Dear Editor,

Thank you for taking the time to find an additional referee for the final referee report. We have done our best to address the minor issues raised by the two referees. We made small corrections to the units for some equation variables. We have made several grammatical corrections. We also re-wrote parts of the abstract, introduction, a paragraph in the discussion, and the conclusions. We hope that we have addressed the issues raised by the two referees.

Issues raised by referee 1:

L3 depends change to depend
Changed (L2).

L17: process-based
Changed (L15).

L25 semi colon
Changed.

L38. Okay, but above you talk only of CH4 emissions and not drawdown.
We have brought this sentence to the first paragraph to introduce and highlight the ability to emit/drawdown emissions (L26).

L65 drier
Changed.

L82 'and aerobic'
Changed.

L92 correct wording?
Yes, it is the 'Wetland and Wetland CH4 Intercomparison of Models Project' (L67).

L95. Hyphenate
Done.

L103. Is plot scale too small for an ecosystem? Better to say 'plot-scale plant competition model'?
NUCOM-BOG describes itself as 'a bog ecosystem model' and we have maintained this wording.

L116. It's noted above that NUBOG simulates undisturbed bogs, yet the new model is being applied to disturbed and managed systems. Perhaps add some explanation on why it is okay to use the new model in this way.
We have added the sentence: "The incorporation of NUCOM-BOG features, a model simulating undisturbed systems, into PVN, a new model simulating disturbed and managed systems, requires that changing environmental conditions and changing management practices both lead to dynamic impacts on vegetation classes" (L95).

L150. Delete comma.
Done.

L153. Wrong equation number?
Yes, this has been changed to Eq. 9.

Fig1. Does ebullition include CO2? Delete 'transport of'.
We have adjusted the model schematic so it is clear that ebullition only transports CH4. We have deleted 'transport of'.

L181. Delete comma.
Done.

L202: delete 'the'.

Done.

L206: I find this a little confusing. If Rd has units of per area why is the integral needed? By its units is it not already a depth-integrated variable?
Indeed, Rd has units kg C m-3 day-1. We have corrected this (Eq 2, L136).

L214: 'm^-2'
Corrected.

L214: See my comment on Eq 2.
See reply to L206.

L234: Comma not needed.
Removed.

L234: Add comma.
Done.

L316: Delete comma.
We see that the comma is relevant.

L331: This doesn't make sense to me. This isn't an equation. Is this a mistake? The same product appears on the rhs of the equation below.
The equation has indeed not been printed correctly in the marked-up version of the manuscript. It's displayed in the revised manuscript (Eq22-Eq24).

L347: But are not inert.
We have changed to 'passive' carbon pools, instead of inert (L252 – L255).

L353: Needs rewording.
Done – 'the decomposition rate for each SOM pool' (L258).

L371: If CH4 can be stored in layers, then surely the total flux is just that from the uppermost soil layer.
Yes. We have re-worded the sentence to make this clearer (L274): "The CH4 concentration of each soil layer is calculated before summing all transport mechanisms, at the soil surface, to obtain the net flux." We have also moved the equation describing the CH4 concentration in each soil layer to the supplementary (now Eq. S19) and instead included the equation summing the different transport pathways (in the uppermost soil layer) in the main text (now Eq 29).

L376: Correct?
This sentence is now in the supplementary (see above comment) and now reads: "Rpr is the temperature dependent production of CH4, where warmer temperatures lead to enhanced CH4 production rates" (L59 in supplementary).

L386: 'is consumed'
Done.

L390: 'conduit' is a noun, not a verb. It's better to use 'conduct' here.
Changed to 'conduct' (L289).

L393: Delete comma.
Done.

L466: I recommend retaining the original text here. It is important to know the sites are in the Netherlands.
We agree and changed it back (L309).

L532: I recommend a full stop here.
We prefer the comma.

L539: Delete space.
Done.

Table 4. Already explained earlier in the paper?
True. Removed.

L614. Already noted earlier in the paper?
True. Removed.

L624: 'model's'
Changed.

L626: '2), and above-' (add 'and')
Done.

L632: 'emissions' and 'fluxes' are used interchangeably here, it seems, against the convention noted above.
Adjusted. We have also reviewed this throughout the manuscript.

L686. Remove brackets?
Yes.

L692. Just say '20 and 100'? Clearer, I think.
Reworded (L643-L647).

L740. Delete or is there a missing word?
Deleted.

L786. Delete comma.
Deleted.

Fig 9. The PVN and observations boxes in the top left plot are very similar colours and not easily distinguished from each other. Why are the upper x-axes labels so small?
We have changed the colour of the observations and increased the font size.

Fig 10. See comment on Figure 9.
We have changed the colour of the observations and increased the font size.

L802. 'mg' twice
Changed.

L847. 'on optimized parameters'
Changed (L673).

L889: Delete comma.
Deleted.

L895: Delete comma.
Deleted.

L951. Should this be 'shown'?
Yes. Edited.

L955. Delete comma.
Deleted.

L972. 'against the functionality'
Edited.

L995. Missing word? 'we can assess'?
Changed to: ‘can be used to assess’.

L1000. Brackets not needed; in fact, they're confusing.
Removed.

L1019. I recommend giving examples of such decisions, such as raising site water tables, or letting a site become inundated in late winter / spring.
Changed to (L842): “By including plant-environmental feedbacks, the model can serve wetland management by estimating changes in the GHG balance of peatland sites in response to environmental change, such as changing air temperatures, water level or precipitation/evapotranspiration; or new management decisions, such as raising the water table, vegetation restoration or modifying mowing regimes.”

Issues raised by referee 2:
Abstract. Delete first paragraph (L1-L5).
We have shortened this paragraph and combined it with the second paragraph.

L6. Restructure sentence.
We have changed this sentence to (L4-L6):
“To assess the impact of vegetation on the GHG fluxes of peatlands, we have developed a new model, Peatland-VU-NUCOM (PVN), built from two parent models, the Peatland-VU and NUCOM-BOG models.”

L16: State the key variables/inputs affecting CH4 fluxes? That will be a useful information for readers.
We have added the sentence (L14):
“We find that daily air temperature, water level, harvest frequency and height, and vegetation composition drive CH4 and CO2 emissions”.

Introduction: This entire introduction is repetitive of what is citied by past published papers. This introduction was relevant if the study was a lab scale or field scale study. But this is a model development study. So authors should include the following:
1) Which existing computer models simulate the vegetation PFT dynamics that the Peatland-VU-NUMCOM model simulates?
2) What components lacking in those models are embedded into this model? Why is the model so different and special that the future readers should use? I see these paragraphs between 75 to 85 but the introduction about that is known to all and not required.
3) Then briefly introduce the model components and define modelling goals and objectives.

We have merged the first two paragraphs and reduced the length of the third paragraph, abbreviating the first half of the introduction. To better discuss existing relevant models, we have added the following text (L76-L81):
“The PEATBOG model simulates three PFTs, moss, shrubs, and graminoids at the Mer Bleue Bog site, and represents a comprehensive array of peatland processes, including the nitrogen cycle and dissolved gases (carbon, CO2, and CH4). LPJ-WHyMe, like its parent model, LPJ-Why (Gerten et al., 2004; Sitch et al., 2003), includes permafrost and peatlands, two peatland-specific PFTs (flood tolerant C3 graminoids and Sphagnum mosses), a new decomposition scheme when under inundation, and the addition of root exudates. LPJ-WHyMe particularly assesses the impacts of inundation on vegetation composition, net primary production, and the deceleration of decomposition under inundation.”

To emphasise what is novel about the PVN model in comparison to existing models, we have added the following text to the final paragraph of the introduction (L89):
“We have developed a model that, with the appropriate site input data, can be used to simulate peatland sites with a wide variety of vegetation types and vegetation management practices.”

L126 change to ’minus plant respiration’
Done.

L152. Insert reference.
Inserted (Heijmans et al., 2008) (L151).

L310: The harvested material can be totally removed from the field and not added into the litter layer. How does the model work/simulate in that scenario?
We have clarified this (L305): "A fixed fraction of the harvested material, assumed to be lost during the harvest process, remains uncollected in the field and is added to the litter layer. This fraction can also be set to zero."

L350: This is a model development paper; so not enough information provided to model users on how the model was stabilized; what is meant by stabilization; shown plots of stabilized pools; this is required. Do the pools are expected to be stabilized in the first 5 years or more years are required depending upon site-specific data? Authors have to provide such information. The stabilized pools can be provided in the supplementary figure.
The spin-up period was determined by the amount of model time needed for these pools to cease fluctuating following model initialisation. To display the spin-up (or stabilisation period) we have included model simulations results, beginning in the year 1990, for PFT root mass, PFT above-ground biomass, PFT SOM CO2 flux, and PFT CH4 flux to the supplementary material (Fig S4), with an in-text citation (L346).

L375: Sensitivity test. Any particular reason for choosing these parameters over other input parameters? Is that they are easily available and site-specific as well?
We modified the daily input parameters (radiation, temperature, water table, harvest) to test the sensitivity of model processes to these driving environmental conditions. Air temperature, water table, radiation, and harvest were chosen to be used for the sensitivity testing because they are key environmental drivers of CO2 and CH4 emissions in peatlands. We added text to clarify this at L373. To prevent any confusion between Table 2 and Table 3 we have now moved Table 2 so it now sits within Section 2.5.

L458: mention the growth limit temps (max and min) for readers.
We have added the reference to Table 2 where these limits are defined.

L469: I observed in Table S5 and S6, they are different for both sites. Are these values calibrated during simulations? How were these values obtained?
This is described in Section 2.4 and highlighted in Table S4. We have referenced this at L464.

L485: What about the impact of harvesting on CH4 plant transport?
We have elaborated on the impacts of harvest on plant transported CH4 (L485-L490):
"Methane emissions were slightly enhanced if harvests occurred, in comparison to no harvest events, for Horstermeer site simulations, whilst the frequency of harvests did not impact emissions. Similarly, enhanced CH4 emissions occurred with increased harvest frequency for Ilperveld site simulations. Spikes in CH4 transported by vascular PFTs occurred after harvest events in both the Horstermeer and Ilperveld simulation results (not shown), contributing to enhanced CH4 emissions, for both Ilperveld and Horstermeer site simulations. The impact of fewer or no harvest events led to variable impacts on CH4 emissions for Ilperveld site simulations, where a single harvest led to slightly reduced emissions and no harvests led to slightly enhanced emissions. In the Ilperveld site simulation without harvest events, vegetation became dominated by vascular PFTs that are efficient transporters of CH4, leading to enhanced CH4 emissions.

L670: If possible can the authors differentiate the inputs of Peatland VU model that were parametrized earlier but now are observation informed.
We have indicated this in Table S3.

L724: The hollow and hummock microtopography can be incorporated.
Yes, we have added this (L732).

L735: Cite a reference for this.
We have added (Gunnarsson et al., 2004) (L744).

L759: This discussion is not relevant. How do the different rooting depths of different PFTs impacted CH4 transport and then compare those with published literature estimates would be ideal.
This discussion was added on the request of a previous reviewer to discuss the relevance of using an exponential function to represent root distribution in the model. We have now added the following text which describes the relationship between PFT CH4 emissions and root representation in the model (L771-L778):
Root exudation plays an important role in the supply of substrates that can later be metabolised into CH4 (Aulakh et al., 2001; Waldo et al., 2019), where the fraction of belowground production that consists of exudates (REX) was an important parameter impacting CH4 production in the model. Next to this, the parameter representing root aerenchyma (PlOx) played a role in the oxidation of CH4 (Walter and Heimann, 2000). These processes as well as plant transported CH4 are only possible from soil layers with roots present (Bansal et al., 2020). For this reason, the parameter representing maximum root depth (MRD) played a role in the production, oxidation, and transport of CH4, where the relative impact of each of these processes on surface CH4 fluxes were dependent on PFT properties.

L826: I think the conclusion should include the key inputs affecting model outputs CO2 and CH4 fluxes, inputs showcasing maximum uncertainties w.r.t to CO2 and CH4 fluxes, statement about carbon pool stabilization, statement of important PFT parameters etc.
We have added the sentence (L842):
By including plant-environmental feedbacks, the model can serve wetland management by estimating changes in the GHG balance of peatland sites in response to environmental change, such as changing air temperatures, water level or precipitation/evapotranspiration; or new management decisions, such as raising the water table, vegetation restoration or modifying mowing regimes.
We added the following two sentences (L846):
PFTs compete for light where production and respiration are dependent on ideal temperature and water levels. Structural differences in vegetation root, exudation, and stem representation impact CH4 production, oxidation, and transport.

Thank you again for your efforts in the handling of this manuscript. We hope that these responses have addressed the issues raised.

Warmly,
Tanya J. R. Lippmann et al.

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