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Interactive comment

Interactive comment on "Technical Note: Comparison of methane ebullition modelling approaches used in terrestrial wetland models" *by* Olli Peltola et al.

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Overall impression

This is an interesting paper. The problem of methane transport has vexed empiricists and modellers alike since the exchange of methane from wetlands and the atmosphere was identified as a serious problem. This manuscript presents three models of methane ebullition from peatlands and then assesses how they perform against annual totals and a time series of half-hourly methane fluxes. They show that all the models give approximately the same annual flux but the proportion for the emissions transported via bubbles varies among the models. They conclude, based on comparison

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Discussion paper

with half-hour eddy covariance data that the model they developed, the free-phase gas volume model (EBG), gives more realistic results than the other two models. I am not convinced by the evidence presented that the EBG more is better because I do not see how half-hour average EC fluxes are a good measure of the bubble flux. My concern is the boundary layer mixing blurs the bubble signal and that the post-processing removes concentrations from the high frequency data (e.g. 10 Hz) that indicate bubbles. I have wondered whether a comparison of the co-spectra of the momentum and concentrations could be used to identify the frequency of bubbles? Bubbles are very hard to measure well. In flooded wetlands funnel traps give a time integrated measure to the magnitude of the bubble flux but they do not work in peatlands. When auto-chambers are used one can see bubbles but examining the trace of concentration over time. At our site, Mer Bleue, we saw evidence of bubbles in less than 1% of our fluxes but in more fen systems such as Sallies fen (Goodrich in the references) bubbles appear in most chamber closers. Ideally the authors would have higher frequency records or used chambers where they can actually see the bubbles but it has to be an automated systems. Probably as good a test of the models is measures of the changes in methane storage. The authors point out this is not easy to do with interfering with the concentrations but diffusion samplers such as peppers or continuous flow samples could give evidence for the changes in storage – this is the state variable in all the models. I think there is value in this manuscript (see below) but I think the authors should outline the ways they think the models could be tested. This would help others recognize the data they are sitting on could be used as evidence to attempt to refute the models. It is only through this testing we will gain confidence in the models and differentiate which model is more appropriate.

I do think the manuscripts serves a useful purpose in setting out the three approaches to modelling ebullition. It is the clearest explanation of these kinds of models I have seen and on that basis alone I think it serves a very useful addition to the literature. On theoretical arguments I do think their EBG model stands up better than the other two models but the authors should be inviting or stimulating the community to test the models. However we are still faced a significant problem with estimating methane production: Rprod in equation (1). It does not really matter how elegant our models of the transport mechanisms are if production is poorly estimated.

Minor points

Pg 1 Ln 25 Not sure of this number. Ebullition is important where it is important but when plants are present that root below the water table plant mediated is important. Diffusion can't be that large. Also think there is steady bubble flux. Regardless it does not matter because it is important.

Pg 1 Ln 30 This is an understatement which is why I question the 0 to 70% claim above.

Pg 5 Ln 21 Subscript 4 on CH4

Pg 10 Ln 11-13 This is fine but it my experience that most peatlands do not have significant confining layers. Beaver ponds are a good example - they a constantly bubbling and the bubbles are shallow.

Pg 10 Ln 35 Patrick Crill is measuring concentrations in peat with circulating diffusion samplers that equilibrate with soil concentrations. They would not sample bubbles but they would tell you the depth and duration that the concentrations approach and exceed saturation. Also peepers would tell you the same thing.

Pg 11 Ln 4 Yes but the easiest thing to measure is the concentration profiles in some non-destructive manner that does not require putting a negative pressure to extract the samples. My guess is diffusion samples circulating through a CH4 analyzer would be the best route to get at this problem. At least then you are measuring the temporal variability of the state variable. If the diffuser were of a sufficient length, say several meters, they could obtain spatial averages. What do you recommend as a test?

Pg 11 Ln 14-26 I am not sure how one can use EC to determine a bubble flux. What EBG shows is that it matches the temporal pattern of the EC fluxes but it can't see bubbles. I have always wondered in the high frequency data the concentration and momentum spectra should see departures that would indicate bubbles being mixed in the boundary layer. Automated chambers see bubble events - the time trace of concentrations show step changes. You refer to Goodrich et al. And they saw thus at Sallies fen in NH.

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