Dear Reviewer,

Thank you very much for your great efforts, comments and suggestion! According to your comments and suggestion, we revised the manuscript carefully and thoroughly. Please see, below, our point-to-point response.

Please do not hesitate to let us know if you have additional questions and/or comments.

Sincerely,

Xiaolu Tang, on behalf of all co-authors

Referee #2

The article studies the carbon use efficiency defined as the ratio of NPP and GPP for different ecosystem types. They used a machine learning algorithm (called "Random Forest") to predict CUE from global climate and soil variables. Their results were compared with simulation output from different DGVMs. They give some explanations about difference between model output and observation and point out the importance to check for variable CUE. The article is well written and organized and fits into the scope of the journal.

General remarks:

The author used data from the TRENDY model ensemble. The differences between observed and modelled CUE is explained by model deficiencies. However new model versions are now available. Within the ISIMIP2b project there exist more up-to date model runs. The focus in the ISIMIP project is more on future climate projections, but there have also data available for present climate. The authors should add a discussion about this.

Answer: thank you for the good suggestion! We used more recent TRENDY models (v3) in the revised manuscript. Since we could not assess a significant temporal global mean CUE, we did not consider a future projection of CUE, and we would rather focus on the spatial pattern of CUE.

The description of the machine learning algorithms is rather brief. The algorithm should at least be described in more detail in the supplement because it is a key part of the study.

Answer: more descriptions about RF were added in the main text in the method section:

"RF is an ensemble learning method which constructs a multitude of decision trees at training time and outputting the mean predicted values for the response variable. RF is fully data-driven, and does not require initial assumptions on data distribution and independency. RF does not only consider non-linear relationships and the interactions of the variables, but also assesses the importance value of the variables. In this study, we calibrated two hyper-parameters, namely the number of variables sampled as candidates for each split, and the number of trees. Moreover, RF regression can deal with a large number of features and help feature selection based on importance values (Jian et al., 2018)".

The authors show in Figure 4 the latitude dependence of modelled, observed and predicted CUE. In addition some quantitative statistical measures should be shown in a table.

Answer: We added a correlation figure between predicted and TRENDY – CUE in Fig. 4.

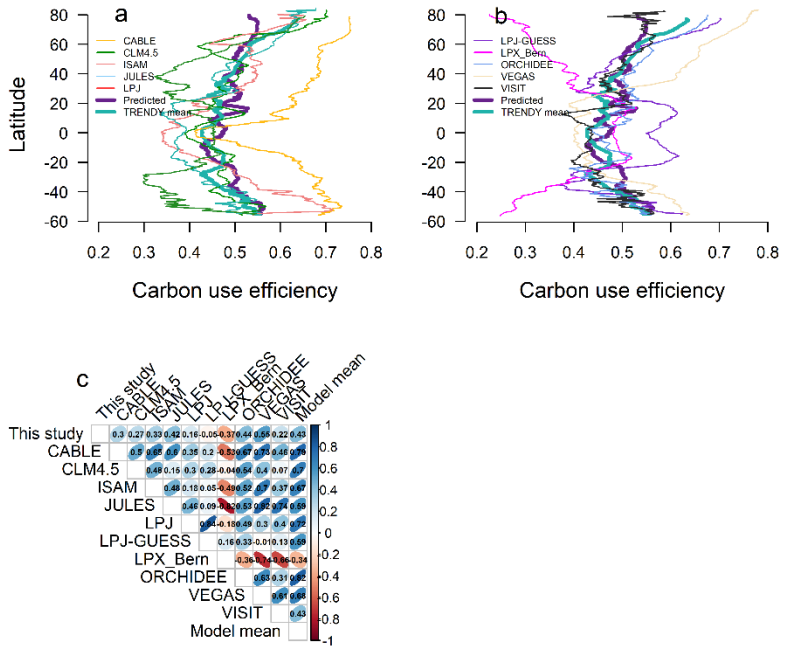

Figure 4. Latitudinal analysis (a, b) of TRENDY carbon use efficiency (CUE), and (c) the correlation coefficients between predicted CUE and TRENDY CUE. The numbers mean correlation coefficient.

More specific comments:

The authors should add a mathematical definition of CUE to the main text instead of the supplement: CUE =NPP/GPP. Furthermore Figure S1 might be moved to the main text

Answer: "CUE = NPP/GPP" was added.

"Carbon use efficiency (CUE), defined as the ratio of NPP to gross primary production (GPP, CUE = NPP/GPP)"

We keep Figure S1 in the supplementary since Figure S1 is closely related to the plausibility check and this placement contribute to make this concept easier to understand to readers.

Page 11, line 315. It is stated that most models do not consider nutrient constraints, in particular nitrogen. However, there are models with explicit nutrient limitations. There exists a version of the LPJ-GUESS model (Smith et al. 2014, Biogeosciences), e.g., that takes nitrogen limitations into account. Also the JSBACH model used in this study has an updated version with nitrogen. Perhaps it is possible to include result from these updated models into their study.

Answer: thank you. We used a TRENDY model v3, since we could not access the most updated version. According to the model developers, then models were included in the TRENDY v3, including CLM4.5, CABLE, ISAM, JULES, LPJ, LPJ-GUESS, LPX-Bern, ORCHIDEE, VEGAS and VISIT.

I contacted model developer, LPJ-GUESS in TRENDY v3 did not include nitrogen limitation in the model, but LPJ-GUESS included nitrogen limitation in later versions.

Page 11, line 311. While growth respiration is generally set to a constant in DGVMs, maintenance respiration in LPJmL, e.g., depends on air/soil temperature and C:N ratios respectively.

Answer: thank you. LPJmL was not in TRENDY v3. We also remove the sentence for easy understanding. Page 11, line 317. Increased CO2 concentration leads to better water use efficiency and therefore lower water stress increasing the productivity in DGVMs. This lead in generally to an overestimate of the CO2 fertilization effect because other limitation such as nutrient limitations are not taken into account. Please comment on that.

Answer: thank you for the good comments. However, whether an overestimate or underestimate

productivity depends on the relative change of GPP due to effects of CO_2 fertilization or lower water stress on GPP, which may vary with ecosystem types or biomes. Additionally, normally, temperature increases with increasing CO_2, which leads to the increase of autotrophic respiration via maintenance respiration (Rm). If the relative change in GPP is larger than Rm, it could be the CO_2 effects and warming could play compensating roles.

Page 13, line 376: Typo: land over instead of land cover

Answer: done!

Page 13, line 378: Typo: TREDNY instead of TRENDY

Answer: done!

Reference

Jian, J., Steele, M. K., Thomas, R. Q., Day, S. D., and Hodges, S. C.: Constraining estimates of global soil respiration by quantifying sources of variability, Glob. Chang. Biol., 24, 4143-4159, http://dx.doi.org/10.1111/gcb.14301, 2018.