Reply to anonymous referee #2

We wish to thank the reviewer for her/his constructive comments. We reply to each comment below (original comments in bold and our response in regular font).

1. Authors assess whether light use efficiency (LUE) based models require vegetation dependent values of LUE, and based on testing seven models at several sites conclude that they don't. LUE models are generally driven with satellite derived vegetation indices (normalized difference vegetation index or enhanced vegetation index) or absorbed photosynthetically active radiation (APAR). However, there is another class of vegetation models called the dynamic global vegetation models (DGVMs) that also simulate gross primary productivity (GPP) among several other vegetation and terrestrial carbon related quantities. The manuscript makes no mention of DGVMs and the fact they have always used several vegetation dependent parameters, most importantly Vmax – the maximum rate of photosynthesis. Any advances in LUE based models do not necessarily transfer to more process-based DGVMs which have become a primary tool for investigating effect of climate change and changing composition of our atmosphere on Earth's terrestrial biosphere.

LUE models and DGVMs are two different types of carbon cycle models, and they have their own advantages and disadvantages. Compared with DGVMs, LUE models are based on clear principle, with very few model parameters and simple calculation procedures. Although, LUE models are not capable to predict due to the dependence on the satellite data, however, LUE models have become major tools in evaluating the actual patterns of vegetation productivity. The major objective of this study is to examine if the LUE model parameters are independent of vegetation cover type, which would help to improve the accuracy and applicability of LUE models in the various biomes and geographic regions. It is interesting to link the LUE models and DGVMs at the region scales, but it beyond the scope of this manuscript, probably future studies can be conducted on this issue.

2. Even if DGVMs are ignored, I am not convinced as a reader that the manuscript has shown to a sufficient extent that LUE is indeed vegetation independent. Having read the

eye-catching title of the manuscript, I was hoping a simulation at the global scale and comparison with some observation-based GPP product such as that of Beer et al. (2010). In its current form, there is no comparison with observations of any kind. Results from global simulations with and without vegetation dependent LUE with an observation-based GPP product are likely to help understand if LUE dependency on vegetation type is worth considering or not.

Yes, we estimated the global GPP based on the model parameters derived from two model parameterization experiments, and compared the differences of global GPP estimates. The results showed there are no significant differences of GPP estimates based on vegetation dependent and independent parameters.

We appreciate the understanding it is not necessary to compare with that of Beer et al (2010). The objective of this study is to examine the differences of GPP estimates using vegetation type dependent and independent parameters, therefore, comparisons should be conducted between GPP estimates based on two sets of parameter, not with other estimates.

3. The manuscript also fails to introduce its readers to how exactly LUE based models work. Few equations describing the basic approach and how they are implemented in the seven models would be extremely helpful.

At the original manuscript, we introduced the model algorithms at the online supplementary material. We moved some necessary model equations to the main text in this revised version.

4. The manuscript claims to have conducted a global comparison. In a strict sense, this is not entirely correct because authors have compared models with and without vegetation-dependent LUE at several selected sites.

Sorry for incomplete global comparison. Please refer the comment #2, we estimated the global GPP based on the model parameters derived from two model experiments, and compared the differences of global GPP estimates.

5. In Table 1, ε_0 varies over an order of magnitude across models, and easily more than twice

when the VPRM model is excluded. So what does LUE actually means in these models? Is it just another tunable parameter or does it have some physical meaning? And, for some of the models in Table 1, ε_0 is more vegetation dependent than others. Why?

Potential light use efficiency ($\boldsymbol{\varepsilon_0}$) indicates the light use efficiency without environment stress, which has the specific physiological meaning in these models. However, LUE models used different algorithms to calculate fPAR and environmental stress factors (Yuan et al., 2012), especially, environmental stress factors are dimensionless scalar varying from 0 to 1 and are not comparable among models, which resulted into the large differences on the magnitude of optimized ε_0 values.

In the CASA, EC-LUE and VPM models, ε_0 is only one of the undetermined parameters and the significant difference of optimized $\boldsymbol{\varepsilon_0}$ between two model experiments only was found in the grassland of CASA. At the other four models, other parameters will impact the optimized ε_0 values and result into the large variations of ε_0 among vegetation types. We integrated this issue into the discussion section.

6. The reason a model-specific constant LUE may work (although the paper doesn't show this globally using results from a global simulation) is that any satellite-derived vegetation index is an integrator of a number of vegetation attributes including leaf N content as authors themselves say.

Yes, we completely agree with this statement.

8. DGVMs do not have the luxury of using satellite-derived vegetation indices. In these models all vegetation attributes, including leaf area index (LAI), must be internally simulated and it would be very difficult to simulate realistic global patterns of GPP without using vegetation-dependent parameters.

Yes, vegetation attributes (e.g. LAI) are very important to simulate GPP, and the simulation biases will induce the incorrect photosynthesis model parameters.

9. The manuscript lacks the connection of results obtained to wider scale application of DGVMs in the community.

Light use efficiency (LUE) model is different model type compared with DGVMs. Independently and as a part of integrated ecosystem models, the LUE approach has been used to estimate GPP and net primary production (NPP) at various spatial and temporal scales because of its theoretical basis and practicality. Therefore, it is also very important to improve the LUE models. The accurate LUE models can help to calibrate or validate DGVMs at the region scale, and we integrated this suggestion into the discussion section.

10. Clearly, at an annual scale simple models like the Miami model may be used to estimate net primary productivity as a function of just mean annual temperature and precipitation (if I am correct). But such models don't have any predictive capabilities. So where do the LUE-based models lie on the spectrum of models from the simple Miami model to the process-based DGVMs.

Some simply models (e.g. Miami model) can estimate net primary production, however these models have some major shortcomings decreased the model reliability.

First, these models are statistical regression model without any processes basics, therefore the regression model coefficients did not have any physiological meanings which need recalibrate when the model was used to a new region.

Second, these models only can be used to estimate annual net vegetation production because the model developed based on the significant correlation between vegetation production and annual temperature/precipitation which only can be observed at the annual scale.

Third, these models only integrate the climate information and ignored satellite-based vegetation information, therefore, the model performance is very low.

On the contrary, LUE models are process-based model based on the light use efficiency principle, and there are significant improvements at the above three issues. Moreover, compared with DGVMs, LUE models also have substantial advantages due to the practicality and better model performance. We added one paragraph to discuss and explain this issue.

11. I suggest that the manuscript needs a major revision including comparison with a global observation-based GPP product, a more thorough assessment of implication of the results for the wider vegetation modeling community, or at the very least some discussion that LUE

based models depend on satellite-derived products so cannot be used in a truly predictive mode.

We made the substantial revisions according to the comments from the reviewers. We appreciate the reviewer can understand some issues are not in the scope of this study (i.e. comparison with DGVMs and the observation-based GPP estimates; please refer the response #1 and 9). Moreover, we integrated many insightful comments into the discussion section, like the disadvantages of LUE model and the connection between LUE model and DGVMs (please refer the response #9 and 10).

References

1. Beer C, Reichstein M, Tomelleri E et al. 2010: Terrestrial gross carbon dioxide uptake: Global distribution and covariation with climate, Science, 329, 834-838.
2. Yuan WP and Chan ZQ. 2012. Estimate of vegetation production of terrestrial ecosystem. In the book edited by Liang SL, Li XW and Wang JD: Advanced Remote Sensing, DOI: 10.1016/B978-0-12-385954-9.00016-2.