# Response to Reviewer 2#

Dear reviewer,

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

**Suggestion and comments from referees** are marked in **Black**.

**Responses to referee's comments** are labelled in **blue**.

**Cited changes made in the manuscript** are marked in **red**.

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

Sincerely,

Xiaolu Tang, Shaohui Fan and Wunian Yang, on behalf of all co-authors.

Heterotrophic respiration (RH) is a large component of the terrestrial carbon flux. There are large uncertainties in RH estimates, especially at the global scale. The study developed the global RH dataset using the RF method and RH observations. Overall, this manuscript is well written and interesting. The global dataset is valuable for global terrestrial carbon study. It is publishable after some modifications.

RH is affected by numerous factors, including litter and soil carbon stocks, soil water content, soil temperature, and soil and litter properties. In this study, RH was estimated using the RF method driven by soil temperature, precipitation, and soil water content, soil organic carbon content. During the period from 1980 to 2016, soil carbon content might changes significantly due to the factor that the increase of productivity driven by CO2 fertilization would induce the increase of litter input into soils. Without consideration of temporal variation of soil carbon content might induce uncertainties in the temporal trends of RH. Figure 1 shows that the number of sites used to train the RH model is limited and they are unevenly distributed. These sites are mainly located in America, Western Europe, and China. In Russia, Africa, Australia, Southwestern Asia, only data from few sites are available.

Response: we full agree with the reviewer (1): soil carbon content might change from 1980 to 2016 and (2) Uneven data distribution has been a known issue that may cause uncertainly to the areas without observations, and we added these limitations in the discussion part - Advantages, limitations and uncertainties, as:

"Besides, without consideration of the temporal changes of soil organic carbon content from 1980 to 2016 might bring uncertainties because the increase of productivity driven by $CO_2$ fertilization would increase litter input into soils. However, there is a lack of soil organic carbon content that considering its temporal changes based on observations, which has constrained the further analysis of the effects of the temporal changes of soil organic carbon content on RH."

"Uneven data distribution has been a known issue in many ecological studies across the world, e.g. Bond-Lamberty and Thomson (2010), Jung et al. (2011), Xu and Shang (2016) and Yao et al. (2018). The observations were mainly from China, Europe and North America, while there were a lack of observations in Russia, Africa, Australia and Southwestern Asia in our study."

It would be great if the uncertainty map of estimated RH can be provided.

Response: thank you for your good suggestion. We produced an uncertainty map defined as the ratio of standard error and mean value according to Greaves et al. (2016). We added this uncertainty map in the supplementary file and cited in manuscript:

"However, the most variable changes in RH over the time from 1980 to 2016 - using standard deviation and coefficient of variation (CV, the ratio of the standard deviation and the mean) as proxies (Fig. 2b an S3), were found in boreal regions with more than 70 g C $m^{-2}$ $a^{-1}$ or CV > 0.7, while the majority areas of RH variability exhibited smaller than 30 g C $m^{-2}$ $a^{-1}$ or CV < 0.3."

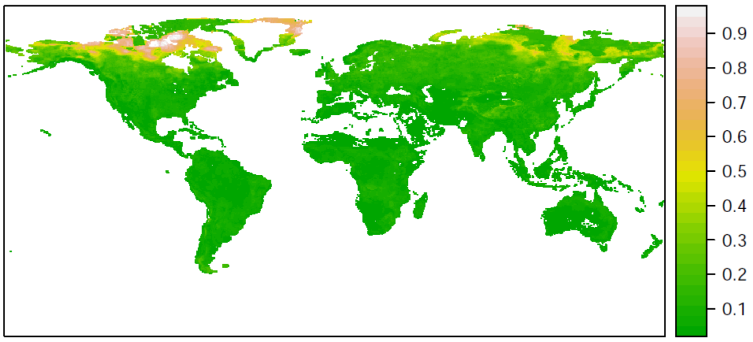


Fig. S3 The uncertainty map (the ratio of the standard deviation and the mean) of RH from 1980 to 2016 following Greaves et al. (2016).

Double check the unit in Line 183.

Response: thank you for your careful revision. We changed the unit to "g C $m^{-2}$ $a^{-1}$"

References:

Bond-Lamberty, B. and Thomson, A.: Temperature-associated increases in the global soil respiration record, Nature, 464, 579-582, http://dx.doi.org/10.1038/nature08930, 2010.

Greaves, H. E., Vierling, L. A., Eitel, J. U. H., Boelman, N. T., Magney, T. S., Prager, C. M., and Griffin, K. L.: High-resolution mapping of aboveground shrub biomass in Arctic tundra using airborne lidar and imagery, Remote Sens. Environ., 184, 361-373, https://doi.org/10.1016/j.rse.2016.07.026, 2016.

Jung, M., Reichstein, M., Margolis, H. A., Cescatti, A., Richardson, A. D., Arain, M. A., Arneth, A., Bernhofer, C., Bonal, D., Chen, J. Q., Gianelle, D., Gobron, N., Kiely, G., Kutsch, W., Lasslop, G., Law, B. E., Lindroth, A., Merbold, L., Montagnani, L., Moors, E. J., Papale, D., Sottocornola, M., Vaccari, F., and Williams, C.: Global patterns of land-atmosphere fluxes of carbon dioxide, latent heat, and sensible heat derived from eddy covariance, satellite, and meteorological observations, J. Geophys. Res. Biogeosci., 116, G00J07, http://dx.doi.org/10.1029/2010jg001566, 2011.

Xu, M. and Shang, H.: Contribution of soil respiration to the global carbon equation, J. Plant Physiol., 203, 16-28, https://doi.org/10.1016/j.jplph.2016.08.007, 2016.

Yao, Y., Piao, S., and Wang, T.: Future biomass carbon sequestration capacity of Chinese forests, Science Bulletin, 63, 1108-1117, http://dx.doi.org/10.1016/j.scib.2018.07.015, 2018.