

Anonymous Referee #1:

General comments:

This manuscript is very interesting because the authors have developed a CH₄ emission rate model for wetland, based on the main biogeochemistry processes including CH₄ production, oxidation, and transportation processes reported by other previous studies. Several important factors that control CH₄ emission processes, such as soil temperature, redox potential, and pH, were incorporated into the model. Sensitivity analysis was carried out using the data collect at Stordalen and BOREAS SSA sites and the results indicated that the release ratio of CH₄ to CO₂ (r) and Q10 for CH₄ production were two major controlling factors in CH₄ emission modelling. The data derived from the literature at 19 sites across different geographical regions were used for model validation. The results showed that the model developed in this study was successful in capturing temporal variations in CH₄ emission even though daily details or emission peaks were poorly caught. The authors also pointed out some factors (methanogenic microbe population and a large data set from site specific observations) should be taken into account in the future study. Thus, the CH₄ emission model developed in this manuscript can be applied to different wetlands under varying conditions and used to improve the capacity of CH₄ emission prediction in wetlands systems.

However, there are some spaces for improvement in the current form of this manuscript. For example, the advantages and disadvantages of the model in this study should be specified when comparing with the previous studies. It would be better if more description of model equation, unit of variables, and time scale of modeling were given. I recommend a minor revision before acceptance for publication. I present my specific comments below.

RE: Thanks for the referee's positive feedback, valuable comments and suggestions. In the revised version, we summarized advantages and disadvantages of the models including previous studies (in Introduction section) and added discussion about the next step of model application and further development to address the disadvantages of current model (Discussion section). We added more information (e.g. unit of variables,

and time scale of modeling etc.) in the model description section and also reorganized section 3, section 4, and section 5 to make the paper more concise and logical.

Specific comments:

Abstract:

Line 1-7 on page 5425: please describe the CH₄ emission model directly rather than TRIPLEX-GHG, because CH₄ emission model development, sensitivity analysis and model test are the main content of the study.

RE: Yes, agree. we rewrote this part as suggested.

Introduction:

Line 4 on page 5426: add "past" or "last" before "decades".

RE: Did as suggested.

Line 5 on page 5426: add "across different scales" after "wetland emission".

RE: Yes, did as suggested.

Model description and key processes:

Line 16-23 on page 5430: please give the unit of all variables in the equation (1), also other equations.

RE: Yes, did as suggested.

Line 11-12 on page 5431: please add a formula to express the CH₄ emission or flux.

RE: Yes, a formula was added in the text.

Line 15-19 on page 5431: the sentence is redundant. Could please merge it into the next sentence.

RE: Yes, we rewrote this part.

Line 21 on page 5431: please specify "hydrological regimes".

RE: The hydrological regimes mainly refers to soil moisture and water table changing in this study, which define the essential anaerobic conditions for methanogenesis.

Line 7 on page 5432: add "when temperature is" before "below zero".

RE: Yes, did as suggested.

Results:

Line 9 and 15 on page 5439: please add references after "previous studies".

RE: Yes, references were added as suggestion. This part was moved to section 2.2.4.

Line 15-16 on page 5439: change the "Two sites were selected (Stordalen and BOREAS SSA, Table 1) for sensitivity analysis testing" into "Two sites (Stordalen and BOREAS SSA, Table 1) were selected for sensitivity analysis testing".

RE: We redid the sensitivity test and rewrote this part.

Line 17 and 22 on page 5439: please use symbols consistently, such as r for the release ratio of CH_4 to CO_2 , I for sensitivity index.

RE: Yes, we rewrote this part and made symbols consistently.

Line 7 on page 5441: add reference after 'these two regions'.

RE: Yes, a reference was added.

Line 9 and 10 on page 5441: add "annual" before "CH₄ emission".

RE: Did as suggested.

Line 9 on page 5445: change "was" into "were".

RE: Did as suggested.

Discussion:

Line 2 on page 5447: please present details in advantages and disadvantages, or difference compared to other models.

RE: We rewrote this part and put some details of advantages and disadvantages of models in introduction section. We also added discussion about the next step of model application and further development to address the disadvantages of our current model in revised

MS (in the Discussion section).

Line 8-12 on page 5450: please move the paragraph to the end of data input section, where explain this study mainly concentrated on CH₄ emission simulation.

RE: Thanks for the good suggestion. We rewrote this part to discuss the deficiencies of current works, including water table simulations presented here in original paper.

Table:

Table 3 : please explain why r values were set a large range to 1.5, which is about 8 times than baseline (0.2).

RE: Good point. We reran the sensitivity test and changed the scenarios. The r changed with a step of 0.05.

Table 4: "Q10 parameters" for what? CH₄ production?

RE: Yes, you are right. We clarified this in the revised version.

Figure:

Figure 3: please give the definition in X coordinate, I think they are sensitivity index?

RE: Figure 3 was re-produced and shown as Figure 2 in the revised paper. The coordinate was checked and revised as suggestion.

Figure 4-8: please give legend of line and explain RMSE in the text.

RE: Legends were added to each figure. More statistical indexes for model performance evaluation were calculated and presented as in Table 3, and also explained in the text.