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Biogeosciences Discussions



# *Interactive comment on* "Quantifying wetland methane emissions with process-based models of different complexities" *by* J. Tang et al.

**Anonymous Referee #1**

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Review of Tang et al: Quantifying Wetland Methane Emissions with Process-Based Models of Different Complexities

General comments:

Several models of methane emission from wetlands have been constructed in the last 15 years. Most of these models are used to simulate methane fluxes on a single site, reproducing fluxes which have been measured by series of flux chamber measurements. The models vary in complexity; generally the more complex models require more parameters and input data. Although these models generally simulate the seasonal variability of fluxes reasonably well, small-scale temporal variability remains a problem. In particular daily variations are often poorly reproduced. Ebullition is one of the processes behind small-scale temporal variation. The paper by Tang et al.

addresses this problem, by introducing an ebullition model that takes account of air pressure and does not rely on a single concentration threshold for the generation of bubbles. Furthermore it includes all relevant gases, simulating also the methane content of the bubbles rather than assuming a fixed value. The paper also shows the effects of using models of different complexity, in particular with respect to the gases and reactions included in the model. The improvements of model fit resulting from the higher complexity models are clear but not spectacular. Despite these results, this paper is worthwhile publishing, albeit with minor modifications. Overall, the paper is well written, the model equations are explained thoroughly, and the figures are clear and informative. The sensitivity tests of the model are quite useful and illustrate very well the effects of changing the model structure. However, the authors should have added a somewhat more critical evaluation of their results. I would have expected a discussion of how large the benefits are from the more complicated models - and their disadvantages in terms of higher parameter and data requirements. Such a discussion would make the article rise above the level of 'just-another-methane-model'. See the remarks below.

Specific comments

1. The discussion and conclusions remain rather technical and comment only on the sensitivity tests of the model. I would appreciate reflection of the authors on the practical use of their model improvements. It is necessary to know the benefits of increasing model complexity in relation to the increasing parameter and input data needs. I suggest the authors to pay attention to the following questions: - Discuss the intended use of the model. This will generally not be just the reproduction of local field data, but temporal or spatial extrapolation. For instance gap filling, spatial upscaling of fluxes across a larger area. - To what extent is the model fit improved by using the higher complexity versions? To what extent are the improvements significant or are they marginal only, and maybe not exceeding the uncertainty in the data? How large are the cumulative differences between the model results with respect to the total emission in the three



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simulated years? Consider statistical testing of the differences in model fit for the lower and higher complexity models. - What are the 'costs' in terms of parameter and data requirements of the models relative to the benefits of increased model fit? For instance the better fit of S4 requires the availability of air pressure data, also list other extra parameter and data requirements.

2. The approach to modeling of ebullition is not entirely novel; also Granberg et al. (Global Biogeochemical Cycles, 15, p 977-991, 2001) use pressure-dependent ebullition in their model.

3. Page 6131 line 14-15: 'It is likely that our algorithm will not always give superior results to that obtained using the volume threshold based method in other studies' . This is a highly relevant remark. To my knowledge model intercomparision has never been done for methane emission models, and will be very useful.

4. P 6137 line 10. Water table sensitivity tests: this is a nice result of the sensitivity tests, why is it not shown?

Detailed remarks:

P 6318, line 12: 'When the cumulative differences were analyzed, we found for a three year period at the Buck Hollow site, the S4 predicted around 2000 mgCH4 $m-2$ $y-1$ using the transient atmospheric pressure data than using the standard 1 atm pressure. ' This sentence is confusing - predicts S4 more or less CH4 with the transient pressures? Please try to quantify the differences also relative to the total flux.

Page 6144, line 14: in the Walter-Heimann model the percentage of oxidation during plant transport can be varied; in their model they set this factor to 50% but they stress the high variability of observed values. So selecting a value of 50% is rather arbitrary, and might be obtained from calibration.

Technical comments

Page 6135, heading 3.1: 'nobservations' - observations



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Page 6140, line 20-24 Have mercy with your readers. Consider splitting up or reordering this very long sentence.

Page 6145, line 9: 'And Rveg is a scaling parameter needs calibration to account for differences in conducting capabilities for different plants.', better: Rveg is a scaling parameter which needs calibration to account for differences in conducting capabilities for different plants.'

Overall judgment according to evaluation criteria

1. Does the paper address relevant scientific questions within the scope of BG? yes

2. Does the paper present novel concepts, ideas, tools, or data? yes

3. Are substantial conclusions reached? could be improved; see remarks above

4. Are the scientific methods and assumptions valid and clearly outlined? yes

5. Are the results sufficient to support the interpretations and conclusions? yes

6. Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)? yes

7. Do the authors give proper credit to related work and clearly indicate their own new/original contribution? with one exception, yes

8. Does the title clearly reflect the contents of the paper? yes

9. Does the abstract provide a concise and complete summary? yes

10. Is the overall presentation well structured and clear? yes

11. Is the language fluent and precise? yes

12. Are mathematical formulae, symbols, abbreviations, and units correctly defined and used? yes

13. Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced,



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combined, or eliminated? no

14. Are the number and quality of references appropriate? yes

15. Is the amount and quality of supplementary material appropriate? yes

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