

## Reviewer 2

In their manuscript "Evaluating alternative ebullition models for predicting peatland methane emission and its pathways via data-model fusion", Shuang Ma and co-authors present their evaluation of two different formulations of the ebullition process in methane components for Land Surface Models, the Ebullition Bubble Growth approach and the Ebullition Concentration Threshold approach. They evaluate these approaches against methane flux and concentration measurements from the SPRCUE site using an MCMC approach and find that the Ebullition Bubble Growth model is far superior.

The authors make a very convincing argument why the Ebullition Bubble Growth approach is superior, which solves one of the many issues that need to be addressed in making methane emission models more reliable.

I am very much impressed by the manuscript. It is superbly written and about ready for publication as it is, though I have found a (very) few minor details. I really must congratulate the authors, as I've never before seen a manuscript that was as good as this during the first round of reviews.

We appreciate your suggestions, please find replies after each paragraph in blue underlined fonts.

As mentioned above, the manuscript is nearly ready for publication, but there are a few minor things to be sorted out:

- Lines 160-162: Double "in this study" -- please remove one.

Thank you! Will remove the latter one:

In this study, however, all observed data we used were only from ambient plots (no infrastructures and no warming treatment) for our research goals and we did not explore the warming effects on CH<sub>4</sub> processes.

- Lines 181-183: Sentence starting with "Samples shallower than..." sounds slightly awkward, I suggest rephrasing it

Indeed! Will rephrase as:

'A perforated stainless-steel tube was inserted into the peat to collect samples within 0-25cm depth.'

- Line 357: I don't see any blue shaded areas in the plot, I only see blue lines. Reformulate.

Thank you for catching this mistake. Will change in the manuscript as:

'The blue lines are the parameter posterior distributions (PPDs) from the ECT model structure trained with CH<sub>4</sub> emission data (ECT F). The green lines are the PPDs from the EBG model

structure trained with CH<sub>4</sub> emission data (EBG\_F). The purple lines are the PPDs from EBG trained with both CH<sub>4</sub> emission and CH<sub>4</sub> concentration data (EBG\_FC).'

- Line 452: The model is called ELM\_SPRUCE, I assume, not ELS-SRUCE, as is written?

Yes. ELM\_SRUCE is the name of model. Also, to be consistent with our previous word choice, we will replace 'Earth system model' with 'Land Surface Model (LSM)'

- Line 455: "...concentrations ... was still not...". Noun is plural, verb is singular. Better use "were" instead of "was".

Thanks! Will correct it.