Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2020-1088-AC2, 2021

Atmospheric Chemistry and Physics Discussions
Open Access

Interactive comment on "Aboveground biomass in Inner Mongolian temperate grasslands decreases under climate warming" *by* Guocheng Wang et al.

Guocheng Wang et al.

wanggc@mail.iap.ac.cn

Received and published: 3 January 2021

Reviewer #2: The authors compiled in situ measurements and long-term experimental data to estimate changes in aboveground biomass over Inner Mongolia at a spatial resolution of 1 km. Moreover, the machine-learning model which was constructed using historical observations is applied to estimate aboveground biomass changes under future climate scenarios. Without implicitly considering the following two major comments, I would not recommend this paper to be published. In a warmer future, the rising CO2 effect on aboveground grassland productivity was not considered. It is well established that the fertilization effect of rising CO2 would greatly offset the warming-induced productivity loss in grasslands. Without considering the CO2 effect, projections of aboveground biomass would be greatly biased in a warmer world.

Printer-friendly version

Discussion paper

Authors' Response: We greatly appreciate the reviewer's useful suggestions and constructive comments, following which we have substantially revised our MS particularly on the CO2 enrichment effect. We in general stand with the reviewer on her/his opinion that fertilization effect of rising CO2 would greatly offset the warming-induced productivity loss in grasslands. In the revision, first, we derived the relationship between CO2 concentration and ANPP based on the data derived from Polley et al. (2019) (Line 184-191; Fig. S4). Second, by applying this relationship on future CO2 concentrations and AGB projected by the machine learning models under different RCP scenarios, we found AGB losses due to climate change (not including CO2 enrichment effect) can not only be offset but also be reversed (Line 240-248; Fig. 8). Third, we noticed that CO2 enrichment effect on AGB can be dependent on resource availability of other environmental factors such as nutrient and water (Brookshire and Weaver, 2015;Wang et al., 2020), thus there remain large uncertainties in the estimated AGB variations under a rising CO2 as estimated in this study. We have thoroughly discussed these possible uncertainties and limitations of our results (Line 284-294). We hope these revisions can satisfy the reviewer's concerns.

Note that the temporal dynamics was deduced from the analysis of climate drivers of spatial gradient in aboveground biomass. This space-for-time method was generally challenged by the fact that the climatic controls in space and time would be different.

Authors' Response: We respectfully disagree with the reviewer on this point although we can understand her/his potential concerns, which is not the case in our study. In this study, we split the study region into three categories (e.g., meadow steppe, typical steppe and desert steppe), these three categorical variables are included as predictors in the machine learning models as dummy variables. This is to avoid deducing the dependent variables in a certain category using the independent variables (e.g., climate variables) across other categories in building the machine learning models, i.e., predicting an apple using an orange. Consequently, we have realized that the climatic controls over spaces are different and they have actually already been taken into account in building the machine learning models. We have further clarified this in the revised MS (Line 134-136).

The authors have six long-term experimental sites, but unfortunately these valuable data set especially for evaluating the inferred long-term trend has not been explored. The authors should add new analyses and figures to evaluate the model-derived productivity changes in terms of mean, inter-annual variation and trend using these data.

Authors' Response: Thanks for this useful suggestion. We have evaluated the temporal changes in AGB at the six long-term field experimental sites and added a figure showing these temporal variations at site scales (Fig. 7). In general, the long-term field observations also show large inter-annual variabilities in the grassland biomass (Fig. 7) and can support our predicted temporal biomass dynamics at the regional scale (Fig. 6). For example, at four of the six sites, AGB showed a general decreasing trend (Fig. 7). We have included these results in the revised MS (Line 226-228).

Minor comments: Change the error of AGB unit "ka ha-1" in Abstract Line 17.

Authors' Response: Modified accordingly (Line 18).

A table showing the details of environmental drivers might be helpful.

Authors' Response: We have previously summarized the details of environmental drivers in the Supplement Table S1 in the last submission. In the revision, we have moved this table to the main text as Table 1 (the previous Table 1 has been accordingly updated to Table 2).

In the future projection, current grazing intensity was kept stable, while it would not be consistent with RCP simulations under RCP4.5 and RCP8.5. Some hypothetic scenarios are necessary.

Authors' Response: Thanks for pointing out this. We admit that this is one of the major uncertainty sources in the predicted AGB, we have included and discussed the associated uncertainties and limitations in the revised manuscript (Line 281-283).

References: Brookshire, E. N. J., and Weaver, T.: Long-term decline in grassland productivity driven by increasing dryness, Nature Communications, 6, 10.1038/ncomms8148, 2015. Brownlee, J.: Machine learning mastery with python, Machine Learning Mastery Pty Ltd, 100-120, 2016. Eldridge, D. J., and Del-gadoâĂŘBaquerizo, M.: ContinentalâĂŘscale impacts of livestock grazing on ecosystem supporting and regulating services, Land Degradation & Development, 28, 1473-1481, 2017. Griffiths, B. S., Spilles, A., and Bonkowski, M.: C:N:P stoichiometry and nutrient limitation of the soil microbial biomass in a grazed grassland site under experimental P limitation or excess, Ecological Processes, 1, 6, 10.1186/2192-1709-1-6, 2012. National Research Council: Grasslands and Grassland Sciences in Northern China, The National Academies Press, Washington, DC, 230 pp., 1992. Polley, H. W., Aspinwall, M. J., Collins, H. P., Gibson, A. E., Gill, R. A., Jackson, R. B., Jin, V. L., Khasanova, A. R., Reichmann, L. G., and Fay, P. A.: CO2 enrichment and soil type additively regulate grassland productivity, New Phytologist, 222, 183-192, 10.1111/nph.15562, 2019. Wang, S., Zhang, Y., Ju, W., Chen, J. M., Ciais, P., Cescatti, A., Sardans, J., Janssens, I. A., Wu, M., Berry, J. A., Campbell, E., Fernández-Martínez, M., Alkama, R., Sitch, S., Friedlingstein, P., Smith, W. K., Yuan, W., He, W., Lombardozzi, D., Kautz, M., Zhu, D., Lienert, S., Kato, E., Poulter, B., Sanders, T. G. M., Krüger, I., Wang, R., Zeng, N., Tian, H., Vuichard, N., Jain, A. K., Wiltshire, A., Haverd, V., Goll, D. S., and Peñuelas, J.: Recent global decline of CO₂ fertilization effects on vegetation photosynthesis, Science, 370, 1295-1300, 10.1126/science.abb7772, 2020. Yang, Y., Fang, J., Pan, Y., and Ji, C.: Aboveground biomass in Tibetan grasslands, J Arid Environ, 73, 91-95, 2009. Zhang, Q., Buyantuev, A., Fang, X., Han, P., Li, A., Li, F. Y., Liang, C., Liu, Q., Ma, Q., Niu, J., Shang, C., Yan, Y., and Zhang, J.: Ecology and sustainability of the Inner Mongolian Grassland: Looking back and moving forward, Landscape Ecology, 35, 2413-2432, 10.1007/s10980-020-01083-9, 2020.

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2020-1088,

2020.