Geoscientific Model Development Discussions

Geosci. Model Dev. Discuss., referee comment RC2
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# Comment on gmd-2021-280

Anonymous Referee #2

Referee comment on "Assessing methane emissions for northern peatlands in ORCHIDEE-PEAT revision 7020" by Elodie Salmon et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2021-280-RC2, 2022

This is my first time reviewing this manuscript. The authors evaluated single-point applications of one land model ORCHIDEE in simulating methane emissions at 14 northern peatland sites. The PEAT model version they employed has been incorporated with several previous methane algorithms.

**General comments:**

The paper is well written and organized. The topic on peatland methane simulation is also very interesting because it remains a challenge to perform the methant processes well for most land surface models. The ORCHIDEE-PEAT model can be a potential helpful addition for the wetland modeling studies. However, in the current manuscript there are still some problems regarding the methods and results the authors need to clarify.

1. The study sites are northern peatlands and the authors have mentioned the importance of snow layer on calculating the diffusion of ch4 flux in the study, but I never found any data or plots of snow observations/simulations to support their claims, such as L385-386, L403-407, L432-433, L466 in the manuscript.

2. For wetland simulations, the anaerobic environment is crucial for methane production/oxidation. It is mainly controlled by water conditions and microtopography. I found the bad performance of methane emissions always with poor water table simulations in the study. for example the US-Wpt and RU-Che sites in fig5, Fig2s, L455-466. How did you consider the impacts or limitations from the biases of hydrological simulations?

3. Some key information on parameter definitions, parameter values and units were missed in the method section. It is a bit hard for readers to understand the methane modeling structure. See specific comments below.

4. The authors should include more details on the parametrization method. (1) Please provide the details of how you determined the final accumulation year for ending the simulations at L279. Because there are two factors of soil peat depth and carbon content, which factor is prior? What are the referential resources of soil peat depth and carbon stock? (2) For you parameter sensitivity analysis at L305-310, which period did you run for the analysis?

5 I have also a couple of concerns on the parameter settings of single-site and multi-site simulations. (1) There are several conflict descriptions on parameter ranges between single-site and multi-site simulations the authors should clarify. See specific comments below. (2) When doing parameter optimization for the multi-site simulation, why didn't you set all parameter ranges to cover the already obtained single-site optimized value, such as L482, L491-499 qmg, zroot and Tveg. For example, the specific optimized value of qmg at PL-Wet is 4; according to the range of qmg from 9 to 10 in table 6, the final multi-site optimized value will miss its single-site optimized value. This may be one reason why the simulations with multi-site optimized values for PL-Wet and DK-Nuf were worse than their single-site smulations.

6. How did you consider the limitation for peat depth simulations in section 4.2? In table 2 I found there are several sites whose peat depths do not consist of observations, such as DE-Zrk, DK-NuF, which should impact the distribution of soil carbon within 0-0.75m.

**Specific comments:**

In equation 1-13 of section 2.1, do variables, such as fmga, fmgs, fmagp,.... fmt, also change with layer depth and time? I assume z is depth and t is time in the equation 1, despite you not giving their definitions. Also lacks the related information on parameters. For example, are kmt of equation 5 at all layers the same value?

L164-165 What's the units of [C], ki?
L165 For soil, it should be 'soil moisture', not 'soil humidity'.
L169 Why didn't you mark O2, p and O2* using brackets as [CH4] and [C]? For example, is the O2 here different from [O2]soil in Fig1?
L174 What's the unit of clay content? For these peatland sites, what are the values of clay you used?
L177 Again, what's the difference among [O2]soil, O2 and O2*? And their units should be added.
L178 What is the exact unit for kmt, hour or day?
L184 Are you sure that kebu= '1 h-1'? This would mean the constant is unuseful during calculation.

L185 What is the unit of Psoil? Why did you set the 0.75m depth as limitation?
L192-193 Again, how did you estimate the layer of 0.75m? Please add more information or results.
L199 What's the unit of tortuosity n? Does it have a constant value?
L201-202 Do you mean wsize = 1cm here?
L206-207 It is not clear. Do you mean that the oxidized methane in the root zone accounts for 39-98% of total methane oxidation in soil? Please provide the exact value used in your study.
L210 Again, what's the value of Tveg used in your study?
L215 I didn't find the root biomass in the root distribution function 10, only the root depth. Please clarify this.
L219 Is the z in this equation the same as that in other equations? How did you distinguish the depths of soil, water or snow coverage?
L224 Please provide the sources for the values.
L286-287 Did you run the carbon accumulation process again for the historical period of each site with these calibrated parameters?
L305-310 For the parameter sensitivity analysis. Which period did you run? Please clarify this.
L324-327 Can you explain why the optimized qmg at PL-Wet is so low at 4? The value is beyond much from the observed ranges in other studies. Do you have any evidence to support this value? The questions are also about qmg, zroot and Tveg for DK-Nuf.
L335 Why the range of qmg here is not 4.0-10.7 as before?
L381/L550 'soil humidity' should be ''soil moisture'
L385-386 Please provide the snow cover depth data to support the claim on diffusion transport.
L403-407, L432-433, L466 Again, please provide the snow depth evidence.
L411, Can you explain why there are so large differences in the depth of maximum methane production among sites. The main controlling factors for methanogenesis are temperature and water conditions. Did you check the relationships/dynamics of soil temp along depth?
L440 "not sufficient to cause methane ebullition" How much ch4 concentration is enough for the ebullition under your study conditions? Please clarify this.
L534 Can you give some citations or explanations for the qmg range of 0.58~10000 because in table 3 you state the range is 9-11.
L554 Still lacks snow depth or accumulation evidence.
L641 What are the full names of 'SS' and 'MS'?
L645-646 I am curious that did the plant transport dominate total ch4 flux for the whole year, or it only occured in the summer?

Table 3, For kMT, it is not consistent with the values at L178; for Mrox, it is not consistent with the values at L206-207; for mxrch4, the citation is not the same at L188;
Table 6, Why is the span of mxrch4 not the same as table 3?
Fig 5 with Fig2s, The performances of water conditions for US-Wpt and RU-Che look not so good. How do you consider this?

**Technical corrections:**

L149 Full names of fmga, fmgs and fmgp?
L185 'depend' to 'depends'
L186-187 I found both mxrch4 and mwrch4, which one is correct?

L189 What's the full name of 'RR'?
L189 "MwCH4 and BCH4 the Bunsen... " should be "MwCH4 and BCH4 are the... "
L293 Again, mwrch4 or mxrch4?
L482, Not correct. 'table 5' must be table 6.
L685 Citations?

Fig 1, 'Lai' should be 'LAI'