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Interactive comment on "Small spatial but large sporadic variability in methane emission measured from a patterned boreal bog" *by* Aino Korrensalo et al.

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This manuscript presents results on methane exchange rates, determined by the static chamber technique, in varying sections of a boreal bog, over three growing seasons. The manuscript is a contribution to the long line of papers that show that methane exchange from peatlands can be complicated, rather then simple, because of the large number of variables which can affect the flux. The primary contribution of the manuscript is to show that, in this particular system, the mixture of temperature, water table position and vegetation combine together to reduce the spatial variability of methane flux (whereas in other bog systems, there may be a larger spatial variability

in flux, associated with a different spatial mix in 'driving' variables). The secondary contribution is to show that, within the overall flux pattern, there are specific fluxes which were very high (emission) or low (consumption by the peatland surface): the extreme fluxes could not be excluded by evidence of ebullition or experimental error. The cause of these extreme fluxes remain unknown, but emphasize, as in other studies, that methane fluxes can be very variable temporally. The upscaled chamber measurements were in general agreement with the flux recorded at an eddy covariance tower. The manuscript is a very useful contribution to the field, though it does raise some unanswered questions about extreme fluxes. The work was conducted at the Siikaneva peatland, characterized by a fairly muted microtopography (only 25 – 30 cm difference in water table position) and a variable distribution of arenchymous and non-arenchymous plants. Measurement of the methane exchange was made by 'standard' static chambers at between 7 and 16 times in three years, and supported by environmental and ecological data. The results have been compiled carefully and presented clearly and a series of statistical tests have been made to establish the relationships between the flux measurements and the 'driving' variables. The manuscript is generally well written, though I have made a few suggestions on wording etc. on the pdf version. The authors express some surprise in the weak relationship between water table position and methane flux, anticipating a larger flux where there is a higher water table, as has been shown elsewhere. As with all relationships between a gradient of an environmental variable and the object of interest (in this case methane flux), the strength of the relationship depends on at least two things: one is the range of the variable, and another is how other variables interact along the gradient. Strong water table:methane flux relationships have been shown elsewhere, but they tend to occur over large water table gradients (50 or more cm, rather than the 25-30 cm encountered here) and when they are of a small scale, the relationship is not simple, for example Bellisario et al. (1999). Moreover, water tables are not static but rise and fall and than can create hysteresis so it is not at the highest water table that maximum emission is reached (e.g. Brown et al. 2014). While mean water table data are presented in Figure 1, was there much variation in water table position during the three seasons, and does this play a role in the observed temporal variability in flux? The interaction between the influence of aerenchymous plants facilitating emission and the non-aerenchymous plants providing root exudate to stimulate methanogenesis, to partially explain the small spatial variability, is well presented, though no evidence is put forward to support the processes involved. Perhaps the most surprising result of the study is the occurrence of large positive or negative methane fluxes, which because of linearity in change of gas concentration in the chambers, could not be discounted (10% of the measurements were excluded because of non-linearity or other reasons). It would be interesting to see a graph depicting the magnitude:frequency of the observed fluxes (n = 516); it is not clear whether the extreme fluxes (2.5%) included both positive and negative fluxes (lines 190 to 195 could be clarified). These extreme fluxes are large by normal measurements, though it should be noted that they were observed over 35 minutes and then scaled up to a daily estimate: it is unlikely that the methane stored in the peat, or its generation, could sustain such a high flux for a day: what are rates of methane production for these systems (g/m2/day, or how much methane is stored in the peat profile?). There seems to be no strong attention to the reasons why a large methane emission could be observed: perhaps, given that these are ‘real’ fluxes, more information could be given on their spatial and temporal patterns (rather than ‘random and sporadic’): this is hinted at in lines 293 to 299: where and when did the fluxes > 1 g/m2/d occur? Perhaps more disconcerting is the occurrence of large uptake rates of methane, up to 300 mg/m2/d and it is difficult to conceive of a mechanism which would allow such large amounts of methane to be ‘taken up’ microbially, through methanotrophy. As noted, the largest methanotrophic potentials are usually observed around the position of the water table, which in these sites are close to the peat surface, so the diffusive pathway for methane consumption is fairly short. Nevertheless, it is somewhat surprising that these large consumption rates appear primarily on bare peat surfaces (line 291), whereas one might expect less microbial activity than where vegetation cover was denser (though the arenchymous R. alba occurs in the bare peat

spots). Are these large consumption rates related to water table position (and hence largest potential rates of methane consumption)?

Bellisario, J.L., J. Bubier, J. Chanton and T.R. Moore, 1999. Controls on the emission of methane from a northern peatland. Global Biogeochemical Cycles 13: 81-91. Brown, M.G., E.R. Humphreys, T.R. Moore, N.T. Roulet and P.M. Lafleur 2014. Evidence for a non-monotonic relationship between ecosystem-scale peatland methane emissions and water table depth. JGR-Biogeosciences 119: 826-835 doi: 10.1002/2013JG002576.

Commented upon pdf attached as Supplement.

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Please also note the supplement to this comment:
https://www.biogeosciences-discuss.net/bg-2017-443/bg-2017-443-RC2-supplement.pdf

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