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

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We thank the Associate Editor and two referees for their providing constructive comments to this manuscript. Below we detail how we have revised the manuscript following their suggestions.

1. It appears that the transient simulations for 20th and 21st century runs are starting from non-equilibrium state, initialized from observations. That introduces artificial disturbance likely to affect conclusions on ecosystem carbon storage trends. Additional tests with well equilibrated initial state are needed to clarify the potential problem.

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Response: Thanks for the comments. We would like to clarify that, we actually initialized the model with the observation-based SOC for transient simulations during the 20th and 21st centuries to compare with the simulations that initialized with equilibrated state. These simulations were presented in Table 3.

2. Model description contains several deficiencies and omissions that need to be corrected (see detailed comments).

Response: Thanks. We have provided more detailed model description. See the manuscript lines 140-202.

3. Model parameters are not presented, a table of the model parameters should be added.

Response: Thanks for the suggestion. In this revision, we moved the model parameter table from supplementary materials to main text, as Table 1.

4. References in a manuscript and the supplement should be formatted according to Biogeoscience journal format.

Response: Thanks. In this revision, we changed the format according to Biogeoscience journal format.

Detailed comments: Line 140 (L140) Abbreviation DOC is used, so it should be introduced here rather than at Line 155.

Response: Yes, we have specified the abbreviation when its first appearance.

L150 “microbial biomass death (DEATH) and enzyme production (EPROD) are modeled as constant fraction of microbial biomass”. According to Eq. 6, DEATH appears as a process rate, so it cannot be a fraction of MIC, it can be proportional to MIC. To avoid confusion, authors need to rewrite the Eq. 6 in terms of monthly increments (delta MIC), not as process rates (dMIC/dt).

Response: Thanks. In this revision, we stated that both microbial biomass death

(DEATH) and enzyme production (EPROD) are modeled as proportional to microbial biomass with constant rates. rdeath and rEnzProd are rate constants. Thus, the formula doesn't need to be changed.

L152 Formally, if Eq. 6 is right, in Eq. 7 DEATH should appear as a multiple of MIC and a process rate constant, the rate constant (units: sec-1) is missing, the rdeath is a ratio, assumed non-dimensional. Same problem with Eq. 8. Authors shou ld explain what is in fact meaning of DEATH and EPROD, is it a process rate (as appears in Eq. 6) or (monthly) increment due to the conversion from one (organic matter) pool to another?

Response: Similar to above, we have stated that both microbial biomass death (DEATH) and enzyme production (EPROD) are modeled as proportional to microbial biomass with constant rates rdeath and rEnzProd.

L157 "MICtoSOC is carbon input" – suggest to write "MICtoSOC is carbon input ratio"

Response: Yes. We have changed it according to your suggestion.

L170 Km not explained.

Response: In this revision, we explained how Km is calculated.

L189 The source of MODIS NPP (version, MODIS product name and parameter) are not mentioned.

Response: The MODIS NPP data was derived by the MOD17 MODIS project. The product name is Net Primary Production Yearly L4 Global 1 km. The critical parameter used in MOD17 algorithm is conversion efficiency parameter ÆŘ. More information about the MODIS NPP product could be found on https://neo.sci.gsfc.nasa.gov/view.php?datasetId=MOD17A2_M_PSN. In this revision, we added this information into main text in lines 193 – 202.

L225-236 Using non-equilibrium initial SOC taken from observations cannot be recommended for transient simulations, even for a model like TEM, that doesn't have very

slow soil carbon pools. Accordingly, additional tests should be made with equilibrated initial SOC set by long enough spinup run (200-300 years) to the equilibrium.

Response: See our above response about comparison between these two types of simulations.

Please also note the supplement to this comment:
https://www.biogeosciences-discuss.net/bg-2018-241/bg-2018-241-AC1-supplement.pdf

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