the Ent TBM, several "phenological factors", ĨŢx, as well as physiological stress factors, βx, are calculated for seasonal environmental cues from various climate measures x. These include air and soil temperature history (cumulative number of growing degree days and of chilling days), day-length and soil moisture. The phenological factors control the allocation of assimilated carbon, while the physiological stress factors affect the efficiency of carbon uptake, and all range from 0 to 1 on a daily basis. Different rules apply to the different PFTs, according to phenotype (woody plant cold-deciduous, cd, drought-deciduous, dd, evergreen, ev, tropical radiation phenology, tr; and cold deciduous herbs, c, whether annual or perennial). The phenological factor controls the timing and rate of carbon transfer between the labile and active carbon pools and hence the seasonal variation in leaf area index (LAI), fine roots, and sapwood.

Furthermore, the Ent TBM determines "phenological status", Phenostatusp, where p is the phenotype, which identifies phenologically different seasons. For plants with

seasonal leaf-out and senescence, Phenostatusp is 1 for the leaf-off season, 2 for the leaf-up period, 3 for the peak foliage period, and 4 for the senescent period. The trend in length of day (ld) is used to determine which season it is, or, rather, which half of the year it is. If day length is decreasing, then it is the latter half of the year, and "fall" may be allowed to commence, depending on other climate variables of phenological factors. Below we itemize these variables and equations in the Ent phenology scheme."

p 5822 line 10 Generally, it is considered that photoperiod plays a much bigger role in leaf phenology, especially in spring and this simple approach you have chosen needs to be justified more.

» We have re-written the paragraph as the original manuscript included some misleading sentences. This part simply explains how we used the photoperiod for determining Phenostatus (for determining whether it is spring or fall). Indeed, as in Eq. (5), we have considered the photoperiod as a critical factor for determining phenological factor ÏŢ.

In the last paragraph of 2.4 phenology of the revised manuscript:

"Furthermore, the Ent TBM determines "phenological status", Phenostatusp, where p is the phenotype, which identifies phenologically different seasons. For plants with seasonal leaf-out and senescence, Phenostatusp is 1 for the leaf-off season, 2 for the leaf-up period, 3 for the peak foliage period, and 4 for the senescent period. The trend in length of day (ld) is used to determine which season it is, or, rather, which half of the year it is. If day length is decreasing, then it is the latter half of the year, and "fall" may be allowed to commence, depending on other climate variables of phenological factors. Below we itemize these variables and equations in the Ent phenology scheme."

p 5822 line 20 How did you choose the 5o C base temperature? What about the 10 day running average?

» We have added the reference, Kim and Wang (2005).

p 5822 eq. 1 This equation does not make any sense. Do you mean sum of maximum?

Also, the sum must be from something to something. Do you actually mean: (Equations here) p 5822 eq. 2 You probably want to format this as above and get rid of the if. p 5823 eq. 4 Do you mean GDD higher than GDDcrit ? Otherwise your index goes from -1 to zero.

» We have corrected the equations 1, 2 and 4.

p 5825 section 2.4.4 What are the drivers for leaf on in seasonally dry systems?

» To clarify the meaning, we have re-written the sentence.

In 2.4.3. Drought deciduous woody and herbaceous plants of the revised manuscript:

"Drought deciduousness depends on available soil water for the plant. In the model, it is determined based on a 10-day running average of the physical time step (∼half-hourly) plant water stress factor β. .... The leaf-on cue for drought deciduous trees is the same as that for cold-deciduous trees, while for grasses the cue is sufficient soil moisture."

p 5828 line 18 I do not understand how in your allocation scheme when the leaves have just started growing so that the LAI is very low, there is enough carbon available for a sudden jump to maximum LAI.

» In general, reserve carbon stores in trees are sufficient to grow maximum LA per plant. In herb seeds, we use a rule of thumb from Bill Parton (pers. Communication) that the carbon store is about 4 times that needed for the max LA of the plant. We have re-written the sentence as follows:

In 4.1.1. Phenology of the revised manuscript:

"First, it is clear that the gradual nature of changes in LAI during spring and fall were not captured in the model. The phenological factor serves as an on-/off cue between environmental thresholds, while growth rate with the ED scheme is limited only by carbon availability, for which reserve carbon is generally not limiting in trees (Sala et al.

2012) or in grass seeds (William Parton, personal communication)."

p 5830 line 5 Information about the sites belongs in the methods section. p 5832 line 12 Again, this belongs in the methods.

» To describe the site data, we have written a separate subsection of 3.1. Fluxnet sites.

In 3.1. Fluxnet sties of the revised manuscript:

"The Ent TBM was evaluated at five Fluxnet sites, including Morgan Monroe State Forest, Harvard Forest, the Vaira Ranch, the Tonzi Ranch and Hyytiala, as briefly mentioned above (Table 3). From all sites, data from the flux tower systems were available. Meteorological driver data include radiation, precipitation, air temperature, air pressure, humidity and wind, used to drive the model. Soil moisture and temperature measurements were also used to drive the Ent standalone simulations. Flux data includes net ecosystem exchange (NEE) and evapotranspiration (ET), and were used to evaluate the simulation results. Among sites, data availability, such as LAI, varied and suited different types of model simulations as described in detail in the next section.

The Morgan Monroe Sate Forest (MMSF), located in Indiana, USA (Schmid et al., 2000) (latitude: 39.32315°, longitude: -86.413139°) is is an extensive managed temperate broadleaf deciduous forest with a total area of 95.3 km2. The area is covered primarily by a secondary successional broadleaf forest within the maple-beech to oak-hickory transition zone of the eastern deciduous forest, dominated by supar maple and tuilip poplar. LAI measurements at 5-14 day intervals during the growing season were available for 1998-2001.

Harvard Forest (latitude: 42.5313°, longitude: -72.1898°) is an eastern temperate mixed forest dominated by deciduous trees. The area surrounding the flux tower is dominated by red oak and red maple, with scattered stands of Eastern hemlock, white pine and red pine. About 1/3 of the existing red oaks were established prior to 1895, another 1/3 prior to 1930, and the rest before 1940, and thus the stand is 75–110 years

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old (Urbanski et al., 2007). O'Keefe (2000) provides the leaf phenology of Harvard Forest. The timings of spring leaf development and fall leaf fall have been recorded for permanently tagged individuals in the field from 1991. The leaf development and senescence data in percent of final leaf size have been used to obtain 'observational' LAI based on the maximum LAI in the model, i.e., (observed LAI) = (observed % of leaf development or fall) X (modeled maxmimum LAI).

The Vaira Ranch (latitude: 38.4066667°, longitude: -120.950733°) and Tonzi Ranch (latitude: 38.4316°, longitude: -120.9660°) in Ione, California, are located in an open grassland ecosystem and an oak/grass savanna ecosystem, respectively, in a Mediterranean climate of cool wet winters, and dry hot summers. The sites are less than 3 km apart. The grasses of both sites are C3 annual species whose growing season is during the winter to spring wet periods. Deciduous blue oaks domimate the savanna overstory of the Tonzi, with a growing season overlapping the grasses during the spring and continuing through the summer drought. In these sites, LAI measurements were available along the tower footprint for 2001 (Kiang, 2002).

Hyytiala (latitude: 61.8474150°, longitude: 24.294770°) in Finland is situated in needleleaf evergreen forest dominated by Pinus sylvestris (Scots pine), in which the phenological behavior of interest is frost-hardening. The climate is boreal. Flux measurements and soil moisture and temperature are available. For seasonal LAI, we used the site investigator's description of a constant minimum all-sided needleleaf LAI (75% of maximum) in January-May, linear increase over June to its maximum of 3.9, remaining at the maximum LAI during July-September, linear decline to its minimum in October, and a constant minimum LAI in November-December (Kolari, personal communication, 2007)."

p 5835 line 12 This last sentence on PFT level parameters is out of place here, either delete it or create a new paragraph.

» As per reviewer's suggestion, we have deleted it.

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p 5835 section 5.2 This part of the discussion is somewhat general. I would be interested to see a discussion of the phenological parameters chosen and assumptions made. Is only using daylength as a senescence trigger a correct assumption? Do all sites have the same sensitivity to temperature and/or water? How sensitive are your predictions to the parameter values chosen?

» As per reviewer's suggestion, we have added discussion about our phenology model, specifically of cold deciduous trees to tackle our assumptions about governing environment conditions for leaf onset and offset.

In the 1st paragraph of 5.2. Cold deciduousness in the revised manuscript:

"For cold deciduous trees, we used the growing degree days and chilling requirements in spring phenology (Botta et al., 2000) and temperature and photoperiod in fall phenology (White et al., 1997; Jolly et al., 2005). While we have taken a widely used approach, some recent studies suggest other possible approaches. For spring phenology, the importance of photoperiod has been pointed out in recent studies (e.g., Korner and Basler, 2010; Migliavacca et al., 2012). Korner and Basler (2010) suggested that when the chilling requirement is fulfilled, plants become receptive to photoperiod signals and such sensitivity to photoperiod is found in late successional species in mature forests. For fall phenology, Delpierre et al. (2009) used chilling degree day-photoperiod to model leaf coloring change for deciduous trees in France, and Yang et al. (2012) and Archetti (2013) found the model suitable for New England, US, with different parameter fits. In general, despite agreement about overall climate cues for cold deciduousness, further work is needed to uncover site-independent parameterizations."

Technical comments

p 5813 line 25 "... a range of success" Rephrase.

» This comment is not applicable, as this part does not exist in the revised manuscript.

p 5814 line 1 "This is..." This paper is?

» We have re-written the sentence to clarify the meaning:

"In this study, we perform a site-based model evaluation study for the Ent Terrestrial Biosphere Model's (Ent TBM version 1.0.1.0.0) coupled phenology/growth schemes."

p 5814 line 14 "a synthesis a variety" Delete one of your choice

» We have corrected it to the following: a synthesis of approaches.

p 5823 eq. 3 Write this as e to the power of rather than exp(..)

» We have corrected it.

p 5823 eq. 4 Equations of this type are commonly formatted as: This applies to equations 5-7 too.

» We have re-written equations 5-7.

p 5829 line 5 "the partitioning... were both larger" clumsy sentence.

» We have re-written the sentience to clarify the meaning as follows:

"However, both GPP and RE were both more extreme in the model compared to the Fluxnet data product."

p 5834 line 28 "VPD may not a good indicator" missing "be".

» We have corrected it.

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