Author response to interactive comment RC3 submitted by an anonymous referee on May 16, 2019

In the document below, the comments by the anonymous referee have been copied from the original review and are shown in black font, while the author comments have been added in blue.

Goeckede and others compare established eddy covariance and wavelet-based flux calculation techniques as well as gap filling techniques to measure methane flux - including episodic ebullition events - in an arctic ecosystem. The manuscript as written is acceptable for publication following minor improvements in my opinion.

Regarding the introduction, the case of ebullition extends beyond arctic ecosystem examples. Arctic ecosystems are of course important, but this approach can extend beyond them.

We will delete large parts of the first paragraph of the introduction to remove references to the Arctic in this general section of the manuscript. The remaining sentences will be merged subsequently with the first part of the second paragraph, this way creating a new first paragraph that generally focuses on eddy-covariance quality control issues, with a specific focus on methane.

In section 2, please write scientific names in italics.

This will be changed.

Does the filter on p 5 line 10 filter out many extreme values or many values close to the thresholds? Just curious if methane ebullition events may be excluded by this filter. (see also p. 17 L. 25).

Using the dataset from Tower 2 as an example, the range filter excluded 235 half-hourly data points in total. Of those, ~30 % were extreme negative outliers (fluxes < -50 nmol m^{-2} s^{-1}, while the majority were moderate negative fluxes (47 % in the range -10 to -50 nmol m^{-2} s^{-1}). Just ~14 % were strong positive outliers (150 – 250 nmol m^{-2} s^{-1}), and the remaining ~8 % were extreme positive outliers (>250 nmol m^{-2} s^{-1}). We acknowledge that the used threshold of 150 nmol m^{-2} s^{-1} is somewhat subjective, but an extension of that cutoff towards higher values would have had minor impact on the presented analysis.

Page 5 line 15 check 'NN, Dengel' reference.

We checked the record with Biogeosciences, but could not find any error in the previously used version ..??

I understand that the wavelet approach is described in detail elsewhere, but more detail in the present manuscript would help the reader grasp the basics of the approach without having to read other manuscripts to understand the present one.

We will add a new appendix A to the manuscript that describes the wavelet approach to calculate turbulent fluxes. The new material will be a shortened version of the original methods description as presented in the companion manuscript by Schaller et al. (2017).

From the results, do you suspect that atmospheric conditions may lead to ebullition events? In other words, does a Venturi effect occur with higher atmospheric wind speeds that results in pressure pumping? (see manuscripts by Bill Massman on this notion for soil and snow gas exchange).

Indeed, the pressure effect associated with changes in atmospheric transport and turbulence conditions, as described e.g. by Massman (2006) and Massman and Frank (2006), may play an important role for the occurrence of methane emission outbursts as analyzed in our study. For example, in the companion manuscript by Schaller et al. (2019) a case example of an emission event triggered by a passing weather front is described where the high methane releases are most likely caused by pressure pumping.

The manuscript as a whole is cautious, insightful, and well-written but the Discussion section could use moderate restructuring so that it is a bit more succinct.

We will revise the Discussion section, and target a new version that will be about 20% shorter than the current one.

References

Massman, W. J.: Advective transport of CO2 in permeable media induced by atmospheric pressure fluctuations: 1. An analytical model, J. Geophys. Res.-Biogeo., 111, 2006.

Massman, W. J., and Frank, J. M.: Advective transport of CO2 in permeable media induced by atmospheric pressure fluctuations: 2. Observational evidence under snowpacks, J. Geophys. Res.-Biogeo., 111, 2006.

Schaller, C., Göckede, M., and Foken, T.: Flux calculation of short turbulent events – comparison of three methods, Atmos. Meas. Tech., 10, 869-880, 2017.

Schaller, C., Kittler, F., Foken, T., and Göckede, M.: Characterisation of short-term extreme methane fluxes related to non-turbulent mixing above an Arctic permafrost ecosystem, Atmos. Chem. Phys., 19, 4041-4059, 2019.