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Interactive comment on "Soil CO_2 efflux errors are log normally distributed – Implications and guidance" *by* Thomas Wutzler et al.

Anonymous Referee #1

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General Model

Generally speaking, flux measurements (as any soil variables) can be seen as the result of a process and the effect of measurement. "Process error" is a suboptimal term and should be replaced by "process variation" – the part that is of interest in environmental research. It can be modeled in space and time. The time variation can be attributed partly to other environmental variables, and space variation is limited to the 4 chanbers in fixed locations in this application. Whatever is not adequately described by such models might then be split into a "process error" and the measurement error on the basis of particular assumptions about the measurement error.

The popular method LUT reflects this general idea. It assumes that the process part is a function of temperature and moisture, and therefore asks that the values to be

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averaged must have respective values within a narrow range, and so should the hour of the day, which stands for other environmental conditions with a daily cycle. In addition, rain events are excluded.

Thus, the time variation can be modeled by – a regression on temperature, moisture – rain, with possible after-effects – possibly other explanatory variables – a daily cycle – a smooth function of time – a stationary fluctuation – the real "process error" – the location of the measurement device Such a model, if based on linear combinations (additive effects), is clearly more successful on a log scale. There is a measurement error that is additive in the non-logarithmic scale and may be assumed as normally distributed.

Describing such a general model, I do not suggest that implementing it should be the content of the paper discussed here. It just describes the background for my comments.

Replies to the replies

Reply1 "RC1 suggest to make the lognormal assumption the default case" and the authors give reasons why they "would rather stick to the more conservative default of the normal assumption" ... for the Instrument Error IE

The authors have argued in their reply that empirical evidence documented in the literature suggests that the variance of the IE does not depend on the flux. This is a convincing argument against my suggestion. It should be mentioned in the revised paper.

Reply2 "revised model": The suggestion has been taken up and documented as Appendix C in the extended Reply. The authors conclude: "However, we applied the analysis and see several discrepancies..."

I think that the model has shown a good potential to gain insight into the process. It intends to split what the authors treat as the "process error" PE (more adequately called

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"process variation") into a (large) part that is explained by the model and a remainder that still needs to be modeled as a random deviation and might rightously be called "process error".

If fitted to short periods, it seems plausible that it fits well enough to act as a better alternative to the LUT method. The authors should decide if they want to include this second use into the paper. The full potential of the model certainly goes beyond the scope.

The authors also fit a Bayesian hierarchical model that allows for their combination of a lognormal "process error" and a normal IE. I do not think that modelling the process variation as an i.i.d. sample of a lognormal variable is adequate. Rather, such a combination can be added to the foregoing model to improve its adequacy and fit. It amounts to fitting a nonlinear regression with the model Y = exp(h) + e , where h is (the linear predictor of) the foregoing model.

Conclusion

In summary, the authors intend to implement some suggestions I have made, and they have convincingly argued against others. The resulting revised paper will be a very valuable contribution to the statistical methodology for the targetted field.

Please also note the supplement to this comment:
https://www.geosci-instrum-method-data-syst-discuss.net/gi-2019-10/gi-2019-10-RC2-supplement.pdf

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