Second review of " Characterisation of short-term extreme methane fluxes related to non-turbulent mixing above an Arctic permafrost ecosystem" by Schaller et al. acp-2018-277

The manuscript has improved compared to the previous version and the authors have addressed most of the reviewer comments in a satisfactory manner. Now it is clearer throughout the text that the identified events are related to meteorology and not changes in surface methane (CH_4) emission and most of the other issues were taken care as well. Good job.

However, one possibly critical issue still remains. The authors did not do any coordinate rotation to their eddy covariance (EC) data, which might significantly impact the results. The authors claim in their response that under high wind velocities mean vertical wind component (<w>) was negligible meaning that their sonic coordinate frame was not tilted respect to the local flow stream lines. However, this claim is not backed by empirical evidence (e.g. figure). If coordinates are not rotated, not only the mean value of w, but also the turbulent fluctuations of w are compromised by horizontal wind speed, which in turn affect the estimated fluxes. In order to emphasise this point, consider Eq. (6.13) in Kaimal and Finnigan (1994):

$$w_3 = -u_2 \sin\varphi + w_2 \cos\varphi, \qquad (1)$$

where w_3 is the vertical wind component in such coordinates that $\overline{w_3} = 0$ (overbar denotes temporal averaging), u_2 is the horizontal wind component in such direction that $\overline{u_2} = U$, i.e. the mean equals mean horizontal wind speed (U), w_2 is the unrotated vertical wind component (i.e. w in the sonic coordinate frame) and

$$\varphi = \tan^{-1}\left(\frac{\overline{w_2}}{\overline{u_2}}\right). \qquad (2)$$

Here w_2 equals the vertical wind speed data in the same coordinate frame as used in this study. Now if we use Reynolds decomposition (primes denote fluctuations around the mean), multiply the Eq. (1) with scalar fluctuations (c'), take the temporal average and reorganize the terms, we get

$$\overline{w_2'c'} = \overline{u_2'c'}\tan\varphi + \overline{w_3'c'}\frac{1}{\cos\varphi}. \qquad (3)$$

Meaning that the horizontal wind speed fluctuations are directly affecting the fluxes if they are calculated utilizing w_2 as done in this study. Maybe even more importantly, it is unclear how the spectral decomposition of $\overline{w_3'c'}$ and $\overline{w_2'c'}$ differ from each other, meaning that the coordinate rotation might have different effect on turbulent fluxes at different frequencies. This would have an effect especially on the interpretation of results derived using the wavelet decomposition of the signal. Therefore, it is essential to show that the sonic was not indeed tilted, meaning that φ is zero in all wind directions.

I suggest that the authors show a figure where $\overline{w_2}$ is plotted against U in different wind direction bins. If there is no significant dependence between $\overline{w_2}$ and U (φ values at max around 2° or so), then no coordinate rotation is needed, yet if there is a dependence, then coordinate rotation is needed. In such case planar fit coordinate rotation method (Wilczak et al., 2001) should be implemented in the data processing chain and the results should be recalculated.

Based on Fig. 2 in the manuscript, φ was around 6° if we assume that the mean w in the figure (0.15 m s^{-1}) is only related to the tilted coordinate frame. In my view, this would already warrant implementation of coordinate rotation to the processing chain.

MINOR REMARKS:

page 3, lines 9-10. This part should be modified since the EC method is doing exactly this: calculating CH_4 fluxes directly from high frequency EC measurements.

p. 3, l. 27 Long-term CH_4 budgets were not analysed in this study. You only discuss the possible effect that these events may have on the long-term budgets, but do not show any hard data. Hence, please reformulate this sentence.

p. 10, l. 13-26 and maybe elsewhere Please use only one format for time (not both 11:00pm and 23:00) and follow the journal recommendations.

REFERENCES

Kaimal, J. C. and Finnigan, J. J.: Atmospheric boundary layer flows : their structure and measurement, Oxford University Press, New York., 1994.

Wilczak, J. M., Oncley, S. P. and Stage, S. A.: Sonic Anemometer Tilt Correction Algorithms, Boundary-Layer Meteorol., 99(1), 127–150, doi:10.1023/A:1018966204465, 2001.