Dear Striednig et al.,

Development of new software to serve the community working on VOC flux measurement is recommended activity. This far everyone working on the field has been developing their own codes, which takes resources and possibly leads to systematic differences in processing of their data. Thus, I see a lot of value on this manuscript. I have a few comments stated below.

1. As the new software is able to process also conventional eddy covariance data, I would like to see some comparison between data processed with the new software and established EC post-processing softwares, e.g. EddyPro, EddyUH (Mammarella et al., 2016).

2. Test site is challenging from micrometeorological point of view. How about including data from some more ideal measurement site to analysis?

3. The equation (1) is not correct and I am not satisfied with how Eq. (2) is derived.

The correct form of the conservation equation for a scalar *s* can be written in the form

$$\frac{\partial \bar{s}}{\partial t} = -\bar{u}\frac{\partial \bar{s}}{\partial x} - \bar{v}\frac{\partial \bar{s}}{\partial y} - \overline{w}\frac{\partial \bar{s}}{\partial z} - \frac{\partial(\overline{u's'})}{\partial x} - \frac{\partial(\overline{v's'})}{\partial y} - \frac{\partial(\overline{w's'})}{\partial z} + D\frac{\partial^2 \bar{s}}{\partial x^2} + D\frac{\partial^2 \bar{s}}{\partial y^2} + D\frac{\partial^2 \bar{s}}{\partial z^2} + Q,$$

where *D* is the molecular diffusivity and *Q* is the chemical source/sink term (e.g. Stull, 1988). Assuming horizontal homogeneity all terms with horizontal derivatives will disappear. Horizontal homogeneity at flat surface also leads to vertical wind speed *w* to be zero, as at the surface *w* is zero and

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} = 0,$$

where horizontal derivatives are zero. Adding stationarity assumption, the time derivative also disappears. Further, if the chemical lifetime of the trace gas in question is much longer than turbulent mixing time scale (Rinne et al. 2012), the source term *Q* vanishes as well. Thus, we are left with two terms we can integrate from surface (*z*=0) to measurement height (*z*=h),

$$\int_0^h \frac{\partial(\overline{w's'})}{\partial z}dz = \int_0^h D\frac{\partial^2 \bar{s}}{\partial z^2}dz,$$

leading to

$$\left(\overline{w's'}\right)_h - \left(\overline{w's'}\right)_0 = D\left(\frac{\partial \bar{s}}{\partial z}\right)_h - D\left(\frac{\partial \bar{s}}{\partial z}\right)_0.$$

Noticing that turbulent flux, $\overline{w's'}$, is orders of magnitudes higher than diffusive flux at typical flux measurement height (1-30 m), and that the turbulent flux at the surface goes to zero as the vertical movements go to zero, we are left with

$$\left(\overline{w's'}\right)_h = -D\left(\frac{\partial \bar{s}}{\partial z}\right)_0,$$

i.e. turbulent flux at the measurement height *h* equals the diffusive surface flux, which we are usually interested in. There are different formulations of this, by e.g. expressing biological sources as term Q, but they will lead to similar final result in which the turbulent flux equals the sources below the measurement level.

4. The required response time of sensor for eddy covariance is stated in the manuscript to be on the order of 0.1 s. However, e.g. Rantala et al. (2014) have shown the response time of a quadrupole PTR-MS to be around 1.2 s. Furthermore, they showed that above forest this response time lead to flux underestimation ranging from below 10% in daytime, to about 20% during night. Thus, if the response time of the instrument is in that range, sampling output at higher frequency does not actually lead to better frequency response. The response time of PTR-ToFMS used in the measurements to test the software is not stated in the paper. The statement on page 3, lines 5-6 "…is nowadays mostly used for instrumentation that can measure single compounds fast enough (e.g. 0.1 s)…" may be bit optimistic.

5. On page page 4, lines 4-6 the authors give an example of systematic error caused by disjunct sampling as 23%, with sampling interval Δ=60 s, integral time scale τ=25 s, and flux averaging time T=300 s, based on equation by Lenschow et al. (1994). However, setting Δ=0.1 s, i.e. typical conventional eddy covariance sampling frequency, leads to flux underestimation of 15%. Thus, more than half of the flux underestimation is not due to disjunct sampling, but rather undersampling the low-frequency contribution by this very short (5 min) flux averaging period. Similarly, for other flux averaging periods shown most of the underestimation does not derive from disjunct sampling. Furthermore, for typical surface flux measurement averaging periods (30 min = 1800 s), the underestimation with sampling interval of even as long as 3 min causes flux underestimation of less than 10%. The authors give a similarly misleading statement on page 12, lines 15-16.

6. Sensor separation (Page 5, line 3) is usually smaller source to lag time than is the long sample tube in the case of closed path analyzers such as PTR-MS.

7. I got the impression that the software is not performing frequency corrections to fluxes using cospectral densities. One could also correct for high-frequency losses in DEC measurements, if system response time is known, e.g. by test-run by the same system with continuous sampling.

Minor comments

Page 6, line 10: That was the flow rate in the 3/8" sample line?

Page 6, line15: Instrument response time, in the sense of the 1-order system, does not cause significant time shift.

Technical comments

Please check that the chemical compounds are properly expressed with subscripts (CO_2, CH_4, H_2O instead of CO2, CH4, H2O).

Page 4, line 26: "…higher signal-to-noise ratio…" should be "…lower signal-to-noise ratio…"

Page 6, line 3: Typo, Wilczac should be Wilczak.

References

Mammarella, I., Peltola, O., Nordbo, A., Järvi, L., Rannik, Ü., Quantifying the uncertainty of eddy covariance fluxes due to the use of different software packages and combinations of processing steps in two contrasting ecosystems. Atmos. Meas. Tech., 9, 4915–4933, 2016.

Rantala, P., R. Taipale, J. Aalto, M.K. Kajos, J. Patokoski, T.M. Ruuskanen & J. Rinne: Continuous flux measurements of VOCs using PTR-MS - reliability and feasibility of disjunct eddy covariance, surface layer gradient, and surface layer profile methods. Boreal Environment Research, 19 (suppl. B), 87-107, 2014.

Rinne, J., T. Markkanen, T.M. Ruuskanen, T. Petäjä, P. Keronen, M.J. Tang, J.N. Crowley, Ü. Rannik & T. Vesala: Effect of chemical degradation on fluxes of reactive compounds – a study with a stochastic Lagrangian transport model. Atmospheric Chemistry and Physics, 12, 4843–4854, 2012.

Janne Rinne
Lund University