

Interactive comment on “Microbial decomposition processes and vulnerable Arctic soil organic carbon in the 21st century” by Junrong Zha and Qianlai Zhuang

Anonymous Referee #2

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Summary

The authors present a microbe-based biogeochemistry model (MIC-TEM) based on an extant Terrestrial Ecosystem Model (TEM). The MIC-TEM heterotrophic respiration is calculated taking into account the influence of the dynamics of microbial biomass and enzyme kinetics. The verified MIC-TEM was used to quantify the regional carbon dynamics in northern high latitudes (north 45 °N) during the 20th and 21st centuries. It is very important that as a rule the models is account climate change but not take account many other parameters which may significantly change the overall picture in conducting global or regional assessments - namely, changes in the vegetation cover

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and microbial communities as a result of climate change, land use change, fires, etc.. The study is valuable and manuscript is well written enough, so it can be accepted after minor revisions.

General comments. L 76. (here and hereinafter in the text) - "Most models treated soil decomposition as a first-order decay process, i.e., CO₂ respiration is directly proportional to soil organic carbon." The region chosen for modeling is very large. There are ecosystems with very different reserves of SOC on this territory. In reality, there can be no direct dependence of respiration CO₂ from SOC. The main and most active processes associated with the transformation of organic carbon and emissions occur mainly in the upper horizons of soils. The authors try to take into account the carbon stocks at different depths of 30, 100 and 300 cm, and according to the model - the more carbon stocks the more it accumulates. However, northern high latitude ecosystems are often represented by wetlands with large organic carbon stocks in the form of peat deposits. While most of them have low productivity, in contrast to boreal forests, where the stock of soil carbon is much lower. Is this taken into account when modeling?

Detailed comments. In the abstract, there is no mention of the improved model (only TEM), therefore it is not clear on which model the values of sink or source of carbon were obtained. Some of model parameters are not presented, a table of the model parameters should be added for example how litterfall is calculated. It is not clear what territory is taken for modeling - in the name and abstract of article are talking about the Arctic ecosystems, in the Fig. 3 and Fig.S5 represent the territory of the exciting 45 N, in the text 45 °N or 60 °N - which territory was being investigated? In fact, a period of 200 years (20th century and 21st century) is simulated, which SOC value was taken as the initial value. A value characteristic of 2000 yr or what? When modeling the 20th century, which parameters of the model were taken as input? The source of MODIS NPP (version, MODIS product name and parameter) are not mentioned. It is also not clear how values of NPP were obtained by model TEM and MIC-TEM.

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